# Export Versus FDI: A Task-Based Approach*

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**Abstract**

This paper shows that standard predictors of the export versus FDI decision hold for manufacturing but not for service industries. I develop an alternative model which decomposes each industry into the tasks required for production and uses these tasks to predict the location of production for that industry. Industries requiring direct communication with consumers are more likely to be produced in the destination market. Production of more nonroutine activities is more likely to occur at the multinational's headquarters for export, especially when the destination market has weak institutions. These predictions are tested using firm-level data from the Bureau of Economic Analysis US Direct Investment Abroad Benchmark Survey of Multinationals combined with task-level data from the Department of Labor's Occupational Information Network. The task-based approach developed in this paper performs well for both manufacturing and service industries, has greater explanatory power than alternative proximity concentration or comparative advantage explanations, and is robust to a variety of specifications.

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# 1 Introduction

Manufacturing and service firms do not serve foreign markets in the same way. In manufacturing, exports and sales through FDI comprise roughly equal shares of total foreign sales by US multinationals. Yet service producers overwhelmingly rely on investment rather than exports (see Figure 1). In this paper, I show that standard predictors of the export versus FDI decision such as distance and market size cannot explain this difference across sectors. I augment the Helpman, Melitz and Yeaple (2004) model with the potential for miscommunication between a firm and its customers, as well as incomplete transfer of headquarters services from a parent firm to its foreign affiliate. I propose a new set of measures that capture the relative cost of shifting production to foreign affiliates through FDI or shipping final products cross-border through exports. This approach is significant for both manufacturing and service industries and can explain most of the difference in export to FDI ratios across the two sectors.

In the export versus FDI literature, the decision to produce at home for export or in the destination market through FDI is based on a tradeoff between the gains to scale achieved by concentrating production in the home country for export and the benefits of producing near the final consumers to avoid transport costs. I show that this tradeoff, while robust for goods, is not a significant determinant of the export to FDI ratio in services. Instead, I use a measure of the relative costs of FDI and exporting that breaks industries down into an even finer level of detail: tasks. A task is a specific activity (such as making decisions, communicating with customers, operating machinery, etc.) that must be performed in the production of a given industry's output. Certain activities are more difficult to export across borders or to offshore to foreign affiliates for production. In particular, tasks requiring direct communication with consumers are more likely to be performed in the destination market where consumers are located. Communicating with customers is about twice as important for services as for manufacturing (see Table 1. Details about how these importance scores were constructed will follow in Section 4). I show that because services require much more interaction with consumers than manufactures, the difference in the importance of this task can explain much of the difference in export to FDI ratios across the two sectors. This relationship between the need for consumer interaction and higher relative FDI is highly intuitive but has never been shown in the economic literature on the export versus FDI decision. Note that although this approach was motivated by observations about trade in services, it does a good job of explaining trade and FDI in both manufactures and services.

If communicating with consumers were the only task that mattered for the export versus FDI decision, we would expect to see nearly all services provided through investment. Figure 1 shows that about 30 percent of of sales of services to foreign markets are through exports. Controlling for standard determinants of trade and investment, I show that the level of complexity of production tasks has an effect that is opposite to that of communication intensity, offsetting some of the impact of the need for consumer interaction. More nonroutine activities are noncodifiable, and thus it is difficult to successfully transfer these processes to teams in another country and to specify clear quality standards for these more abstract tasks than for more routine activities. Thus their production is less likely to be offshored to foreign affiliates. This is true for both manufacturing and service industries. For example, when a headquarters firm tasks an affiliate with complex and potentially problematic assembly procedure, the parent is relinquishing some control over production and transferring greater responsibility for the ultimate quality of the product to the affiliate. This is in contrast to a more routine good or service (such as data entry or the assembly of simple and easily inspectable goods like plain tee shirts or reams of paper), for which clear quality standards can be fully specified in advance.[1] This is consistent with recent work by Keller and Yeaple (2010) who show that headquarters services cannot always be transferred costlessly from parents to affiliates, especially in knowledge-intensive industries. I introduce this possibility into a Helpman, Meltiz and Yeaple framework to explain how the level of routineness of tasks determines how easily they can be offshored.

When each industry is defined by the series of tasks used in its production, the differences between manufactures and services become clear. On average, the importance of working with the public is twice as high for services as for manufactures. Scores for nonroutine tasks, such as creative thinking, are 44 percent higher. In general, manufacturing industries are comprised of relatively more manual and routine tasks, while service production requires relatively more nonroutine, cognitive, and communication tasks. Table 1 summarizes the key task dimensions that I will use in this paper. The data on these tasks that are collected by the Department of Labor allow for empirical identification of the role tasks play in determining patterns of trade and investment. See Table 2 for detail on a broader range of tasks and Tables 3 and 4 for lists of the service industries used in this study. Business, professional and technical services make up most of the sample.

[1]Intellectual property concerns may also factor into this decision, as nonroutine goods likely have a higher innovational content than routine goods, and thus are more vulnerable to intellectual property rights violations or information leakage when they are produced abroad, especially if the foreign affiliate is in a country with weak institutions.

The results show that the task model I propose is robust for both manufacturing and services, even after controlling for distance, market size, tax rates, education levels, and standard measures of endowment-based comparative advantage. The intensity with which an industry uses communication and nonroutine tasks is a significant determinant of the location of multinational production. The relationship between task intensity and the export to FDI ratio is similar for manufacturing and service industries, suggesting that the difference in task compositions across sectors presented in Table 1 can explain the difference in trade and investment outcomes presented in Figure 1.

# 2 Related Literature

This paper is motivated by a broad literature on the organization of multinational activities. However, for the empirical exercise, I focus on one specific aspect of this organization: the decision to serve foreign markets through exports or FDI. When US firms sell goods to foreign consumers they have three options: (1) produce at home for export, (2) open up an affiliate in the destination market and produce locally, or (3) fragment production such that firm ownership, production, and consumption each occur in one or more different locations. Option (2) is broadly referred to as horizontal FDI and option (3), which includes licensing, franchising and subcontracting, as vertical FDI. While evidence of both vertical and horizontal motives for FDI have been well documented (see for example, Krugman (1983), Helpman (1984), Markusen (1984), and Markusen and Maskus (2002)), focusing on the subset of horizontal FDI sales relative to exports of final goods allows for sharp predictions to be made about the determinants of trade relative to investment in final goods. Krugman (1983), Horstmann and Markusen (1992), and Brainard (1993 and 1997) develop and test models in which firms trade off proximity to consumers (FDI) against the gains to scale achieved by concentrating production in one location for export. Helpman, Melitz, and Yeaple (2004) introduced firm-level heterogeneity and found that the impact of heterogeneity is similar in magnitude to that of the proximity-concentration effect.

Despite the growing importance of services in international trade (see Figure 1), nearly all empirical research focuses on trade in manufactures.[2] To my knowledge, no papers have examined the decision of service firms to serve foreign markets though exports or FDI. This paucity of research on services trade would not be problematic if we could be certain that

[2]See Freund and Weinhold (2002), Amiti and Wei (2005), Jensen and Kletzer (2005), or Hanson and Xiang (2008) for examples of research on international trade in services

trade and investment in services were determined by the same factors as trade and investment in manufactures. However, Figure 1 suggests that this is not the case. This paper exploits those differences in the task composition of manufacturing and service industries to explain the different ways in which manufacturing and service firms serve foreign markets. The result is a framework that is robust for both manufacturing and services, and that can explain much of the difference in patterns of trade and investment across the two sectors.

# 3 Theoretical Framework

In this section, I present a model of horizontal FDI in which US multinationals trade off the costs of exporting and the costs of FDI when deciding how to serve foreign markets. The basic framework follows a Helpman, Melitz and Yeaple (2004) model of heterogeneous firms. I extend Helpman, Melitz and Yeaple by including task-based trade and investment costs.[3] Because tasks differ in their level of complexity, the potential for quality control failure and miscommunication is a source of variation between country-industry pairs. This model generates predictions about how characteristics of the tasks embodied in each industry interacted with characteristics of the trading countries determine the extent of trade and investment costs, and thus the relative magnitudes of exports versus FDI. The task-based framework of this model is particularly useful for the study of trade and investment in services as well as goods.

This model begins with a continuum of goods and services producing industries, $z \in (0, 1)$. Each of these industries is comprised of a discrete number of tasks, $s \in (1, 2, ..., S_z)$, which must be performed to produce the final good or service. The key characteristics of each industry can be represented by the specific tasks involved in producing the final good or service as well as the importance of each of these tasks in that industry. Tasks are defined by their specific characteristics (e.g. decision-making, communicating with customers, handling objects, etc.). Tasks can be performed in any country. Because each of the tasks, $s$, contained in $z$ must be performed to complete the product, firms are modeled as having a Leontief production function

[3]Grossman and Rossi-Hansberg (2008) develop a model of trade in tasks in which production consists of a series of value-added tasks that can be performed in any location. My framework differs from theirs in that I focus on a horizontal FDI decision in which final products are produced at home or abroad according to their task characteristics, rather than a vertical model of the fragmentation of production tasks across countries

$$q(z) = min[\alpha_{1z}s_1, \alpha_{2z}s_2, ..., \alpha_{Sz}s_S] \quad (1)$$

where $\alpha_{sz}$ is the importance of each task in industry $z$ and $q(z)$ is the output of $z$. Note that $z$ can be either a final or intermediate good or service.

**Costs Associated with Task Performance**

The difference in task compositions across industries leads to differences in the costs of trade and FDI. Because US multinational headquarters decide whether to produce each good or service at home for export or offshore its production to a local affiliate, FDI can be conceived of as giving up headquarter's control over production in exchange for other potential benefits. Breakdowns in communication between the producer and the final consumer are also costly. I model both of these types of costs: (1) costs relating to quality control failure and (2) costs related to communication failure.

When the parent firm exports directly to consumers, the contract for delivery of the good or service is between the headquarters and the consumer. However, under FDI, the affiliate is providing the service or producing the good for the final consumer according to the specifications of the headquarters firm. Because the delivery contract under FDI is between the affiliate and the final consumer, who both reside in the destination country, we would expect to see more FDI sales in countries with stronger contract enforcing institutions. Also, when unforeseen events arise, it is the affiliate (not the parent) that must adapt to them, potentially not to the satisfaction of the parent firm. Because routine tasks can be clearly described in writing (see Autor, Levy and Murnane (2003)), parent firms can more easily convey expectations and product or service standards (i.e. transfer headquarters services) to their affiliates in industries with a greater share of routine to nonroutine tasks.

This is perhaps best illustrated with an example from the service sector. Consider a management consulting firm headquartered in New York and serving a client who is located in Beijing. The firm could provide these services through export, that is by having New York based consultants do the work in the US and communicating with the customer in China through email, phone calls, airplane trips, etc. Alternately, the consulting firm could open up an affiliate in Beijing and deliver the services through FDI sales out of that affiliate. In the case of exports, the headquarters firm has direct control over fulfilling the contract for delivery of consulting services to the client. In the case of FDI, it is the affiliate branch in China that fulfills the obligations of the contract on behalf of the parent firm, forcing the parent to relinquish some control over the quality of the final product. When expectations

about quality can not be fully specified ex ante due to the nonroutine nature of the service, problems may arise that impose costs in the form of quality reductions and reputational effects for the parent firm. We would expect these problems to vary by industry. For example, outcomes related to providing strategic direction for a client firm are more problematic to convey across borders than outcomes related to assembling auto parts or sewing tee-shirts.

The product or service is delivered successfully according to the specification of the headquarters firm with a probability of $e^{-\theta_{zi}}$ where $0 < \theta_{zi} < 1$ is a quality level parameter in country $i$ and industry $z$. Thus $e^{-\theta_{zi}}$ is the share of production expected to be completed successfully at the agreed upon level of quality if the tasks embodied in $z$ are performed in country $i$. $\theta_{zi}$ can be further decomposed into:

$$\theta_{zi} = \theta_z + \theta_i + (\theta_z * \theta_i) \tag{2}$$

$\theta_z$ captures the task-requirements of industry $z$, such as importance of nonroutine tasks, $\theta_i$ captures the country-specific institutional environment, and $(\theta_z * \theta_i)$ interacts country and task characteristics. This specification is similar to Kremer (1993) and Costinot (2008), except that in this case the success probability is a function of institutions and task intensities. Anderson and Marcouiller (2002), show that institutions matter for the likelihood that a shipment will reach its intended destination, functioning like an iceberg-style transport cost on exports. Acemoglu, Antras, and Helpman (2007) demonstrate that the quality of institutions affects the level of investment in a Grossman Hart (1986) framework. I will allow for both of these roles of institutions (protecting shipments and enforcing contracts). Because the probability of success is different for exporting than for FDI, let $\theta^x_{zi}$ denote the risk parameter for exporting and let $\theta^I_{zi}$ denote the risk parameter for FDI.

Along the communication task dimension, the risk is that miscommunication between producers and consumers will prevent transactions from occurring, effectively imposing transport costs on the export of communication-intensive goods and services. Each $z$ will be completed with no communication problems with a probability of $e^{-\delta_{zi}}$, where

$$\delta_{zi} = \delta_z + \delta_i + (\delta_z * \delta_i) \tag{3}$$

$\delta_z$ captures the task-requirements of industry $z$, such as importance of communication with consumers, $\delta_i$ captures country-specific characteristics such as the language spoken in the country, and $(\delta_z * \delta_i)$ interacts country and task characteristics (e.g. the language spoken in a country should matter differently for tasks associated with answering customer

service telephone calls than for tasks associated with assembling automobiles). Because the probability of communication failure is different for exporting than for FDI, let $\delta_{zi}^x$ denote the risk parameter for exporting and let $\delta_{zi}^I$ denote the risk parameter for FDI. In addition to the costs of potential quality control failure or miscommunication, a standard iceberg-style trade cost, $\tau_{zi}$, is applied to US exports of $z$ to country $i$. $e^{-\tau_{zi}}$ represents the share of the good or service that survives transport.[4] Each firm will choose trade or investment for each destination market based on whether expected profits, as a function of country and industry characteristics, are larger for exporting or for FDI.

Consumers have CES preferences with elasticity of substitution $\sigma_z > 1$. A firm's profits from exporting can be written as

$$\pi_{xi} = [e^{-(\tau_{zi}+\delta_{zi}^x+\theta_{zi}^x)} w_{us} a_{us}(z)]^{1-\sigma_z} B_i - f_{xi} \tag{4}$$

Additional profits from locating production abroad for foreign consumption (FDI) are given by:

$$\pi_{Ii} = [e^{-(\delta_{zi}^I+\theta_{zi}^I)} w_i a_i(z)]^{1-\sigma_z} B_i - f_{Ii} \tag{5}$$

where $a_{us}$ is the labor required to produce one unit of $z$ in the US, $a_i$ is the labor required to produce one unit of $z$ in country $i$, $w_i$ and $w_{us}$ are the wages in each country, $B_i = (1-\gamma)A^i/\gamma^{1-\sigma}$ is income share spent on $z$ where $A^i$ captures country-level demand and $1/\gamma$ is the mark up factor (a function of the elasticity of substitution), $f_{xi}$ is the fixed cost of exporting, $f_{Ii}$ is the fixed cost of FDI and $f_{xi} < f_{Ii}$. $a$ is drawn randomly by each firm from a pareto distribution, $G(z)$ and thus firms can be ordered from least productive to most productive. Each firm observes its productivity draw, and then decides whether or not to serve foreign markets and, if so, whether to use exporting or FDI sales. Relative profits of each production location depend on trade costs, relative productivity, $a_i$, wages, fixed costs, and risks associated with communication and quality. These profit equations are very similar to those of Helpman, Melitz and Yeaple (2004) but incorporate the task-based trade costs.

From these profit equations, the cutoff for exporting can be written as:

$$[e^{-(\tau_{zi}+\delta_{zi}^x+\theta_{zi}^x)} w_{us} a_{us}(z)]^{1-\sigma_z} B_i = f_{xi} \tag{6}$$

[4]Even though services do not fit as obviously into the "melting" metaphor of standard iceberg type trade costs, services have still been shown to exhibit a similar effect of distance on trade. See, for example, Bacolod, Blum, and Strange (2007).

and the cutoff for FDI can be written as:

$$[(w_i e^{-(\delta^I_{zi}+\theta^I_{zi})})^{1-\sigma_z} - (w_{us} e^{-(\tau_{zi}+\delta^x_{zi}+\theta^x_{zi})})^{1-\sigma_z}](a_i(z))^{1-\sigma_z} B_i = (f_{Ii} - f_{xi}) \tag{7}$$

The firm will choose to export if $\pi_{xz} - \pi_{Iz} > 0$ and produce the task abroad through FDI if $\pi_{xz} - \pi_{Iz} < 0$. Thus the ratio of exports, $X_{zi}$, to FDI, $I_{zi}$ is

$$\frac{X_{zi}}{I_{zi}} = (\frac{w_{us} e^{-(\tau_{zi}+\delta^x_{zi}+\theta^x_{zi})}}{w_i e^{-(\delta^I_{zi}+\theta^I_{zi})}})^{1-\sigma_z} [\frac{V_s(a_{us}(z))}{V_s(a_i(z))} - 1] \tag{8}$$

where $V(a) = \int_0^a y^{1-\sigma} dG(y)$ is the distribution of productivity. V is pareto with shape parameter $k-(\sigma-1)$. This distribution implies that $V(a_{us})/V(a_i) = (a_{us}/a_i)^{k-(\sigma-1)}$. Plugging in using the cutoff values for FDI and exporting to get $a_{us}$ and $a_i$, this condition becomes

$$\frac{X_{zi}}{I_{zi}} = (\frac{w_{us} e^{-(\tau_{zi}+\delta^x_{zi}+\theta^x_{zi})}}{w_i e^{-(\delta^I_{zi}+\theta^I_{zi})}})^{1-\sigma_z} [\frac{f_I - f_x}{f_x} \frac{1}{(w_{us} e^{-(\tau_{zi}+\delta_{zi}+\theta_{zi})})^{\sigma_z - 1} (w_i e^{-(\delta_{zi}+\theta_{zi})})^{1-\sigma_z} - 1}]^{\frac{k-(\sigma_z-1)}{\sigma_z-1}} \tag{9}$$

Linearizing this equation produces the primary regression specification:

$$\ln \frac{X_{zi}}{I_{zi}} = \beta_1 ln \frac{w_i}{w_{us}} + \beta_2 \delta_{zi} + \beta_3 \theta_{zi} + \beta_4 \tau_{zi} + \beta_5 f_x + \beta_6 f_I + \beta_7 k \tag{10}$$

Where $\delta_{zi}$ denotes the net difference between $\delta^x_{zi}$ and $\delta^I_{zi}$ and $\theta_{zi}$ denotes the net difference between $\theta^x_{zi}$ and $\theta^I_{zi}$.

I estimate a reduced form version of equation (11), where $\delta_{zi}$ and $\theta_{zi}$ are replaced by Equations (2) and (3):

$$\ln \frac{X_{zi}}{I_{zi}} = \beta_1 ln \frac{w_i}{w_{us}} + \beta_2 \tau_{zi} + \beta_3 k + \beta_4 \delta_z + \beta_5 \delta_i + \beta_6 (\delta_z * \delta_i) + \beta_7 \theta_z + \beta_8 \theta_i + \beta_9 (\theta_z * \theta_i) + \varepsilon_{zi} \tag{11}$$

This specification is similar to Brainard (1997) and Helpman, Melitz and Yeaple (2004). But in addition to the proximity-concentration trade off, communication risk and quality risk must also be balanced to make exporting more profitable than incurring the cost of opening a new plant in the final consumption market. We should see more exports relative to FDI for countries with weak institutions and those that are linguistically distant. More nonroutine tasks are more vulnerable to quality risk and are thus more likely to be exported, especially when the destination country has weak contract-enforcing institutions.

Communication-intensive tasks are associated with greater risk at the time and location of delivery to consumers and thus are more likely to be sold through FDI. So while the analytical result is similar to previous models of the trade versus investment decision for goods, the empirical implications are different.

# 4 Construction of Task Intensities

Autor, Levy and Murnane (2003) divide the set of all possible job tasks that workers perform into two basic categories: routine and nonroutine. Routine tasks are those that can be accomplished by following a set of specific, well-defined rules. Non-routine tasks require more complicated activities like creative problem solving and decision making. These tasks are sufficiently complex that they can not be completely specified in computer code and executed by machines as emphasized by Autor, Levy and Murnane, nor can they be fully described in words when communicated from a headquarters firm to its affiliate. I use this routine-nonroutine dichotomy and add another dimension, communication, which captures tasks that require interaction with customers. This activity has the largest average difference in importance between manufacturing and service industries. It also offers a meaningful measure of a characteristic that has often been cited as a intuitive explanation for why some activities are more offshorable than others, namely the extent to which producers and consumers must be in the same location at the time of delivery (Blinder 2007).

The Department of Labor's Occupational Information Network (O*NET) includes data on the importance of these and other tasks in about 800 occupations. To match the relevant task measures to the industry-level trade and investment data, I aggregate the raw O*NET scores up to the industry level, weight them by share in total task composition of each industry and merge them with trade data to get an index of the intensity of each task in each industry. Industries can then be defined by a vector of tasks, each weighted by its importance in that industry. O*NET lists 277 different skills, abilities, work activities, etc. Blinder (2007) and Jensen and Kletzer (2007) use this data to construct subjective rankings of the offshorability of service occupations. Bacolod, Blum, and Strange (2007) use O*NET's predecessor, the Dictionary of Occupational Titles (DOT), to estimate the impact of agglomeration on the hedonic prices of worker skills. Autor, Levy and Murnane (2003) use the DOT to classify the extent to which industries and occupations are comprised of routine versus nonroutine tasks.

I combine data on the task requirements of occupations from O*NET with data on

services and manufactures trade from the BEA to create an index of task intensity in each industry which will serve as a measure of trade costs in the export versus FDI framework described above. The importance score of each task, $s$ in each industry, $z$ is

$$M_{sz} = \sum_c \alpha_{zc} \ell_{sc} \tag{12}$$

where $s$ indexes tasks, $c$ indexes occupations, and $z$ indexes industries. Thus $\alpha_{zc}$ is the share of occupation $c$ used in the production of industry $z$, and $\ell_{sc}$ is an index of the importance of task $s$ for occupation $c$.[5] Summing over occupations in a given industry results in an index of the un-scaled importance score for each each task in that industry. Each raw score is then divided by the sum of scores for each task in each industry, resulting in an input intensity measure for each task, $s$, in each industry, $z$:

$$I_{sz} = \frac{M_{sz}}{\sum_s M_{sz}} \tag{13}$$

Occupations are matched to industries using the Bureau of Labor Statistics Occupational Employment Statistics. These intensities are then matched to the BEA data on multinational firms. BEA collects data at the level of the firm and then reports the primary industry classification of each firm. Thus (13) can be used as a component of the industry characteristics vector $\delta_z$ in regression equation (11).[6]

I took two different approaches to distilling the O*NET data into a simple measure of each task characteristic. The primary approach is similar to Autor, Levy and Murnane (2003) and consists of identifying an individual task measure that most closely proxies each desired characteristic. Under this approach, I use the O*NET measure "working with the public" as a proxy for the importance of communicating with consumers. To capture the level of task complexity (which corresponds to Autor, Levy and Murnane's "non-routine cognitive" category), I use the O*NET measure of "creative thinking". As a robustness check, I replicate the regressions using "making decisions and solving problems" and "communicating inside the organization" as alternate measures of non-routine task intensity. I also use

[5] $\ell_{sc}$ corresponds to the 0-100 score O*NET reports to measure the importance of each task in each occupation. These scores are constructed from surveys of individuals in those occupations and are normalized to a 0-100 scale by analysts at the Department of Labor. Due to the subjective nature of the surveys, one unit of importance for given task can not be directly compared to one unit of another task. This is a limitation of the data and motivates the use of relative intensity scores rather than the raw scores reported by O*NET.

[6] I also test equation (11) using the raw importance scores, $M_{sz}$, instead of the scaled $I_{sz}$ and obtain qualitatively similar results.

the O*NET measures "handling objects", "operating machines (other than vehicles)", and "general physical activities" to proxy routine manual activities and obtain coefficients with the opposite sign of the nonroutine task measures.

The second approach, which serves as a robustness check, uses principal components analysis to distill a large number of tasks down to their core elements. I create one measure of non-routine intensity using the primary component among creativity, problem solving, giving consultation or advice, developing objectives, communicating internally, and working with computers. The routine manual component is drawn from the tasks handling objects, operating machines and general physical activities. No principal components were constructed for communication because working directly with the public is the single O*NET task that corresponds directly to that concept. All empirical results are robust to the use of individual task proxies or principal component measures.

# 5 Data

**FDI Data**

The Bureau of Economic Analysis collects firm-level data on US multinational company operations in both goods-producing and service-producing industries in its annual and benchmark surveys of US direct investment abroad. I use data on local sales by foreign affiliates from these surveys as a measure of sales through FDI. The information on manufacturing firms contained in this dataset has been used in previous studies (see for example Hanson, Mataloni, and Slaughter 2005 or Desai, Foley and Hines 2001), however the data on service trade and investment are not frequently exploited. I restrict my sample to the years in which the Benchmark surveys were conducted. These include 1982, 1989, 1994, 1999, and 2004. The BEA surveys cover 54 manufacturing industries and 33 service industries, classified according to BEA versions of 3-digit SIC codes. For this paper, I aggregated the affiliate firm level data up to the industry level, defined by the primary industry of the affiliate, to be matched with industry level export data.

**Export Data**

Data on exports of manufactures are taken from the U.S. Census Bureau's Related Party Trade database. These data were converted from 4-digit NAICS codes to 3-digit BEA SIC-based codes using concordance tables provided by Raymond Mataloni. This database allows

me to use only trade between unrelated parties, i.e. trade that is not done within the firm. Because the model address horizontal rather than vertical FDI, it is these unaffiliated transactions that I want to compare to local sales by multinational affiliates. Data on exports of services were taken from BEA's survey of selected services transactions with unaffiliated foreign persons. This survey provides information on both the general product categories that are being traded and on the primary industry of the exporting firm, as reported by the firm itself. These classifications are highly correlated (e.g. we observe firms in the legal industry exporting legal services and firms in the advertising industry exporting advertising services). I use the industry of the exporting firm, rather than the product category, to classify service exports, as these codes are also used in the FDI data. Data from this survey are available annually beginning in 1992, resulting in a final dataset containing three years (1994, 1999, and 2004), 54 manufacturing industries, 32 service industries, and 88 countries. Because of the time dimension of these data, year fixed effects will be included in all regressions. Table 4 lists service industries in descending order of their export to FDI ratios.

There are a few key differences between the public versions of the BEA services trade data and the confidential BEA survey data I use for this paper. Based on BEA definitions, service exports reported in the public data occur when "the residents of one country sell services to the residents of another country." (Nephew et al. 2005). This could occur in the US (e.g. a foreign resident travels to the US to purchase services) or abroad (a company located in the US provides services to an individual or company located in another country). These exports can be within firm or unaffiliated. Table 3 gives the values of these exports by major category in 2004. They include services that are classified by BEA as "other private services". These do not include travel, transportation, retail, or wholesale services. The largest categories are financial and business services, the latter of which includes information, management, telecommunications, legal, accounting, engineering, advertising, and other similar services. For this paper, I use firm-level data from BEA's survey of selected services transactions with unaffiliated foreign persons, which is one component of the aggregate public data (compiled by BEA from several different sources). This survey covers a subset of other private service and only includes exports by US companies to unaffiliated persons abroad. Therefore my analysis is not complicated either by intrafirm trade or by service exports sold to foreign citizens traveling to the US.

**Institutional Quality Data**

I use an index of regulation and enforcement from the World Bank's Doing Business

Database to proxy for the level of institutional quality. This index is based on surveys of local experts, including lawyers, business consultants, accountants, freight forwarders, government officials and other professionals routinely administering or advising on legal and regulatory requirements. The index includes an overall measure of business institutions, as well as separate measures for ten specific areas: starting a business, protecting investors, dealing with construction permits, paying taxes, employing workers, trading across borders, registering property, getting credit, closing a business, and enforcing contracts. Countries are ranked based on their strength on each of these dimensions. Each country's score for each dimension is its rank from 1 to 181. The overall score for a country is the simple average of that country's scores on each of the ten dimensions. I normalize these rankings to fall between 0 and 100, with 100 representing the highest level of institutional quality. For the baseline specification, I use the difference between the contracting institutions score and the overall score to isolate the specific role of contract enforcement apart from the overall business environment. As a robustness check, I also use the overall measure of institutional quality for each country.

**Other Data**

The great circle distance between capital cities proxies for transport costs. GDP is used to capture market size. Data on firm-level sales by industry from Compustat are used to construct a measure of productivity dispersion for each industry in the sample. Relative wages in manufacturing and services are constructed using data from Freeman and Oostendorp (2000). As a robustness check, I also use a ratio of high to low skill wages from Grogger and Hanson (2008), which defines low-skill wages as the income level at the 20th percentile and high-skill wages as the income level at the 80th percentile. Data on corporate tax rates are from the University of Michigan World Tax Database. I use data on the educational level of industries from the US Census 2004 American Community Survey. Data on common religion between the US and its trading partners is from Helpman, Melitz and Rubinstein (2008). I use data on Bilateral Investment Treaties (BITs) from the United Nations Conference on Trade and Development (UNCTAD). The linguistic distance between countries based on language trees from Fearon (2003) is used to capture the effect of language. The more nodes on these trees that two languages have in common, the more likely they are to trace their roots to a recent common ancestor language. In this sense, the number of common nodes (out of a possible total of 15) that two languages share can be used to measure their linguistic similarity. Fearon (2003) also provides information on the linguistic

composition of countries. Combining the information on language trees with the linguistic composition of countries results in a linguistic distance measure for each country, which is bounded by 0 and 1 and increasing in linguistic distance. For correlations between these and other variables, see Table 5.

# 6 Empirical Specification

**Two-Stage Estimator**

Helpman, Melitz, and Rubinstein (2008) demonstrate that standard gravity models suffer from bias because they do not account for the empirical fact that not all countries trade all goods with all other countries. Ignoring these zero-valued observations results in selection bias, as trade volumes are only observed for those countries that choose to trade with each other.

Figure 2 shows the share of country-industry pairs for which the US has zero exports, zero FDI sales, or an undefined or zero-valued export to FDI ratio in the manufacturing and service sectors. These patterns suggest that zero-valued observations are an even greater concern for the study of services than manufacturing. Correcting for selection into service exports or FDI is especially important if the biases are more systematic than in manufacturing, which could be the case if the task characteristics of certain service industries make them nontradable or if individual countries have restrictions barring service-sector FDI or trade.

I correct for selection into exporting and FDI sales using the non-parametric two-stage estimator proposed by Helpman, Melitz, and Rubinstein (2008). This estimator has the advantage of controlling both for the endogenous number of firms engaged in export and FDI and for bias due to correlation between the error term and the independent variables, which is generated by the selection of country-industry pairs into non-zero exports and FDI (e.g. a Heckman (1979) selection correction), but without the normality assumptions required by a similar parametric estimator. A disadvantage of the non-parametric functional form is that it does not allow for decomposition of the two types of bias. However, because the goal of this paper is to get unbiased estimates of the determinants of the export-FDI ratio, rather than to decompose the potential sources of bias, I am less concerned with this limitation. I use the difference between the top marginal corporate tax rate in the U.S. and in the destination market as the necessary exclusion restriction. It is well documented that tax rates affect the location of multinational affiliates (see for example Grubert and Mutti (1991) or Desai, Foley

and Hines (2002)). However, the primary purpose of tax-motivated FDI is not to serve local markets in the host country, but rather for vertical or export platform FDI. I show that the relative tax rate of the destination country impacts the likelihood of the log export to FDI ratio being defined and non-zero, but does not impact the magnitude of this ratio, using the definition of horizontal exports and FDI described above. As robustness checks, I also use common religion, which is one of the exclusion restrictions proposed by Helpman, Melitz and Rubinstein (2008), and a dummy variable indicating whether or not each country has a Bilateral Investment Treaty (BIT) with the US as the exclusion restrictions and obtain similar results which are not reported here.

The log of the export to FDI ratio could be undefined either because exports equal zero, FDI sales equal zero, or both. However, positive selection into the sample of export-FDI observations occurs only if both exports and FDI sales are strictly positive. Therefore, I do not distinguish between the source of an undefined log export-FDI ratio and estimate the likelihood that both exports and FDI sales exist based on observables in the first stage, and then control for this selection in the second stage. Define indicator variable $T_{zi}$ to equal 1 if the log of the export to FDI ratio exists, that is, if US has both non-zero exports and non-zero FDI sales to country $i$ in industry $z$. Thus the two stage estimator is:

**Stage 1:**

$$\rho_{zi} = Pr(T_{ij} = 1| \text{ observed variables }) = \Phi(\gamma_0 + \gamma_1) \tag{14}$$

**Stage 2:**

$$\ln \frac{X_{zi}}{I_{zi}} = \beta_1 ln \frac{w_i}{w_{us}} + \beta_2 \tau_{zi} + \beta_3 k_z + \beta_4 \delta_z + \beta_5 \delta_i + \beta_6 (\delta_z * \delta_i) + \beta_7 \hat{\rho}_{zi} + e_{zi} \tag{15}$$

Where $\gamma_1$ is the vector of independent variables and $\hat{\rho}_{zi}$ is the predicted value from stage 1.

# 7 Results

**Testing the Proximity-Concentration Story**

Table 6 gives the results of a proximity-concentration model of the export versus FDI

decision run on separate samples of manufacturing and service industries. The results for manufacturing industries are consistent with previous papers on the export-FDI trade off. Consistent with a proximity explanation, the coefficient on physical distance is negative and significant for manufactures. I measure concentration by the number of firms operating in each industry. The coefficient on this measure is negative and significant for manufactures, suggesting that industries with a higher concentration of sales (lower number of firms) are more likely to use exports rather than FDI. For services, the coefficient on the number of firms is positive, suggesting that more concentrated industries use relatively more FDI, a result that is contrary to the proximity-concentration story. Taken together, these results suggest that manufacturing firms are more likely to serve foreign markets though FDI sales when those markets are far away (making transport of exports more costly) and when industries are not highly concentrated (making it easier to recover the fixed costs of setting up a local affiliate branch). Table 6 also shows that these results do not hold for service industries, suggesting that a distance-concentration tradeoff is not driving the decision of service firms to serve foreign markets through FDI or export. In regressions not reported here, I also ran this specification separately for exports and for FDI sales (rather than using their ratio). Distance was a significant deterrent to both exports and FDI in services, however the differential effect of distance on exports relative to FDI was not as large as for manufacturing, which can explain the difference in the significance of distance across the samples in Table 6.

The variable *dispersion* is the standard deviation of sales by firms in each industry. It was constructed using total sales information on US firms from the Compustat database. This variable captures the degree of firm level heterogeneity within an industry that was emphasized by Helpman, Melitz, and Yeaple (2004) and was one of the measures that they propose to proxy for the level of dispersion of productivity among firms in an industry. Consistent with their results, I find that greater firm-level heterogeneity significantly increases FDI relative to exports in an industry. This result holds for both manufacturing and service industries.

**Two-Stage Selection Model**

Table 7 presents the first stage of the two-stage model described in Section 6. The variable $taxdifference$ is the U.S. top marginal corporate tax rate minus the top marginal corporate tax rate in the destination market. As expected, this variable is positively and significantly associated with the existence of exports and FDI sales. However, it is not associated with the log of the export to FDI sales ratio, making it a useful exclusion restriction. We would expect the difference in tax rates to determine whether an export and/or FDI relationship

exists at all, but then have little impact on the relative volume of horizontally motivated trade and investment because tax motives are much stronger for vertical and export platform FDI and within firm trade than for horizontal FDI and arms length exports.[7]

Table 8 presents the second stage results. The selection bias coefficient, $\rho$, is significant for services but not for manufactures, highlighting the importance of the selection model for service sales. This possibly the case because there are more zero-valued observations for services than for manufactures. In addition, the sign on $\rho$ is positive for manufactures and negative for services, possibly because the importance of selection for exports relative to the importance of selection for FDI matters differently for services than for manufactures.

Table 8 introduces additional variables that may influence the export to FDI ratio, as well as testing the task framework that was proposed in Section 3. In addition to the number of firms, this specification also includes GDP of the destination country, which captures market size. Although the results are not statistically significant for manufacturing, the coefficient is negative, which suggests that manufacturing firms are more likely to use FDI sales over exports when serving large markets, evidence that is consistent with the concentration side of the proximity-concentration model. For services, the sign is positive, providing further evidence that the proximity-concentration story does not do a good job of explaining the pattern of trade and investment in services. One possible explanation for production location decisions is that firms prefer to locate production in countries with lower relative labor costs. This is generally thought of as a motive for vertical FDI, but may be relevant here to the extent that firms engage in both vertical and horizontal FDI (see for example Yeaple 2003 and Carr, Markusen and Maskus 2001). I measure the relative wage in a number of different ways. The results presented in Table 8 show the average wage in the destination market relative to the average wage in the U.S. The results in Table 8 suggest the wage ratio is not driving the export to FDI ratio in manufacturing industries. For services, the relationship is negative and significant, suggesting that higher wage countries have greater FDI sales relative to exports. This is the opposite of what we would observe if horizontal prodiction location decisions were based on low-wage competition. In other specifications not reported here, I also use the measure of high to low skilled wages proposed by Grogger and Hanson (2008) as well as the manufacturing wage relative to the service wage in the destination country. None of these relative wage measures are significant predictors of the export versus

[7] As a robustness check, I also ran the two-stage model using common religion as the exclusion restriction, as was suggested by Helpman, Melitz and Rubinstein (2008) and obtained similar results. Similar results were also obtained using the existence of bilateral investment treaties as the exclusion restriction.

investment decision for either manufacturing or service industries.

The coefficient on linguistic distance is positive and significant, suggesting that linguistic distance imposes a cost on FDI that is greater than the cost it imposes on exports.

**The Role of Communication Tasks**

Table 8 shows the results of the task-based model using communication and nonroutine tasks, correcting for selection bias. The negative coefficient on *communication* in Table 8 suggests that industries that require a higher degree of interaction with the public are more likely to be sold though FDI than through exports. Because services use communication tasks much more intensively than manufactures, this relationship is important for explaining why service firms use FDI rather than exports to a greater extent than do manufacturing firms. This result is not surprising, as FDI brings production closer to the final consumers. However, the simple and intuitive relationship between the need to communicate with customers and the propensity to use FDI rather than exporting is new to the empirical literature. Note that communication intensity is not acting as a prohibitive transport cost that renders certain services untradable, as all industries in this dataset exhibit nonzero trade volumes. Thus communication intensity is having an impact on the volume of exports relative to FDI sales.

I also interact the communication measure with contracting institutions in columns 4-6 of Table 8. This interaction does not have a significant coefficient for the sample of manufacturing or service industries, suggesting that communication intensity matters regardless of the institutional environment of the destination country.

**The Role of Nonroutine Tasks**

The importance of nonroutine tasks in an industry is positively correlated with the educational level of workers in that industry (see Table 5). Therefore I control for the average educational level of workers in each industry. Industries requiring higher educational levels are more likely to produce in the US for export rather than offshore production through FDI, which is consistent with a US comparative advantage in high-skilled activities. However, nonroutine task intensity is significant even when education is controlled for, suggesting that nonroutine tasks play a role in the production location decision that is distinct from their educational content.

The importance of nonroutine tasks in an industry significantly increases relative exports. This result is consistent with the model proposed in Section 3. Because specific quality parameters of nonroutine tasks can not be fully specified ex ante, they are subject to greater

risk when their production takes place away from the firm's headquarters. Given that services are more nonroutine task intensive than manufactures, this relationship works in the opposite direction of communication intensity in that it increases the relative exports (rather than FDI) of service firms compared to manufacturing firms, offsetting some of the effect of the need to communicate with consumers.

The coefficient on contract enforcement is negative and statistically significant for services, implying that FDI relative to exports is higher for countries with stronger contract-enforcing institutions. This result is consistent with the model proposed in Section 3. However, this result does not hold for manufacturing. The coefficient on institutions interacted with nonroutine task intensity is also negative and significant for the set of service industries. In other words, an increase in the quality of contracting institutions increases relative FDI sales for nonroutine industries to a greater extent than for routine industries. This result also supports the model in which institutions matter more for activities the quality of which is more difficult to fully specify in a complete contract.

Taken on its own, the positive relationship between nonroutine tasks and exporting could potentially be explained by a US endowment-based comparative advantage in non-routine cognitive tasks. However, the interaction of routinization with contract enforcing institutions is significant. To the extent that a country's institutions are not associated with a relative abundance of the factors used intensively in the production of nonroutine tasks, then the significance of these interactions can be taken as evidence for a contracting model over a comparative advantage model. To further identify the role of tasks separately from a comparative advantage story, I include controls for traditional endowment-based comparative advantage (see Table 9). Following Romalis (2004), this comparative advantage story can be tested by interacting each country's relative endowment of a given factor with the relative intensity with which this factor is used in each industry. Table 9 shows that the interaction of contracting enforcement institutions and nonroutine task intensity is still significant for the set of service industries even when traditional comparative advantage controls are included. It may seem surprising that the intensity-endowment interactions are not significant. However, we would expect the results to be weaker than in Romalis, given that this exercise only uses one exporter (the US) and compares the relative importance of the ways in which the US serves each market, not the standard exercise of looking at who specializes in what given a large set of potential producing countries and industries. The key result is still that for the export to FDI decision of US firms already serving foreign markets in a given industry, task intensities are more significant than measures of comparative advantage. The regressions in

Table 8 do not include country or industry fixed effects in order to examine variation in the industry-specific task measures and the country-specific language and institutions measures. The results presented in Table 9 include both country and industry fixed effects and examine variation in the interactions between institutions and the task measures. Again, the general results from Table 8 still hold. More nonroutine task intensive industries are more likely to be sold through FDI in countries with stronger contract enforcing institutions. The role of communication intensity is independent of contracting institutions.

**Explaining Differences in Trade and Investment Patterns between Manufacturing and Service Industries**

These results support the model in which differences in trade and investment patterns between goods and services can be explained at least in part by their differential task compositions. To quantify the level of these differences, recall that the task intensities represent the importance score of a given task re-scaled to reflect the share of that task in the sum of total importance scores across all work activities. So the coefficients on task intensities give the percentage change in the export to FDI ratio for a one point increase in the task intensity of an industry. To isolate the average effects of communication and nonroutine intensity, I use coefficients from the specification without interaction terms presented in Table 8. The coefficient on communication task-intensity implies that a 1 point decrease in the communication intensity score of an industry will lead to an 82 percent increase in the share of exports relative to FDI sales in that industry. On average, services have a communication intensity that is 1.22 points higher than the delivery intensity of manufactures. Holding all else constant, we would expect the export share in manufactures to be twice as high as that of services. The coefficient on nonroutine task-intensity from Table 8 implies that a 1 point increase in nonroutine intensity leads to an 87 percent increase in the share of exports relative to FDI. On average, the non-routine task intensity of services is 0.44 points higher than that of manufactures. Holding all else constant, this corresponds to an export-FDI ratio that is 38 percent higher for services than for manufacturing. Together, these two task measures would predict that the export FDI share for service industries is about 62 percent less than for manufactures. During the time period used in the data, the export to FDI ratio for services was about 67 percent lower than for manufacturing. So these two task variables alone explain a significant amount of the difference between the ratio of exports to FDI in services versus manufactures.

# 8 Robustness Checks

As mentioned previously, I also ran the regressions using a principal components measure of nonroutine task intensity. The results were unchanged. Similar results were also obtained using the importance of problem solving and making decisions rather than creativity as the measure of nonroutine task intensity.

I also ran the specifications described above on several subsets of the service industries to investigate whether or not a few highly traded services were driving the results. For this exercise, I defined highly tradable services in five different ways: first as those industries in which at least 20 percent of foreign sales occur through exports rather than FDI, second as those industries in which at least 10 percent of foreign sales occur through exports rather than FDI, third as the top five industries ranked by level of exports, fourth as the top ten industries ranked by level of exports, and fifth as the as the top fifteen industries ranked by level of exports. No consistent patterns emerge among more and less traded service industries, suggesting that the results are not being driven by a subset of highly tradable services.

One drawback of using the export to FDI ratio is that it masks the underlying volumes of trade and investment such that an country-industry observation with $2 million in exports and $1 million in FDI sales would be indistinguishable from a country-industry observation with $20 billion in exports and $10 billion in FDI sales. To ensure that the results were not biased by this weighting effect, I re-ran the model using only the smallest third, middle third, and largest third of industry-country observations, defined by total foreign sales. The results for all three of these subsets were consistent with those using the full sample.

# 9 Conclusion

Manufacturing and service producing firms use exports and FDI in different proportions. In this paper, I demonstrate that concentration and distance are significant predictors of the export to FDI ratio for manufactures but not for services. To explain the difference across sectors, I focus on two empirically new sources of the relative costs of FDI and exports. The first of these is the need to communicate with consumers. I provide rigorous empirical support to the intuitive idea that industries requiring greater interaction with consumers are more likely to locate production near those consumers through the use of FDI. Because

communicating with consumers is about twice as important for services as for manufactures, this variable can explain why service firms use FDI relative to exports at a much higher rate than manufacturing firms.

The second variable captures a hidden cost of FDI: the difficulty of offshoring nonroutine activities to foreign affiliates. Industries that are more intensive in their use of nonroutine tasks are more likely to be produced at home for export rather than offshoring to foreign affiliates. Because services are more nonroutine task intensive than manufactures, this relationship partially offsets the propensity towards FDI in services implied by the role of communicating with consumers. Differences in these two task measures between manufacturing and services can explain a large portion of the difference in export to FDI ratios across the sectors.

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Table 1: Mean Task Intensities for Manufacturing and Service Industries

| | **Task** | **Goods** | | **Services** | | **Difference** | |
|---|---|---|---|---|---|---|---|
| | | **raw** | **scaled** | **raw** | **scaled** | **raw** | **scaled** |
| **1** | Working with the public | 21.3 | 1.34 | 50.3 | 2.56 | 29.0 | 1.22 |
| **2** | Creative Thinking | 35.7 | 2.19 | 49.3 | 2.63 | 13.6 | 0.44 |
| **3** | Problem solving/ decisions | 54.4 | 3.30 | 66.5 | 3.51 | 12.1 | 0.21 |
| **4** | Handling objects | 62.5 | 3.67 | 35.0 | 1.76 | -27.5 | -1.91 |
| **5** | Operating machines | 61.0 | 3.59 | 31.7 | 1.65 | -29.3 | -1.94 |

Raw scores are unadjusted importance levels of each task reported by O*NET. Scaled scores are the percentage shares of each task in the total task input requirements of a given industry.

Table 2: Mean Task Intensities for Manufacturing and Service Industries

| | Task | Manufacturing | Services | Difference |
|---|---|---|---|---|
| **1** | Working with the public | 1.34 | 2.56 | 1.22 |
| **2** | Working with computers | 2.25 | 3.39 | 1.13 |
| **3** | Interpersonal relationships | 2.75 | 3.58 | 0.83 |
| **4** | Conflict resolution | 1.80 | 2.56 | 0.76 |
| **5** | Administrative tasks | 1.85 | 2.56 | 0.71 |
| **6** | Selling | 1.28 | 1.91 | 0.63 |
| **7** | Interpreting | 2.03 | 2.61 | 0.59 |
| **8** | Developing Objectives | 1.74 | 2.22 | 0.47 |
| **9** | Creative Thinking | 2.19 | 2.63 | 0.44 |
| **10** | Scheduling | 2.03 | 2.47 | 0.44 |
| **11** | Organizing work | 2.90 | 3.32 | 0.42 |
| **12** | Caring for others | 1.70 | 2.12 | 0.42 |
| **13** | Building teams | 1.86 | 2.26 | 0.40 |
| **14** | Updating and using knowledge | 2.91 | 3.27 | 0.36 |
| **15** | Communicating inside organization | 3.47 | 3.82 | 0.36 |
| **16** | Documenting information | 2.82 | 3.17 | 0.35 |
| **17** | Consulting/advice | 1.67 | 2.02 | 0.34 |
| **18** | Staffing | 0.88 | 1.17 | 0.28 |
| **19** | Monitoring resources | 1.50 | 1.78 | 0.27 |
| **20** | Guiding subordinates | 1.68 | 1.90 | 0.22 |
| **21** | Coaching | 1.83 | 2.05 | 0.22 |
| **22** | Problem solving/decision making | 3.30 | 3.51 | 0.21 |
| **23** | Processing information | 2.93 | 3.15 | 0.21 |
| **24** | Coordinating others | 2.19 | 2.38 | 0.19 |
| **25** | Teaching/training | 2.09 | 2.26 | 0.18 |
| **26** | Analyzing data | 2.69 | 2.82 | 0.13 |
| **27** | Getting information | 4.28 | 4.14 | -0.14 |
| **28** | Identifying objects | 3.66 | 3.31 | -0.35 |
| **29** | Estimating quantifiable characteristics | 2.65 | 2.27 | -0.38 |
| **30** | Evaluating compliance | 3.35 | 2.90 | -0.45 |
| **31** | Repairing electric equipment | 1.51 | 0.94 | -0.57 |
| **32** | Drafting technical documents | 1.54 | 0.92 | -0.62 |
| **33** | Monitoring processes | 3.75 | 2.89 | -0.86 |
| **34** | Inspecting | 3.64 | 2.22 | -1.41 |
| **35** | General physical activities | 3.31 | 1.79 | -1.51 |
| **36** | Repairing mechanical equipment | 2.53 | 0.88 | -1.65 |
| **37** | Handling objects | 3.67 | 1.76 | -1.91 |
| **38** | Operating machines | 3.59 | 1.65 | -1.94 |

Constructed using data from O*NET as described in Section 4

Table 3: US Exports of "Other Private Services"

| **Service Category** | **2004 US Exports ($M)** | **2004 Share of US Service Exports** |
|---|---|---|
| **Financial services** | 36,389 | 24% |
| **Education and Training** | 13,634 | 9% |
| **Insurance** | 7,314 | 5% |
| **Telecommunications** | 4,651 | 3% |
| **Business/professional** | | |
| Computer and information | 8,693 | 6% |
| Research and development | 9,563 | 6% |
| Management and consulting | 16,372 | 11% |
| Other business/professional | 26,304 | 18% |
| **Other services** | 26,349 | 18% |
| **Total** | 149,269 | 100% |

constructed using publicly available data from www.bea.gov

Table 4: Service Industries Ranked from Highest to Lowest Export/FDI Ratio

1 Legal services
2 Accounting, auditing, and bookkeeping services
3 Communications (other than telegraph and telephone)
4 Amusement and recreation
5 Research, development, and testing
6 Information retrieval services
7 Educational services
8 Repair Services
9 Engineering, architectural, and surveying services
10 Management and public relations services
11 Telephone and telegraph communications
12 Business services
13 Equipment rental
14 Computer related
15 Other insurance
16 Other services
17 Hotels and other lodging places
18 Computer processing and data preparation
19 Advertising
20 Other finance, including security and commodity br.
21 Health services
22 Real estate
23 Motion pictures, including television tape and film
24 Life insurance
25 Accident and health insurance
26 Depository Institutions
27 Savings institutions and credit unions
28 Holding companies
29 Services to buildings
30 Personnel supply services
31 Automotive rental and leasing
32 Automotive parking, repair, and other services

Table 5: Correlations

| | ln x | ln fdi | ln x/fdi | ln dist | ln gdp | inst | lang |
|---|---|---|---|---|---|---|---|
| ln x | 1 | | | | | | |
| ln fdi | 0.302 | 1 | | | | | |
| ln x/fdi | 0.618 | -0.563 | 1 | | | | |
| ln dist | -0.197 | -0.211 | 0.003 | 1 | | | |
| ln gdp | 0.332 | 0.370 | -0.017 | -0.215 | 1 | | |
| institutions | 0.018 | -0.008 | 0.022 | -0.304 | -0.166 | 1 | |
| lang dist | -0.069 | -0.247 | 0.144 | 0.427 | -0.223 | -0.268 | 1 |

| | edu | nr | comm |
|---|---|---|---|
| education | 1 | | |
| nonroutine | 0.620 | 1 | |
| communication | 0.277 | 0.608 | 1 |

Table 6: Proximity-concentration model of the determinants of the export to FDI ratio, controlling for selection bias, standard errors clustered by country

| Model : | 1 | 2 | 3 |
|---|---|---|---|
| Sample: | goods | services | gds+svc |
| N: | 3648 | 1704 | 5352 |
| Depvar: | ln(x/fdi) | ln(x/fdi) | ln(x/fdi) |
| dispersion | -0.636*** | -0.361*** | -0.491*** |
| | (0.084) | (0.060) | (0.048) |
| ln distance | -0.431** | -0.080 | -0.350** |
| | (0.188) | (0.186) | (0.142) |
| n firms | -0.001*** | 0.001*** | -0.001*** |
| | (0.0003) | (0.0002) | (0.0003) |
| R-sq | 0.115 | 0.105 | 0.236 |

*,** and *** indicate significance at the
10, 5 and 1 percent levels, respectively

Table 7: Stage 1: Export-FDI selection model, standard errors clustered by country

| Model : | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Sample: | goods | services | gds+svc | goods | services | gds+svc |
| N: | 8869 | 5068 | 13937 | 8869 | 5068 | 13937 |
| Depvar: | xfdi dum | xfdi dum | xfdi dum | xfdi dum | xfdi dum | xfdi dum |
| tax difference | 0.028*** | 0.022*** | 0.025*** | 0.028*** | 0.022*** | 0.025*** |
| | (0.009) | (0.008) | (0.008) | (0.009) | (0.008) | (0.008) |
| dispersion | 0.064** | 0.072*** | 0.023* | 0.064** | 0.072*** | 0.023* |
| | (0.025) | (0.017) | (0.014) | (0.025) | (0.017) | (0.014) |
| n firms | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| ln gdp | 0.512*** | 0.455*** | 0.477*** | 0.512*** | 0.455*** | 0.477*** |
| | (0.038) | (0.028) | (0.030) | (0.038) | (0.028) | (0.030) |
| ln distance | -0.162 | 0.011 | -0.099 | -0.162 | 0.008 | -0.100 |
| | (0.146) | (0.093) | (0.118) | (0.146) | (0.095) | (0.118) |
| lang distance | -1.002* | -1.016** | -0.989** | -1.002* | -1.005** | -0.988** |
| | (0.560) | (0.434) | (0.478) | (0.560) | (0.434) | (0.477) |
| rel wage | 0.028 | 0.206*** | 0.086 | 0.028 | 0.207*** | 0.086 |
| | (0.084) | (0.052) | (0.062) | (0.084) | (0.052) | (0.062) |
| institutions | 0.002 | 0.002* | 0.002 | 0.001 | 0.005 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.004) | (0.009) | (0.004) |
| edu (industry) | 0.133 | 0.028 | 0.039 | 0.133 | 0.028 | 0.039 |
| | (0.084) | (0.065) | (0.050) | (0.084) | (0.065) | (0.050) |
| communication | 0.520*** | -0.288*** | -0.183*** | 0.520*** | -0.288*** | -0.183*** |
| | (0.008) | (0.058) | (0.032) | (0.008) | (0.059) | (0.033) |
| inst*comm | | | | -0.004 | -0.012 | -0.009 |
| | | | | (0.189) | (0.147) | (0.100) |
| nonroutine | -0.195* | 1.247*** | 0.556*** | -0.195* | 1.245*** | 0.555*** |
| | (0.101) | (0.102) | (0.094) | (0.108) | (0.101) | (0.094) |
| inst*nonroutine | | | | -0.009 | 0.271 | -0.114 |
| | | | | (0.218) | (0.230) | (0.151) |
| R-sq | 0.36 | 0.39 | 0.35 | 0.36 | 0.39 | 0.35 |

*,** and *** indicate significance at the 10, 5 and 1 percent levels, respectively

Table 8: Stage 2: Export-FDI selection model, standard errors clustered by country

| Model : | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Sample: | goods | services | gds+svc | goods | services | gds+svc |
| N: | 3819 | 1783 | 5602 | 3819 | 1783 | 5602 |
| Depvar: | uaflxi | uaflxi | uaflxi | uaflxi | uaflxi | uaflxi |
| rho | 1.139 | -2.392*** | 0.150 | 1.131 | -2.120** | 0.236 |
| | (1.251) | (0.871) | (0.957) | (1.254) | (0.906) | (0.968) |
| dispersion | -0.528*** | -0.287*** | -0.472*** | -0.526*** | -0.289*** | -0.470*** |
| | (0.088) | (0.063) | (0.042) | (0.087) | (0.064) | (0.042) |
| n firms | -0.001 | 0.001*** | -0.001 | -0.001 | 0.001*** | -0.001 |
| | (0.0010) | (0.0002) | (0.0010) | (0.0010) | (0.0002) | (0.0010) |
| ln gdp | -0.212 | 0.255* | -0.051 | -0.211 | 0.223* | -0.062 |
| | (0.172) | (0.126) | (0.132) | (0.173) | (0.130) | (0.132) |
| ln distance | -0.353* | -0.227** | -0.324** | -0.353* | -0.238** | -0.326** |
| | (0.212) | (0.097) | (0.150) | (0.212) | (0.096) | (0.150) |
| lang distance | 3.664*** | 1.480*** | 3.032*** | 3.663*** | 1.572*** | 3.062*** |
| | (1.117) | (0.480) | (0.805) | (1.117) | (0.483) | (0.804) |
| rel wage | -0.054 | -0.287*** | -0.145 | -0.053 | -0.297*** | -0.148 |
| | (0.124) | (0.074) | (0.095) | (0.124) | (0.076) | (0.096) |
| institutions | 0.002 | -0.001 | 0.001 | 0.005 | -0.047*** | 0.007 |
| | (0.003) | (0.002) | (0.002) | (0.011) | (0.017) | (0.009) |
| edu (industry) | 0.478** | 0.830*** | 0.402*** | 0.481** | 0.821*** | 0.396*** |
| | (0.208) | (0.172) | (0.132) | (0.209) | (0.172) | (0.131) |
| communication | -2.267*** | -0.663*** | -0.819*** | -2.278*** | -0.658*** | -0.797*** |
| | (0.274) | (0.169) | (0.115) | (0.276) | (0.168) | (0.114) |
| inst*comm | | | | 0.357 | 0.083 | -0.407 |
| | | | | (0.398) | (0.222) | (0.224) |
| nonroutine | 1.492*** | 0.993*** | 0.868*** | 1.502*** | 0.807** | 0.855*** |
| | (0.191) | (0.319) | (0.237) | (0.195) | (0.339) | (0.242) |
| inst*nonroutine | | | | 0.333 | -1.605*** | -0.054 |
| | | | | (0.558) | (0.496) | (0.359) |
| R-sq | 0.15 | 0.13 | 0.25 | 0.15 | 0.13 | 0.25 |

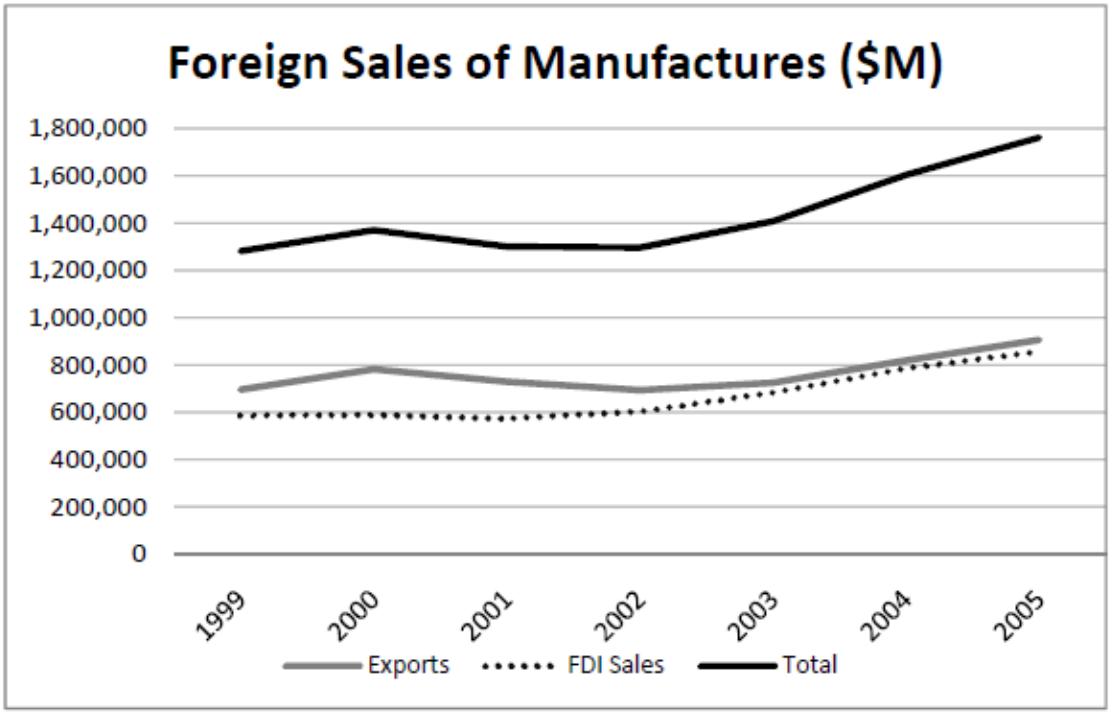
*,** and *** indicate significance at the 10, 5 and 1 percent levels, respectively

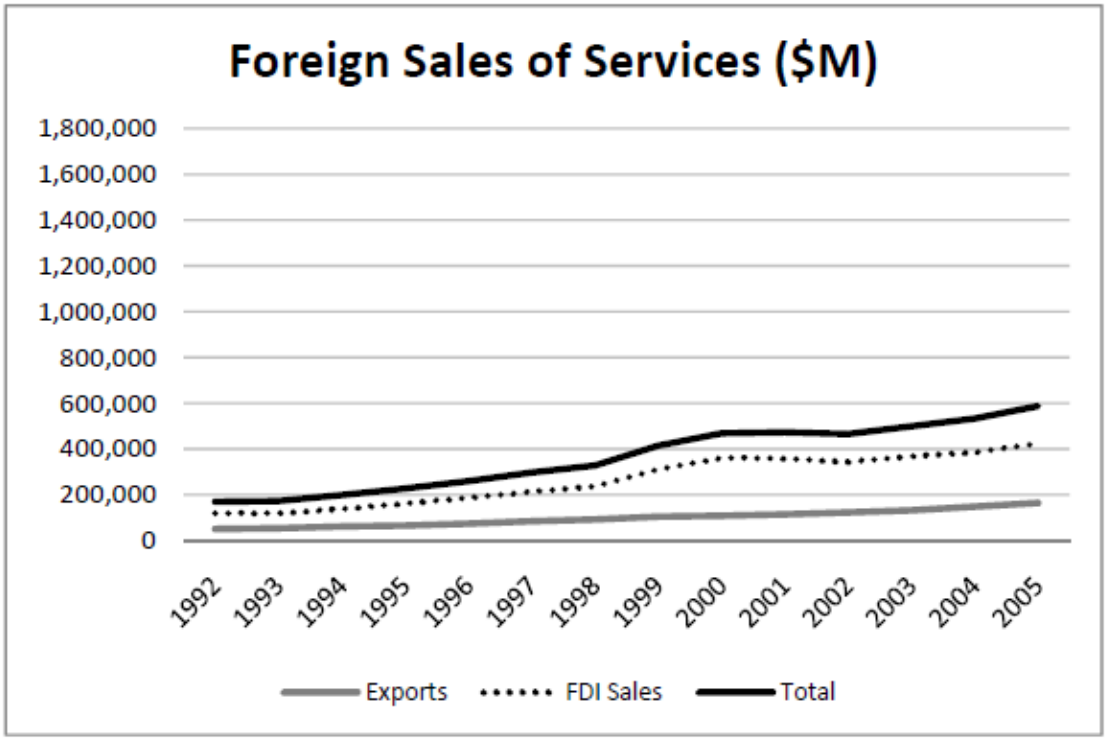
Table 9: Export-FDI model with comparative advantage controls, country and industry fixed effects

| Model : | 1 | 2 | 3 |
|---|---|---|---|
| Sample: | goods | services | goods |
| N: | 3819 | 1783 | 3819 |
| Depvar: | ln(x/fdi) | ln(x/fdi) | ln(x/fdi) |
| inst*nonroutine | 0.11 | -0.565** | 0.072 |
| | (0.295) | (0.241) | (0.293) |
| inst*communication | -0.259 | 0.012 | -0.227 |
| | (0.359) | (0.068) | (0.357) |
| capital intensity*endowment | | | 0.009 |
| | | | (0.063) |
| skill intensity*endowment | | | 0.199 |
| | | | (0.163) |
| R-sq | 0.41 | 0.39 | 0.41 |

*,** and *** indicate significance at the 10, 5 and 1 percent levels, respectively

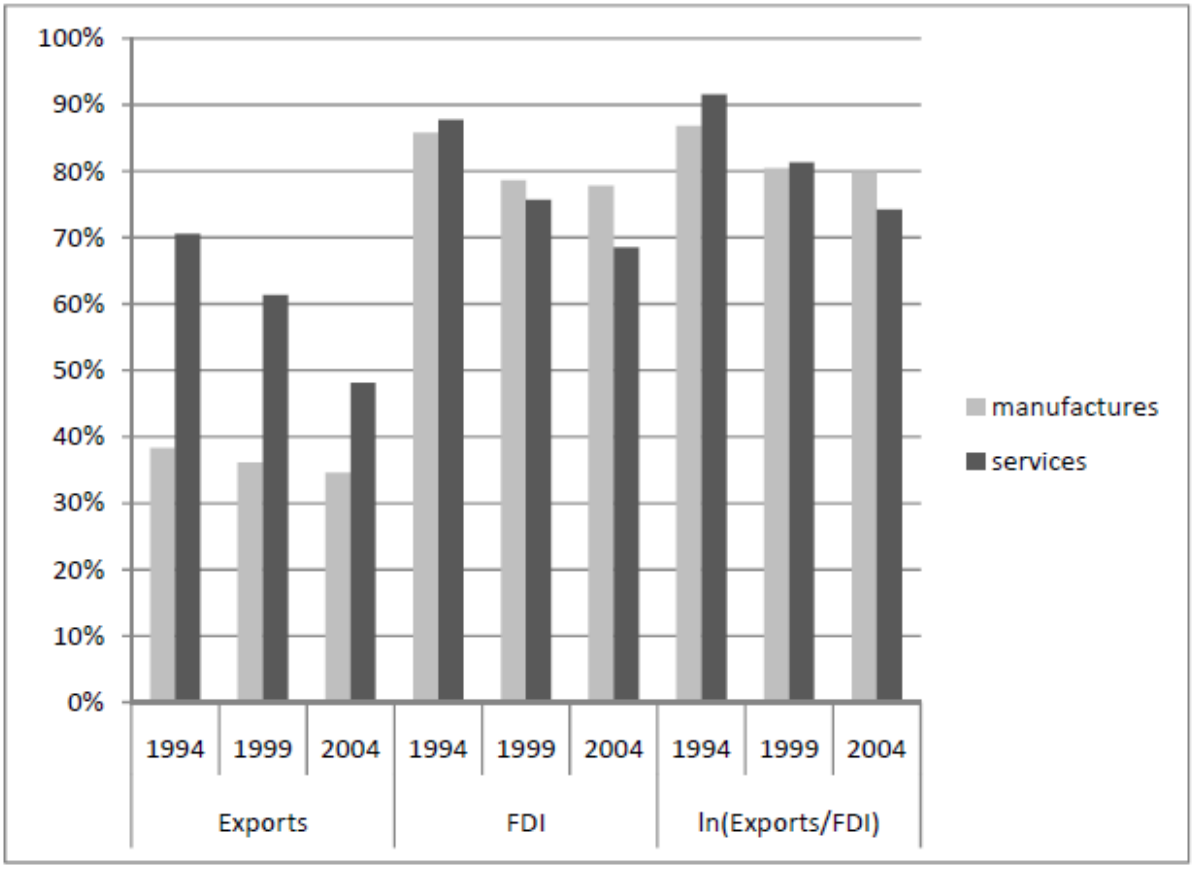
Figure 1: Share of export and FDI sales in manufacturing and service industries




Constructed using publicly available data from www.bea.gov

Figure 2: Share of zeros in all possible country-industry pairs




Compiled using data from Feenstra and BEA.