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Export Potential for U.S. Advanced Technology Goods to India Using a Gravity Model Approach

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Abstract[1]

This paper applies an augmented gravity model of international trade and a two-step regression procedure to empirically estimate the impact of India's market access policies on U.S. exports of advanced technology goods. Estimations are based on panel data and a fixed-effect model of U.S. exports in 5 product sectors to India and 76 major U.S. trading partners during 1990 to 2011. As expected, the gravity model demonstrates that per capital income, trade freedom, importers' physical land area, India's stage of economic development, common culture, trading to island partners, and common membership in a free trade agreement are significant determinants of the volume of U.S. exports of advanced technology products. Transportation and transaction costs (international distance) are significant and negative determinants of U.S. exports of advanced technology goods. Although India's has progressively lowered its average applied MFN tariffs on advanced technology goods, its tariffs remain some of the world's highest. India also subjects its imports to additional taxes and fees that create a substantial gap between its applied and its effective (real-world) rates. Consequently, relying solely on customs duties as a measure of market openness is misleading. Vestiges of India's former import substitution policies have encouraged U.S. multinationals to find an alternative to exporting directly to India, such as making substantial investments in India's manufacturing sector in order to participate in the domestic market. India's market access policies continue to act as protectionist barriers against U.S. exports; moreover all five disaggregated product sectors are negatively affected by India's low level of economic development. U.S. exports are negatively affected by India's relatively low quality physical infrastructure and its market access barriers, though the effect varies by product sector. The factors impeding U.S. exports include the already mentioned high tariffs and fees, as well as diverse problems reflected in India's low ratings in several global indexes. These include the market size index, prevalence of trade barriers index, trade freedom index, and its overall economic competitiveness index.

JEL Classification: F10, F13, F14, F15.

Keywords: Gravity model, panel data, India, economic freedom, advanced technology goods.

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1. Introduction

Traditionally, exports of advanced technology goods have accounted for a significant percentage of U.S. merchandise exports and have been an important contributor to U.S. gross domestic product (GDP). In 2011, advanced technology goods accounted for 44.3 percent of total U.S. merchandise exports and 1.3 percent of U.S. GDP. These goods cover a broad range of industry segments including defense and security, civil nuclear energy, pollution control and waste management, clean energy, nanotechnology, electronics, flexible manufacturing, optical-electronics and software, high performance computers, aerospace, and information and communications.[2]

In 2011, U.S. merchandise exports reached an all-time record level of $1.5 trillion, with advanced technology goods leading the way with India accounting for only $21.6 billion, or 1.5 percent of the total. India currently represents one of the world's fastest growing and most dynamic economies and as India moves up the technological ladder and progressively opens its markets to imports, the United States can play a larger role in supplying India with a vast range of advanced technology goods. For example, the demand for advanced technology goods is expected to increase significantly with an announcement that the Indian government (GOI) intends to modernize and substantially upgrade its manufacturing sector (USDOC 2012). The government stated that it would invest more than $1 trillion in infrastructure development over the next several years and would make it a priority to obtain whatever advanced technology machinery and equipment items it needed through imports, joint ventures, and other cooperative agreements.[3] The GOI has also established entities such as the Manufacturing Industry Promotion Board, National Manufacturing Competitiveness Council, and Planning Commission to assist Indian industry in acquiring needed new technologies and advanced manufacturing systems. These trends indicate that there is greater import potential for U.S. products.

Nonetheless, many hindrances/governmental measures still impede the fulfillment of this potential. The objective of this paper is to employ an augmented gravity model (discussed in detail below) and a two-step regression procedure to examine the impact of India's trade protectionist policies and market access restrictions its imports of U.S. advanced technology goods. The empirical literature defines market access barriers as any import protectionist policies that artificially inflate trade costs and distort trade flows (Rose 2002). This paper contributes to the existing literature by specifically investigating the effects of India's market access barriers on U.S. exports of advanced technology products.

Traditional economic variables such as GDP, population, geographical distance, physical area, exchange rates, and non-traditional variables such as trade-weighted tariffs, index of global competitiveness, index of trade freedom, and index of infrastructure quality are used in the analysis. The gravity model used in this paper was estimated with panel data and the fixed-effect technique as the Hausman specification test rejected the null hypothesis that the dependent variable and the country-specific effects are not correlated. The results reveal that U.S. exports are positively correlated with traditional gravity variable- per capital GDP (national wealth) -and negatively correlated with international distance. The estimation results are consistent with gravity model estimates in other empirical studies.

The gravity model was also applied to five disaggregated subsectors within the advanced technology goods sector. They are civil aircraft; telecommunications equipment; optical-medical and scientific

[2] Advanced technology goods includes non-electric machinery (HTS chap. 84), electrical machinery (HTS chap. 85), aerospace (HTS chap. 88), motor vehicles and parts (HTS chaps. 86, 87, and 89), and optical-medical and scientific instruments and equipment (HTS chap. 90).

[3] Ministry of Commerce and Industry, Government of India.

instruments; motor vehicles, parts, and subassemblies; and computers, parts, and accessories. These five subsectors, account for 33 percent of total U.S. exports of non-agricultural products to India.

A number of recent gravity model studies have augmented the traditional gravity model with variables examining the impact of market access and “at the border” barriers on international trade flows. Wall (1999) used a gravity model to capture the effects trade protection measures on U.S. bilateral trade; International Trade Centre (2003) used it to analyze the trade potential of developing countries and economies in transition; Walsh (2006) used it, to assess the determinants of services imports; Kimura and Lee (2006) used it, to access the impact of economic freedom on bilateral services trade between the United States and Japan; Galvão de Miranda, Ozaki, Mendoça Fonseca, and Moratti (2007) used it, to identify relevant factors affecting merchandise trade between Brazil and China and the United States; Sonora (2008) used it, to examine the impact of economic freedom on U.S. consumer imports and exports; Natos, Botonaki, and Mattas (2008) used it, to analyze the impact of economic freedom on bilateral trade flows of agricultural products; Khatibi (2008) uses it, to investigate the impact of the WTO accession and the quality of its institutions on Kazakhstan’s bilateral trade; Marimoutou, Peguin, and Peguin-Feissole (2009) used it, to estimate the role of distance between trading partners; and Raudonen and Freytag (2012) use it, to analyze FDI inflows into Baltic countries. All of these studies demonstrated a positive association between economic freedom and international trade flows.

The remainder of the paper contains 11 sections and an appendix. Section 2 briefly reviews the literature on the empirical gravity model at the disaggregated or single-commodity level; section 3 presents the theoretical background of the gravity model and presents the explanatory variables used in the gravity equation; section 4 presents an overview of the Indian market for imported advanced technology goods; section 5 presents the data sources and descriptive statistics; section 6 discusses model selection; section 7 presents the estimated results of the aggregate model; section 8 presents estimated results for five disaggregated sectors; section 9 presents evidence of market access barriers; and section 10 concludes the paper. Appendix A lists India’s customs duties and India’s effective duty rates by product; appendix B lists multinational corporations which manufacture advanced technology goods in India; and appendix C lists the 77 countries that dominate U.S. exports of advanced technology goods.

2. Empirical literature

An overview

Gravity models are econometric models applied to predict the volume of bilateral trade flows (the sum of exports and imports) between trading partners, trade flows in one direction only, and product-specific trade. Most empirical gravity model studies rely on three elements: an augmented gravity model, panel data, and either a fixed-effect model (FEM), a random-effect model (REM), or a pooled ordinary least squares model (OLS). Recent literature analyzing aggregate trade flows present an augmented gravity model using panel data and the FE-model. However, only a limited number of gravity model studies have examined bilateral trade flows for government policies and other measures that affect market access or create “at the border” barriers to imports. This paper will examine the determinants of U.S. exports of advanced technology goods to India in aggregate and for five specific advanced technology goods sub-sectors: computers, parts, and accessories; telecommunications equipment; civil aircraft, parts, and accessories; motor vehicles, parts, and subassemblies; and optical-medical equipment.

Gravity model studies

A number of recent empirical studies have augmented the traditional gravity model with variables to measure market access or "at the border" barriers including market size, infrastructure quality, macroeconomic policies, trade openness, trade-weighted average tariffs, non-tariff barriers (i.e., local compliance needs and domestic content requirements, restrictions on trade, import quotas), overall economic competitiveness, and economic development. Empirical literature has included indexes of economic freedom to capture the effect of trade policies on bilateral trade.[4] The most commonly used indexes include the Australian Productivity Commission's *Trade Restrictive Index;* the Fraser Institutes' *Economic Freedom of the World Index (EFWI),*[5] Transparency International's *Corruption Perception Index;* the Heritage Foundation's *Index of Economic Freedom (Trade Freedom)* and *Index of Freedom from Corruption,* [6] and the World Economic Forum's *Global Competitiveness Report*.[7] This paper will rely on the Heritage Foundation's *2012 Index of Trade Freedom* and the World Economic Forum's *Global Competitiveness Report* as measures of trade and economic freedom.

Wall (1999) used the gravity model to provide new estimates of the effects trade protectionist policies on the volume of U.S. trade and to obtain estimates of the resulting welfare effect. The paper estimated two least squares estimations using panel data for 85 countries during 1994-96. The basic gravity model was augmented with the trade policy-component of Heritage Foundation's *Index of Trade Freedom*. The Index's coefficient was negative which implied that worldwide protectionism in 1996 lowered total U.S. exports by 26.2 percent and lowered U.S. imports from non-NAFTA countries by 15.4 percent, which had a net welfare cost of 1.45 percent of U.S. GDP. When restrictions on the intercept term were removed the GDP coefficients were substantially smaller and the coefficient for the index of Trade Freedom was larger and statistically significant. The author stated that the principal cause of welfare loss was the transfer of quota rents overseas rather than deadweight efficiency loss.

The International Trade Centre (UNCTAD) (2003) developed an augmented gravity model for calculating trade potentials for developing countries and economies in transition called *TradeSim*. The model is estimated on 36 exporting countries (developing economies) towards 58 importing countries using the MAcMap database. *TradeSim* includes conditioning variables language diversity, literacy rates, FDI stock, a bilateral market access measure (average applied tariffs, specific duties, tariff quotas, and anti-dumping duties), conflict intensity, and telecommunications infrastructure. The paper found that bilateral market access measures had a negative and significant effect on bilateral trade. Walsh (2006) used an

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[4] According to the Heritage Foundation, economic freedom encompasses all liberties and rights of production, distribution, or consumption of goods and services. The Foundation maintains that countries with higher levels of economic freedom significantly surpass others in terms of economic growth, per capita incomes, health care, education, protection of the environment, and the reduction of poverty.

[5] Fraser's *EFWI* and the Heritage Foundation's *Index of Trade Freedom* are calculated by using a weighted average of several different components of economic freedom. The *EFWI* is based on 42 variables (or sub-variables), covers 141 countries, a measures the degree of economic freedom in five major areas: size of government (expenditures, taxes, enterprises), legal structure and security of property rights, access to sound money, freedom to trade internationally, and regulations of credit, labor, and business. Within the five major areas are 21 components that are incorporated into the index. The index is scored on a scale of 1 (worst) to 10 (best).

[6] The Heritage Foundation's *Trade Freedom Index* ranks compares countries to each other and compares overall levels of economic freedom across time. The Index is based on 10 different economic measurements: the rule of law, limited government, regulatory efficiency, and open markets (trade freedom, investment freedom, financial freedom). The freedoms for each of the categories are individually scored on a scale of 0 (worst) to 100 (best), and a country's overall economic freedom score is a simple average of its scores of the 10 individual freedoms. One sub-variable is trade freedom that reflects an economies' openness to imports of goods and services.

[7] The World Economic Forum's *Global Competitiveness Report* assesses the competitive landscape of 144 economies providing insight into the drivers of their productivity and prosperity.

augmented gravity model and the OECD (2003) database to assess the determinants of services imports between 27 OECD countries during 1999-2001. The paper used a Hausman-Taylor model and trade-policy variables constructed from the trade-policy component of Heritage Foundation's *Index of Economic Freedom* and the Australian Productivity Commission's *Trade Restrictive Index (TRI)*. The *Index of Economic Freedom* had a negative, but insignificant effect on imports of government services, whereas the TRI coefficient was found to be weakly significant for total services.

Kimura and Lee (2006) used a gravity model to assess the impact of economic freedom on bilateral services trade between the United States and Japan and 24 trading partners for the period 1996-2003. Fraser's *EFWI* was used to measure the consistence of a nation's policies and institutions on economic freedom and the Heritage Foundation's *Economic Freedom Index* was used to measure the degree of economic freedom on different countries. The paper found that economic freedom had a consistently significant positive relation with most types of service exports as well as service imports. The paper also found that countries with high levels of economic freedom tended to trade more than countries with low levels of economic freedom.

Galvão de Miranda, Ozaki, Mendoça Fonseca, and Moratti (2007) extended the basic gravity model to identify relevant factors affecting merchandise trade between Brazil, China, and the United States during 1995 through 2003. The model was estimated using panel data and was augmented variable to measure trade policy including relative price index, weighted average tariffs, Transparency International's *Corruption Perception Index*, and the Heritage Foundation's *Index of Trade Freedom, Economic Freedom Index*, and its *Freedom from Corruption Index*. Empirical analysis demonstrated that the coefficients for GDP was positive and those for trade barriers, specifically importers' applied weighted average tariffs and *Freedom from Corruption Index* had a statistically significant and negative effect on North American trade flows and on Brazil-China trade, particularly Brazil's exports.

Sonora (2008) used a gravity model to analyze the impact of economic freedom on U.S. consumer imports and exports to 131 trading partners during 2000-05. The augmented gravity model employed a pooled OLS an incorporated trade policy variables "obstacles to doing business," and Fraser's *EFWI*. The gravity model found that an increase in world economic freedom would positively affect the volume of U.S. trade. Natos, Botonaki, and Mattas (2008) use an augmented gravity model using OLS and time series cross sectional data across 30 OECD countries during 1999-2004. The study accessed the impact of economic freedom on bilateral trade flows of agricultural products and trading patterns for the agricultural, machinery, chemicals, and other manufacturing sectors. The model incorporated the Fraser's *EFWI* as a proxy for trading partners' trade policies, which had a positive and statistically significant relationship between it and agricultural trade.

Khatibi (2008) investigates the impact of Kazakhstan's WTO accession and the quality of its institutions on its bilateral trade flows by using an augmented gravity model. The model was estimated using OLS and was augmented with an index for institutions variable constructed from the Heritage Foundation's *Index of Economic Freedom*. The gravity model found that institutions play an important role in determining trade flows and that higher institutional qualities make trade more attractive and profitable by providing an environment that is conducive to safe exchanges.

Marimoutou, Peguin, and Peguin-Feissole (2009) used cross-section data gravity model (Flexible Least Squares analysis) to estimate the role of distance between trading partners.[8] The paper covered the period 1994-96 for bilateral merchandise trade between 85 trading partners. The Heritage Foundation's *Index of Economic Freedom* was used to augment the gravity model to measure level of import protection. The model demonstrated that the distance has a varying role in the relation between the size of bilateral trade

[8] See Kalaba and Tesfatsion (1990) for a description of FLS analysis.

flows and the economic size of the partner. Raudonen and Freytag (2012) used a Hausmann-Taylor estimation method to analyze FDI inflows into the Baltic region. The gravity model was augmented with the Fraser's *EFWI* that determined that institutional variables had significant and positive impact on FDI inflows into the Baltics.

Studies on U.S. exports of advanced technology goods

There are no known empirical studies that employ a gravity model to analyze government policies and other measures that act as market access or "at the border" barriers, specifically to U.S. exports of advanced technology goods to India.

3. The Gravity Model for Exports and Variable Selection

Theoretical foundations

Tinbergen (1962) and Pölyhönen (1963) are often credited for being the first to apply Newton's gravity model (see following page) to analyze international trade flows. They independently and concurrently discovered that trade flows between two countries are determined by their national incomes and the geographical distance between them. Despite the gravity model's popularity and its ability to successfully analyze international trade flows, the model was targeted by critics for lacking a solid theoretical foundation (Bergstrand 1985). For the next two decades economists ignored the gravity model due to its weak theoretical foundations (Sohn 2001).

Anderson (1979) was the first to provide a strong theoretical foundation for the gravity model. He derived a reduced-form gravity equation from a Cobb-Douglas version of a constant elasticity of substitution (CES) expenditure system. His model assumed that consumers view products as differentiated by country-of-origin (Armington assumption[9]). Anderson concluded that his model was an alternative to cross-section budget studies.

Bergstrand (1985, 1989) also derived a reduced-form gravity equation as a partial equilibrium sub-system of a general equilibrium model. He used the general CES preferences instead of Cobb-Douglas, and his gravity equation incorporated price-weighted averages of bilateral transport costs for both importers and exporters. He demonstrated that goods were not perfect substitutes and that imports are closer to being substitutes for each other than they are for domestic goods (Deardorff 1998). Bergstand (1989) extended his analysis by incorporating Dixit and Stieglitz's (1977) monopolistic competition model.

Deardorff (1995) demonstrated that a simple gravity equation could be derived from the Heckscher-Ohlin (H-O) model without assuming product differentiation.[10] The first case involves free trade in homogenous products with producers and consumers indifferent as to choice of trading partners. The second case, including countries producing distinct goods and Cobb-Douglas or CES preferences, again leads to a version of the gravity equation. More recently, Anderson and van Wincoop (2003) demonstrated how a simple gravity equation could be derived from a general equilibrium model with CES preferences.

[9] The Armington assumption implies that there is imperfect substitutability between traded goods, based on the country of origin.
[10] The Hecksher-Ohlin (H-O) model predicts that countries with dissimilar per capita incomes will trade more than countries with similar levels. On the other hand, the Linder hypothesis predicts that countries with similar levels of per capita incomes will trade more because they have similar preferences for differentiated products.

The basic gravity model and trade theory

A gravity-type equation was used during the late 19th century to estimate migration, capital (investment and foreign direct investment, or FDI), human migration, tourism, and other social flows in terms of "gravitational forces of human interaction" (Sichei, Erero, and Gebreselassie 2008). As noted above, Tinbergen (1962) and Pölyhönen (1963) were the first to adapt Newton's gravity model to analyze international trade flows. Since then, the gravity model has become a popular tool for empirically analyzing international trade flows (Martinez-Zarzoso 2003).

The gravity model for international trade is analogous to Sir Isaac Newton's 1686 law of universal gravitation. Newton's law asserts that two bodies attract each other proportionally to the product of each other's mass divided by the square of the distance between them (Anderson 2011). The basic theoretical model for Newton's theory can be expressed as follows (Head 2003):

$$F_{ij} = G(M_i * M_j)/D^2_{ij} \qquad (1)$$

where: F_{ij} is the gravitational attraction or force between two bodies *i* and *j*, M_i and M_j are their respective masses, G is a gravitational constant, and D_{ij} is the distance between the masses.

Using the principles of Newton's equation, a pair of countries is substituted for the bodies, the countries' respective GDP replaces the masses of the bodies, and the geographical distance remains in its original form (Benedictis and Vicarelli 2005). GDP and population are proxies for national income (economic mass) and geographical distance between the country pairs is a proxy for resistance effect on trade flows (transportation and transaction costs). As with Newton's law, the larger and closer these countries are to each other, the stronger the attraction.

Equation (1) is the basic gravity equation and it assumes that bilateral trade flows between two countries are directly proportional to the product of each country's gross domestic product (GDP) and inversely proportional to the distance (trade costs) between them (Baldwin 1994; Linneman 1966). The simplest form of the gravity model for international trade between two countries can be stated as:

$$F_{ij} = \beta_0 + (GDP_i * GDP_j)^{\beta 1}/(Dist_{ij})^{\beta 2} \qquad (2)$$

where F_{ij} is the dependent variable and value of the trade flows between countries, β_0 is a constant of proportionality, GDP_i and GDP_j are the gross domestic product of the exporting country (*i*) and the importing country (*j*), and $Dist_{ij}$ is the geographical distance between the two trading partners.

The basic gravity model in equation (2) can be converted into a natural log linear form for econometric analysis, as shown below:

$$ln(F_{ij}) = \beta_0 + \beta_1 ln(GDP_i) + \beta_2 ln(GDP_j) + \beta_3 ln(Dist_{ij}) + \mu_{ij} \qquad (3)$$

Here F_{ij} represents the trade flows between countries, β_0 is the country-pair fixed effects covering all unobservable factor affecting bilateral trade, GDP_{ij} is exporter and importer gross domestic products, $Dist_{ij}$ is the distance between capitals or economic centers, and μ_{ij} is the error term. β_0, β_1, β_2, and β_3 are coefficients to be estimated.

Augmented gravity model and variable selection

The dependent variables most often used in gravity models are exports, imports, and total trade (exports + imports). The most commonly used independent variables include market size, national income level, purchasing power, country surface area, and population. Geographical distance between the two countries is another independent variable commonly used in gravity model specifications. It is employed as a resistances factor that can either promote or hinder trade flows (Sichei *et al* 2008). Other less frequently used conditioning variables include difference in per capita income, exchange rate volatility, remoteness, infrastructure endowment, and market openness.

The most commonly used time-invariant dummy variables include: common language, FTA membership (i.e., EU, NAFTA, SAFTA, and MERCOSUR), geographic characteristics (i.e., landlocked, island, and coastal), common colonial history, and region of the world (i.e., Africa, Americas, Asia, and Europe). Membership in regional or preferential trading arrangements is generally associated with increased trade and the variables also help to assess the impact of foreign government policies on imports.

Gravity model tested in this paper

The dependent variable used in this paper is the natural log of U.S. merchandise exports of advanced technology goods to India measured in current in 2011 U.S. dollars. In addition to the two standard variables (national income and distance), this paper augments the basic model (equation 3) by adding several conditioning variables to control for unobserved country characteristics that can either promote or impede U.S. exports (Linnemann 1966).

The independent variables are as follows: per capita GDP, stage of economic development, population, population density, physical land area, exchange rates, geographical distance between capitals or business centers in kilometers, openness to imports, common language, common culture, an index of trade freedom, trade-weighted tariffs, an index of market access barriers, a measure of the prevalence of trade barriers, stage of economic competitiveness, an index of openness to international trade, an index of overall competitiveness, and an index of infrastructure quality.

$$ln(EX_{ij}^{t}) = \beta_0 + \beta_1 lnGDPP_{ij}^{t} + \beta_2 lnDist_{ij}^{t} + \beta_3 lnEXC_{ij}^{t} + \beta_4 lnArea_j^{t} + \beta_5 lnPop_{ij}^{t} + \beta_6 lnInfra_j^{t} + \beta_7 lnPopDensity_j^{t} + \beta_8 lnFreedom_j^{t} + \beta_9 lnMarket_j^{t} + \beta_{10} lnBarriers_j^{t} + \beta_{11} lnWeighted_j^{t} + \beta_{12} lnOverall_j^{t} + \beta_{13} lnOpenness_{jt} + \mu_{ij}^{t} \qquad (4)$$

EX_{ij}^{t} is the dependent variable and represents U.S. merchandise exports of advanced technology goods (*i*) to India and its other major trading partners (*j*) during the years 1990-2010 (*t*). The independent variables are per capita GDP (GDPP), geographical distance, real exchange rates, importers' physical land area, population, and population density. The variable, μ_{ij}^{t} represents the estimation residual (model error) and reflects the effect of other influences on bilateral trade that are not included in the model.

Equation (5) is further "augmented" with the addition of time-invariant variables including geographical characteristics (landlocked, island, and coastal), English as a common language, regional trade agreements with the United States, and NAFTA membership. The stage of economic development was also included as a proxy for India's market access barriers. The benchmark gravity model equation used in this paper to examine factors that affect U.S. exports of advanced technology goods appears as follows:

$$ln(EX_{ij}^{t}) = \beta_0 + \beta_1 lnGDPP_{ij}^{t} + \beta_2 lnDist_{ij}^{t} + \beta_3 lnEXC_{ij}^{t} + \beta_4 lnArea_j^{t} + \beta_5 lnPop_{ij}^{t} + \beta_6 lnInfra_j^{t} + \beta_7 lnPopDensity_j^{t} + \beta_8 lnFreedom_j^{t} + \beta_9 lnMarket_j^{t} + \beta_{10} lnBarriers_j^{t} + \beta_{11} lnWeighted_j^{t} + \beta_{12} lnOverall_j^{t} + \beta_{13} lnOpenness_j^{t} + \beta_{14} Development_j + \beta_{15} Commonculture_{ij} + \beta_{16} llocked_j + \beta_{17} Island_j + \beta_{18} Coastal_j + \beta_{19} Clang_{ij} + \beta_{20} FTAUS_{ij}^{t} + \beta_{21} NAFTA_{ij}^{t} + \mu_{ij}^{t} \qquad (5)$$

where,

Per capita income (GDPP): a country's GDP divided by its population. The GDPP is commonly used as a proxy for a country's standard of living, capital-labor endowment ratio, purchasing power, and stage of economic development. The more developed two countries are, the more they will trade. The estimated coefficient for GDPP is expected to be positive and significant.

Distance (Distance): the geographical distance in kilometers between New York City (the U.S. commercial capital) and the capitals or commercial capitals of partner countries (Frankel 1996; Balassa and Bauwens 1987). Mumbai, India's commercial capital was used in this paper measuring the geographical distance from New York City. Distance is a proxy for the various trade and shipping costs that change over distance. The most commonly cited trade costs are transportation and transaction costs (e.g., price of fuel, infrastructure, and physical shipping costs), transport time, cultural unfamiliarity, and market access. Distance serves as a trade barrier and the estimated coefficient is expected to be negative and statistically significant.

Physical land area (Area): the physical land area of trading partners measured in square kilometers. The literature suggests that (1) bigger countries have a greater capacity to absorb imports than do smaller countries, and (2) countries with larger land masses trade less because greater size is related to larger domestic markets and greater access to natural resources.

***Real exchange rate (Exchange*)**: represents the real exchange rate of foreign currency per unit in U.S. dollars and is used as a proxy for financial risk, relative prices, and purchasing power parity. The sign of the estimated coefficient may be either positive or negative. Some studies consider real exchange volatility as the most important factor affecting bilateral trade flows (Koo, Karemera, and Taylor 1994), whereas others contend that such fluctuations have limited effect on bilateral trade (Rose 2002). The literature suggests that the appreciation of one currency over another can lower exports while increasing the demand for imports, whereas depreciation can stimulate the country's exports (Bergstrand 1985, 1989).

Population density (Popdenstiy): a country's total population divided by its physical land area, acting as a proxy for infrastructure development. This variable can be either positive or negative (Martinez-Marzoso and Nowak-Lehman 2003). Generally, larger countries with larger populations can absorb greater quantities of imports than can countries with smaller populations and smaller land masses.

Population (POP): a proxy for a country's market size, potential domestic consumption capacity, and degree of economic diversification (Linnemann 1996). Literature suggests that countries with larger populations have larger and more diversified economies (production), are more self-sufficient, and tend to trade less than countries with smaller populations. An importer's population is expected to have a positive impact on trade since bigger markets are expected to demand more goods. An exporter's population is also expected to have a positive effect on exports, since an exporting country can supply a greater variety of goods for its masses as it population grows. Population size can be trade-enhancing as well as trade-inhibiting. The estimated coefficient for population can be either positive or negative depending on the size of the trading partners' economies.

To explore any potential adverse effects of India's government market access policies have on U.S. exports the model is further augmented with the following explanatory variables:

- ***Index of infrastructure quality (Infra)***: a calculation by the World Bank and taken from its *World Development Indicators* to representing a country's physical infrastructure. It is an index of the mean over four variables that include kilometers (km) of roads, km of paved roads, km of rail (each divided by per population density), and telephone main-lines per person. This index is also used as a proxy for a country's level of technological sophistication. Countries with more advanced infrastructures are expected to trade more than ones with less advanced infrastructures. The variable is normalized on a 1 to 7 (best scale). India scored 3.6 with a ranking of 84th (out of 181 countries); the United States scored 5.8, ranking it 14th. A negative relationship is expected between U.S. exports and the level of infrastructure. Most studies conclude that poor infrastructure and poor infrastructure penalize trade.

- ***Index of trade freedom (Freedom)***: a calculation by the Heritage Foundation and *Wall Street Journal*'s *Index of Economic Freedom* and represents a composite measure of a country's tariff and nontariff barriers (Johnson, Holms, and Kirkpatrick 1998). The index measures the degree of a country's trade liberalization regime and the sign of the coefficient is expected to be positive, meaning that countries with freer trade policies tend to trade more than others. Higher values for the overall index score correspond to lower economic freedom in the country and more trade impediments for imports. India was ranked as the 123rd freest country (out of 179 countries) in 2011-2012, scoring 55.2 on a zero to 100 scale, where 100 represents maximum freedom. In terms of the Index of Economic Freedom, India ranked as the 119th freest country with an overall score of 64.1, placing it in the index's "mostly unfree category" below Brazil and above China and Russia.[11] The sign of the estimated coefficient is expected to be positive, meaning that countries with a freer trade policy than others tend to trade more.

- ***Index of market size (Market)***: a calculation by World Economic Forum from its *Global Competitive Index* as GDP plus imports of goods and services minus exports of goods and services. The variable is normalized on a 1 to 7 (best scale), with India as the world's third-largest domestic market receiving a score of 6.2 and the United States ranking first with a score of 7. The size of the importers' market affects productivity since larger markets allow exporters to exploit economics of scale. Market size is positively associated with economic growth.

- ***Prevalence of trade barriers index (Barriers)***: a calculation by World Economic Forum from its *Global Competitive Index* to measure tariff and nontariff barriers faced by exporters that may limit their ability to compete in an importers' domestic market. The index runs from "strongly limits" (a score of 1) to "do not limit" (a score of 7). In 2011-12, India ranked 78th of 149 countries with a score of 4.2 (the United States scored 4.5 with a ranking of 51st). The sign of the coefficient is expected to be negative.

- ***Trade-weighted tariffs (Weighted)***: a calculation by the WITS database as the weighted average of all applied tariff rates, which captures the restrictiveness of a country's tariffs on imports.[12] Trade-weighted tariffs are also commonly used to measure various nontariff barriers, quantitative restrictions, FDI policies, and the impact of regional and free trade agreements. A negative sign is expected and a reduction in trade-weighted tariffs is associated with a decline in the relative price of imports. According to the World Economic Forum, India had an average trade-weighted tariff rate of 12.6, which places it in 126th place out of 181 countries in 2011-12. The negative sign is expected for this variable.

- ***Index of overall competitiveness (Overall)***: a calculation by the World Economic Forum from its *Global Competitive Index* representing a competitive assessment of the key factors underpinning a country's national competitiveness. This variable is normalized on a 1 to 7 (best scale), with India scoring 4.32 as the world's 59th most competitive economy, and the United States scoring 5.47 as the 7th most competitive economy. The sign of the coefficient is expected to be positive.

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[11] The Heritage Foundation's Economic Freedom Index classification scores: "free" economies (> 79.9), "mostly free" economies (70.0 – 79.9), "mostly unfree" economies (50.0 – 59.9), and "repressive" economies (< 50.0).
[12] Tariffs are trade-weighted because countries differ in resource endowments and comparative advantage.

- ***Index of trade openness (Openness)***: a calculation by the World Economic Forum from its *Global Competitive Index* representing the degree to which a country is integrated into international trade, in terms of imports as a share of GDP. This variable is expected to have a positive influence on U.S. exports since demand for imports increases with the level of integration. In 2012-13, India was relatively open to imports, with a ratio of imports to GDP of 34.7 percent, putting it in 101st place out of 181 countries; the United States scored 17.6, ranking it 142nd. The sign of the coefficient is expected to be positive.

Economic development index (Development)*:* a calculation by the World Economic Forum from its *Global Competitive Index* of a country's stage of economic development. The index measures the quality of public and private institutions, the quality of basic infrastructure, macroeconomic soundness, general health of the population, quality of education, size of the domestic market, and the effect of policy limits on foreign participation in the domestic market. The index is normalized on a 1 to 3 (best scale), with stage 1 representing countries with limited development (1 pt.). The next stage represents countries in transition from stage 1 to stage 2 (1.5 pts.); stage 2 represents countries that are efficiency-driven (2 pts.); the next stage represents countries in transition from stage 2 to stage 3 (2.5 pt.); and the final stage represents advanced countries with economies driven by innovation (3 pts.). This index places India in the first development stage since it competes in international markets based on its factor endowments (low-labor costs and extraction of natural resources).

Common culture (Commonculture): a binary variable that assumes that countries with similar cultures will trade more than countries with dissimilar ones. A positive sign is expected since shared histories lower transaction costs caused by cultural differences and help facilitate trade. Common culture is equal to "1" if the trading partner was an English colony, zero otherwise. Literature suggests that cultural differences can negatively affect customer preferences.

Landlocked (Llocked): a binary dummy variable that represents trading partners without sea ports or direct access to the sea. A negative sign is expected because landlocked countries generally incur higher transportation and transaction costs with those with access to the sea. This variable equals "1" if the trading partner is landlocked; otherwise it is zero.

Island (Island): a binary dummy variable including trading partners that are island nations. Small island nations are expected to trade more due to their limited domestic markets and natural resources. A negative sign is expected because trading from an island is likely to increase transportation costs. This variable equals "1" if the trading partner is landlocked; otherwise it is zero.

Coastal (Coastal): a binary dummy variable including countries with coastlines and direct access to the sea. The sign is expected to be positive since these countries are expected to trade more than landlocked countries. This variable equals "1" if the trading partner is landlocked; otherwise it is zero.

Common language (Clang): a binary dummy variable including trading partners that share English as a common language. The clang variable reflects similarities in history, culture, tastes, and shared social relations, which can facilitate trade negotiations and thus; lower transaction costs. The clang variable is expected to have a positive sign and equals "1" if the trading partner shares English as a common language; otherwise, it is, zero.

Free trade agreement (FTAUS): a binary variable that captures free trade agreements between the United States and its trading partners. Countries often enter into free trade agreements to facilitate trade. FTAs increase the volume of U.S. exports by streamlining formalities and lowering tariffs and nontariff barriers, and common membership in an FTA increases trade more than between countries without such free trade membership. FTA membership is expected to have a positive impact on U.S. exports (Frankel and Rose

2002). This variable equals “1” if the trading partner has a free trade agreement with the United States; otherwise, it is, zero.[13]

NAFTA: a binary variable that captures linkages between the United States and members of NAFTA. A positive effect is expected. This variable equals “1” if the trading partner is a member of NAFTA, otherwise, it is, zero.

4. India’s market for imported advanced technology goods

The advanced technology goods sector is very large a diverse, but it can be grouped into five basic areas: non-electrical machinery; electrical machinery; aerospace; motor vehicles, parts, and subassemblies; and optical-medical and scientific instruments and equipment.

Non-electrical machines and parts (HTS chap. 84): includes parts for boring and sinking machines; machines for manufacturing semiconductor devices; gas turbines and parts; computers, parts, and accessories; taps, cocks, and valves; engines for motor vehicles; and air pumps and gas compressors.

Electrical machines and parts (HTS chap. 85): includes electronic integrated circuits, telecommunications equipment; optical fiber cable; diodes; electrical switching equipment; discs and tapes; electrical transformers; electric generating sets; parts for television and radio apparatus; radio broadcasting equipment; boards and panels for switching electrical circuits; electric motors and generators; and electric storage batteries.

Aerospace accessories and parts (HTS chap. 88): includes aircraft, parts, and accessories; balloons and dirigibles; gliders; helicopters, parts, and accessories; and space vehicles and parts.

Motor vehicles, parts, and subassemblies (HTS chap. 86, 87, 89): includes automobiles, trucks and buses; parts for motor vehicles; tractors, trailers, and semi-trailers; special-purpose motor vehicles; railway/tramway locomotives and parts; yachts; and motorcycles.

Optical-medical instruments and equipment (HTS chap. 90): includes optical-medical and scientific instruments and appliances; orthopedic appliances; instruments for chemical or physical analysis; oscilloscopes and spectrum analyzers; measuring and checking instruments; X-ray apparatus; and liquid flow-level-pressure measuring instruments.

India’s for advanced technology goods

India’s import policies have induced many U.S., Japanese, Korea, and Western European multinational corporations (MNCs) to invest heavily in India’s manufacturing sector in order to participate in India’s market, rather than rely solely on exports. Although India has progressively lowered the simple average applied most-favored nation (MFN) tariffs on its imports of advanced technology goods, its tariffs remain some of the highest in the world, in particular because of the additional taxes and fees that India imposes on imports. These additional obligations create a significant gap between India’s “applied” MFN duty rates and its effective duty rates.

[13] To date, the United States has signed free trade agreements with Canada and Mexico (NAFTA), Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua (CAFTA); Bahrain, Chile, Israel, Jordan, Morocco, Oman, Peru, Singapore, Colombia, Panama, and South Korea.

To promote self-sufficiency, industrialization, and economic development, India adopted an import-substitution development strategy in the 1950s for virtually all industrial sectors that lasted through the late 1980s. This strategy relied on high tariffs, import prohibition, local-content requirements, foreign equity limits, quantitative restrictions (QRs), and import licensing to restrict imports and promote local value addition and employment.[14] Because India's advanced technology goods sector was sheltered behind high tariffs, foreign MNCs were induced to make substantial capital investments in India through joint ventures and/or wholly-owned subsidiaries rather than rely on exporting to India.[15] Similarly, local-content requirements forced foreign original equipment manufacturers to source a certain percentage of their parts, accessories, and sub-assemblies from local Indian companies.

India's imports of advanced technology goods grow from a low base: India represents a small, but growing market for imported advanced technology goods. Its imports of these products from all sources increased more than 10 fold, rising from $8.5 billion in 2000 to $84.1 billion in 2011 (table 1). Advanced technology goods accounted for 39 percent of India's non-petroleum and non-precious metals imports in 2011. The share of advanced technology goods in India's total merchandise imports rose from 16.8 percent in 2000 to 18.2 percent in 2011. Electrical and non-electrical machinery dominated India's imports of advanced technology goods (80.5 percent), followed by motor vehicles, parts and components (10.3 percent); optical-medical instruments (7.3 percent); and aerospace products (1.9 percent) in 2011 (figure 1).

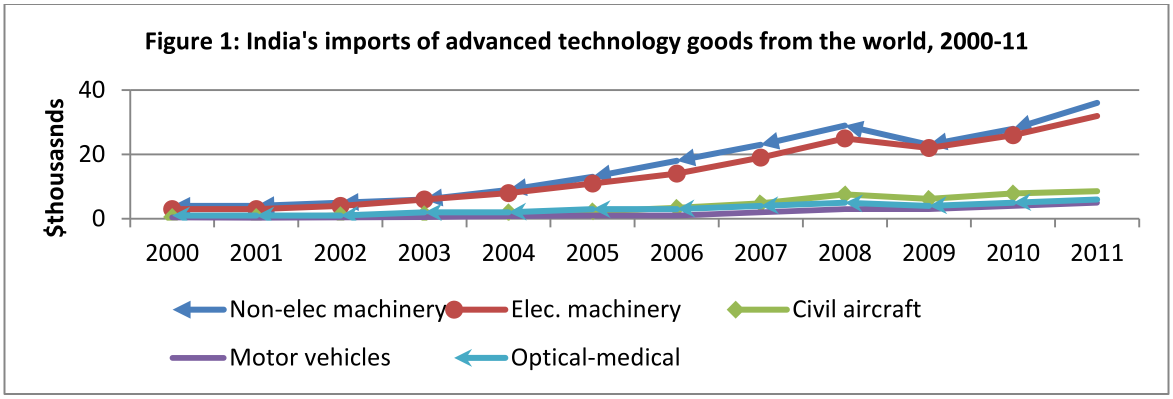
Table 1: Indian imports of advanced technology goods (2000-2011) ($thousands)

	Non-elec. machinery	Electrical machinery	Civil aircraft	Motor vehicles and parts	Optical-medical equipment	Total
2000	4,195	2,679	123	568	939	8,504
2001	4,181	2,953	144	552	1,139	8,969
2002	4,824	4,342	283	1,054	1,280	11,783
2003	6,327	6,269	504	1,378	1,498	15,976
2004	8,603	8,266	476	1,973	1,802	21,120
2005	12,840	11,051	1,000	2,327	2,565	29,783
2006	17,533	14,025	1,466	3,377	3,009	39,410
2007	22,586	18,635	1,536	4,815	3,871	51,443
2008	29,257	25,248	4,411	7,604	4,976	71,496
2009	22,949	22,324	5,841	6,213	4,309	61,636
2010	27,816	25,620	3,345	7,889	5,294	69,964
2011	35,520	32,260	1,630	8,631	6,101	84,142
	42.2%	38.3%	1.9%	10.3%	7.3%	100%

Source: Global Trade Atlas.

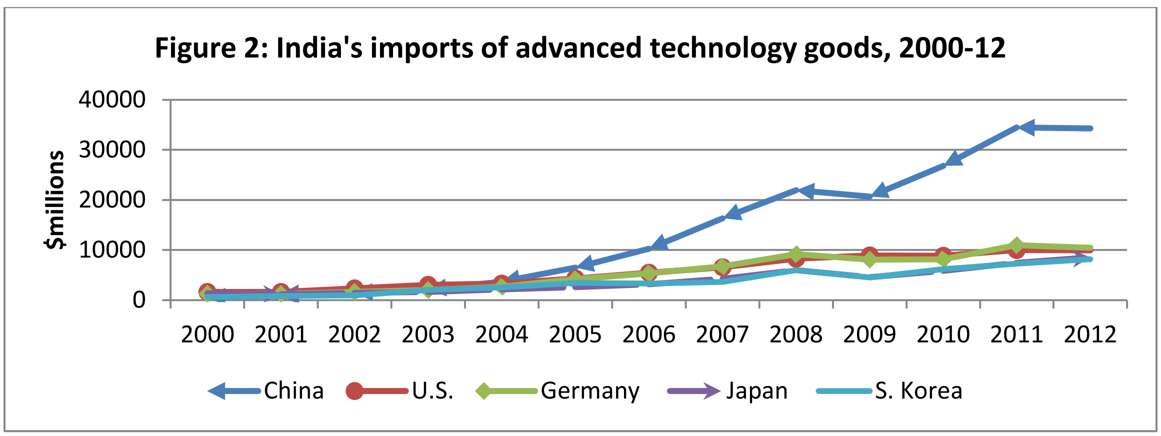
[14] In 2001, the United States challenged before the WTO India's regulations that required foreign auto manufacturers to sign memorandums of understanding (MOUs) that imposed local content requirements and trade balancing obligations on U.S. car manufacturers with plants in India. The MOU required no more than 50 percent imported content in passenger cars and required companies importing auto kits and components to export cars and components of at least equal value of those imported. USTR, "U.S. Wins WTO Case on Indian Auto Restrictions," Decmber. 21, 2001.

[15] According to Kulkarni and Meister (2009), import substitution refers to trade and economic policy based on the premise that a developing country should attempt to substitute products which it imports (mostly finished goods) with locally produced substitutes.



Five countries dominate India's imports of advanced technology goods:

In 2012, India's leading suppliers of imports were China, Germany, the United States, Japan, and South Korea (figure 2). Collectively these countries accounted for 59 percent of India's imports of advanced technology goods in 2011. China surpassed the United States as India's leading source of imported advanced technology goods in 2005 and Germany surpassed it in 2007 to become India's second leading source of these products.



India's demand for advanced technology goods from China, Germany, Japan, and South Korea

The type of advanced technology goods imported into India depends greatly on the level of involvement MNCs have in India's domestic manufacturing and assembly capabilities. Because few Chinese companies manufacture advanced technology goods in India, China's exports tend to be finished and assembled consumer durables and electronics. In 2011, China dominated India's imports of motor vehicle parts, electrical and non-electrical machinery, and telecommunications equipment, including such goods as air conditioners, washing and dryers, refrigerators, textile machinery, ships and boat, smartphones, SIM cards, mobile network gear, LCD TVs and monitors, desktop computers and laptops, solar cells, nuclear reactors, and boilers (table 2). In 2011, more than 60 percent of India's merchandise imports from China consisted of advanced technology goods, and China accounted for 44 percent of India's imports of electronics.

Because Germany is more integrated into India's manufacturing sector than China, German companies manufacture locally, importing auto kits for assembly from Germany as well as fully assembled consumer durables.[16] Germany was India's second leading source for electrical and non-electrical machines and, motor vehicles, and its third leading source of aerospace products. In 2011, Germany was India's fifth leading source of mobile phones and parts, while Germany's other leading exports consisted of complete knock-down kits (CKDs) for automobiles, buses, and trucks; data processing and electronic equipment; power generation equipment; and motor vehicle parts and subassemblies (15.9 percent).[17]

Table 2: India's imports of advanced technology products from the world, China and Germany, 2011

Product	HTS No.	India's imports ($thousands)	% of total
Imports from the world			
Mobile phones and parts	8517.12, 8517.70	8,519	10.1
Motor vehicle parts	8708	3,356	4.0
Elect. integrated circuits & micro-assemb	8542	1,986	2.4
Semiconductor devices	8541	1,864	2.2
Parts of office machines	8523.80	1,801	2.1
Media for recording sound	8523.80	1,795	2.1
Total imports from the world		84,132	
Imports from China			
Mobile phones and parts	8517.12, 8517.70	5,200	19.7
Laptop, notebook, portable computers	8471.30	1,138	4.3
Parts for Adp machines	8473.30	793	3.0
Mach for recp/convr/trans of voice/image	8517.62	506	1.9
Light vessels (fire-float, flt docks/platforms)	8905.90	532	2.0
Motor vehicle parts	8708	484	1.8
Photosensitive semiconductor devices	8541.40	476	1.8
Vessels for transporting persons	8905	414	1.6
Tugs and pusher craft	8904	406	1.5
Bicycle parts	8712	353	1.3
Total imports from China		10,302	
India's imports from Germany			
Motor vehicle parts	8708	477	5.5
Auto and others for transporting persons	8703	383	4.4
Machines have individual function	8479	318	3.6
Mobile phones and parts	8517.12, 8517.70	206	2.4
Mach & mech. app W individual function	8479.89	204	2.3
Compression-ingtn combustion piston eng	8408.20	156	1.8
Spark-ignition recp. com pistn eng parts	8409.99	130	1.5
Static converters (Adp power supplies)	8504.40	121	1.4
Parts of electric motors, generators & sets	8503.00	119	1.4
Parts for elec. switching/protecting circuits	8538.90	116	1.3
Total imports from Germany		2,230	
Source: Global Trade Atlas.			

[16] In October 2012, the GOI proposed raising tariffs on certain automobiles and auto parts including: completely built cars (HTS 8703) with FOB value greater than $40,000 and engine capacity greater than 3000cc (gasoline powered) and on diesel-powered cars with engine capacity greater than 2500cc from 60% to 75%. The GOI also aims to raise duties on finished/semi-knocked down bicycle kits from 60% to 75% and on bicycle parts from 10% to 20%. It proposed to raise excise duties on diesel cars 400mm in length and engine capacity under 1500cc from 22% to 24% and on diesel powered cars having length exceeding 400mm and engine capacity exceeding 1500cc from 22% plus Rs1500 to 27%. The GOI also adopted a new definition for "completely knocked down kits" (HS 8703) that called for a raise in duties on pre-assembled engines, gearboxes, and transmissions from 10% to 30%. European Commission, Directorate-General.

[17] German exports of CSK kits face an effective tariff of 60 percent, as opposed to a 111% tariff on exports of completely built cars. Society of Indian Automobile Manufacturers (SIAM).

German luxury car makers Mercedes-Benz and BMW supplement their domestic Indian production with imports. Mercedes assembles compact and full-size executive sedans and SUVs, while importing full-size luxury coupes and executive-size coupes, SUVs, multi-purpose vehicles (MPVs), and grand touring and roadster-class sports cars. Likewise, BMW assembles compact executive cars, mid-size/executive cars, and compact crossover SUVs in its Gurgaon (Haryana), Chakan (Pune), and Chennai (Tamil Nadu) plants, while importing compact executive and mid-size/executive cars, executive coupes, full-size luxury cars, luxury crossover utility vehicles (CUVs), and high–performance coupes, sedans, and convertibles. Volkswagen India assembles CKD kits locally and imports completely built cars (CBUs) under the Audi, Skoda, Bentley, Lamborghini, Porsche, Volkswagen, and Bugatti brand names.

MNCs from Japan and Korea are highly integrated into India's manufacturing sector. They tend to manufacture a substantial amount of goods locally. As a result, the goods they import into India include both finished consumer products and accessories, and sub-assemblies for their manufacturing activities. These activities include consumer electronics (indicator panels of LCDs and LEDs, calculators, electrical-battery chargers, gaming systems), telecommunication equipment (mobile phones, SIM and memory cards), and heavy machinery. Japanese and Korean car makers manufacture compact cars and SUVs, motorcycles, scooters, and mopeds in India and import both CBUs, and CKDs, as well as parts and components (e.g., diesel engines, gear boxes, and automotive safety equipment), from Japan and Korea.[18]

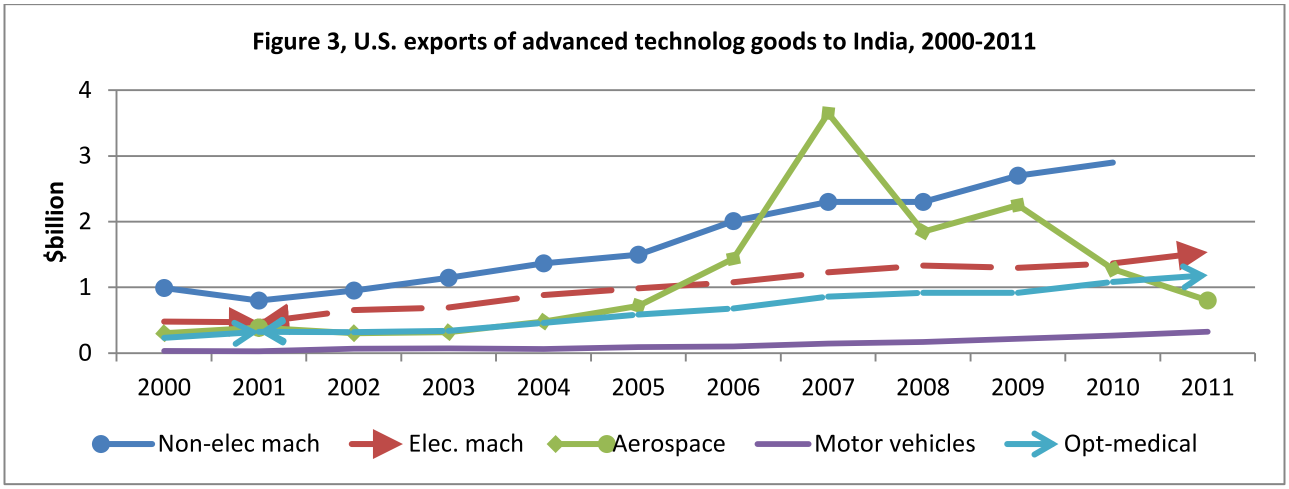
U.S. exports of advanced technology goods to India

India's imports of advanced technology goods from the United States more than tripled from $2.1 billion in 2000 to $6.7 billion in 2011 (table 3). In 2011, advanced technology goods accounted for 83 percent of total U.S. non-agricultural and non-petroleum exports to India. The United States was India's leading supplier of aerospace products and optical-medical and scientific equipment. U.S. exports of aerospace products, primarily commercial passenger aircraft, peaked in $3.7 billion in 2007 when U.S. manufacturers delivered 68 aircraft ordered in 2005, representing India's largest purchase of commercial aircraft (figure 3). In 2011, India was the 20th leading market for U.S. exports of advanced technology goods. India was the 20th leading market for U.S. exports of advanced technology goods, the 18th largest market for U.S. exports of non-electric machinery and optical-medical instruments and equipment, the 19th largest market for electrical machinery, the 26th largest market for aerospace products, and the 37th largest market for motor vehicles and parts.

Although, U.S. exports of advanced technology goods to India continued to grow significantly, the share of U.S. exports in India's total imports of advanced technology goods declined from 15 percent in 2000 to 8.1 percent in 2011, whereas China's share increased from less than 1 percent in 2000 to 31 percent in 2011. China also surpassed the United States as India's largest supplier of imported advanced technology goods and Germany became its second leading source of imports in 2007.

[18] On October 2012, India's draft National Telecom Policy 2011 proposed to advance domestic production of telecommunications equipment to meet 80 percent of India's telecommunication sector's demand through domestic manufacturing by 2020.

Table 3: U.S. exports of advanced technology goods to India (2000-2011) ($thousands)						
	Non-elec. machinery	**Electrical machinery**	**Aerospace**	**Motor vehicles & parts**	**Optical-medical equipment**	**Total**
2000	992.6	481.5	307.8	30.1	233.0	2,045.0
2001	791.3	470.2	387.1	26.7	324.5	1,999.8
2002	841.4	653.5	303.2	63.9	320.3	2,182.3
2003	945.9	695.1	317.5	72.1	341.3	2,371.9
2004	1,148.1	883.5	482.8	59.3	461.5	3,035.2
2005	1,364.8	987.3	716.6	89.2	585.2	3,743.1
2006	1,496.7	1,076.2	1,440.1	100.0	678.5	4,791.5
2007	2,077.2	1,234.9	3,649.6	145.5	859.9	7,967.1
2008	2,322.4	1,325.9	1,849.5	169.8	917.0	6,584.6
2009	2,323.8	1,299.2	2,254.0	216.1	919.8	4,758.9
2010	2,665.7	1,364.2	1,277.4	266.8	1,083.1	6,657.2
2011	2,927.7	1,537.0	770.4	322.7	1,186.0	6,743.8
Source: Global Trade Atlas.						



U.S. exports limited primarily to parts, accessories, and subassemblies

Except for civil aircraft and boring and sinking machines, U.S. MNCs manufacture locally and supplement their Indian production with imported parts, accessories, and subassemblies such as auto parts, gas turbines, semiconductors, piston engines, and air and gas pumps, compressors, and fans (table 4). Civil aircraft led U.S. exports of advanced technology goods to India in 2011, which consisted primarily of commercial airliners for India's airlines.

Table 4. Leading U.S. exports of advanced technology goods to India, by product group (2011)			
Product	**HTS No.**	**U.S. exports ($thousands)**	**% of total**
Civil aircraft, engines, parts	8800	642.4	35.5
Mach for recp/convert voice/image	8517.62	325.0	18.0
Parts for motor vehicles	8708	133.2	7.4
Photo-sensitive semiconductor device	8451.40	127.4	7.0
Parts of spark-ignition rec pist engines	8409.99	113.0	6.3
Boring & sinking machines	8430.49	112.3	6.2
Gas turbines	8411.82	111.4	6.2
Parts & attachments for derricks	8431.49	89.1	4.9
Parts for boring & sinking machines	8431.43	82.1	4.5
Air-gas pumps, compressors, fans	8414.80	72.8	4.0
Total U.S. exports to India		1,808.7	
Source: Global Trade Atlas.			

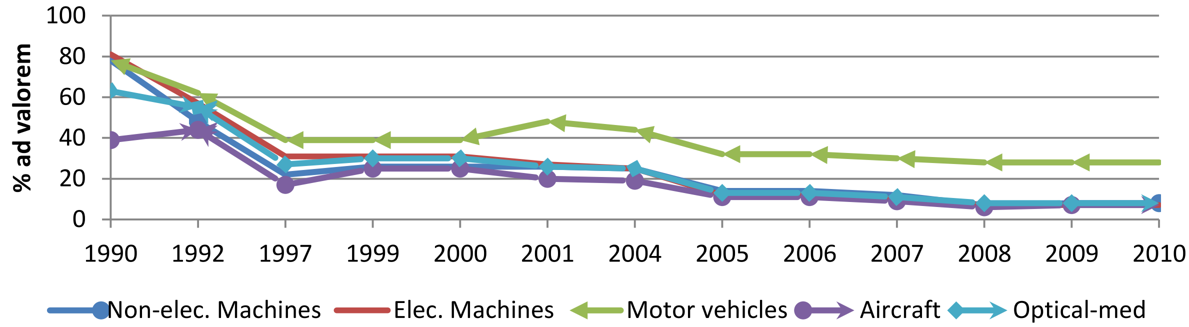
Market access challenges for U.S. exports

Recurring fiscal deficits in the late 1980s and a negative balance of payments encouraged the Indian government to initiate an economic reform package that moved the country from central planning to a market-based economy. At the behest of international financial agencies, especially the World Bank and the IMF, the reforms instituted in 1991 under the "New Economic Policy" included privatizing some public enterprises, making currency convertible, liberalizing rules for foreign investment in selected industries, lowering tariff rates, and reducing import barriers overall. Since 1991, India has ended or lowered quantitative restrictions, has lowered domestic content requirements for automobiles, and made its trade regime more transparent. It also delicensed the automotive sector, opening it up to 100 percent foreign ownership through the automatic route.[19] As part of its WTO commitments, India has also progressively lowered its simple average applied MFN tariff rates on advanced technology goods from 59 percent to 9.5 percent in 2010 (figure 4). In 2010, India's average applied tariff rate for advanced technology goods ranged between duty-free and 100 percent, whereas the effective rate ranged from 12 to 121 percent.[20]

[19] The Indian government enacted legislation in 1953 prohibiting foreign companies from selling automobiles in the Indian market without using local production facilities. This induced foreign companies to enter the Indian market through joint ventures, which subsequently attracted MNCs manufacturing parts and components.

[20] In October 2012, India's draft Union Budget increased applied tariff rates on completely built cars (HTS 8703) with FOB value greater than $40,000, with an engine capacity greater than 3000 cc for gasoline-powered vehicles and greater than 2500 cc for diesel-powered cars; rates rose from 60 percent to 75 percent. Duties on finished/semi-knocked down bicycle kits were also increased, from 60 percent to 75 percent, and those on bicycle parts from 10 percent to 20 percent. The excise duties on diesel cars 400 mm in length and with an engine capacity under 1500 cc increased from 22 percent to 24 percent and duties on diesel-powered cars over 400 mm in length and an engine capacity exceeding 1500 cc rose from 22 percent plus Rs 1,500 to 27 percent. A new definition of CKD kits (HTS 8703) increased duties on pre-assembled engines, gearboxes, and transmissions from 10 percent to 30 percent. EC Commission.

Figure 4: India's simple average applied tariffs on advanced technology goods, 1990-2010



In addition to the basic MFN applied tariff rate, importers of advanced technology goods are required to pay a series of additional taxes and fees that increase the "effective" duty rate (table 5). The most commonly cited fees and taxes include (1) additional duty, (2) education assessment, (3) secondary and higher education assessment, (4) special additional duty, and (5) customs handling/landing fee.[21]

Table 5: India's additional duties, fees and taxes on imported advanced technology goods	
Additional customs duty (CVD)	The CVD is equivalent to the central excise duty[22] levied on similar products manufactured in India. The duty is levied on the c.i.f value of all imported goods; in 2011 the additional duty was 10 percent.[23]
Educational assessment (EC)	This surcharge is applied to nearly all direct and indirect taxes and contributes to India's education budget. The 3 percent assessment is assessed on the aggregate of the customs duties payable on all items imported into India, not on the value of the goods.
Secondary & higher education assessment (SEC)	This surcharge is applied to nearly all direct and indirect taxes and is payable at 0 to 3 percent of the amount of the basic customs duty plus the additional customs duty (CVD).
Special additional duty of customs (SAD	The SAD is levied on imports to partially compensate for various internal taxes on domestically produced goods such as sales taxes, state value-added taxes (VAT), and other municipal or local taxes or any other charges levied on a like article on its sale, purchase, or transportation in India. The SAD is intended to provide a level playing field for domestic Indian products already subject to these taxes. In 2011, the SAD was 4 percent.
Handling/landing fee	All imports are charged for loading, unloading, and handling at 1 percent on the c.i.f value of all imports.
Effective duty rate	The effective tariff rate includes totaling the basic customs duty + CVD + EC + SEC + SAD + customs handling/landing charge.

For example, the effective duty rate on a completely assembled imported BMW 7 series valued at Rs 89 lakh)[24] in 2011 was 100% + Rs 15,000 [25] + 3% + 3% + 4% + 1%, or 111% + Rs 15,000. The final cost to the India consumer was $100,178, representing a difference of $10,178. As seen below, computers and mobile phones enter India duty-free, but face an effective rate of 21 percent and 12 percent, respectively

[21] Ministry of Finance, Government of India.
[22] The Central Excise Duty is levied on goods manufactured and produced in India intended for domestic consumption. It is payable at the time of production or manufacture.
[23] The CVD is designed to neutralize what the GOI regards as a pro-import bias arising from the administration of central excise duties on domestically produced goods. WTO, *India Trade Policy Review*, August 10, 2011.
[24] Approximately $90,000.
[25] Or $277.84, based on engine capacity.

(table 6).[26] The effective rate on other advanced technology goods ranges from 11 percent to 121 percent (appendix A).

Table 6: A effective duty rate for selected advanced technology goods (percent)							
Product	**Customs duty**	**CVD**	**SAD**	**EC**	**SEC**	**Handling fee**	**Effective duty**
Motorcycles	100	10	4	3	3	1	121
Large-luxury autos/SUVs	100	0	4	3	3	1	111
CD players	10	10	4	3	3	1	31
Computers	Duty free	10	4	3	3	1	21
Mobile phones	Duty free	1	4	3	3	1	12
Agr. machinery	7.5	0	4	3	3	1	18.5
Steam turbines	7.5	10	4	3	3	1	28.5
Refrigerators	7.5	10	4	3	3	1	28.5
Home air conditioners	10	10	4	3	3	1	31
Printed circuits	Duty free	10	4	3	3	1	21
Source: Central Board of Excise and Customs, Ministry of Finance, GOI.							

Foreign MNCs dominate certain sectors of the Indian advanced technology goods market due to Indian policies

As a consequence of India's domestic market access restrictions on advanced technology products, multinationals now dominate certain sectors of this market in India, primarily through domestic Indian production. For example, foreign MNCs control 65 percent of India's consumer durables market and 90 percent of India's consumer electronics goods market.[27] Companies like LG Electronics (South Korea) and Samsung Electronics (South Korea) are India's first and second-largest manufacturers of consumer durables, accounting for nearly one-third of India consumer durables and mobile phone production. Samsung also enjoys 57 percent of India's tablet PC market. Whirlpool (United States) is India's single-largest refrigerator and second-largest washing machine brand with more than 25 percent of India's home appliance market. Chinese equipment manufacturers have dominated India's power generation equipment market. Huawei and ZTE of China have vigorously contributed to building India's telecommunications network; Huawei is responsible for 25 percent of India's third-generation wireless broadband networks. Companies from the EU control India's electronics equipment market. Likewise, Philips Electronics (Netherlands) and Sony (Japan) also have significant shares of India's consumer durables market.

In 2011, there were 12 multinational companies in the OEM segment of India's automotive market. Maruti Suzuki is India's largest car manufacturer (45 percent);[28] Suzuki Powertrain India supplies diesel engines and transmission; Hyundai is India's second-largest carmaker (14 percent); Toyota Kirloskar (20 percent) and General Motors (10 percent) are India's third and fourth-largest SUV manufacturers (by market share); and Honda accounts for 41 percent of India's motorcycle and 56 percent of India's scooter markets.

Boeing is India's principal supplier of large civil airliners and is scheduled to deliver twenty-seven 787s Dreamliner aircraft to Air India in 2012-13.[29] Indian airlines Jet Airways and Spicejet also have 30 aircraft ($2.7 billion) on order.[30] The ABB Group, the Alstom Group, and Siemens also dominate India's

[26] See appendix table A for a more complete list of products and their effective tariff rates.
[27] Approximately 85 percent of India's consumption of electronics is imported, primarily from South Korea, Japan, and Taiwan.
[28]In May 2012, foreign MNCs accounted for 89 percent of India's passenger car sales. Society of Indian Automotive Manufacturers.
[29] "Boeing celebrates delivery of Air India's first 787 Dreamliners," Boeing India, June 9, 2012.
[30] "Spicejet to buy 30 Boeing aircraft for $2.7 billion," Hindustan Times, Nov. 6, 2010.

electrical equipment industry.[31] Other prominent U.S. multinationals with manufacturing plants in India include Caterpillar and Cummins (highway trucks, engines, earthmovers, and construction equipment), John Deere (agricultural tractors), Ford (autos, parts, and subassemblies), Otis (elevators and escalators), Ingersoll Rand (reciprocating and rotary compressors), Hewlett-Packard and Dell (computers), Carrier (air conditioners and refrigeration equipment), Harley Davidson (motorcycles), and Briggs & Stratton gasoline engines.

As shown in Box 3, U.S. MNCs, like Ford Motor Company, initially used joint ventures to overcome India's market access barriers for automobiles and other advanced technology goods. Using similar strategies, many U.S. corporations were able to supply advanced technology goods to the Indian market through domestic Indian production rather than exports.

Box 3: Ford Motor Company history in India

- In 1995, Ford Motor Company entered the Indian automotive market through a 50-50 joint venture (JV) with Mahindra & Mahindra to assemble and distribute the Ford Escort, forming Mahindra Ford India.
- In 1999, Ford purchased a majority stake in the JV and renamed it Ford India.
- In 2005, Ford India became a 100 percent subsidiary of Ford Motor Company.
- Ford manufactures small low-cost cars (Fiesta sedan, Fiesta classic, and Figo hatchback), SUVs (Endeavor), and engines in its Chennai (Tamil Nadu) production facility. Ford plans to build a second factory in Gujarat by 2015 that will offer eight new products.
- Ford plans to introduce a new urban SUV model (EcoSport) in 2013 that will have 80 percent local content.
- Nearly 90 percent of all steel panels, parts, and components used in Ford's cars are supplied by local vendors.
- Ford is currently India's sixed leading auto manufacturer with a 3.2 percent market share.
- Ford plans to use India as an export platform. The company currently exports the Figo to 34 countries and plans to export the EcoSport throughout the Asia-Pacific and Africa.
- Ford exported 30,000 Indian-made cars in 2011 (25 percent of production) and exports engines to Thailand and powertrains to South Africa.

5. Data and descriptive statistics

This paper analyzes U.S. export trading patterns for advanced technology goods with 77 countries, including India, that were selected based on their trading relationship with the United States and the availability of data.[32] The paper used panel data for analysis over a 22-year period (1990-2011). Annual trade data were acquired from the Global Trade Atlas at the HTS 4-6 digit level. Advanced technology goods includes non-electric machinery (HTS chap. 84), electrical machinery (HTS chap. 85), aerospace (HTS chap. 88), motor vehicles and parts (HTS chaps. 86, 87, and 89), and optical-medical instruments and equipment (HTS chap. 90). Data sources are listed in table 7.

[31] India currently offers up to 20 to 25 percent subsidy on capital expenditure incurred to set up manufacturing plants for electronics. In 2012, the GOI proposed a (Electronics System Design and Manufacturing) $2 billion initiative to lure global electronics makers to set up manufacturing facilities in India; especially from Korea, Taiwan, Japan, Germany, and the United States. Department of Electronics and Information Technology, Government of India, August 24, 2012.

[32] For a complete list of countries covered in this study see appendix C.

Table 7: Data sources

	Variables	Source
Basic gravity specifications	Per capita GDP and population	World Bank's *World Development Indicators*
	Distance and language	CEPII[33]
Augmented gravity specifications	Physical land area	CIA's *World Factbook*
	Trade	Global Trade Atlas
	Exchange rates, population density, infrastructure quality	World Bank's *World Development Indicators*
	Trade freedom	Heritage Foundation's *Trade Freedom Index*
	Trade weighted tariffs	WITS-TRAINS
	Market access, trade barriers, overall competitiveness, trade openness, economic development	World Economic Forum's *Global Competitiveness Index*
	Common culture, coastal, island, common language, landlocked, FTA, NAFTA	CEPII

Data on country surface area was obtained from the CIA's *World FactBook* in square kilometers and data on geographical distance (in kilometers) between New York City (the U.S. commercial capital) and the capital cities of trading partners are sourced from http://www.happyzebra.com. GDP and U.S. exports are measured in current 2011 U.S. dollars and the populations of all countries are considered in millions. Data on exchange rates are available in national currency per U.S. dollar for all countries.

In 2011, U.S. exports with these countries together composed 99 percent of total U.S. exports advanced technology goods. The country sample included nine countries from Asia, 27 from Europe, 10 from South America, four from Central America, four from South Asia, seven from the Middle East, two from North America, two countries from Australasia, and 12 from Africa. In particular, advanced technology goods accounted for 83 percent of total U.S. non-agricultural and non-petroleum exports to India in 2011. Appendix table C provides a complete listing of the trading partners included in the sample.

6. Model Selection

The most commonly used methods for estimating a gravity model with panel data, including simple ordinary least squares (OLS), the fixed-effect models (FEM), and the random-effect models (REM) (Gul and Yasin 2011). Since the regressions include individual effects it is essential to determine if they are either random or fixed. The literature suggests that a random-effect estimations is better when estimating trade flows between a randomly selected group of trading partners taken from a larger population. The literature also suggests that fixed-effect estimations are preferable when estimating trade flows between *ex ante* predetermined group of trading nations (Egger 2000; Eita and Jordann 2007).

[33] http://www.cepii.fr.

In order to differentiate between the random-effect and fixed-effect estimations, a Hausman specification test is applied to determine if fixed effects model is more appropriate than the random effects model. According to Amini and Delgado (2012), "the Hausman test provides a formal statistical assessment of whether or not the unobserved individual effects are correlated with the conditioning regressors in the model." If the null hypothesis is rejected, then the fixed-effect estimator is more appropriate than the random-effect model. Since this paper analyzes the effect of India's imports of advanced technology goods on its 77 largest trading partners, the fixed-effect specification is more appropriate than the random-effect specification. A listing of the leading Indian trading partners is presented in appendix C. They were selected on the basis of trade statistics during the years 1990-2011. On the basis of the Hausman test, the fixed-effect model is selected as the most appropriate because it shows that the null hypothesis of no correlation between the country-specific effects and the regressors is rejected (Eita 2008).

The fixed-effect model offers two basic benefits: (1) it controls for omitted variables that are unobservable or difficult to measure and (2) fixed economic distance variables are subsumed into the trading-partner intercept, instead of being proxied for by the geographical distance between trading partners (Wall, 1999). However, there is one major disadvantage in using a fixed-effects model in that it cannot directly estimate variables that do not change over time since the fixed effects absorb these variables. Attempting to estimate country-specific effects and time-invariant regressors concurrently lead to perfect mulitcollinearity (Sichei, Erero, Gebreselassie 2005). Nonetheless, time-invariant explanatory variables can easily be estimated in a second step by running second regression where country-pair fixed-effects are regressed on independent time-invariant variables (Cheng and Wall 2005). Therefore, based on empirical results from equation (5) on page 9 the following equation is estimated using OLS estimation:

$$FE_{ij} = \beta_0 + \beta_1 lnDist_{ij} + \beta_2 lnArea_j + \beta_3 Development_j + \beta_4 Commonculture_{ij} + \beta_5 Llocked_j + \beta_6 Coastal_j + \beta_7 Island_j + \beta_8 Clang_{ij} + \beta_9 FTAUS_{ij} + \beta_{10} NAFTA_{ij} + \mu_{ij}^{t} \qquad (6)$$

Here, country-specific fixed effects (FE_{ij}) are regressed on time-invariant variables distance, importers' physical area, and dummy variables that include economic development index, common culture, landlocked, coastal, island, common language, and membership in FTA and NAFTA.

7. Estimation Results of the Aggregate Model

Results from 1st stage regressions

The estimation results from the first stage of a two-step regression procedure are presented in table 8 using the different estimation techniques. The columns in table 8 sequentially add more impedance factors to the basic gravity equation. OLS, random-effect, and fixed-effect models are estimated and the basic features of the gravity model work well, the regressions are consistent with theoretical expectations, and most explanatory variables have the expected sign and are significant.

- Column (1) of table 8 presents the estimation results for the basic gravity model with pooled OLS, where U.S. exports to India and its other leading trading partners are regressed on per capita income (GDPP) and geographical distance (distance) for the period 1990 to 2011.
- Column (2) "augments" the baseline gravity equation with additional independent and time-invariant variables, many of which are included to capture market access barriers.
- Column (3) estimates the "augmented" gravity equation using a random-effects estimator. The model introduces heterogeneity, but unlike the fixed-effect model it prevents loss of degrees of freedom and presupposes that the effects are produced by a specific distribution (Jordann and Eita, 2007).

- Column (4) estimates the "augmented" gravity equation using a fixed-effect estimator and introduces heterogeneity. As expected, the time-invariant variables are absorbed by the FEM estimator.

The R^2 values presented in column (4) show a "within" estimation of 0.3807. The model explains 38.1 percent of the variation in U.S. exports across the dataset during the years 1990-2011. Recent literature suggests that low R^2 values are not unusual for large panels (Herrmann and Mihaljek 2010; Schaefer, Anderson, and Ferrantino 2008). From this point forward, results will focus on the fixed-effect estimation presented in column (5), which was estimated using panel data with fixed-country and fixed-year effects, employing STATA 11 software.

Per capita income (GDPP) is a proxy for a country's wealth and its stage of economic development. The estimated coefficients for the exporting (United States) and importing (India) countries had the expected positive sign and are statistically significant. A higher U.S. per capita income suggests that an increase in a U.S. GDPP will increase its production capacity and its ability to exports, whereas an increase in India's income translates into higher purchasing power and a greater capacity to absorb imports. This implies that a 1 percent increase in U.S.GDPP will boost domestic production and U.S. exports by 1.7 percent, and that a similar increase in importers' GDPP will boost demand for U.S. exports by 0.7 percent. The coefficient for U.S. GDPP provides most of the explanatory power for the fixed-effect model and is significantly larger than the importers' coefficient.

Surprisingly, population and population density, which are commonly used as proxies for market size, are insignificant and have negative coefficients. A negative coefficient runs counter to other findings concluding that growing populations positively and significantly influence imports (Nikbakht and Nikbakht 2011; Vlontzos and Duquenne 2008; Martínez-Zarzoso and Márquez-Ramos 2005; Edmonds and Yi 2010).

India's infrastructure quality, a proxy for telecommunications and transportation costs, is negative and insignificant. The literature suggests that India's poor infrastructure quality increases transportation costs and is directly tied to import levels. In addition, exchange rates and market access barriers such as importers' market size, prevalence of trade barriers, importers' trade-weighted tariffs, importers' overall competitiveness, and importers' trade openness have an unexpected inconsequential effect on U.S. exports to India.

The *Index for Trade Freedom* is positive and statistically significant at 1 percent, which implies that India's market access policies may have an important influence on U.S. exports of advanced technology goods. These policies include tariffs and nontariff barriers, discriminatory taxation measures, local-content requirements, import licensing, etc. According to the Heritage Foundation, India possesses some of the world's most restrictive market access barriers, ranking 123rd of 179 countries in openness. The estimated coefficient implies that a 1 percent decline in India's market access barriers will boost U.S. exports by 0.67 percent.

Table 8: Gravity model estimation for U.S. exports of advanced technology products to India at the aggregate level, 1990-2011

Dependent variable: log(U.S. exports of advanced technology goods to India)

Explanatory variables	Basic GM regression	Augmented GM	REM regression	FEM regression
Log($GDPP_j$)	0.9381378(30.96)***	1.092547(16.02)***	0.7188289(8.74)***	0.7071787(7.64)***
Log($GDPP_i$)	0.676255(3.55)***	1.4701(1.50)	1.532483(2.66)*	1.657498(2.86)**
Log($Distance_{ij}$)	-0.0186894(-0.21)	-0.356135(-4.10)***	-0.4100139(-1.53)	*Omitted*
Log($Exchange_{ij}$)		0.0067678(0.44)	0.0048584(0.27)	0.0047763(0.262)
Log($Area_j$)		-0.18127492(-0.70)	0.6706328(1.17)	*Omitted*
Log(Pop_j)		1.552972(5.95)***	0.4621338(0.83)	-0.3256657(-0.44)
Log(Pop_i)		-10.42829(-3.01)**	-5.465908(-2.54)	-3.066713(-1.33)
Log($Infra_j$)		-0.0313308(-0.02)	-0.1627221(-1.48)	-0.1084965(-1.33)
Log($popdensity_j$)		-0.2471013(-0.84)	0.449522(0.78)	-1.656525(-1.65)
Log($Tradefreedom_j$)		0.985989(4.73)***	0.6240051(3.83)***	0.6738991(3.81)***
Log($Market_j$)		-1.113233(-3.78)***	-0.5344609(-2.05)	-0.6293093(-2.24)
Log($Barriers_j$)		-0.2299505(-4.03)***	-0.2220655(-1.35)	-0.2973628(-0.69)
Log($Weighted_j$)		0.1043294(2.44)	-0.050205(-0.96)	-0.082169(-1.45)
Log($Overall_j$)		0.554065(1.67)	-0.3923605(-1.07)	-0.7636248(-1.93)
$Development_j$		0.3286986(2.66)*	0.8651975(3.97)***	*Omitted*
$Commonculture_{ij}$		0.3286986(2.50)	0.4869384(1.20)	*Omitted*
$Llocked_j$		*Omitted*	-0.2692682(-0.80)	*Omitted*
$Island_j$		0.4438368(3.84)***	0.3908736(1.13)	*Omitted*
$Coastal_j$		0.0801973(0.71)	*Omitted*	*Omitted*
$Clang_{ij}$		-0.0026825(-0.02)	-0.0504211(-0.12)	*Omitted*
$NAFTA_{ij}$		-0.1140188(-0.43)	0.2526863(0.30	*Omitted*
FTA_{ij}		0.828603(8.03)***	0.5910801(2.31)	*Omitted*
Constant	4.172709(2.02)	170.3728(2.93)**	32.86168(0.96)	70.09798(1.73)
Country fixed effects	No	No	Yes	Yes
Year fixed effects	No	No	Yes	Yes
R^2	0.3999	0.8422	-----	------
Within	-----	-----	0.2254	0.3807
Between	-----	-----	0.8721	0.0026
Overall	------	-----	0.8417	0.0011
Adjusted R^2	0.3989	0.8381	-----	-----
Hausman test	------	-----	-----	11.40(0.6547)
Breush-Pagan LM test	------	-----	-----	43.99(0.000)***
F-statistic	F(3, 1712)= 380.31	-----	-----	F(71,761)=24.23
No. of observations	1716	864	412	848

Note: Omitted due to collinearity. All non-dummy variables are in logs, and *** denotes statistical significance at 1% level, ** represents statistical significance at 5% level, and * represents statistical significance at 10% level. The standard error (t-statistic) is in parentheses. Source: Author's own estimates.

2nd stage regression results: individual effects on distance, area, and dummy variables

The estimation results from the second stage of a two-step regression procedure are presented in table 9 using fixed-effects estimation. The country-specific fixed effects (FE_{ij}), the dependent variable, is regressed on explanatory variables distance, area, index of economic development, and time-invariant dummy variables common culture, landlocked, island, coastal, common language, NAFTA, and free trade agreements (FTAs). An R^2 value of 0.909 explains 91 percent of the variation in U.S. exports across the dataset; the remainder is attributed to the error term.

Table 9: Secondary estimation of U.S. exports to India (1999-2011) Dependent variable: fixed effects		
Independent variables	**Coefficients**	**t-statistic**
Constant	12.42515	13.29***
$Distance_{ij}$	-0.4625873	-4.91***
$Area_j$	1.389203	43.55***
$Development_j$	0.8152956	14.48***
$Commonculture_{ij}$	0.4698438	3.43**
$Llocked_j$	-0.1979644	-1.73
$Island_j$	0.3970833	3.39**
$Coastal_j$	*Omitted*	*Omitted*
$Clang_{ij}$	0.0091062	0.07
$NAFTA_{ij}$	0.1889349	0.65
FTA_{ij}	0.8537523	7.87***
R^2	0.9095	
Adjusted R^2	0.9084	
F-statistic	(10, 837) = 841.29	
Note: ***/**/* significant at 1%, 5%, and 10% level. The t-statistics are in parentheses. Source: Author's own estimates.		

Geographic distance has a negative and statistically significant estimated coefficient (at the 1 percent-level) that is consistent with *a priori* expectations. Distance, a proxy for transportation costs, mirror the costs associated with physically shipping a product from its production location to its export destination. Geographic distance is a significant determinant of U.S. exports of advanced technology goods, and a coefficient of -0.46 implies that a 1 percent increase in the distance will cause U.S. exports of advanced technology goods to decline by 0.46 percent.

The total size of an importer's land area has a positive and statistically significant coefficient (at the 1 percent-level) on U.S. exports. Importers' land area is generally used as a proxy for market size. A 1 percent increase in importers' land area will boost demand for U.S. exports by 1.4 percent. On the other hand, the literature also suggests that countries with large land areas trade less than ones with smaller land areas since larger countries have larger domestic markets, are more self-sufficient, and have access to larger quantities of natural resources.

The coefficient for the importer's stage of economic development is both positive and statistically significant at the 1 percent level, which indicates that a positive correlation between India's stage of development. A coefficient of 0.82 implies that an improvement in India's (importer's) level of economic development will boost demand for U.S. exports by 127.1 percent [exp(0.82)-1*100].[34] The common culture coefficient is positive and statistically significant at the 5 percent-level, which implies that U.S. exports of advanced technology goods will be 60 percent [exp(0.47)-1*100] higher than with other trading partners.

The coefficient for island status is positive and statistically significant at the 5 percent-level. A coefficient of 0.40 implies that U.S. exports of advanced technology goods to island nations are 49.2 percent [exp(0.40)-1*100] higher than with non-island trading partners.

The FTA coefficient, which proxies for a country's economic integration, is positive and statistically significant at 1 percent. This implies that U.S. exports to FTA partners will be 134 percent [exp(0.85)-

[34] The model for this paper was specified in logarithmic form, therefore the coefficient of all dummy variables must be interpreted by taking the exponent [exp(dummy variable)-1*100].

1*100] greater than with other trading partners. The variable for NAFTA is positive, but has a statistically insignificant coefficient.

8. Estimation Results for 5 Disaggregated Sectors

Having estimated the gravity model for U.S. exports of advanced technology goods to India and 76 other leading trading partners, this paper now estimates separate regressions for U.S. exports of civil aircraft; telecommunications equipment; optical-medical equipment; motor vehicles, parts, and subassemblies; and computers, parts, and accessories to India. Each sector includes a wide range of products that differ significantly in their sensitivity to India's market access policies, its market size, its level of national wealth, and its geographic distance from New York City. For example, U.S. exports of aircraft, parts, and accessories are not significantly influenced by India's market access barriers because of U.S. manufacturers' comparative advantage and the nature of the product. Also, civil aircraft, parts, and accessories accounted for 64.6 percent of total U.S. exports of advanced technology goods to India in 2011. The other sectors, ranked according to importance include computers, parts, and accessories (19.2 percent); optical-medical equipment (9.9 percent); motor vehicles, parts, and subassemblies (3.7 percent); and telecommunications equipment (2.5 percent). The results of the first-stage regressions procedure using an FEM-estimation are presented in table 9, and the results for the second-stage are presented in table 10.

According to the World Economic Forum, India maintains some of the world's most restrictive domestic market access policies, ranking it 90th out of 130 countries (where the 130th is the most restrictive). The Forum also demonstrated that India's trade-weighted import tariff rate is high at 11 percent (104th of 139 countries), that India currently has the world's 96^{th} highest prevalence of trade barriers and the world's 124th highest average MFN tariff rates. These data imply that as India lowers its domestic market barriers, its demand for U.S. exports of advanced technology goods may also increase substantially.

Results from 1^{st} stage regression

The per capita income coefficient for the United States is positive and statistically significant for two of the five product sectors, including the aircraft and motor vehicle sectors. Results suggest that India's wealth is a significant determinant of U.S. exports and that a 1 percent increase in U.S. per capital income may boost civil aircraft sector exports by 2.8 percent and 5.0 percent for motor vehicle sector exports. A similar increase in importers' per capita income may boost India's demand by 0.6 percent for computer sector equipment; 0.50 percent for telecommunications equipment; 0.9 percent for civil aircraft, parts, and accessories; 1.6 percent for motor vehicles, equipment, and parts; and 0.6 percent for optical-medical equipment.

The estimated coefficient for exchange rate (financial risk and currency devaluation) is negative and statistically significant (10 percent) for the computer sector, but plays no significant role in U.S. exports of the other sectors. A negative coefficient implies that price competitiveness is a very important determinant and that a 1 percent decline in the value of the U.S. dollar against foreign currencies (Indian rupee) will boost demand for U.S. computer sector exports by nearly 0.2 percent.

Importers' population density is positive and statistically significant at 1 percent for U.S. computers sector exports, but plays no significant role in U.S. exports of the other product sectors. A 1 percent increase in India's population density will boost demand for U.S. exports of computers, components, and parts by 4.0 percent. The estimated coefficient for India's market size is an important determinant of U.S. exports of telecommunications equipment, but plays no significant role in U.S. exports of the other product sectors. With a negative and statistically significant coefficient (10 percent), a 1 percent increase in India's domestic market size will lead to a decline in U.S. exports of telecommunications equipment by 0.13 percent.

The index for the prevalence of trade barriers is a proxy for tariff and nontariff barriers faced by exporters that restrict access to India's domestic market. The estimated coefficient for telecommunications equipment is a positive and statistically significant a 1 percent, but plays no significant role in U.S. exports of other product sectors. A coefficient of 1.7 implies that a 1 percent reduction in the index of the prevalence of trade barriers will boost U.S. telecommunications equipment exports by 1.7 percent. The World Economic Forum's prevalence of trade barrier index ranked India 78th of 149 countries with the most restrictive market access policies in 2011-12.

Average trade-weighted tariff variable is a proxy for India's market access barriers, including tariffs, nontariffs barriers, quantitative restrictions, and FDI policies, etc. Import tariffs directly reflect India's market access policies, and the literature suggests that higher trade-weighted tariffs are commonly connected to lower volumes of imports and vice versa. Accordingly, the coefficient for average trade-weighted tariffs is negative and significant for computers and motor vehicles, but plays no significant role in U.S. exports of the other product sectors. With a negative and statistically significant coefficient (1 percent), a 1 percent reduction in India's market access barriers may lead to an increase of 0.2 percent in U.S. exports of computers. A positive and statistically significant coefficient (5 percent) implies that a 1 percent reduction in India's market access barriers may lead to an increase of 0.05 percent in U.S. exports of motor vehicles, parts, and subassemblies.

The sign of the coefficient for India's *Trade Freedom Index* is positive and statistically significant for telecommunications equipment, the motor vehicle sector, and optical-medical equipment, but plays no significant role in U.S. exports of the other product sectors. A 1 percent increase in the trade freedom index may lead to an increase in of 0.64 percent for U.S. exports of telecommunications equipment; 0.89 for motor vehicles, parts, and subassemblies; and 0.67 percent for optical-medical equipment. The Heritage Foundation ranked India in its *Trade Freedom Index* with a score of 54.6 (mostly not free), ranking it 123rd of 179 countries.

The *Index of Overall Economic Competitiveness* is a measure of 100 factors that influence a country's economic growth. The index has a positive and statistically significant coefficient for optical-medical equipment (5 percent), but plays no significant role in U.S. exports of the other product sectors. A coefficient of -1.15 implies that a 1 percent increase in the index may boost U.S. exports by 1.15 percent. In its overall competitive index, the World Economic Forum gives India a score of 4.32, normalized on a 1 to 7 (best) scale, which ranks it as the 59th most competitive economy.

Table 10: Gravity model estimations for U.S. exports to India at the sectorial level (1990-2011)					
Variables	**Computers**	**Telecom**	**Aircraft**	**M. vehicles**	**Optical-Med.**
Log(GDPP$_j$)	0.562159(7.13)***	0.51487(5.31)***	0.9074(6.41)***	1.556(11.60)***	0.5877(8.92)***
Log(GDPP$_i$)	1.017503(2.29)	1.395846(2.20)	2.79762(3.16)**	5.0086(5.97)***	0.389932(0.95)
Log(Distance$_{ij}$)	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Log(Exchange$_{ij}$)	-0.0396236(-2.70*	-0.021859(-0.61)	0.0237028(0.81)	-0.01482(-0.54)	-0.00271(-0.20)
Log(Area$_j$)	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Log(Infra$_j$)	-0.0626908(-0.74)	-0.049144(-0.40)	*Omitted*	*Omitted*	0.0204649(0.26)
Log(Pop$_j$)	0.3372392(0.60)	1.540232(1.89)	-0.91943(-0.81)	-0.40304(-0.38)	-1.22083(-2.32)
Log(Pop$_i$)	-10.4886(-5.92)***	-1.104506(-0.44)	-5.19018(-1.47)	-16.6(-4.99)***	3.144926(1.91)
Log(Popdensity$_j$)	2.708399(3.51)***	0.5017943(0.45)	-2.60006(-1.69)	0.8762746(0.60)	1.341649(1.87)
Log(Market$_j$)	-0.1340074(-0.62)	-0.75716(-2.57)*	-0.43585(-1.01)	-0.62838(-1.55)	-0.38058(-1.90)
Log(Barriers$_j$)	0.1171208(0.35)	1.75368(4.08)***	-0.22162(-0.33)	0.1784624(0.29)	0.4727542(1.54)
Log(Freedom$_j$)	0.3086812(2.27)	0.640235(3.41)**	0.6561425(2.42)	0.89190(3.36)**	0.6780(5.38)***
Log(Weighted$_j$)	-0.16300(-3.75)***	0.0357279(0.58)	-0.02947(-0.34)	0.25833(3.15)**	0.0459752(1.14)
Log(Overall$_j$)	-0.6139664(-2.03)	-0.945186(-2.19)	-0.41209(-0.68)	-0.79759(-1.40)	-1.15(-4.11)***
Log(Openness)	0.238283(1.99)	0.2814482(1.67)	0.3412853(1.43)	0.3184855(1.41)	-0.01741(-0.16)
Development$_j$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Commonculture$_{ij}$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Llocked$_j$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Island$_j$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Coastal$_j$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Clang$_{ij}$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
NAFTA$_{ij}$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
FTA$_{ij}$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Constant	190.5369(6.13)***	-9.6314(-0.22)	107.451(1.73)	277.10(4.73)***	-36.4461 (-1.27)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes
R^2					
Within	0.2686	0.4533	0.2694	0.5192	0.6036
Between	0.0840	0.2838	0.0121	0.1012	0.0078
Overall	0.0879	0.2923	0.0095	0.1282	0.0130
F statistic	(71, 761)=68.13	(14, 777)=46.01	(71,761)=18.70	(71, 758)=26.67	(71, 761)=43.30
No. of observations	848	864	848	845	848

Note: Omitted due to collinearity. All non-dummy variables are in logs, and *** denotes statistically significance at 1% level, ** represents statistical significance at 5% level, and * represents statistical significance at 10% level. The standard error (t-statistic) is in parentheses. Source: Author's own estimates.

2nd stage regression results: individual effects on distance, area, and dummy variables

Distance has a negative and statistically significant coefficient for four of the five sectors, but plays no significant role in U.S. exports of telecommunications equipment (table 11). Distance has its greatest influence on optical-medical instruments and has the least impact on U.S. civil aircraft exports. This implies that a 1 percent increase in distance will cut U.S. exports by 1.6 percent for computers, parts, and accessories; 2.4 percent for telecommunications equipment; 0.86 percent for motor vehicles, parts, and subassemblies; and 1.82 percent for optical-medical equipment. The insignificant coefficient for U.S. aircraft exports could be caused by the fact that U.S. manufacturers rarely deliver aircraft (customers typically take delivery at the factory door), and accordingly, there are no transportation costs. The positive and significant coefficient for optical-medical equipment suggests that U.S. exports may be dominated by advanced technology medical equipment that is only available from the United States.

Table 11: Secondary estimation for U.S. exports to India (1999-2011)
Dependent variable: fixed effects

Independent vars.	Computers	Telecom	Aircraft	Vehicles	Opt-med
Constant	12.862(14.21)***	8.4330(7.93)***	12.4(13.29)***	15.7(14.91)***	-18.0(-6.74)***
$Distance_{ij}$	-0.4201(-4.5)***	-0.17100 (-1.59)	-0.46(-4.91)***	-0.86(-8.13)***	1.699(6.06)***
$Area_j$	1.3675(43.85)***	0.376(12.83)***	1.38(43.55)***	0.40(13.75)***	0.11084(1.27)
$Development_j$	1.6186(15.42)***	2.184(33.07)***	0.81(14.48)***	1.68(25.50)***	1.038(5.96)***
Infrastructure	-2.854(-85.68)***	-----	-2.8(-84.90)***	-----	-----
$Commonculture_{ij}$	0.448926(3.33)**	1.1024(6.59)***	0.4698(3.43)**	0.588(3.52)***	0.201813(0.48)
$Llocked_j$	-0.24414(-2.17)	-0.739(-5.62)***	-0.19796(-1.73)	-1.24(-9.44)***	-1.87(-5.39)***
$Island_j$	0.342371(2.95)**	-0.4781(-3.48)**	0.3970(3.39)**	-0.97(-7.12)***	-1.43(-4.02)***
$Coastal_j$	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
$Clang_{ij}$	0.1586167(1.14)	0.3754804(2.21)	0.009106(0.07)	0.359729(2.12)	1.601(3.74)***
$NAFTA_{ij}$	0.2592501(0.91)	0.4549357(1.28)	0.188934(0.65)	1.300(3.68)***	1.7306(1.93)
FTA_{ij}	0.81536(7.64)***	0.8872(6.88)***	0.853(7.87)***	0.229503(1.79)	0.8963(2.67)*
R^2	0.9119	0.4857	0.9095	0.4662	0.1303
Adjusted R^2	0.9108	0.4830	0.9084	0.4633	0.1209
Observations	848	1716	848	1687	848

Note: ***/**/* significant at 1%, 5%, and 10% level. The t-statistics are in parentheses.
Source: Author's own estimates.

The estimated coefficient for importers' (India's) physical land area is positive and statistically significant for four of the product sectors, but plays no significant role in U.S. exports of optical-medical equipment. Results suggest that a 1 percent increase in importers' land area will boost U.S. exports by 1.4 percent for the computer sector, 0.38 percent for telecommunications equipment, 1.38 percent for the civil aircraft sector, and 0.4 percent for the motor vehicle sector. These findings run counter to those found at the aggregate level, which suggests that an increase in importers' land area has a negative and statistically significant impact on U.S. exports.

The stage of importers' (India's) economic development has a positive and statistically significant coefficient for all five product sectors. Results suggest that a 1 percent improvement in an importer's stage of economic development may boost importer demand for U.S. exports by 166.4 percent [exp(0.98)-1*100] for computers, 182.9 percent [exp(1.04)-1*100] for telecommunications equipment, 126.0 percent [exp(2.61)-1*100] for civil aircraft, 441.9 percent [exp(1.69)-1*100] for motor vehicles, and 535.6 percent [exp(1.85)-1*100] for optical-medical equipment.

The quality of India's infrastructure is negative and has a statistically significant coefficient for computers and civil aircraft. Poor infrastructure is seen as a major impediment to trade implying that a 1 percent improvement in India's infrastructure will boost U.S. exports of computers by 95.5 percent [exp(2.9)-1*100] and U.S. civil aircraft exports by 93.9 percent [exp(2.8)-1*100].

Sharing a common culture has a positive and statistically significant effect on U.S. exports of aircraft, motor vehicles, and optical-medical equipment, but plays no significant role in U.S. exports of the other product sectors. This implies that a common culture may boost U.S. exports of civil aircraft by 631.6 percent [exp(1.99)-1*10], motor vehicles by 80.4 percent [exp(0.59)-1*100], and optical-medical equipment by 200.4 percent [exp(1.1)-1*100].

Landlocked status is negative and statistically significant for U.S. exports of civil aircraft and motor vehicles, which implies that landlocked countries import less than other trading partners. This further suggests that trading with landlocked countries will lead to a decline in U.S. civil aircraft exports by 66.4 percent [exp(-1.09)-1*100] and a decline in U.S. motor vehicle exports by 71.0 percent [exp(-1.24)-1*100]. Results show that sharing a common language is important for optical-medical equipment. It has a positive and statistically significant coefficient (1 percent); for the other four product sectors, the estimated coefficients are positive, but are statistically insignificant. This implies that countries sharing English as a common language import 395 percent [exp(1.6)-1)*100] more optical-medical equipment than countries that do not share English.

The island coefficient is positive and statistically significant for the computers, telecommunications equipment, and optical-medical equipment, and is, negative and significant for the aircraft and motor vehicle sectors. Trading with island economies has its greatest influence on telecommunications equipment and its least influence on the motor vehicle sector. Trading with island economies boosts U.S. exports by 95.4 percent [exp(0.67)-1*100] for computers, 256.0 percent [exp(1.27)-1*100] for telecommunications equipment, and 156.0 [exp(0.94)-1*100] for optical-medical equipment. It also lowers U.S. exports of civil aircraft by 38.1 percent [exp(-0.48)-1*100] and 62.1 percent [exp(-0.97)-1*100] for motor vehicles.

The FTA coefficient is positive and significant for the computers, telecommunications equipment, aircraft, and optical-medical equipment sectors, but plays no significant role in U.S. exports of motor vehicles. This implies that sharing a free trade agreement may boost U.S. exports of computers by 127.1 percent [exp(0.82)-1*100], telecommunications equipment by 143.5 percent [exp(0.89)-1*100], civil aircraft by 133.9 percent [exp(0.85)-1*100], and optical-medical equipment by 146 percent [exp(0.90)-1*100]. The results also suggest that sharing an FTA does not necessarily boost U.S. exports of telecommunications equipment, motor vehicles, or optical-medical equipment.

The NAFTA coefficient is positive and statistically significant for the computers, telecommunications equipment, aircraft, and optical-medical equipment sectors, but plays no significant role in U.S. exports of motor vehicles, parts, and subassemblies. This implies that being a member of a regional trade agreement is a significant determinant of U.S. exports and may boost U.S. computer and telecommunications exports by 124.8 percent, civil aircraft by 134.0 percent [exp(0.85)-1*100], and optical-medical equipment by 146.0 percent [exp(0.9)-1*100]. This suggests that FTA membership does not necessarily enhance U.S. exports of motor vehicles, parts, and subassemblies.

9. Presence of market access barriers

At the aggregate level, market access proxies index of trade freedom and stage of economic development show that U.S. exports of advanced technology products are limited by India's high tariffs, its discriminatory tax measures on imports, and other nontariff barriers that effectively limits access and raise the price of U.S. exports in the Indian market. This suggests that India's domestic industries continue to benefit from the vestiges of India's former import substitution policies that sought to limit imports. Table 12 identifies the leading market access barriers for each of the five product sectors.

Table 12: Summary of proxies for market access barriers, effect on specific product sectors

Proxies	**Computers**	**Telecom**	**Aircraft**	**Motor vehicles**	**O-medical**	**Aggregate**
Infrastructure	√		√			
Trade freedom		√		√	√	√
Market access		√				
Trade barriers		√				
T-weighted tariffs	√			√		
Overall comp.					√	
Openness to trade		√				
Econ. development	√	√	√	√	√	√

For variable definition, see Aggregated Gravity Model and Variable Selection (pp. 10-11).

The civil aircraft sector is the least affected by India's market access barriers, while telecommunications equipment sector is the most affected. All five product sectors are negatively affected by the stage of India's economic development. Quality of infrastructure, tariff levels, and India's stage of economic development play an important role in U.S. exports of computers, parts, and accessories to India. Telecommunications exports are affected by India's level of trade freedom, market access policies, tariff levels, openness to imports, and its stage of economic development. Motor vehicle, parts, and subassembly exports are affected by India's infrastructure quality, tariff levels, and its stage of economic development, while optical-medical exports are affected by trade freedom, overall competitiveness, and stage of economic development.

10. Conclusion

The objective of this paper is to employ an "augmented" gravity model of international trade to empirically analyze the impact of India's market access policies on U.S. exports of advanced technology goods during the years 1990-2011. The gravity equation included standard gravity variables plus indexes and other variables designed to capture the influence of India's market access policies. The results are based on the study of 77 major trading partners over a 22 year period (1990-2011). Regression analysis was performed on panel data in three ways: pooled OLS, the random-effect model, and the fixed-effect model. The fixed-effect model was selected because it fits the data better and is more efficient than either OLS or the random-effect models.

Although India has progressively lowered its average applied MFN tariffs on its imports of advanced technology goods, its tariffs remain some of the highest in the world. Consequently, relying solely on customs duties as a measure of market openness is misleading since India subjects its imports of advanced technology goods to additional taxes and fees that create a significant gap between the official average applied MFN customs duties and its effective duty rates. In 2011, India's applied tariff rates for advanced technology goods ranged from duty-free to 100 percent, whereas the effective duty rate ranged from 12 percent to 120 percent.

Fees and taxes are based on the c.i.f value of the imported good, including an additional customs duty (0 to 22 percent), an education assessment (3 percent) that contributes to India's education budget, a secondary and higher education assessment (3 percent), a special additional duty (4 percent), and customs handling/landing fees (3 percent). In addition, the vestiges of India's former import substitution policies have induced many U.S. multinationals to find an alternative to exporting directly to India, such as substantially investing in India's manufacturing sector in order to directly participate in the domestic market. This has significantly limited U.S. exports to India of finished goods such as automobiles, trucks, motorcycles, agricultural and horticultural machinery and equipment.

As expected from empirical literature, the fixed-effects model demonstrates that per capita income, trade freedom, importers' physical land area, India's stage of economic development, common culture, exporting to island trading partners, and common membership in a regional trade agreement are strongly related to determining U.S. exports to India. U.S. per capita income is the most important variable in explaining U.S. exports to India. This suggests that larger economics have greater production capacity, can produce a wider variety of goods, and generally have the ability to offer more in the export market. It also suggests that importers with higher national incomes have a greater capacity to absorb greater quantities of imports. On the other hand, transportation and transaction costs (distance) are significant and negative determinants of U.S. exports of advanced technology goods at the aggregate level. Exchange rate volatility, population, importers' population density, index of market size, prevalence of trade barriers index, trade-weighted tariffs, index of overall economic competitiveness, landlocked, coastal, and common language are not as significant and do not determine U.S. exports.

At the product sector level, India's market openness policies continue to act as a protectionist barrier to its imports of advanced technology goods. Although all five sectors are negatively affected by India's relatively low stage of economic development, there are substantial variations in response to India's market access barriers across the five product sectors. Depending on the specific sector, U.S. exports are negatively affected by India's relatively low-quality transportation and communications infrastructure, its high tariffs and fees, market size index, prevalence of trade barriers index, trade freedom index, and its overall economic competitiveness index.

Appendix A: India's effective duty rates for advanced technology goods

Table 7: India's effective duty rate for selected advanced technology goods (2011)

HTS No.		Customs duty	CVD	SCVD	EC	SEC	Handling fee	Effective duty
8401.1000	Nuclear reactor	7.5	10	4	3	3	1	28.5
8402.0000	Steam/vapor generating boilers	7.5	10	4	3	3	1	28.5
8403.1000	Boilers	7.5	10	4	3	3	1	28.5
8406.0000	Steam/vapor turbines	7.5	10	4	3	3	1	28.5
8407.1000	Aircraft engines	5	10	4	3	3	1	26.0
8407.2100	Marine engines (outboard motors)	7.5	10	4	3	3	1	28.5
8407.3100	Motorcycle engines	7.5	10	4	4	4	1	28.5
8408.0000	Diesel or semi-diesel engines	7.5	10	4	3	3	1	28.5
8410.0000	Hydraulic turbines & water wheels	7.5	10	4	3	3	1	28.5
8411.0000	Turbo-jets, gas turbines	10	12	4	3	3	1	33.0
8414.0000	Air or vacuum pumps	7.5	10	4	3	3	1	28.5
8415.0000	Air conditioning equipment	7.5	10	4	3	3	1	28.5
8416.0000	Furnace burners	7.5	10	4	3	3	1	28.5
8417.0000	Lab furnace burners and ovens	10	10	4	3	3	1	31.0
8418.2100	Household refrigerators	10	10	4	3	3	1	31.0
8418.4010	Upright freezers	7.5	10	4	3	3	1	28.5
8419.1110	Instantaneous gas water heaters	10	10	4	3	3	1	31.0
8421.0000	Centrifuges	7.5	10	4	3	3	1	28.5
8422.1100	Household dish washing machines	10	10	4	3	3	1	31.0
8429.0000	Bulldozers, angledozers	7.5	10	4	3	3	1	28.5
8430.0000	Scrappers	7.5	10	4	3	3	1	28.5
8432.0000	Agr & horticultural machinery	7.5	0	4	0	3	1	28.5
8433.0000	Harvesting, threshing machinery	7.5	10	4	3	3	1	28.5
8443.0000	Printing machines (plates)	7.5	10	4	3	3	1	28.5
8450.1100	Household-laundry washing machines	10	10	4	3	3	1	28.5
8451.1000	Dry cleaning machines	7.5	10	4	3	3	1	28.5
8456-8465	Machine tools	7.5	10	4	3	3	1	28.5
8470.1000	Electronic calculators	Free	10	4	3	3	1	28.5
8471.3010	Portable computers	Free	10	4	3	3	1	21.0
8471.4110	Other computers	Free	10	4	3	3	1	21.0
8471.6026	Laser jet printers	Free	16.32	4	0	3	1	27.32
8471.6029	Other printers and plotters	Free	10	4	3	3	1	21.0
8471.6030	Monitors	Free	10	4	3	3	1	21.0
8471.6040	Keyboards	Free	10	4	3	3	1	21.0
8471.6050	Optical scanners	Free	10	4	3	0	1	18.0
8471.6060	Mouse	Free	10	4	3	3	1	21.0
8471.7020	Hard disc drives	Free	4	4	3	3	1	21.0
8471.7030	Removable disc drives	Free	4	4	3	3	1	15.0
8471.7060	CD-ROM drives	Free	4	4	3	3	1	15.0
8472.9030	Automatic bank note dispensers	7.5	10	4	3	3	1	15.0

8502.1200	Elec. generating sets/rotary converters	10	10	4	3	3	1	31.0
8504.0000	Elec. transformers, static converters	7.5	10	4	3	3	1	28.5
8506.0000	Primary sells and batteries	10	10	4	3	3	1	28.5
8517.1100	Cordless line telephones sets	Free	10	4	3	3	1	12.0
8517.1210	Mobile phones (push button)	Free	1	4	3	3	1	13.0
8517.1911	Video phones	7.5	16.32	4	0	0	1	11.0
8517.2100	FAX machines	7.5	16.32	4	0	0	1	28.82
8517.3000	Switching apparatus	7.5	16.32	4	0	0	1	28.82
8417.5030	Modems	7.5	16.32	4	0	0	1	28.82
8517.5040	High bit rte digtl subscriber ln system	7.5	16.32	4	0	0	1	28.82
8517.5050	Digital loop carrier system (DLC)	7.5	16.32	4	0	0	1	28.82
8517.5070	Multiplexers	7.5	16.32	4	0	0	1	28.82
8517.5091	ISDN terminals	7.5	16.32	4	0	0	1	28.82
8517.5093	Routers	7.5	16.32	4	0	0	1	28.82
8601.0000	Rail locomotives (electric power)	10	10	4	3	3	1	31.0
8602.1000	Diesel-electric locomotives	10	10	4	3	3	1	31.0
8602.9000	Steam locomotives and tenders	10	10	4	0	3	1	28.0
8702.1011	Motor vehicles for more than 13 people	10	22	4	0	3	1	40.0
8702.1020	Motor vehicles for less than 13 people	10	22	4	0	3	1	40.0
8702.9013	Electrically operated vehicles	10	10	4	0	3	1	28.0
8703.1000	Golf carts	100	10	4	0	3	1	118.0
8703.2100	Automobiles	100	0	4	3	3	1	111.0
8701.2010	Road tractors for semi-trailers	10	10	4	3	3	1	31.0
8701.3000	Garden tractors	10	10	4	3	3	1	31.0
8704.1000	Dumpers designed for off-highway use	10	10	4	3	3	1	31.0
8709.0000	Work trucks	10	10	4	3	3	1	31.0
8711.1000	Motorcycles	100	10	4	3	3	1	121.0
8711.2011	Scooters	100	10	4	3	3	1	121.0
8711.2090	Mopeds	100	10	4	3	3	1	121.0
8716.0000	Trailers and semi-trailers	10	10	4	3	3	1	31.0
8801.0000	Gliders, balloons	10	0	4	0	3	1	18.0
8802.0000	Helicopters	10	0	4	0	3	1	18.0
8802.2000	Civil aircraft	3	0	4	0	3	1	11.0
8802.6000	Spacecraft	10	0	4	0	3	1	18.0
90011000	Optical fiber cable	10	10	4	3	3	1	31.0
90058020	Astronomical instruments	10	10	4	3	3	1	31.0
90060000	Cameras	10	10	4	3	3	1	31.0
90071100	Cinematographic cameras/projectors	10	10	4	3	3	1	31.0
90111000	Stereoscopic microscopes	7.5	10	4	3	3	1	28.5
9012.1010	Electron microscopes	7.5	10	4	3	3	1	28.5
9013.8010	LCD devices	Free	10	4	3	3	1	21.0
9013.9010	Parts of LCD devices	Free	10	4	3	3	1	21.0
9018.1100	Electro-cardiographs	7.5	5	0	3	3	1	19.5

9018.1210	Linear ultrasound scanner	7.5	5	0	3	3	1	19.5
9018.1300	Magnetic resonance imaging app.	7.5	5	0	3	3	1	19.5
9018.1910	Eco-cardiograph	7.5	5	0	3	3	1	19.5
9018.2000	Ultra-violet/infrared ray app.	7.5	5	0	3	3	1	19.5
9018.5030	Ophthalmic lasers	7.5	5	0	3	3	1	19.5
9018.9094	Defibrillators	7.5	5	0	3	3	1	19.5
90215000	Pacemakers	7.5	0	0	0	3	1	11.5
9022.1420	Portable X-ray machines	7.5	5	0	3	3	1	19.5
9022.9020	Radiation generation units	7.5	5	0	3	3	1	19.5
9024.1000	Machines for testing metals	7.5	10	4	3	3	1	28.5
9026.1010	Flow meters	Free	10	4	3	3	1	22.0
9027.8040	Nuclear magnetic resonance instru.	Free	10	4	4	3	1	22.0
9028.1000	Gas meters	7.5	10	4	3	3	1	28.5
9030.1000	Oscilloscopes and oscillographs	7.5	10	4	3	3	1	28.5
Sources: Central Board of Excise and Customs, Ministry of Finance (GOI); Gazette of India.								

Appendix B: MNCs active in India's manufacturing sector

Table 8: Selected multinational corporations with manufacturing facilities in India

Corporation	Year of incorporation	Products	Ownership type	Country of parent
Motor vehicles, parts, and accessories				
General Motors India	1994	Small cars, light commercial vehicles (UVs), engines	Joint Venture	United States
Ford India	1995	Small cars, utility vehicles, diesel engines, parts	Subsidiary	United States
Toyota Kirloskar	1997	Small cars, multi-utility vehicles, auto parts	Joint Venture	Japan
Bosch		Aftermarket auto parts (petrol systems, electronic units, brakes)	Subsidiary	Germany
Hyundai Motor India	1996	Small car, UVs	Subsidiary	S. Korea
Daimler-Mercedes	1994	Heavy-duty trucks, mid-size cars, buses	Joint Venture	Germany
Maruti Suzuki	1981	Small cars and UVs	Subsidiary	Japan
Honda Siel Cars India	1995	Small cars, UVs	Joint Venture	Japan
India Yamaha	2008	Motorcycles	Subsidiary	Japan
Nissan Motor India	2005	Small cars	Subsidiary	Japan
Mahindra Renault	2007	Small cars	Joint Venture	France
Volvo Buses India	1998	Buses, commercial vehicles (trucks), engines	Joint Venture	Sweden
Volkswagen	2007	Small cars, diesel engines	Subsidiary	Germany
India Fiat	1997	Small cars	Joint Venture	Italy
India Yamaha Motor	2008	Motorcycles	Joint Venture	Japan
Honda Motorcycle	1999	Motorcycles, scooters	Subsidiary	Japan
Delphi India	1995	Aftermarket auto parts	Subsidiary	United States
BMW India	2006	Mid-size cars	Subsidiary	Germany
Skoda Auto India	2001	Small cars	Subsidiary	Czech
Swaraj Mazda Ltd	1983	Trucks, buses, ambulances, police personnel carriers, water tankers.	Subsidiary	Japan
Consumer durables				
Samsung Electronics	1995	Mobile phones, color TVs and monitors, refrigerators, washing machines, air conditioning equipment, microwave ovens.	Subsidiary	S. Korea
Philips Electronics	1938	TVs, DVD players, audio products, computers, phones.	Subsidiary	Netherlands
LG Electronics	1997	PC monitors, refrigerators, TVs, mobile phones, air conditioners, DVD players, washing machines, car audio systems, home theater systems,	Subsidiary	S. Korea
Haier Appliances India	2003	Refrigerators, TVs, DVDs, washing machines, microwave ovens, dishwashers, air conditioners.	Subsidiary	China
Nokia Siemens	2006	Mobile phones	Subsidiary	Finland
Dell India	2001	Personal computers	Subsidiary	United States

General Electric	1902	Steam and wind turbines, low & medium voltage switchgear, control and relay panels, marine and industrial breakers, Plans in 2013 to build hybrid batteries, diesel locomotives, X-ray products, diagnostic imaging systems.	Subsidiary	United States

Appendix C: List of Countries

The data base includes 77 countries, listed in the table below.

1. Algeria	40. Madagascar
2. Angola	41. Malawi
3. Argentina	42. Malaysia
4. Australia	43. Mexico
5. Austria	44. Morocco
6. Bangladesh	45. Mozambique
7. Belgium	46. Namibia
8. Bolivia	47. Netherlands
9. Brazil	48. New Zealand
10. Bulgaria	49. Nicaragua
11. Cameroon	50. Nigeria
12. Canada	51. Norway
13. Chile	52. Pakistan
14. China	53. Panama
15. Colombia	54. Paraguay
16. Democratic Republic of Congo	55. Peru
17. Czech Republic	56. Philippines
18. Denmark	57. Poland
19. Ecuador	58. Portugal
20. Egypt	59. Romania
21. Finland	60. Russia
22. France	61. Saudi Arabia
23. Gabon	62. Singapore
24. Greece	63. Slovakia
25. Germany	64. Slovenia
26. Guatemala	65. South Africa
27. Honduras	66. South Korea
28. Hong Kong	67. Spain
29. Hungary	68. Sri Lanka
30. Iceland	69. Sweden
31. India	70. Switzerland
32. Indonesia	71. Thailand
33. Ireland	72. Tunisia
34. Israel	73. Turkey
35. Italy	74. United Kingdom
36. Japan	75. Uruguay
37. Kenya	76. Venezuela
38. Latvia	77. Zimbabwe
39. Lithuania	

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