The Task Composition of Offshoring by U.S. Multinationals *

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Abstract

Grossman and Rossi-Hansberg (2008) develop a model in which the extent of offshoring done by a firm is determined in part by an exogenous cost parameter that varies depending on which activity is being offshored. I build on their framework by explicitly modeling the source of these costs. I draw on insights from adaptive theories of the firm to sketch a model in which less routine tasks are more costly to offshore. I test this prediction using firm level data on U.S. multinationals to identify which intermediate inputs these firms offshore to their foreign affiliates. Controlling for parent firm and country fixed effects as well as a measure of the feasibility of offshoring, I find that U.S. producers are more likely to import an intermediate input from a foreign affiliate the more intensively that input uses routine tasks. More complex and nonroutine activities are more likely to be performed at the multinational's headquarters in the U.S.

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1 Introduction

The nature of trade has been changing in recent years. Improvements in information technology allow for increased fragmentation of the production process across borders not just in manufacturing, but also in information and business services. Figure 1 shows that total U.S. imports of services more than doubled from 1997 to 2005. These include services provided to final consumers, however the main driver of this growth is trade in intermediate service inputs. As with goods, intermediate or support services may be imported even if the final product is produced in the U.S., a practice often referred to as offshoring. Figure 2 shows that imports of services by U.S. firms from their affiliates in other countries, a measure of one dimension of offshoring, has increased by about 70% since 1999. Figure 3 shows these intrafirm service imports as a share of total U.S. multinational sales.

Even though the fragmentation of production in services is in many ways similar to the fragmentation of production of goods, this expansion of services trade has been accompanied by fears among some in the U.S. that service offshoring will result in the loss of "good" jobs, perhaps because service occupations pay higher average wages than manufacturing jobs. Economist Alan Blinder has advanced his view that "the dividing line between the jobs that produce services that are suitable for electronic delivery (and are thus threatened by offshoring) and those that do not does not correspond to traditional distinctions between high-end and low-end work." (Blinder 2006). If service offshoring negates the traditional U.S. comparative advantage in high skilled industries as Blinder suggests, then offshoring of services has implications not only for trade policy but also for education and job training. I attempt to shed some empirical light on this question by examining which characteristics determine the likelihood that a certain service activity will be offshored. A few papers have attempted to estimate which U.S. jobs are most likely to be offshored. However, due to a lack of data on service offshoring, these have primarily relied on "guesstimates" (Blinder 2007) or extrapolations based on U.S. production patterns (Jensen and Kletzer 2007).

This paper will also make a distinction between the feasibility of offshoring due to characteristics such as the extent to which an activity must be performed close to consumers (e.g. haircuts vs. data entry), and the desirability of offshoring in equilibrium, regardless of these technical delivery characteristics. For example, the technology may exist for a U.S. firm to offshore its research and development to China, however the firm may choose not to do this in equilibrium because of costs associated with intellectual property rights or quality assurance. In other words, just because it is possible to offshore something, that does not necessarily imply that it is optimal to do so.

In this paper, I use confidential, firm-level data on the operations of U.S. multinational companies in both manufacturing and service industries, paired with data on the specific activities performed in these industries, to identify which activities multinational companies perform in the U.S. and which activities they perform offshore. This exercise is motivated by a desire to explain business process offshoring, however because the theory applies to any activity being offshored, I use data on both manufacturing and service industries. I exploit the fact that each U.S. multinational parent firm has multiple affiliates operating in different countries and industries. By controlling for the identity of the parent firm and the country of location, I can identify which tasks are more likely to be performed at the U.S. headquarters and which tasks are more likely to be offshored. The results show that more complex, nonroutine activities stay in the U.S. and more routine, manual tasks are more likely to be offshored. The results hold up when industry fixed effects are included, as well. I also control for the importance of interacting with customers to address the issue of tradeability and find that the importance of routineness for offshoring still holds.

The empirical specification follows from a theoretical model of trade in tasks. Grossman and Rossi-Hansberg (2008) develop a model in which trade consists of a series of value-added tasks that can be performed in any location, rather than as physical shipments of goods. In their model, the extent of offshoring is determined by an exogenous cost parameter, which varies by task. I use their basic framework, but I explicitly model the source of task-specific trade costs. During the production process, problematic situations may arise, the nature of which cannot be fully specified ex ante. These problematic situations are more easily resolved within the management center of the firm than at a foreign affiliate. Thus we would expect that firms are more likely to offshore intermediate inputs that are less likely to give rise to problematic situations that can't be fully specified ex ante. In other words, the more routine an intermediate input is, the more offshoring relative to domestic production should take place.

The use of the routine versus nonroutine dichotomy is motivated by Autor, Levy and Murnane (2003) who use this distinction to measure how certain activities respond to skill biased technical change. Anecdotal evidence suggests that this dichotomy is also relevant for firm-level offshoring decisions. In an interview with a former vice president of a well known consulting firm responsible for handling offshoring contracts, he explained that the firm had a lot of success offshoring routine activities, such as looking up publicly available information on IPOs and share prices and packaging that information into presentations. However, a pilot program attempting to offshore more nonroutine, or in his words "strategic", activities, was a failure.[1] In "The World is Flat", Thomas Friedman includes an interview with Vivek Kulkarni, who tells a very similar story from the perspective of an Indian firm that handles those tasks offshored by U.S. investment firms. Kulkarni says, "We will do the lower-end work and they will do the things that require critical judgment and experience" (Friedman 2005). A Stanford Graduate School of Business case study about an offshoring company in India, ExlService, distinguishes between "commoditized" services, which western firms are eager to offshore, and more complex processes, an area in which it is much more difficult for Indian firms to attract business (Spitzer 2006). However, in spite of this anecdotal and case study evidence, to my knowledge this is the first paper that empirically estimates the relationship between the routineness of tasks and offshoring.

2 Theoretical Framework

2.1 Motivation

A number of different theoretical frameworks have been used to study offshoring. Feenstra and Hanson (1996) divide the production of final goods into a continuum of intermediate inputs and identify which activities along that continuum will be offshored based on the relative costs of production across countries. Antras, Garicano and Rossi-Hansberg (2006) look at the formation of global teams of high and low skilled workers. Grossman and Rossi-Hansberg (2008) develop a model in which trade consists of a series of value-added tasks that can be performed in any location, rather than as physical shipments of intermediate goods. For this paper, I use a model based on the one developed by Grossman and Rossi-Hansberg. In their model, the extent of offshoring is determined by an exogenous cost parameter that varies by task. I use their basic framework but I explicitly model the source the the task-specific trade costs using insights from adaptive theories of the firm.[2]

[1] In person interview conducted December 2007 in Washington DC

[2] The adaptive motives described here are similar to those in the literature on the "make or buy" decision. That is, whether a firm will own its suppliers or source arms length. Adaptive theories of the firm have been developed by Simon (1951) and Williamson (1975) and have been summarized more recently by Tadelis (2002) and Gibbons (2005) and tested empirically by Costinot, Oldenski and Rauch (2009). Rather than focusing on the ex ante costs of production, these models emphasize costs associated with the contracting of inputs that are incurred ex poste. During the production process, problematic situations may arise, the nature of which can not be fully specified ex ante. In the adaptive literature, these problematic situations have been shown to be more easily resolved within the firm than between a headquarters firm and its arms-length suppliers because renegotiation costs are lower (Bajari and Tadelis 2001), because incentives

When the unpredictable happens, it is much more easily dealt with in the management center of the firm than at a foreign affiliate. Thus we would expect that firms are more likely to offshore those intermediate inputs that are less likely to give rise to problematic situations that can't be fully specified ex ante. In other words, the more routine an intermediate input is, the more offshoring relative to domestic production should take place.

Ideally, I would like to compare four options that are available to the firm: (1) sourcing domestically within the firm, (2) sourcing domestically outside of the firm, (3) sourcing internationally within the firm (i.e. producing at a foreign affiliate), and (4) sourcing internationally at arms length. However I only have access to firm-level data for production within the firm (options (1) and (3)). Thus, this analysis necessarily assumes that the firm has already decided to source internally and and asks, conditional on that decision, whether production will be done in the U.S. headquarters or at a foreign affiliate.

2.2 Basic Setup

The basic set up follows Grossman and Rossi-Hansberg (2008). Their framework essentially tells a comparative advantage story in which the ex ante cost of producing a task is lower in certain countries than in others. This explains the composition of offshoring across countries. I then draw on adaptive models, following Costinot, Oldenski and Rauch (2009) to put structure on the task-specific trade costs.[3] This explains the composition of offshoring across tasks. In other words, differences in country characteristics explain why firms offshore in the first place, but they do not explain the composition of offshoring between different tasks. This is explained by the trade costs I outline below which prevent offshoring of certain activities that would otherwise occur. My contribution is to show that these trade costs are greater for less routine tasks.

Grossman and Rossi-Hansberg develop their model for the purpose of looking at the impact of offshoring on high versus low skilled workers in high and low skill-intensive industries. Because my goal is to determine which activities are more likely to be offshored rather than how this offshoring impacts the wages of high and low skilled workers, I make several simplifications relative to Grossman and Rossi-Hansberg. Specifically, I only include one type of labor and I do not divide final output into high and low skill intensive industries.

for opportunistic behavior are lower (Tadelis 2002 and Williamson 1985), or because firms have internal languages that facilitate communication and problem soling (Cremer, Garicano, and Prat (2007)).

[3]Costinot Oldenski and Rauch look at the make or buy decision, however the same intuition used to evaluate production inside or outside the boundaries of the firm can be used to evaluate the decision to produce inside or outside the headquarters country.

The production process can be divided into two stages: the production of intermediate tasks and the production of final goods and services. Intermediate suppliers use one factor of production, labor (L), to produce tasks (i) according to a constant returns to scale production function. The total output of task i in country c for multinational parent firm p is given by

$$Y_{pc}(i) = \frac{L_{pc}(i)}{a_c(i)} \tag{1}$$

where $L_{pc}(i) \geq 0$ is the amount of labor allocated to task i in country c at affiliates of parent firm p and $a_c(i) > 0$ is the amount of labor necessary to perform task i once in country c.

Final goods and services are produced at the multinational headquarters in country 1, the United States. Parent firms transform intermediate task inputs into goods and services using a constant returns to scale technology. The total amount of final output in industry j produced by parent firm p using tasks $i = 1, ..., I$ is given by

$$Y_{pj} = F_j[Y_{pc}(1), ..., Y_{pc}(I)] \tag{2}$$

Grossman and Rossi-Hansberg (2008) introduce an offshoring cost $t(i)$ that captures the unspecified costs of performing each task abroad. I put structure on this cost by reframing it as a function of the routineness of each task. For each task there exist two states of the world, "routine" and "problematic." Tasks only differ in their probabilities $\mu(i)$ of being in the routine state. $\mu(i) \geq 0$ is an exogenous characteristic of a task, which can be thought of as its routineness. Without loss of generality, tasks are indexed such that higher numbered tasks are less routine, $\mu'(i) < 0$. Note that the probability of being in the routine state, $\mu(i)$, is inversely related to the cost of offshoring, $t(i)$.

For each task input, parent firms in the United States can choose between producing that task domestically or offshoring. Firms compare the cost of producing intermediate tasks in the U.S. ($c = 1$) against the cost of offshoring ($c = 2, ...C$). Location choices affect the cost of production at the task level both ex ante and ex post. Grossman and Rossi-Hansberg assume that the amount of labor required to to perform a task once in a given country is fixed, and they model $t(i)$ as an additional cost imposed on offshoring. In my adaptive framework, the higher cost of offshoring less routine activities manifests itself as an increase in the unit labor requirement, as firms must expend effort to deal with the problematic state. Let $a_c(i) > 0$ denote the amount of labor necessary to perform task i once in country c and let w_c denote the wage in country c. The cost of producing a task in a given country, $w_c a_c(i)$

can be decomposed into

$$w_c a_c(i) = w_c(\alpha_c(i) + [1 - \mu(i)]\beta_c(i)) \tag{3}$$

where $\alpha_c > 0$ is the ex ante unit labor requirement, and $\beta_c > 0$ is an additional ex post unit labor requirement capturing the amount of labor necessary to deal with the problematic state.

If this adaptive motive for determining the location of task production holds, then we would expect that for any country $c = 2, ..., C$, cost savings result from offshoring ex ante, $w_{us}\alpha_{us}(i) > w_c\alpha_c(i)$, but if the problematic situation obtains, then productivity is higher under domestic production ex post, $w_{us}\beta_{us}(i) < w_c\beta_c(i)$.

The basic trade-off associated with the decision to locate production at home or abroad is that domestic production is more costly ex ante, but less costly ex post. It has been shown in previous research that this tradeoff exists for the decision to produce inside or outside the firm (see Costinot, Oldenski and Rauch 2009). The same result should hold for the geographic location of production inside the firm. Traditional studies of adaptive theories of the firm define the boundaries of the firm based on ownership regardless of location. The intuition is the same for moving across the boundary of the multinational parent to produce at an affiliate branch.

2.3 Testable implications

For each intermediate task input, profit maximization requires that the firm produces that task where $w_c a_c$ is lowest. Recall that, without loss of generality, tasks can be indexed such that $i = 1$ is the most routine and $i = I$ is the least routine. By equation (3), then for any country $c = 2, ..., C$, there exists $i_c^* \in 0, ..., I$ s.t. task i is offshored if and only if $i \leq i_c^*$.

Ideally I would like to test the relationship between routineness and offshoring using task-level data. However, data on multinational operations are collected at the level of industries and firms, not tasks. Instead, I define an industry-level measure that captures the intensity with which each task is used in a given industry.

Definition 1 *An industry j is less routine than another industry j' in country c if, for every pair of tasks $I \geq i \geq i' \geq 1$, task intensities satisfy $b_c^j(i)/b_c^j(i') \geq b_c^{j'}(i)/b_c^{j'}(i')$.*

Where $b_c^j(i)$ is the share of task i relative to total task inputs required for the production of output in industry j. In other words, an industry j is less routine than another industry

j' if j is relatively more intensive in the less routine tasks. I will be using this industry level definition of task intensity to test the relationship between routineness and offshoring.[4]

3 Empirical Specification

As mentioned in the theoretical motivation, I would ideally like to use data on how multinationals divide tasks across locations. But trade and FDI data are collected at the industry and firm level, rather than at the task level. Thus I rely on firm level data augmented with industry level task intensity measures to examine the relationship between routine task intensity and offshoring. Several additional characteristics of the data on multinational activities aid in the empirical identification strategy. First, a single U.S. multinational parent firm often has affiliates operating in a number of different countries and industries. I use this variation in location of activities within the firm to identify which activities are offshored, controlling for both parent firm and destination country fixed effects. Second, while a single multinational parent generally operates in several different industries, individual affiliates of that parent tend to be much more narrowly focused by industry. Therefore I can exploit the variation in the focus of production activities across affiliates of one parent.

The primary specification is:

$$V_{pci} = \beta_1 T_i + \delta_c + \delta_p + \varepsilon_{pci} \tag{4}$$

Where V_{pci} is a measure of vertical offshoring, defined as shipments from foreign affiliates of U.S. multinational to the U.S. as a share of total sales by the multinational parent. More specifically, V_{pci} includes shipments from affiliates of parent p that are operating in industry i and located in country c as a share of total sales by the parent firm. T_i captures the intensity with which industry i uses certain routine or nonroutine tasks. δ_c is a country fixed effect and δ_p is a parent firm fixed effect.

To accurately capture vertical offshoring, I would like to have data on the volume of each input that is imported relative to the volume that is produced in the multinational headquarters. However, absent this data, weighting by total firm sales provides a measure of vertical offshoring relative to total production.

Equation (4) does not include industry fixed effects because task intensity is a time-

[4] Note that this assumes that the ranking of sectors in terms of routineness does not vary across countries. This assumption allows me to conduct empirical tests using data on the task intensity of industries from the U.S. (rather than the country in which the offshoring occurs).

invariant industry level characteristic. However, as a robustness check I also include a specification with industry fixed effects where the variable of interest is the task intensity of the industry interacted with the total sales of the firm. An extensive literature has provided evidence that it is the largest and most productive firms that engage in the most trade and offshoring (see, for example, Melitz (2003), Antras and Helpman (2004), Bernard et al. (2006), or Breinlich and Criscoulo (2009)). Thus we would expect these larger firms to be more responsive to offshoring opportunities provided by routine task intensive activities.

4 Data

The Bureau of Economic Analysis collects firm-level data on U.S. multinational company operations in both goods-producing and service-producing industries in its benchmark surveys of U.S. direct investment abroad. I use these data to define a measure of vertical offshoring. This variable consists of the total shipments by a foreign affiliate back to the U.S. as a share of the U.S. parent firm's total sales. The data do not distinguish between sales back to the U.S. parent of intermediates and final goods. However, the basic decision to locate production at the U.S. headquarters or at a foreign affiliate should apply to both intermediate inputs as well as final goods and services that are simply distributed by the parent firm.

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. My primary specification uses data from 2004, however for robustness checks I also use data from 1994 and 1999, two other years in which benchmark surveys were conducted. The BEA surveys cover 54 manufacturing industries and 33 service industries, classified according to BEA versions of 3-digit Standard Industrial Classification (SIC) codes.

Data from other sources are used for robustness checks. I use an index of regulation and enforcement from the World Bank's Doing Business Database to proxy for the level of institutional quality. 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. Data on the relative endowment of skilled to unskilled labor by country are from Hall and Jones (1999). 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 the U.S. Census. The linguistic distance between countries based on language trees from Fearon (2003) is used to capture the effect of language.

5 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. Nonroutine tasks require more complicated activities like creative problem solving and decision making. Autor, Levy and Murnane emphasize that these tasks are sufficiently complex that they can not be completely specified in computer code and executed by machines. I follow this routine/nonroutine categorization in estimating the location of intermediate production activities, generalizing the Autor, Levy and Murnane framework to classify any activities that are too complex to be fully specified in a contract ex ante as nonroutine.

The Department of Labor's Occupational Information Network (O*NET) includes data on the importance of 277 tasks, skills and abilities in about 800 occupations. Blinder (2007) and Jensen and Kletzer (2007) use this data to develop 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. To match the relevant task measures to the industry-level trade and investment data, I aggregate the 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.

I combine data on the task requirements of occupations from O*NET with data on the operations of multinational firms from the BEA to create an index of task intensity in each industry. The importance score of each task, i in each industry, j is

$$M_{ij} = \sum_{o} \gamma_{jo} \ell_{io} \tag{5}$$

where i indexes tasks, o indexes occupations, and j indexes industries. Thus γ_{jo} is the share of occupation o used in the production of industry j, and ℓ_{io} is an index of the importance of task i for occupation o.[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, i, in each industry, j:

$$I_{ij} = \frac{M_{ij}}{\sum_i M_{ij}} \tag{6}$$

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.

I took two different approaches to distilling the O*NET data into a simple measure of each task characteristic. The first approach is similar to Autor, Levy and Murnane (2003) and consists of identifying an individual task measure that most closely proxies each desired characteristic. To capture the level of task complexity (which corresponds to Autor, Levy and Murnane's "non-routine cognitive" category), I use the O*NET measures of "creative thinking" and "making decisions and solving problems." I use the O*NET measures "handling objects" and "operating machines (other than vehicles)" to proxy routine manual activities. To control for the feasibility of offshoring as emphasized by Blinder (2007), I use the O*NET measure "working with the public" as a proxy for the need to interact with customers.

The second approach 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

[5] ℓ_{io} 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.

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. Table 1 shows these task intensity scores for a selection of industries included in the sample.

Table 2 shows correlations between the task measures and other relevant variables. All three measures of nonroutine task intensity are positively correlated with each other and negatively correlated with the measures of routine task intensity. Nonroutine tasks are positively correlated with the average worker education level by industry, while routine tasks are negatively correlated with this measure of skill-intensity. Similarly, the need to communicate with customers is positively associated with nonroutine task intensity and negatively associated with routine task intensity. Observations for less routine tasks are positively correlated with institutions and wages, while more routine tasks are associated with countries that have low wages and weaker institutions, however the magnitudes are small in these unconditional correlations.

6 Results

Table 3 presents the results of the specification using 2004 data and controlling for both country and parent firm fixed effects. The dependant variable is vertical offshoring by parent firms whose primary industry is either manufacturing or services. Column 1 shows that there is a negative and significant relationship between the importance of communicating with customers in an industry and the extent of offshoring done by firms in that industry. Column 2 shows the impact of the principal component measure of nonroutine task intensity. Columns 3 and 4 show the impact of the individual task proxies for nonroutineness: problem solving and creativity. All three sets of results suggest that the more nonroutine and industry is, the lower is the share of value-added by foreign affiliates. Columns 5 through 7 present the results using three different measures of routineness. Consistent with the first three specifications, more routine task-intensive intermediates are more likely to be performed by foreign affiliates. These results support the adaptive theory of offshoring outlined in Section 2. More routine task intensive industries are less likely to give rise to unpredictable and problematic situations and are therefore less costly to offshore relative to nonroutine task intensive industries.

Table 4 controls for communication intensity in the routineness regressions. Even when controlling for this measure of the feasibility of offshoring, nonroutine tasks are still significantly associate with less offshoring while routine tasks are significantly more likely to be offshored. In all specifications, the role of routine task intensity is greater than the role of communication intensity in terms of coefficient magnitude and/or significance.

Because the nonroutine task intensity of an industry is correlated with skill intensity, I also run the regressions controlling for the average education level of workers in each industry. These results are presented in Table 5. The coefficient on skill is positive and significant for most specifications, suggesting that, all else equal, an increase in the skill-intensity of an industry is associated with a larger share of offshoring in total firm sales. This is perhaps surprising from a comparative advantage perspective, since we would expect the U.S. to offshore more low skilled activities. However, keep in mind that these regressions also control for the task composition of industries as well as country fixed effects. Also, because data are not available to compare the task intensity of offshored intermediates to that of inputs produced at home, the left hand side of the regression captures the share of offshoring in total production. If the per unit value of high-skill intensive inputs is higher than that of low-skill intensive inputs, then this could explain the larger share for those high-skilled inputs. These results also suggest that routine task intensity, rather than skill intensity, may be a better measure of U.S. comparative advantage.

The preferred specifications presented in Tables 3 through 5 control for country fixed effects. However, these country dummies hide potentially interesting information about individual country characteristics that may impact the offshoring decision. Table 6 presents the results of a specification that replaces the country fixed effects with several relevant country characteristics. Consistent with standard gravity results, distance decreases the offshoring share and GDP increases it. Linguistic distance ($langdist$) is also a deterrent to offshoring. The variable $dispersion$ measures the standard deviation of sales of firms within each industry. Consistent with Melitz (2003), an increase in this proxy for heterogeneity of productivity among firms in an industry increases trade. The variable $lnwcwu$ is the log of the average manufacturing wage in the country in which the the affiliate is located relative to the average U.S. manufacturing wage. The negative coefficients on this measure suggest that U.S. firms offshore more intermediate production to countries with lower wages. Institutional quality, as measured by the World Bank's Doing Business database, increases the offshoring share. Low corporate tax rates have no significant impact on the offshoring decision, as defined in this study. It is possible that tax rates determine where affiliates are located in the first place, however this study considers the shares of shipments from existing affiliates by industry, which does not vary with corporate tax rates. The relationship between task intensity and offshoring still holds in this specification.

In addition to their statistical significance, the results are also economically significant in magnitude. The results from Table 3 suggest that a 1 point decrease in the scaled problem solving intensity of an industry leads to a 228% increase in the share of offshoring in total production. The standard deviation of the problem solving scores is 0.21. So, for example, moving from the 25th to the 75th percentile in terms of problem solving intensity results in a 60% decrease in the expected offshoring share. Also, the average service industry has a problem solving intensity score that is 0.21 points higher than the average manufacturing industry. This would suggest that there should be about 48% more offshoring in manufacturing relative to service industries due to this task dimension.

7 Results using industry fixed effects

Because the measures of task intensity are non-time varying industry level characteristics, it is not possible to control for industry fixed effects in specifications using these measures. However, I draw on findings from the literature on trade by heterogeneous firms to interact this industry level characteristic with firm size, creating a variable of interest that allows for the inclusion of industry fixed effects when looking at the role of tasks. The literature on trade by heterogeneous firms has shown that it will be the larger, more productive firms that are able to most effectively engage in trade. This result also applies to the division of tasks across geographic locations. In particular, Breinlich and Criscoulo (2009) examine firm level data on service importers and exporters in the UK and find that firms that import services are larger and more productive than non-trading firms. Thus we would expect that the interaction between firm size (which has been shown to be a good proxy for firm productivity) and routine task intensity, should be positive and significant. Table 7 presents the results including fixed effects at the industry, country and firm level. Columns 2 through 4 show that the interactions between total firm sales and the nonroutine task intensity are negative and significant. The coefficients on interactions between routine tasks and total firm sales are positive and significant. These results suggest that the task content of firm activities is a significant predictor of the geographic location of production within the firm, even when industry fixed effects are controlled for. In addition, the relationship between the routineness of tasks and offshoring is stronger for larger, more productive firms. The same result holds for the importance of communicating with customers.

Table 8 shows the impact of routine task intensity interacted with total firm sales while controlling for communication intensity interacted with sales. The results for routineness still hold. however, when the routineness interactions are included, communication intensity interacted with firm sales is either not significant or else significantly positive. This implies that, controlling for routineness, larger firms are more likely than smaller ones to offshore tasks that involve communicating with consumers.

Table 9 includes both the task intensity measures (without industry fixed effects) and the interactions between task intensity and total firm sales. Again, the results suggest that nonroutine tasks are less likely to be offshored to foreign affiliates, and this effect is greater for larger, more productive firms. More routine tasks are more likely to be offshored, especially in the case of firms with higher volumes of sales. Tasks requiring communication with customers are less likely to be offshored, however, there is some evidence that larger firms are more likely to overcome this communication hurdle than are smaller firms.

8 Robustness Checks

The results described above all use data on offshoring from 2004. To test the sensitivity of the results to the use of this year, I also run the regressions using data from 1994 and 1999. Table 10 pools these years and also controls for year specific fixed effects. As in the previous results, more routine tasks are more likely to be offshored and less routine tasks are less likely to be offshored, even when controlling for the skill intensity of the industry and the importance of communicating with customers. To see if the relationship between tasks and offshoring has changed over time, I also run the model using only 1994 and only 1999 offshoring data. These results are presented in Tables 11 and 12. The numbers of observations for these two years are much smaller than for 2004, showing that the number of affiliates shipping products back to the U.S. increased between 1994 and 2004. The basic relationship between tasks and offshoring holds for all years. However, the magnitude and significance of the effect of task intensity is increasing with time.

It is possible that manufacturing and service industries exhibit different relationships between task intensities and offshoring. Table 13 presents the results of the model using only affiliates whose primary activity is a service industry. Table 14 presents the results using only manufacturing affiliates. The coefficients are all larger in magnitude for the sample of services producers relative to the sample of manufacturers, suggesting that the task composition of an industry matters more for the offshoring of services than for the offshoring of manufactures.

Also, while the the routine task intensities are all highly significant for manufacturing, the nonroutine task intensities are mixed. This could be because there is less variation across manufacturing industries in their use of nonroutine tasks.

9 Conclusion

Much of the political debate over services trade rests on the assumption that an increase in offshoring will put a large number of jobs at risk in the U.S., particularly those that can be considered "good" jobs. This paper shows that when offshoring by U.S. service firms occurs, it is the more routine activities that are the most likely to go overseas while to more nonroutine activities remain at U.S. headquarters. Certain analysts perpetuate fears of massive U.S. job loss resulting from the increasing tradability of services, suggesting that the majority of jobs that can be performed remotely will be offshored. For example, Alan Blinder claims that we should focus on "the types of jobs that can be delivered electronically with ease" because "the majority of these jobs are at risk" (Blinder 2005). However, the data suggest that the offshoring decisions of multinational firms are much more complicated than that. Simply because certain activities can be performed at a distance, that does not imply that it will be more profitable for firms to import all of those activities. In addition, because more nonroutine jobs are correlated with higher wages and greater educational levels, the results of this paper suggests that the increased specialization that occurs with service offshoring results in higher skilled, higher paying jobs being performed in the U.S. and relatively more low skilled, low paying jobs moving abroad.

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Table 1: Top ten most routine and nonroutine services, ranked by raw creativity scores

	Most nonroutine industries	
1	Computer related services	83.06
2	Engineering & architecture	74.98
3	Computer processing & data prep	72.84
4	Other finance	72.76
5	Telephone and telegraph	71.48
6	Research, development & testing	71.45
7	Information retrieval	71.01
8	Communications	70.47
9	Advertising	70.44
10	Mgmt consulting & pub relations	70.19

	Most routine industries	
1	Meat products	32.74
2	Leather and leather products	45.18
3	Glass products	47.54
4	Bakery products	47.73
5	Apparel and textile products	48.32
6	Textile mill products	48.65
7	Grain mill products	48.97
8	Heating equip, plumbing, etc	49.37
9	Preserved fruits & vegetables	49.73
10	Plastics products	49.90

Table 2: correlations

	skill	comm	nonrtne	prob	creative	routine	object	machine	gdp	inst	wages
skill	1										
communicate	0.281	1									
nonrtne	0.8741	0.4514	1								
prob solve	0.7555	0.3242	0.9252	1							
creative	0.7632	0.3582	0.8803	0.7566	1						
routine	-0.8154	-0.675	-0.9386	-0.8313	-0.7742	1					
object	-0.8092	-0.6608	-0.9344	-0.8292	-0.7571	0.9966	1				
machine	-0.7911	-0.732	-0.917	-0.798	-0.7681	0.9917	0.9853	1			
gdp	-0.0191	-0.025	-0.0145	-0.0163	0.0139	0.0246	0.0304	0.0256	1		
institutions	-0.0611	-0.0849	-0.0935	-0.0803	-0.0889	0.0991	0.0932	0.0987	-0.239	1	
wages	0.0361	0.0783	0.0711	0.0584	0.0732	-0.0747	-0.0704	-0.0759	0.3292	-0.6696	1

Table 3: Share of shipments from affiliates to parents in total parent sales, 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6	7
N:	13296	13296	13296	13296	13296	13296	13296
communicate	-0.899***						
	(0.088)						
nonroutine		-0.330***					
		(0.025)					
prob solve			-2.277***				
			(0.244)				
creative				-1.813***			
				(0.154)			
routine					0.390***		
					(0.029)		
object						0.553***	
						(0.042)	
machine							0.627***
							(0.046)
Firm FE	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes
R-sq	0.152	0.132	0.133	0.119	0.152	0.153	0.152

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

Table 4: Share of shipments from affiliates to parents in total parent sales, 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	13296	13296	13296	13296	13296	13296
communicate	-0.408***	-0.668***	-0.593***	-0.135	-0.165	-0.018
	(0.103)	(0.096)	(0.095)	(0.126)	(0.124)	(0.136)
nonroutine	-0.268****					
	(0.030)					
prob solve		-1.483***				
		(0.270)				
creative			-1.425***			
			(0.166)			
routine				0.357***		
				(0.042)		
object					0.498***	
					(0.059)	
machine						0.634***
						(0.072)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.125	0.146	0.116	0.141	0.143	0.135

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

Table 5: Share of shipments from affiliates to parents in total parent sales, 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	13296	13296	13296	13296	13296	13296
skill	1.009***	-0.042	0.395**	1.090***	0.937***	1.304***
	(0.190)	(0.150)	(0.160)	(0.201)	(0.193)	(0.208)
communicate	-0.368***	-0.664***	-0.636***	0.153	0.047	0.483***
	(0.104)	(0.099)	(0.096)	(0.137)	(0.131)	(0.155)
nonroutine	-0.438****					
	(0.044)					
prob solve		-1.441***				
		(0.311)				
creative			-1.717***			
			(0.204)			
routine				0.628***		
				(0.065)		
object					0.812***	
					(0.088)	
machine						1.196***
						(0.115)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.130	0.145	0.115	0.155	0.157	0.148

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

Table 6: Share of shipments from affiliates to parents in total parent sales, 2004. Standard errors clustered by country are in parentheses

Model :	1	2	3	4	5	6
N:	10556	10556	10556	10556	10556	10556
skill	0.964***	-0.090	0.210	1.053***	0.855***	1.280***
	(0.216)	(0.168)	(0.184)	(0.227)	(0.217)	(0.235)
ln(distance)	-0.466***	-0.467***	-0.468***	-0.467****	-0.467***	-0.466***
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
ln(gdp)	0.177***	0.178***	0.178***	0.177***	0.178***	0.179***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
lang dist	-0.372**	-0.365*	-0.365*	-0.373**	-0.373**	-0.379**
	(0.187)	(0.188)	(0.188)	(0.187)	(0.187)	(0.187)
dispersion	0.215***	0.241***	0.178***	0.203***	0.203***	0.205***
	(0.042)	(0.042)	(0.043)	(0.042)	(0.042)	(0.042)
lnwiwu	-0.072**	-0.071**	-0.076**	-0.073**	-0.073**	-0.074**
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
institutions	0.008****	0.008***	0.008***	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
tax benefit	-0.003	-0.003	-0.002	-0.003	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
skill endowment	0.044	0.049	0.051	0.043	0.043	0.042
	(0.072)	(0.072)	(0.072)	(0.072)	(0.072)	(0.072)
communicate	-0.369***	-0.661***	-0.703***	0.132	-0.001	0.488***
	(0.124)	(0.119)	(0.115)	(0.158)	(0.151)	(0.179)
nonroutine	-0.443***					
	(0.050)					
prob solve		-1.510***				
		(0.346)				
creative			-1.384***			
			(0.236)			
routine				0.632***		
				(0.073)		
object					0.790***	
					(0.097)	
machine						1.218***
						(0.130)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	no	no	no	no	no	no
R-sq	0.092	0.098	0.090	0.114	0.116	0.110

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

Table 7: Industry fixed effects model, share of shipments from affiliates to parents in total parent sales for 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6	7
N:	13296	13296	13296	13296	13296	13296	13296
comm*sales	-0.270**						
	(0.126)						
nrtne*sales		-0.002***					
		(0.000)					
prob*sales			-1.426***				
			(0.499)				
crtv*sales				-1.259***			
				(0.276)			
rtne*sales					0.002***		
					(0.000)		
objct*sales						0.262***	
						(0.066)	
mchn*sales							0.253***
							(0.070)
Firm FE	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes
R-sq	0.166	0.144	0.254	0.266	0.139	0.073	0.076

Table 8: Industry fixed effects model, share of shipments from affiliates to parents in total parent sales for 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	13296	13296	13296	13296	13296	13296
comm*sales	0.346*	-0.050	0.079	0.563**	0.519**	0.626**
	(0.189)	(0.171)	(0.153)	(0.244)	(0.233)	(0.272)
nrtne*sales	-0.003***					
	(0.001)					
prob*sales		-1.294*				
		(0.675)				
crtv*sales			-1.356***			
			(0.334)			
rtne*sales				0.004***		
				(0.001)		
objct*sales					0.489***	
					(0.122)	
mchn*sales						0.560***
						(0.150)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes
R-sq	0.095	0.257	0.266	0.064	0.032	0.028

Table 9: Share of shipments from affiliates to parents in total parent sales for 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	13296	13296	13296	13296	13296	13296
skill	0.893***	-0.013	0.331**	0.968***	0.844***	1.178***
	(0.191)	(0.150)	(0.160)	(0.202)	(0.193)	(0.208)
communicate	-0.616***	-0.615***	-0.779***	-0.212	-0.269*	0.002
	(0.131)	(0.121)	(0.120)	(0.170)	(0.163)	(0.191)
comm*sales	0.669***	0.000	0.378***	0.890***	0.818***	1.151***
	(0.170)	(0.148)	(0.142)	(0.220)	(0.212)	(0.243)
nonroutine	-0.246***					
	(0.050)					
nrtne*sales	-0.004***					
	(0.001)					
prob solve		-0.918**				
		(0.362)				
prob*sales		-1.654***				
		(0.577)				
creative			-0.673***			
			(0.238)			
crtv*sales			-2.412***			
			(0.284)			
routine				0.398***		
				(0.075)		
rtne*sales				0.005***		
				(0.001)		
object					0.512***	
					(0.100)	
objct*sales					0.675***	
					(0.110)	
machine						0.795***
						(0.130)
mchn*sales						0.899***
						(0.133)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
Industry FE	no	no	no	no	no	no
R-sq	0.097	0.235	0.245	0.041	0.030	0.023

Table 10: Share of shipments from affiliates to parents in total parent sales for 1994, 1999 and 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	21180	21180	21180	21180	21180	21180
skill	0.725***	-0.084	0.187	0.672***	0.548***	0.708***
	(0.136)	(0.104)	(0.114)	(0.142)	(0.134)	(0.148)
communicate	-0.394***	-0.698***	-0.663***	-0.068	-0.163	0.082
	(0.084)	(0.077)	(0.076)	(0.109)	(0.103)	(0.124)
nonroutine	-0.357***					
	(0.033)					
prob solve		-1.261***				
		(0.223)				
creative			-1.195***			
			(0.148)			
routine				0.459***		
				(0.048)		
objects					0.585***	
					(0.063)	
machines						0.782***
						(0.085)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
R-sq	0.139	0.147	0.133	0.154	0.156	0.151

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

Table 11: Share of shipments from affiliates to parents in total parent sales for 1994. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	3893	3893	3893	3893	3893	3893
skill	0.645**	0.102	0.408*	0.683**	0.579**	0.554*
	(0.278)	(0.214)	(0.240)	(0.290)	(0.270)	(0.312)
communicate	-0.043	-0.409**	-0.234	0.156	0.059	0.084
	(0.225)	(0.195)	(0.198)	(0.273)	(0.254)	(0.317)
nonroutine	-0.226***					
	(0.076)					
prob solve		-0.193				
		(0.499)				
creative			-0.817**			
			(0.324)			
routine				0.310***		
				(0.106)		
object					0.376***	
					(0.135)	
machine						0.390**
						(0.195)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.097	0.101	0.096	0.103	0.105	0.102

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

Table 12: Share of shipments from affiliates to parents in total parent sales for 1999. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	3991	3991	3991	3991	3991	3991
skill	0.897***	0.310	0.749***	0.794**	0.778**	0.707**
	(0.331)	(0.248)	(0.275)	(0.334)	(0.311)	(0.353)
communicate	-0.174	-0.533**	-0.322	-0.057	-0.081	-0.085
	(0.249)	(0.215)	(0.214)	(0.308)	(0.283)	(0.355)
nonroutine	-0.245***					
	(0.091)					
prob solve		-0.321				
		(0.567)				
creative			-1.205***			
			(0.371)			
routine				0.271**		
				(0.123)		
object					0.381**	
					(0.153)	
machine						0.370*
						(0.220)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.123	0.126	0.118	0.127	0.129	0.128

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

Table 13: Service affiliates only: Share of shipments from affiliates to parents in total parent sales for 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	4739	4739	4739	4739	4739	4739
skill	1.098***	0.155	0.577*	1.275***	1.340***	1.801***
	(0.383)	(0.332)	(0.323)	(0.414)	(0.413)	(0.427)
communicate	0.427*	0.918***	0.240	1.299***	1.307***	1.633***
	(0.239)	(0.220)	(0.254)	(0.200)	(0.200)	(0.212)
nonroutine	-0.492***					
	(0.095)					
prob solve		-1.605**				
		(0.749)				
creative			-2.532***			
			(0.461)			
routine				0.785***		
				(0.159)		
object					1.183***	
					(0.227)	
machine						1.730***
						(0.272)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.093	0.088	0.094	0.092	0.093	0.096

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

Table 14: Manufacturing affiliates only: Share of shipments from affiliates to parents in total parent sales for 2004. Robust standard errors are in parentheses

Model :	1	2	3	4	5	6
N:	8182	8182	8182	8182	8182	8182
skill	0.442*	-0.052	0.106	0.642***	0.544**	0.677***
	(0.240)	(0.173)	(0.197)	(0.243)	(0.226)	(0.254)
communicate	-1.111***	-1.407***	-1.337***	-0.781***	-0.871***	-0.655***
	(0.161)	(0.133)	(0.130)	(0.204)	(0.188)	(0.236)
nonroutine	-0.181***					
	(0.066)					
prob solve		-0.054				
		(0.386)				
creative			-0.396			
			(0.283)			
routine				0.332***		
				(0.087)		
object					0.413***	
					(0.112)	
machine						0.581***
						(0.157)
Firm FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes
R-sq	0.153	0.153	0.149	0.158	0.160	0.157

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

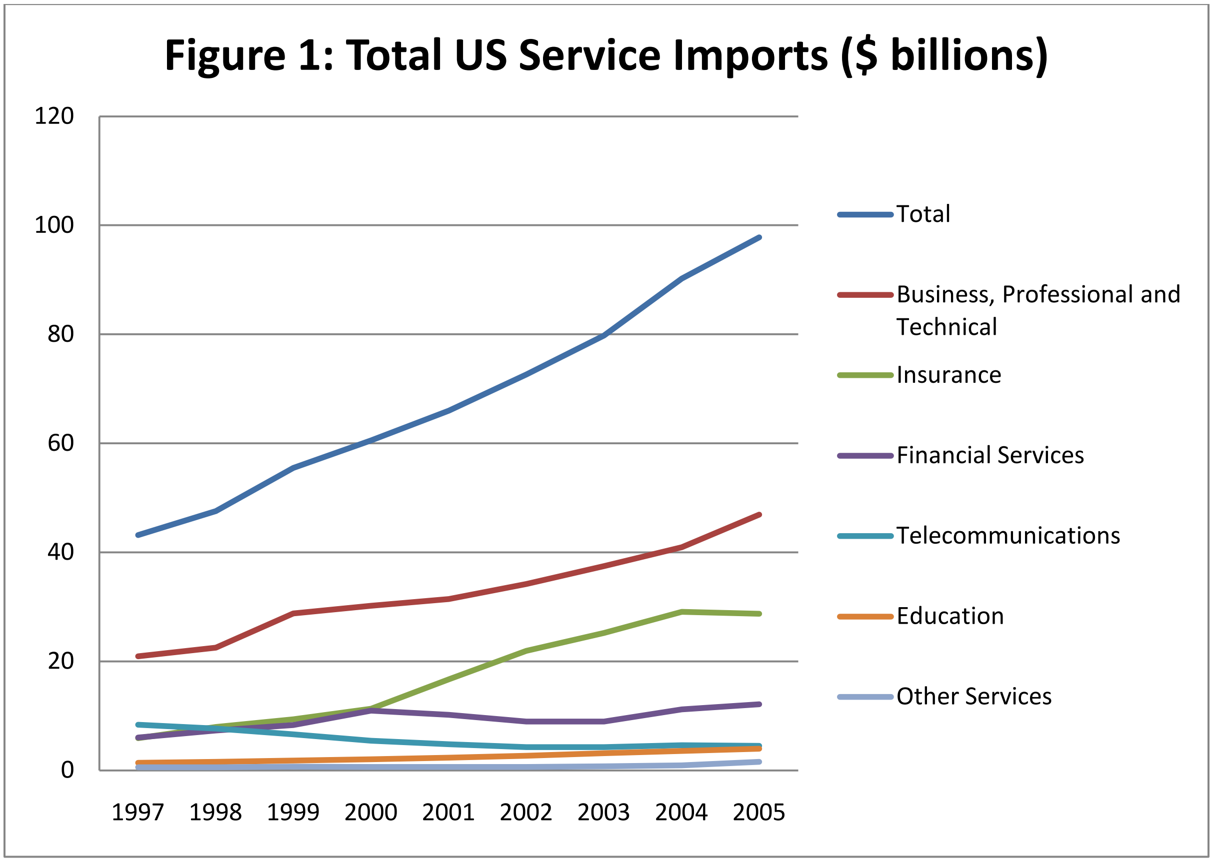
Figure 1: Total US Service Imports ($ billions)
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
Total
Business, Professional and Technical
Insurance
Financial Services
Telecommunications
Education
Other Services

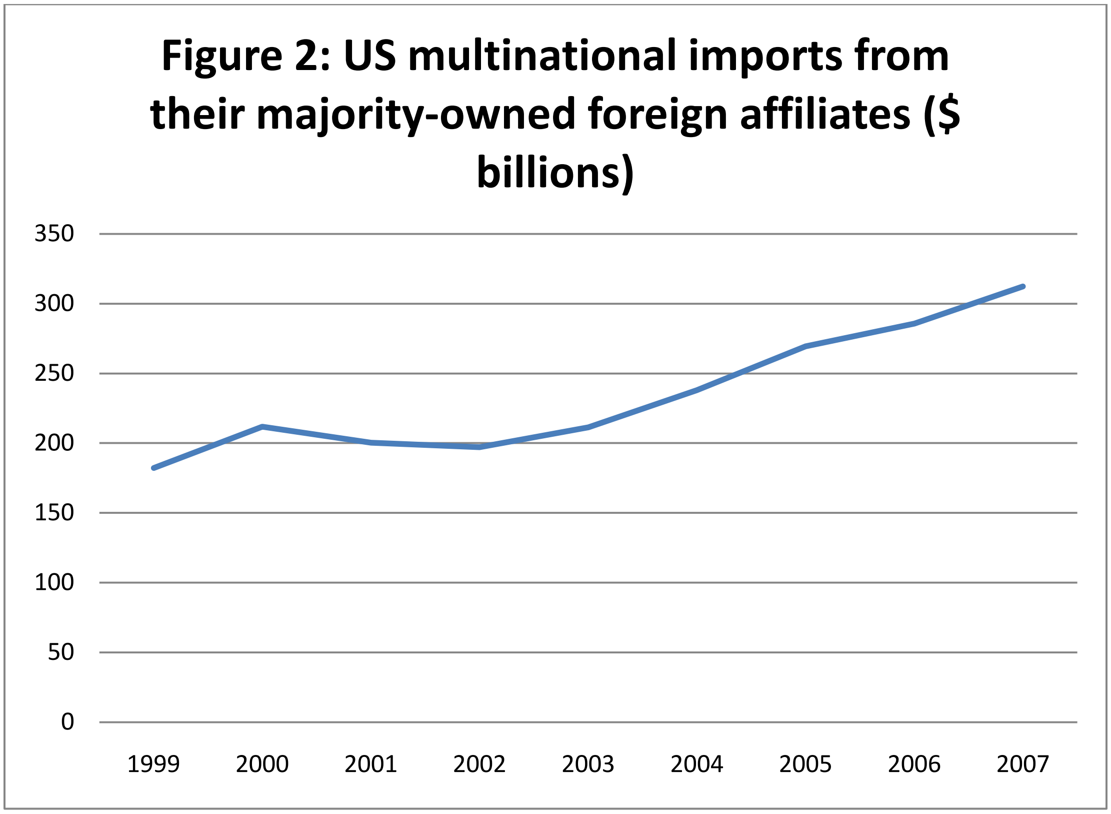
Figure 2: US multinational imports from their majority-owned foreign affiliates ($ billions)
350
300
250
200
150
100
50
0
1999
2000
2001
2002
2003
2004
2005
2006
2007

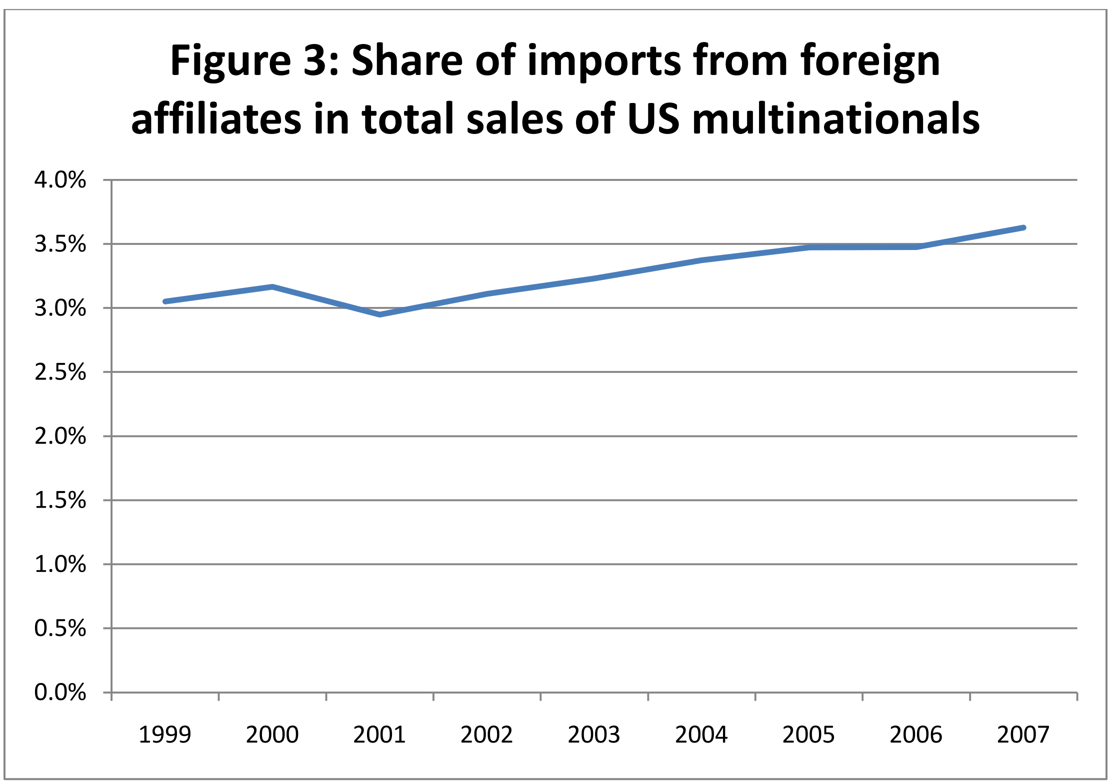
Figure 3: Share of imports from foreign affiliates in total sales of US multinationals
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
1999
2000
2001
2002
2003
2004
2005
2006
2007