Are Services Tradable?

Evidence from U.S. Microdata*

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Abstract

The service sector broadly defined accounts for the majority of global production and employment and a significant share of global trade. However, limitations in official statistics preclude a detailed examination of bilateral service trade flows using standard methods such as the "gravity equation." Instead, we develop and implement a new methodology that exploits detailed, highly reliable microdata on U.S. service establishments to identify cross-industry variation in the tradability of services. We use our estimates to evaluate the share of services susceptible to international competition, estimate the potential gains from policy liberalization in services trade and characterize the types of service activities are tradable.

Keywords: Service sector, international trade, imperfect competition, microdata.

JEL Classification Numbers: F1.

1 Introduction

Empirical studies in international trade focus almost exclusively on the impact and implications of international trade in the manufacturing sector. The scarcity of research on international trade in the service sector would be acceptable if the service sector was small and services were non-tradable. Yet, this is not the case. The service sector in the U.S. is large and there is a growing sense that many service activities are increasingly tradable.[1] Therefore, understanding the impact of trade increasingly requires a better comprehension of service trade.

The main impediment to research on international trade in the service sector is the lack of detailed official statistics. In this paper, we circumvent the lack of data by developing and implementing a novel empirical strategy that does not rely on bilateral trade flows. Instead, we exploit detailed, highly reliable microdata on U.S. service establishments to identify cross-industry variation in the tradability of services and obtain industry-level estimates of trade costs.[2] The intuition for our approach comes from Jensen et al. (2006). If we observe a mismatch between supply and demand at the region-level we infer that there is trade.

We use our estimates of trade costs to address three important questions: How much economic activity is susceptible to international competition? How large are potential gains from policy liberalization in services trade? What types of service activities are tradable and what are the implications for adjustment if services trade were liberalized?

[1] According to the CIA Factbook, the same is true in many advanced economies. Services account for 80 percent of employment in the U.K., 68 percent in Germany, 66 percent in Japan. Even in some developing countries, the share of service employment is high – in Brazil the service sector accounts for 66 percent of employment. Services trade flows are growing rapidly and growing as a share of exports. While merchandise still accounts for the bulk of US exports, the service sector's share of international trade is growing. In the decade prior to the financial crisis, service imports and exports both more than doubled and services now account for 30 percent of U.S. exports and about 17 percent of U.S. imports.

[2] While the nature of the data potentially limits the range of conclusions we can draw, it increases the confidence we have in them. Further, we expect that our methodology could be replicated in other countries and that the estimates of trade costs will prove useful as indicators of the potential for international trade in detailed service industries.

Our findings indicate that the average service industry is less tradable compared to the average manufacturing industry. However, there is significant dispersion in the estimated trade costs of different service industries. In particular, many business services industries are estimated to be as tradable as manufacturing industries. Importantly, even though a smaller fraction of business services are classified as tradable, because the share of employment in the business service sector is so large, the share of total employment in internationally tradable business services is larger than the share of total employment in the entire manufacturing sector.

Second, we find that the potential impact of trade liberalization in services is more important than in manufacturing. This happens for two reasons. First, average trade barriers are much higher in services so that the scope for welfare gain is simply higher. Second, the service sector's share of economic activity is much larger. This implies a change in policy impediments in services will have a greater impact on overall welfare compared to an equivalent change in manufacturing and seems to suggest that services liberalization should be a priority for U.S. trade negotiators.

Third, we find that the characteristics of tradable services are consistent with the U.S. comparative advantage. This has important policy implications that are complementary to the estimates of the gains from services liberalization. Workers in business service industries categorized as tradable have significantly higher wages than workers in other service sectors or the manufacturing sector. This suggests that these tradable business services are consistent with U.S. comparative advantage in skill-intensive activities. Because tradable service activities are higher skill on average than the manufacturing sector, it seems plausible that services liberalization would impose lower adjustment costs on the U.S. economy than those experienced in the manufacturing sector.

The lack of detail in official international trade statistics for the service sector is striking (and is a likely explanation for the lack of empirical research on international trade in the service sector). For example, for the 70 percent of U.S. exports that are merchandise, there

are more than 10,000 product categories. For the 30 percent of U.S. exports that are services, beginning in 2006, trade flows are published for 30 categories. Prior to 2006, there were fewer than 20 categories. The coarseness of official statistics covering international trade in services is a significant challenge to empirical researchers and a gap that this paper addresses directly.

Typically, the impact of changes in trade barriers on trade volume are obtained by estimating gravity equations using data on bilateral trade flows. Anderson, Milot, Yotov (2012) apply this model to services trade but are constrained by data limitations to consider only 9 categories of services trade. The high level of data aggregation is problematic because, as we show below using detailed establishment level microdata, there is considerable variation across producer characteristics for industries even in narrow industry groups. For example, Payroll Services (NAICS 541214) has relatively large producers that are concentrated in a dozen or so regions. In contrast, Tax Preparation Services (NAICS 541213) is characterized by a large number of relatively small, store-front operations that are ubiquitously located throughout the U.S.

This variation in producer characteristics and, as we explain below, tradability across industries within sectors implies the limitations of using highly aggregated services trade data are potentially problematic for a range of important issues. In particular, it is not clear that the estimated elasticity of trade obtained from estimating gravity equation in aggregate data will provide a useful measure to evaluate the impact of changes in trade barriers on trade volume and welfare. Therefore, the standard approach of using some variant of a gravity equation to investigate trade costs in the service sector is going to be unsatisfactory given the severe data limitations.[3] Instead, in this paper, we develop a new methodology for estimating trade costs that does not require direct information on international trade flows.

[3]Further, it is not clear that distance would be an appropriate proxy for trade barriers in all service sectors. While for some industries where moving the consumer is important (like education or health services) distance might be useful, for industries where digital delivery is more important (like software and media-related industries) it is not clear that physical distance is an appropriate proxy for trade barriers.

A key insight we exploit in our approach is that the geographic concentration of production, unexplained by the location of demand, is a useful indicator of tradability.[4] We present micro-level statistics for the service sector in the U.S. and show there is significant heterogeneity across industries within the service sector in a range of producer characteristics. A striking feature of the data is the variation across industries in the geographical concentration of services production. Some industries are heavily concentrated in particular regions (e.g. software publishing is concentrated in Seattle and Silicon Valley) while other industries exhibit little or no concentration in production (e.g. movie theaters and doctors' offices). Many industries in the service sector exhibit levels of geographic concentration comparable to those in the manufacturing sector. If the distribution of production across regions is different than the distribution of demand, this is strong evidence of tradability.

A second feature of the data is the considerable variation in producer size. Consistent with popular perception, the service sector is characterized by a large number of small producers on average. However, these averages hide the fact that there are very large establishment in the service sector that are important in terms of economic activity. For example, in the business service sector (defined below) the average worker is employed at an establishment that is twice the size of that in the manufacturing sector. The combination of large producers and geographic concentration (beyond that explained by local demand) suggest that some activities are produced in one region and consumed in other regions. Where the mismatch between production and consumption is large, we take this as evidence of trade occurring across regions within the U.S.

Our empirical approach exploit the link between concentration and tradability to obtain estimates of trade costs. To bridge the gap between the intuition and the data, section 3 extends Krugman (1980) to develop a partial equilibrium model of interregional trade. The framework shows how returns to scale and trade costs interact to determine the amount of interregional trade in the industry conditional on the distribution of demand and producers

[4]The intuition behind this approach draws on Jensen et al. (2006)

across regions. The model provides a simple, parsimonious mechanism that allows use to use the limited information we have to obtain estimates for trade and production costs.

In section 5, we use the model to obtain estimates of trade costs for each 6 digit industry. We find plausible variation in the estimates of trade costs across industries in the manufacturing sector and services. In section 6, we use the estimates to classify employment across tradable and non-tradable industries, examine the impact of trade liberalization across sectors, and investigate whether the characteristics of tradable business service producers are consistent with U.S. comparative advantage. Section 7 concludes.

2 The Service Sector in the U.S.

The service sector in the United States is large and growing. The service sector broadly defined accounts for about 80 percent of employment in the U.S. Because the service sector is so large and diverse, we focus on business services and personal services and exclude government, wholesale and retail trade, transportation, and utilities from our definition of the service sector.[5] Even this less expansive definition of the service sector that includes only business and personal services accounts for roughly 50 percent of US employment, see Table 1.

In addition to accounting for a large share of employment, the service sector is growing. Table 1 also reports that business services employment grew almost 30 percent over the decade prior to the financial crisis and personal services employment grew over 20 percent over the same period. In contrast, employment in the U.S. manufacturing sector decreased more than 20 percent and now accounts for about 10 percent of employment.

Beyond the size of the service sector, there is a growing sense that changes in technology have made more services tradable. As illustrated in figure 1, official statistics show increases in services' share of exports in the U.S. and for the world. There is a steady increase in

[5]We define business services as the two-digit NAICS sectors in the 50s and personal services as the NAICS sectors in the 60s, 70s, and 80s.

TABLE I
U.S. EMPLOYMENT AND GROWTH ACROSS SECTORS

NAICS	Sector description	Employment	Share	Growth
2	Mining, utilities and construction	8,734,608	6.50%	28%
3	Manufacturing	13,333,390	9.90%	-21%
4	Wholesale and retail trade, transportation and warehousing	26,341,579	19.5%	18%
5	Business Services	33,430,809	24.70%	29%
6-8	Personal Services	34,595,857	25.60%	23%
9	Federal, state and local government	18,862,000	13.90%	–

Notes: From 1997 and 2007 Economic Census and 2007 Census of Government.

the service sector's share of exports, particularly in the U.S. In the U.S., cross-border trade in services (both exports and imports) more than doubled between 1992 and 2007. Service exports now account for almost 30 percent of U.S. exports, and about 16 percent of U.S. imports are service imports. The United States has consistently maintained a positive trade balance in services. The trade surplus in services was $172 billion in 2011 (triple the surplus in 1992).

We would like to understand which service activities are contributing to the increase in services trade. Is it traditional traded services like transportation and tourism, or instead service activities that are newly tradable? The Bureau of Economic Analysis divides "private services" trade into five main groups: travel, passenger fares, other transportation, royalties and license fees and other private services. Other private services includes education, financial services, insurance services, telecommunications, and business, professional, and technical services. Other private services roughly encompass what we refer to as business services in this paper. Although all of the categories grew from 1992 to 2007, other private services grew the fastest: both imports and exports more than doubled. Other private services also contributed the most to overall service trade growth, accounting for more than half of the increase in service exports and about half of the increase in service imports. Business services trade is growing rapidly and is increasingly important.

If it is conceivable that at least some services are tradable, the size of the service sector suggests that trade in services might have important implications for the domestic labor

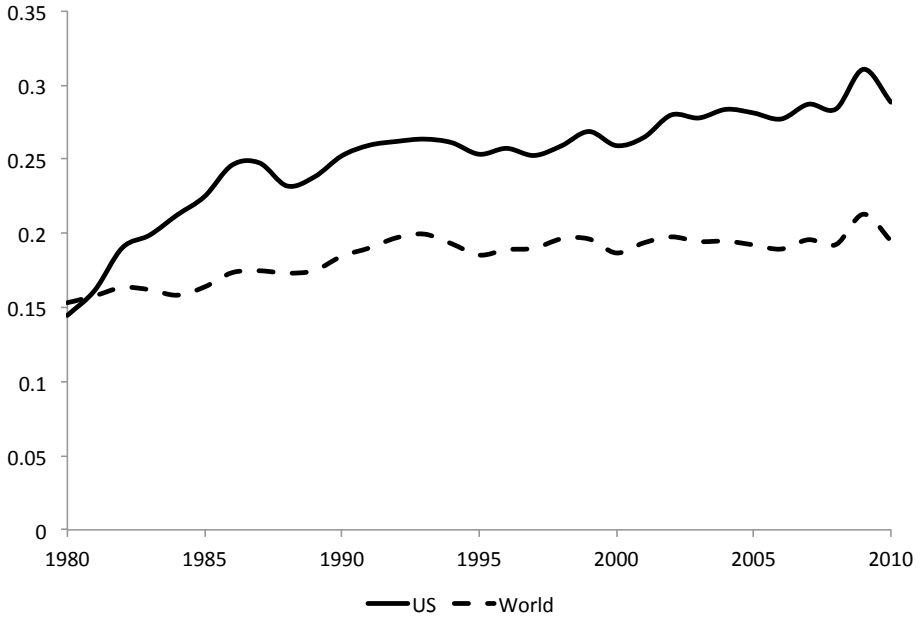


Figure 1: Export share of Services (WTO)

market. Yet, in spite of the size of the service sector and growing trade in services, there is little empirical research on the service sector in general or trade in services in particular.[6] Hoekman (2006) presents a survey of the literature on trade in services.[7] One reason for the lack of empirical research on the service sector is that official statistical data covering the service sector has become available more recently and the basic input and output information collected from service producers is less detailed than that collected from manufacturers.

More problematic for examining trade in services is the fact that international trade data for the service sector is far less detailed and comprehensive than that for merchandise trade. In the U.S., which has a relatively robust official statistical system, the U.S. Census Bureau publishes information on imports and exports of goods for more than 10,000 product categories. In comparison, the Bureau of Economic Analysis (BEA) recently began publishing services trade data for about 30 categories (up from 17 categories in 2005) with only lim-

[6]The burgeoning empirical literature exploiting plant and firm level microdata has historically focused on the manufacturing sector. See Foster, Haltiwanger, and Krizan (xxxx) Holmes and Schmitz (xxxx) Hubbard (xxxx) (??and others??) for notable exceptions.

[7]Other recent papers on trade in services include Liu and Trefler (2008) which examines the impact of services outsourcing using on US worker employment outcomes and Hanson and Xiang (2008) which examines international movie distribution XXalso need the paper using UK estab level data on service exporters.

ited geographic coverage. Data on international services transactions are currently available from 1986 through 2006 for cross border trade. These data are available by country for approximately 35 countries and country groupings for 1986-2006. Bilateral trade data among countries for the service sector is only available for very broad categories of services.

The high level of data aggregation in the service sector is problematic because there is considerable variation across producer characteristics for industries in the same industry groups. For example, Motion Picture and Video Production (NAICS 512110) has significantly fewer and larger producers that are highly concentrated in Los Angeles than Motion Picture Theaters (except Drive-Ins) (NAICS 512131) which is characterized by a large number of relatively small producers located in every market in the U.S. For another example, Payroll Services (NAICS 541214) is characterized by relatively large producers that are concentrated in a dozen or so regions. In contrast, Tax Preparation Services (541213) is characterized by a large number of relatively small, store-front operations that are ubiquitously located throughout the U.S. In the next section we show that there is considerable variation in producer characteristics across industries in the service sector. Therefore, official data on international trade in services are not detailed enough to develop reliable estimates of the size and scope of economic activity in tradable services or to examine the potential impact of trade in services on the U.S. economy. We need more detailed information on which activities are tradable. Given that it is unlikely that new data for the past decades will become available or that more detailed official trade in services data will become available in the near future, we develop a new methodology that relies on available data for identifying which activities are tradable.

To preview, our strategy is to use highly reliable, detailed industry, regional, and establishment level data to estimate trade costs at a detailed industry level. A key feature of the methodology is that it is not very demanding in terms of data availability. We do not have trade data. Instead, we use industry census data for the service sector available from many statistical agencies. We use information on the number of establishments in an

industry, their revenue and their location, to estimate a simple model of trade costs between regions that features returns to scale and trade barriers. The estimates of trade costs are based solely on production and consumption information for the United States. Because the U.S. is a relatively large economy situated in a large geographical area, we feel that the estimates of trade costs derived from this approach approximate technological trade costs for services. The estimates of trade costs allow us to identify the share of employment in the U.S. in tradable service activities and consider a number of thought experiments relating to the implications of changes in impediments to services trade.

2.1 Service Sector Establishment Characteristics

To begin to address the paucity of information on the service sector, we use detailed establishment level microdata from the 2007 Economic Census collected by the U.S. Census Bureau to develop these statistics. The Economic Census collects information regarding economic activity from business establishments with employees across a broad range of sectors in the United States. The Economic Census collects operating characteristics (e.g. employment, payroll, sales, location, primary industry) from establishments for the vast majority of the private economy. The Economic Census does not provide information on self-employed individuals, employees of private households, railroads, agricultural production, and most government activities.

The unit of observation is the establishment – a single physical location at which business is conducted or services or industrial operations are performed. It is not necessarily identical with a company (or enterprise), which may consist of one or more establishments. When two or more activities are carried on at a single location under a single ownership, all activities generally are grouped together as a single establishment. The entire establishment is classified on the basis of its major activity and all data are included in that classification. Business establishments in the economic census are grouped into industries based on

the similarity of their production processes and classified according to the North American Industry Classification System (NAICS).

The Economic Census covers 8 NAICS service sectors: Information (51); Professional, Scientific, and Technical Services (54); Management of Companies and Enterprises (55); Administrative and Support and Waste Management and Remediation Services (56); Educational Services (61); Health Care and Social Assistance (62); Arts, Entertainment, and Recreation (71); Other Services (except Public Administration) (81). Descriptions of each of these sectors is contained in an appendix. We group industries into 4 broad groups: manufacturing (NAICS 30s), wholesale trade, retail trade, transportation and warehousing (NAICS 40s), business services (NAICS 50s), and personal services (NAICS 60s, 70s, and 80s). We exclude mining and utilities (NAICS 20s) because of disclosure issues in a number of industries and construction because of the transient nature of a number of establishments.

Table II presents information on the number of establishments, mean establishment size, and mean average wage for establishments in the manufacturing sector, business service sector and personal service sector. The service sector is characterized by a large number of establishments that are relatively small on average. The mean establishment in business services employs about 15 workers, in personal services the average establishment employs about 17. In contrast, in the manufacturing sector the average plant employs 45 people. In terms of average wages, business services have slightly higher mean average wages than the manufacturing sector, about $42,000 compared to $39,500. Personal services average wages are considerably lower than either manufacturing or business services. These averages generally conform to widely held perceptions regarding the manufacturing and service sectors, i.e. service producers are relatively small and pay relatively low wages.

However, these averages conceal considerable heterogeneity in the size distribution of service establishments. The last column of Table 2 presents information on the co-worker mean (the employment weighted mean which shows the size and average wage of the establishment where the average worker is employed) for each sector. In stark contrast to the simple

TABLE II
Establishment Characteristics

NAICS	Sector Description	Mean Employment	Mean Average Wage ($000s)	Co-worker Mean Employment
3	Manufacturing	45.22	39.49	782.6
4	WRT, transportation and warehousing	13.79	27.92	268.3
5	Business Services	14.92	42.01	1,402
6-8	Personal Services	17.48	27.53	571.3
	Total	16.99	33.21	782.8

Notes: From 2007 Economic Census.

averages, the co-worker mean shows that the average business service worker is employed in an establishment that is almost twice the size of the average manufacturing worker. In addition, co-worker mean average wages are significantly higher for business services than manufacturing. While the business and personal service sectors are characterized by a large number of small establishments, there are some very large, relatively high wage business service establishments that employ most workers in the business service sector.

The existence of very large business service establishments is at odds with traditional characterizations of the service sector as mostly small establishments serving local customers. The prevalence (in terms of where most business service workers are employed) of very large business service establishments at least presents the possibility that some of these large producers might be serving customers beyond their local region. In the next section, we implement a measure of geographic concentration and investigate how concentrated services production is within the U.S.

2.2 Geography of Services Production

A key dimension of our investigation is the geographical distribution of production. We assign establishments to regions using the Bureau of Economic Analysis' definition of Labor Market Areas (LMA) as our unit of geography. The 183 LMAs are mutually exclusive and exhaustive of the land area of the United States. We construct regional level statistics on service producers using these 183 regions. LMAs include cities and adjacent counties based

on commuting patterns, i.e. the definition of a LMA is based on an economic concept, not a political concept. LMAs seem preferable to counties as in many regions economic activity in a metropolitan area spans several counties and preferable to states as metropolitan areas sometimes span state boundaries.

To characterize how geographically concentrated various industries are, we construct the Ellison-Glaeser (1997) index of concentration of production for all industries in our sample. The Ellison-Glaeser index compares the share of industry i's employment located in a region with that region's share of total employment, specifically:

$$EG_i = \frac{\sum_{i=1}^{M}(s_i - x_i)^2 - (1 - \sum_{i=1}^{M} x_i^2)^2 H}{(1 - \sum_{i=1}^{M} x_i^2)(1 - H)}. \quad (1)$$

where s_i represents the share of industry employment in region i, x_i represents the share of total employment in region i, and the Herfindahl index $H = \sum_{j=1}^{N} z_j^2$ of the plant size distribution. The Ellison-Glaeser index is in essence comparing the share of an industry's production in a region to a rough approximation of the region's share of industry demand. When the Ellison-Glaeser index is high, this suggests that some regions produce significantly more than is consumed in the region. We will interpret high geographic concentration of production as being consistent with the possibility of trade across regions.

Table III presents descriptive statistics of the Ellison-Glaeser measure by sector. Manufacturing has the highest Ellison-Glaeser index on average at 0.059. Business services has the next highest Ellison-Glaeser index at 0.036. Personal services has the lowest Ellison-Glaeser index on average at 0.015. These averages conform to our priors regarding manufacturing production as being quite concentrated (and manufacturing output being quite tradable) and services production being more dispersed (and service output generally less tradable). However, when we examine the standard deviations of the Ellison-Glaeser measures across sectors, we see that there is considerable variation across industries within the business service sector – indicating that some service sector industries are quite geographically concentrated.

TABLE III
ELLISON-GLAESER INDEX OF CONCENTRATION

NAICS	Sector Description	Number of Industries	EG Index		
			Mean	Std. dev.	Interq. range
3	Manufacturing	464	0.059	0.063	0.059
4	WRT, transportation and warehousing	191	0.022	0.053	0.015
5	Business Services	180	0.036	0.070	0.023
6-8	Personal Services	138	0.015	0.033	0.010
	Total	973	0.041	0.062	0.045

Figure 2 shows the dispersion in the Ellison-Glaeser index across sectors. Again, the general pattern of manufacturing being more geographically concentrated on average is evident. Personal services industries (NAICS sectors in the 60s, 70s, and 80s) generally have relatively low levels of geographic concentration. Industries like education, health care services, and many personal services (e.g. barber shops and beauty salons) are fairly ubiquitously distributed with population (and thus have low measures of geographic concentration). For

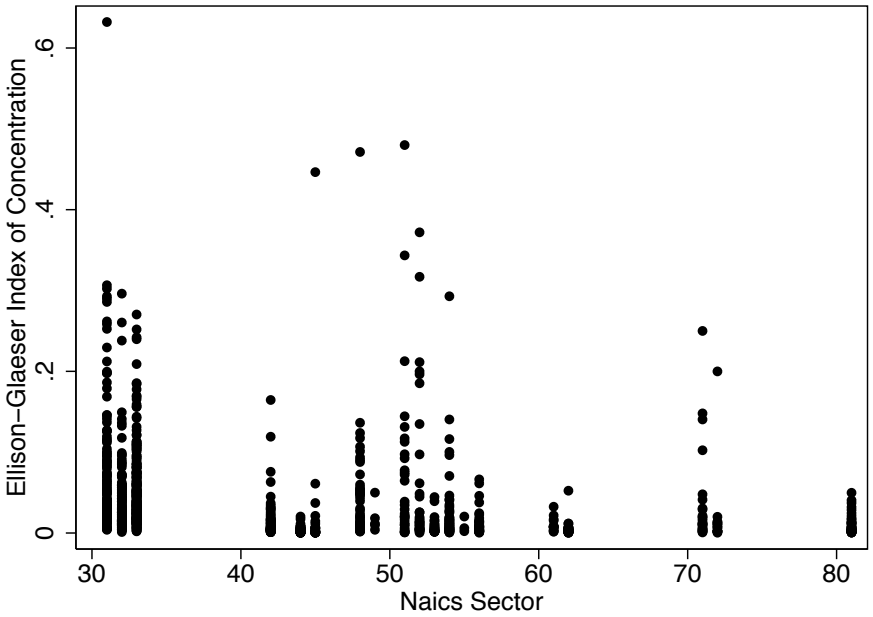


Figure 2: ELLISON-GLASER INDEX BY SECTOR

the business service sector, many industries exhibit low levels of geographic concentration. Yet, there are a number of business service industries that are as geographically concentrated as manufacturing industries. As examples of specific industries that are more or less

TABLE IV

5 MOST AND LEAST CONCENTRATED BUSINESS SERVICE AND MANUFACTURING INDUSTRIES

NAICS	Industry description	EG Index
312210	Tobacco Stemming and Redrying	0.632
512199	Other Motion Picture and Video Industries	0.480
523110	Investment Banking and Securities Dealing	0.372
512110	Motion Picture and Video Production	0.343
523210	Securities and Commodity Exchanges	0.317
315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing	0.307
315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors	0.302
325110	Petrochemical Manufacturing	0.296
541360	Geophysical Surveying and Mapping Services	0.293
315111	Sheer Hosiery Mills	0.293
332322	Sheet Metal Work Manufacturing	0.003
327320	Ready-Mix Concrete Manufacturing	0.003
339950	Sign Manufacturing	0.003
337212	Custom Architectural Woodwork and Millwork Manufacturing	0.002
323114	Quick Printing	0.001
541213	Tax Preparation Services	0.001
512131	Motion Picture Theaters (except Drive-Ins)	0.001
541219	Other Accounting Services	0.001
562111	Solid Waste Collection	0.000
524210	Insurance Agencies and Brokerages	0.000

concentrated, Table IV reports Ellison-Glaeser measures for the most and least concentrated manufacturing and business service industries.

Some of the manufacturing industries on the list are well-known examples of geographically concentrated industries. Tobacco stemming and drying, and several apparel production industries are geographically concentrated; these industries are also well-known for being traded. A number of the geographically concentrated service industries also conform to our priors regarding service industries that are tradable. Motion picture production, investment banking and securities dealing, securities and commodities exchanges, and mapping services (not including surveying) are all geographically concentrated and apparently tradable.

It is interesting to note that both manufacturing and services have industries with dispersed production. In manufacturing, the industries are characterized by high transport cost to value ratios and typically have low trade shares, for example ready-mix concrete and quick printing. The least concentrated business service industries include industries like movie the-

TABLE V
Distribution of employment across sector and concentration

NAICS	Sector description	Qrt. 1	Qrt. 2	Qrt. 3	Qrt. 4	Total
3	Manufacturing	0.014	0.039	0.050	0.032	0.134
4	Wholesale and Retail	0.166	0.042	0.011	0.004	0.223
5	Business Services	0.173	0.067	0.029	0.033	0.302
6-8	Personal Services	0.287	0.039	0.009	0.006	0.341
	Total	0.639	0.188	0.098	0.075	1.000

aters and tax preparation – industries that are ubiquitously distributed across the U.S. and industries not associated with international trade.

The manufacturing sector has, on average, more geographically concentrated industries, but the business service sector has a number of industries that are as geographically concentrated as manufacturing. Because the business service sector is twice the size of the manufacturing sector, the possibility exists that the share of economic activity in concentrated business services is as large as the manufacturing sector. Table V reports the share of total employment across sectors by how geographically concentrated production is in the industry. Industries are grouped into quartiles based on the Ellison-Glaeser measure of concentration and Table V shows the share of total employment in each group. While most employment is in industries that are not geographically concentrated (i.e. in the lowest Ellison-Glaeser index quartile), the share of employment in geographically concentrated business services is comparable to that in the manufacturing sector. Whether comparing the most geographically concentrated industries (quartile 4) or comparing across quartiles 2, 3, and 4 – the share of employment in concentrated industries is roughly comparable in manufacturing and business services.

2.3 Discussion

The simple descriptive statistics suggest that there is considerable variation across industries in the size and geographic scope of service producers. While manufacturing industries are characterized by larger producers and higher levels of geographic concentration on average,

there is considerable variation in both the size of producers and levels of geographic concentration of production within service industries. The average business service worker is employed in an establishment that is twice the size of the average manufacturing worker's plant. Further, a number of business service industries exhibit high levels of geographic concentration of production – suggesting a mismatch between local production and local consumption and trade in some industries.

We would like to push further on the intuition of a spatial mismatch between production and consumption as evidence of trade and attempt to estimate trade costs for these detailed service industries. To do so will require imposing additional structure on the data. The descriptive statistics presented above provide a number of stylized features that any model should incorporate regional differences in establishment size and excess supply. In the following section we develop a model that incorporates producer differentiated products, multiple regions and trade costs to examine how these factors influence the geographic distribution of service production.

3 Econometric Strategy

In this section, we develop a partial equilibrium model of interregional trade based on Krugman (1980). Our model shows how returns to scale and trade costs interact to determine the amount of interregional trade in the industry conditional on the distribution of demand and producers across regions. The model makes strong and unrealistic assumptions but it provides a simple, parsimonious mechanism that allows use to use the limited information we have to obtain estimates for trade and production costs.

3.1 Theoretical Framework

Consider an economy composed of a fixed number of regions $j = 1, 2, ..., G$ each populated with a mass of identical consumers. Preferences are the same across regions and defined over

the consumption of differentiated varieties. In particular, aggregate utility in region i is given by

$$U_i = \left(\sum_{j=1}^{G} \sum_{k=1}^{N_{ij}} q_{ijk}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \text{with} \quad \rho \in (0,1),$$

where q_{ijk} is the quantity of variety k produced in region j and consumed in region i, N_{ij} is the number of varieties produced in region j available for consumption in region i and the parameter σ represents the price elasticity of demand. Consumption of each variety is chosen to minimize the cost of the aggregate bundle $Q_i \equiv U_i$, so that region i's optimal demand for a variety k produced in region j is

$$q_{ijk} = E_i P_i^{1-\sigma} p_{ijk}^{-\sigma}, \quad \text{with} \quad P_i = \left(\sum_{j=1}^{G} \sum_{k=1}^{N_{ij}} p_{ijk}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \tag{2}$$

E_i and P_i respectively denote total expenditure and the price of a unit of the aggregate bundle in region i, and p_{ijk} is region i's price of variety k produced in region j.

Production is subject to increasing returns to scale. Firms need to invest a fixed number of units of output, f, before they can bring their production to the market. Afterwards, they face a constant marginal cost of production, c, per unit produced. We assume varieties are tradable across regions at some cost. For simplicity, trade barriers take the iceberg form so that when firms ship $\tau_{ij} \geq 1$ units from region j to region i only one unit arrives. Under these assumptions, the total cost function for a representative firm in region j is given by:

$$C_j = \left(f + c \sum_i \tau_{ij} q_{ij} \right) w_j \quad \text{with} \quad \tau_{ij} > 1 \,\forall\, i \neq j, \text{ and } \tau_{jj} = 1 \,\forall\, j, \tag{3}$$

where q_{ij} denotes demand for output from region i consumers and w_j is the wage rate in region j. Henceforth, we assume the wage rate is the same in all regions and use it as numeraire, $w_j = w = 1$.

We assume firms produce a single variety. The presence of fixed production costs implies firms find it optimal to produce a variety different from all other varieties produced by other firms. Therefore, the number of distinct varieties produced in equilibrium is equal to the number of firms in the industry and is given by $N = \sum_{j=1}^{G} N_j$. Further, since there are no fixed export costs and consumers love variety, all varieties produced in equilibrium are consumed in every region. Therefore, the number of varieties produced in region j sold in region i is simply given by the number of firms in region j, N_j.

Profits for a representative firm in region j can be expressed as:

$$\pi_j = \sum_{i=1}^{G} \left(p_{ij} - c\tau_{ij}\right) q_{ij} - f. \tag{4}$$

We assume the industry is characterized by monopolistic competition and that producers are numerous enough that they ignore the impact of their actions on the aggregate variables - the Chamberlinian "large group" assumption. Under those assumptions, profit maximization implies the equilibrium price of a variety produced in region j sold in region i is:

$$p_{ij}^{*} = \left(\frac{\sigma}{\sigma - 1}\right) c\, \tau_{ij}. \tag{5}$$

Firms charge a constant markup above marginal production costs and prices vary across destinations because of differences in trade costs. Because of fixed production costs, the model is consistent with the observation that some regions will not produce in equilibrium. From equations (4) and (5), a region produces if and only if firms generate enough revenue to cover the set-up costs:

$$\left(\frac{c}{\sigma - 1}\right) \sum_{i=1}^{G} \tau_{ij} q_{ij} \geq f.$$

Therefore, firms in remote regions that face high trade costs (τ) and low demand (q) are less likely to produce.

If there is free entry in the industry firms will make zero profits in equilibrium. This implies that output (including output lost in transit) is constant across all firms independent of where they are located

$$q_j^* \equiv \sum_{i=1}^{G} \tau_{ij} q_{ij} = \frac{(\sigma - 1)f}{c} = q^* \tag{6}$$

In that case, firm-level demand for labor is also constant across firms and given by: $l^* = cq^* + f = \sigma f$. This implies that the number of firms in each region can be obtained by imposing the labor market clearing condition:

$$N_{ij}^* = \frac{L_j}{l^*} = \frac{L_j}{\sigma f}, \tag{7}$$

where L_j is the number of workers available for hire in region j in the industry.

These results imply that, in the free trade equilibrium, both firm size and the distribution of producers across regions depend *only* on technology parameters and factor supply. We find this property of the model particularly attractive for our estimation purpose because it provides a simple link between trade costs and trade volume. Since changes in trade costs have no effect on the location of producers across regions we can take it as given.

3.2 Empirical Approach

We now describe how we use the simple framework to identify trade costs from the data. For simplicity, we choose physical units so that the marginal labor requirement is equal to one, $c = 1$ that trade costs are dichotomous $\tau > 1$ if $i \neq j, \tau = 1$ otherwise. Using the pricing rule (5) we can show that equilibrium value of export for a representative firm located in region j is given by

$$x_j^* = \sum_{i \neq j} p_{ij}^* q_{ij}^* = \left(\frac{\sigma - 1}{\sigma}\right)^{1-\sigma} \sum_{i \neq j} E_i P_i^{\sigma - 1} \tau_{ij}^{1-\sigma}. \tag{8}$$

This equation clearly shows that trade flows depend on the distribution of demand (E) across regions, the number of competing firms in each market (through P) and trade costs

associated with selling in each market. As one would expect, the appendix shows that the value of exports is monotonically decreasing in trade costs.

Our data is very detailed. For each region-industry pair we observe the number of firms and aggregate supply and can construct a measure of aggregate demand. However, we do not observe trade flows between regions. Hence, we cannot rely on the usual gravity equation approach to estimate trade costs for each industry. Instead, we use measures of regional demand and supply to tease out information on trade by computing the excess supply (ES) for each region. The ES is defined as the difference between supply and demand in the region-industry

$$ES_j = R_j - E_j = N_j \left(\frac{E_j}{\tau^{1-\sigma}(N - N_j) + N_j} + \sum_{i \neq j} \frac{E_i}{(N - N_i) + \tau^{\sigma-1} N_i} \right) - E_j. \qquad (9)$$

In the model, it depends on the distribution of revenue across domestic (first term in parenthesis) and foreign sales (second term in parenthesis). The ES is positive when the sum of firms' revenue in a region is greater then that region's total expenditure. In that case, the additional revenue must be generated by selling to consumers in other regions and the region is a net exporter. When the ES is negative, demand is greater than local supply and the region is a net importer. When trade costs are prohibitive ($\tau \to \infty$), aggregate revenue equal regional demand ($R_j = E_j$) and the excess supply equal zero.

We can use the excess supply to infer trade costs from the data. From equation (9), the ES depends only on the distribution of demand (E) and firms across regions (N), the price elasticity of demand (σ), and trade costs (τ). However, since the relationship between the excess supply and trade costs is non-linear we cannot use simple OLS to estimate trade costs. Instead, we use the simulated method of moments to infer trade costs. For any given value of σ and τ, we can use information on the distribution of demand and number of firms to simulate revenue in each region and construct a simulated share of excess supply (SES) in

the industry

$$SES(\widehat{\tau}) = \frac{\sum_j \|ES_j(\widehat{\tau})\|}{2\,E},$$

where ES_j denotes the excess supply in region j defined in (9). In the estimation, we fix the price elasticity of demand and search over values of τ until we find the value that minimizes the difference between the measured and simulated excess supply, $u = \left\|\widehat{SES} - SES\right\|$. We do this separately for each industry.

The appendix shows that two industries with identical trade flows but different fixed production costs must have different trade costs. Intuitively, from equation (7) the equilibrium number of firms in a region-industry is decreasing in fixed costs and, given consumers' preferences, a decrease in the number of local firms (or equivalently varieties) leads to an increase in demand for imported varieties. It is therefore important to control for variation in fixed costs when estimating trade costs. We accomplish this by using information on the number and distribution of firms across regions. The impact of changes in fixed production costs are captured indirectly through variation in average firm size across industries so that industries with similar trade flows but different firms characteristics will have different estimated trade costs.

In the estimation we choose to fix the price elasticity of demand (σ) to 5. We do this for two main reasons. First, we do not have information in the data that would allow us to identify variation in elasticity across sector. Second, we do not want arbitrary differences in consumers' tastes to drive the results.

4 Data and Measurement

As described in section 2 above, we use from the 2007 Economic Census. The unit of analysis in the Economic Census is the establishment. We aggregate establishments in the same 6-digit NAICS industry in the same BEA Labor Market Area (LMA) into one "firm" based on

ownership information contained in the Economic Census.[8] We aggregate in this way because our concept of geography treats each LMA as a single location, i.e. there is not distance within LMAs. Thus, our measure of the number of firms in a region (that corresponds to N in the model) is the number of companies active in the same 6-digit NAICS industry in the LMA (region).

4.1 Measurement

We estimate trade costs for each 6 digits NAICS industries separately. For each industry, we measure supply (E) in each region by taking the sum of revenue over all plants in an industry in a region. Therefore, the revenue (or supply) in region j is given by $R_j = \sum_{k=1}^{N_j} r_{jk}$ where r_{jk} is the revenue of the k^{th} plant in region j.

In addition to a measure of supply in each region, we also need region-specific measures of demand. The Ellison-Glaeser index implicitly uses a region's share of total employment as a measure of demand. A limitation of using a region's share of total employment as a proxy for demand is that the composition of industries varies across regions. This variation in industrial composition could create differences in actual demand for particular products or services. To address this possibility, we follow Jensen and Kletzer (2005) to construct region-specific measures of demand for each industry using the BEA's Input-Output Use tables.[9]

Our measure of industry i demand in region j (E_{ij}) is defined as:

$$E_{ij} = \left(\sum_{t=1}^{T} s_t^o s_{tj}^e \right) \sum_{j=1}^{C} R_{ij}.$$

[8] A company or enterprise is comprised of all the establishments that operate under the ownership or control of a single organization. A company may be a business, service, or membership organization; consist of one or several establishments; and operate at one or several locations. It includes all subsidiary organizations, all establishments that are majority-owned by the company or any subsidiary, and all the establishments that can be directed or managed by the company or any subsidiary.

[9] We use the 1997 Benchmark Input-Output Use tables published by the BEA. For more information, see www.bea.gov/industry/io_benchmark.

where s_t^o is the share of industry i output demanded by industry t (for all $t = 1, ..., T$ industries) and s_{tj}^e is the share of industry t employment located in region j. [10] We multiply the share of industry demand in the region by the value of total output in industry i across all regions $j = 1, ..., C$ to obtain our region-specific measure of demand.

4.2 Sample Characteristics

We use the measures of regional supply and demand to define region j's excess supply as the difference between revenue and expenditure for each industry and region and obtain the SES for each industry. Table VI reports the coefficient of variation for our measure of region supply (R), region demand (E),and the number of producers in a region (N). We see that there is considerably more variation in region supply across industries than there is in region demand across industries. Manufacturing and business services are the sectors with the largest coefficient of variation in region supply (R), while personal services has the lowest coefficient of variation in R. The sectors with the greatest concentrations of production are manufacturing and business services.

Table VI also reports information on our measure of excess supply (ES) across regions. Industries where tradability is high should be characterized by a high degree of ES since some regions will be large net importers and other large net exporters. Table VI shows that the manufacturing sector has the highest mean ES measure, on average a almost 60 percent of manufacturing output is consumed in a region other than where it is produced. Business services has the next highest level of average ES with about 36 percent of the average business service industry output consumed in a region other than where it is produced. The averages also conceal considerable variation in excess supply measures across industries within sectors. For example, in personal services the average ES measure is relatively low with 28 percent of output consumed outside of the region where it is produced – but the standard deviation

[10] We use the location of employment instead of revenue because we include demand from the government sector and revenue data is not available.

TABLE VI
Descriptive Statistics

NAICS	Sector description	Coefficient of variation			Excess Supply			Correlation
		R	E	N	Mean	Std Dev	iqr	ES, EG index
3	Manufacturing	3.59	1.61	2.42	0.590	0.163	0.237	0.632
4	WRT, trnsp. & warehousing	2.80	1.63	2.03	0.331	0.178	0.253	0.593
5	Business Services	3.55	1.70	2.10	0.359	0.164	0.230	0.706
6-8	Personal Services	2.58	1.59	1.78	0.281	0.510	0.203	0.667
	Total	3.30	1.63	2.20	0.455	0.211	0.351	0.650

is quite large at .5. All sectors have significant inter-quartile ranges for the ES measure – indicating variation in ES across industries within each sector.

The last column of Table VI reports the correlation between the Ellison-Glaeser measure of industry concentration and our measure of excess supply (ES). The correlation across industries within each sector is quite high – suggesting that industries with geographically concentrated production also have relatively high measures of excess supply. These results seem to confirm our intuition that highly geographically concentrated production is associated with higher trade shares.

5 Estimated Trade Costs

In this section we present the estimated trade costs and evaluate the model's ability to match the data. For each 6 digit NAICS industry we estimate trade costs by minimizing the objective function described above. Table VII presents the average and standard deviation for estimated trade cost (τ) for each sector in columns 3 and 4 while column 5 presents the mean simulated excess supply measure (SES). The results show that the estimated trade costs are increasing in the share of excess supply. Consistent with our priors, the manufacturing sector has the lowest average estimated trade cost while personal services have the highest.

We also find enormous variation within sectors in the estimated trade costs. This points to the importance of using disaggregated data. It would not be right to say that manufacturing industries are tradable while business services are not. Within both sectors, some industries

TABLE VII
MEAN ESTIMATED TRADE COSTS

NAICS	Sector description	$\widehat{\tau}$	std dev	SES	$Corr(ES, \widehat{ES})$	u
3	Manufacturing	1.332	0.493	0.583	0.368	0.038
4	WRT, trnsp. & warehousing	1.816	0.820	0.332	0.435	0.017
5	Business Services	1.871	0.656	0.357	0.438	0.027
6-8	Personal Services	1.969	1.030	0.281	0.405	0.014
	Total	1.614	0.738	0.450	0.399	0.029

Notes: This table present results from estimating trade costs separately for each industry. For each sector, it shows the mean estimated trade costs, share of excess supply in the industry (SES) and fixed production costs. In addition, the table also reports statistics that help evaluate the model's ability to match the data.

are tradable and others are not. The dispersion is particularly large within personal services indicating that the average is driven up by a small number of outlier industries such as Amusement and Theme Parks (NAICS 713110) and Skiing Facilities (NAICS 713920).

Overall, the model is able to replicate the mismatch between supply and demand observed in the data. We assess the model's fit using three different metrics. First, we look at the correlation between *region* simulated and actual revenue. As can be seen in Table VII the correlation is positive and large in all cases. Recall that in the estimation we choose trade costs to match the share of excess supply at the industry level, but do not target region level excess supplies. The correlations show that the model is able to replicate not only the overall trade share but also replicates the distribution of revenue across regions.

Second, we present the value of the objective function evaluated at the estimated value of the trade costs. The average of 0.03 is relatively high and mainly driven by a few large outliers.

Third, we evaluate how well the estimates fit the predictions of the theoretical model. We start by using the simulated data and the assumptions of the model to obtain a measure of fixed costs. In the free entry equilibrium, zero profits imply that $\widehat{f_j} = \widehat{R}_j/\sigma N_j$. We therefore estimate trade costs by taking the average across all regions within the industry as follow: $\widehat{f} = G^{-1} \sum_j \widehat{f_j}$. Recall that the model predicts that trade costs and fixed costs are positively correlated, conditional on trade flows. We report the results from regressions of trade costs

TABLE VIII
Relation between trade costs and fixed costs

NAICS	Sector description	Fixed costs		SES		R^2
3	Manufacturing	0.320	(0.068)	-0.880	(0.081)	0.240
4	WRT, trnsp & warehousing	0.158	(0.097)	-1.210	(0.173)	0.210
5	Business Services	0.252	(0.095)	-0.773	(0.186)	0.095
6-8	Personal Services	0.457	(0.191)	-1.610	(0.300)	0.193
	Total	0.256	(0.046)	-1.090	(0.056)	0.347

Notes: This table present results from OLS regressions of estimated trade costs on estimated production costs.

on fixed costs and share of excess supply for each sector and the pooled sample in Table VIII.

The results are consistent with the model's predictions. Industries characterized by high share of excess supply have lower estimated trade costs and, conditional on trade, an increase in fixed production costs is associated with an increase in estimated trade costs. As expected, in addition to trade costs, fixed production costs are important determinants of trade flows.

Overall our simple model does a reasonable job of capturing variation in the data and the estimates behave as expected.

6 Results

In this section we use our trade costs estimates to obtain three important sets of results. First, we estimate the share of U.S. employment in tradable services industries. We find that while the average business services industry is less tradable than the average manufacturing industry, the business services sector is so large relative to manufacturing that more U.S. workers are employed in business services industries that we think are potentially tradable internationally than in the entire manufacturing sector. Second, we evaluate the impact of trade liberalization in services on welfare and compare it to the impact of trade liberalization in manufacturing. We find that the high tariffs rates applied in services and the relative importance of services in consumption lead to a much larger increase in welfare. Third, we compare the characteristics of tradable and non-tradable industries. We find that tradable

business services are more skill-intensive compare to non-tradable services and manufacturing. This suggest that the U.S. has a comparative advantage in the production of these services and would likely be a net exporter.

6.1 Share of Tradable Employment

To gain a sense of how much employment is in tradable business service activities, we compare the share of total employment in manufacturing and business services using a variety of thresholds determining whether an industry is "tradable." We present two sets of results. The first, shown in Figure 3, shows the share of employment in the business service sector in industries classified as tradable assuming different levels of tradability in the manufacturing sector. The chart shows the share of employment in business services in tradable industries is we use a trade cost cutoff that would leave 10 percent of employmentin the manufacturing sector in tradable industries. If we assume 10 percent of employment in the manufacturing sector is in industries that are tradable and use that trade cost threshold as the cutoff for business services, we find that 15 percent of business service employment is in tradable industries. Moving along the horizontal axis varies the threshold of trade costs for tradability. If most of manufacturing sector employment is considered to be in tradable industries, say 90 percent, this suggests that about half of business service sector employment is in industries classified as tradable using the threshold from manufacturing.

The second metric examines the share of total private sector employment in tradable business services. Figure 4 shows the share of employment in tradable service industries (and tradable manufacturing industries) assuming that 10 percent of manufacturing employment is in tradable industries, 20 percent is in tradable industries, and so forth. Given that we typically think of the manufacturing sector as being predominantly tradable, we focus on the right side of the chart. Assuming that 70 percent of manufacturing employment is in tradable industries suggests almost 10 percent of total employment is in tradable manufacturing and about 7 percent of total employment is in tradable business services. Assuming a 90 percent

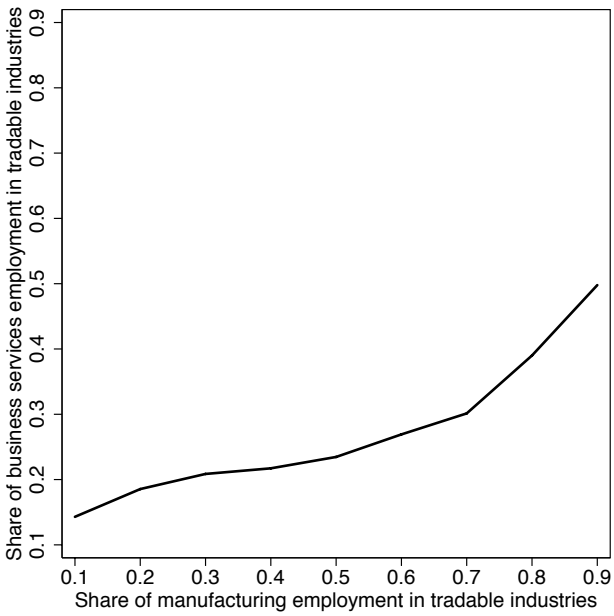


Figure 3: Share of business services employment in tradable industries

threshold, suggests that 12 percent of total employment is in tradable manufacturing and about 13 or so percent is in tradable business services.

While the average business service industry has higher trade costs than the average manufacturing industry, the combination of the size of the business service sector and the fact that a significant number of business service industries have relatively low trade costs leads to more employment being in tradable business services than in tradable manufacturing.

6.2 Welfare

In this section we investigate the impact of changes in trade barriers on welfare. We estimate the impact of imposing trade barriers roughly equivalent to those prevailing in the EU and BRICs. We use data from the World Trade Organization's World Tariff Profiles for 2011 to obtain rough estimates of the tariff levels applied to manufactured goods by the European Union (EU) and Brazil, Russia, India, and China (BRICs). We use tariff equivalent information on barriers to services trade reported in Hufbauer, Schott, and Wong (2011).

To obtain a measure of welfare in the economy, we need to aggregate across regions and industries. For simplicity, we assume the aggregate utility function for the economy

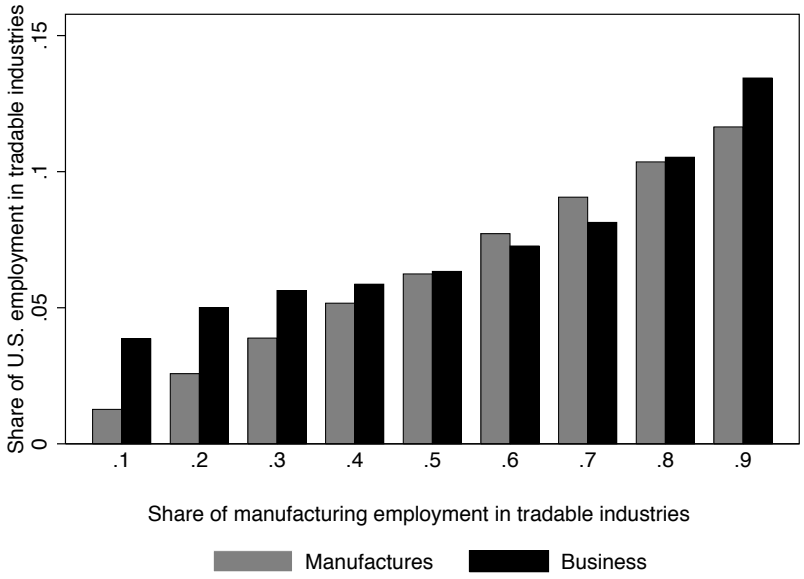


Figure 4: Share of total employment in tradable industries

is Cobb-Douglas over sectors as follow: $U = \sum_{s=3}^{6} Q_s^{\alpha_s}$, where Q_s represent the aggregate consumption bundle in sector s and α_s represents the share of expenditure in sector s. Under the maintained assumptions, welfare (real wage) in a sector is equivalent to the inverse of the aggregate price index defined in equation (2) because nominal wages serve as numeraire. Therefore we can evaluate welfare as follows

$$W = \sum_{s=3}^{6} \widehat{P}_s^{-\alpha_s}, \tag{10}$$

$\widehat{P}_s$ represent the average estimated real wage in an industry. It is obtained by first computing the inverse price index for each region and then taking the average across regions within the industry.

The results are reported in Table IX. The within column shows the average changes in real wage within the sector. The overall column shows variation in welfare as defined in (10).

These results suggest that the potential impact of trade liberalization in services is more important than in manufacturing. This happens for two reasons. First, average trade barriers

TABLE IX
THE EFFECT OF TARIFFS ON WELFARE

NAICS	Sector description	Within Sector		Overall	
		EU	BRIC	EU	BRIC
3	Manufacturing	-0.040	-0.152	-0.005	-0.020
4	WRT, trnsp. & warehousing	-0.031	-0.119	-0.007	-0.026
5	Business Services	-0.064	-0.298	-0.017	-0.080
6-8	Personal Services	-0.066	-0.300	-0.022	-0.102
	Total	-0.046	-0.193	-0.010	-0.043

Notes: This table reports average industry level changes in welfare associated with imposing EU and BRIC tariffs equivalents. The within column reports the impact on consumer's welfare in that sector. The overall column takes into account the relative importance of each sector in overall consumption.

TABLE X
AVERAGE WAGE ACROSS SECTORS AND TRADABILITY

NAICS	Sector description	Non-tradabable	Tradable	Total
3	Manufacturing	40.49	44.82	44.68
4	WRT, trnsp. & warehousing	30.13	39.65	37.62
5	Business Services	51.27	57.84	56.08
6-8	Personal Services	28.92	32.13	31.04
	Total	37.85	44.70	43.65

are much higher in service sector, so the scope for welfare gain is higher. Second, the service sector's share of economic activity is much larger. This implies a change in policy impediments in services will have a greater impact on overall welfare compared to an equivalent change in manufacturing.

6.3 Comparative Advantage

In this section, we seek to gain a rough sense of the potential adjustment costs associated with a decrease in impediments to services trade. To do this, we examine how consistent tradable business service activities are with U.S. comparative advantage.

In Table X, we present information on the average wage as a proxy for skill-intensity in production across sectors. We categorize industries as tradable and non-tradable based on their estimated trade costs. Industries with a trade cost greater than XX is deemed to be tradable. We report average wages for each sector for industries classified as tradable and non-tradable.

TABLE XI

Mean industry wages and industry characteristics

Variable	(1)	(2)	(3)	(4)
SES	0.377			
	(0.030)			
Log trade costs (τ)		-0.140		-0.143
		(0.032)		(0.032)
Log fixed costs (f)			0.148	0.151
			(0.032)	(0.032)
R^2	0.142	0.020	0.022	0.043
S.e. of regression	0.926	0.990	0.989	0.979

Notes: This table present the results of OLS regression of industry mean wages on trade and fixed production costs estimates.

Table X shows that tradable business services have relatively high average wages – significantly higher than non-tradable business services and higher than the manufacturing sector.

In Table XI, we present OLS regression results on the relationship between the industry SES, trade costs, and fixed costs and the average wage in an industry. Trade costs are negatively associated with industry average wages – again suggesting that industries that are more tradable are more skill intensive. Higher levels of fixed costs and higher SES are also associated with higher average wages.

The results presented in this section suggest that tradable business services are relatively skill-intensive. The U.S. is (at least for now) a relatively skill-abundant country, suggesting that tradable business services are consistent with U.S. comparative advantage.

7 Conclusion

We find the features of the detailed microdata emphasized in this paper – geographic concentration, large producers, and relatively low estimated trade costs – particularly salient in the business service sector. While the average level of geographic concentration in business service industries is lower than manufacturing, many business service industries exhibit geographic concentration in production and have estimated trade costs similar to the manu-

facturing sector. Because the business service sector is large (it employs more than twice as many people as the manufacturing sector) and many industries within it appear tradable, we find that liberalization of trade policy impediments in the business service sector would have a relatively large impact on welfare. Further, because business service industries we estimate to be tradable have relatively high average wages, we think these types of services are consistent with U.S. revealed comparative advantage in skill intensive activities. These findings highlight the potential gains from liberalization in the business service sector and underscore the need for additional research to understand and measure policy impediments to services trade.

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Appendix

A Modes of trade in services

We are accustomed to thinking of trade in goods. Commodities such as wheat, corn, sugar, and oil, and manufactured goods such as clothing, furniture, consumer electronics, automobiles, and jet aircrafts are shipped all over the world. We can visit any port or border and see evidence of trade in goods. So, when we speak of trade in goods, it is not difficult to conjure a mental image of the phenomena. Yet, when we speak of trade in services, it may be more difficult to conceptualize exactly what this means because services are often intangible. Yet, services are traded in a variety of ways. The General Agreement on Trade in Services (GATS) definitions of trade in services are generally referred to as the following four "modes" of trade in services:

> Mode 1: *Cross-border provision* (A software produced in one region and sold via Internet to a consumer located in another region)
>
> Mode 2: *Consumption abroad* (A consumer from Chicago travels to a resort in Miami for a vacation)
>
> Mode 3: *Commercial presence in foreign region* (A restaurant opens local branch to serve foreign demand)
>
> Mode 4: *Temporary movement of natural persons* (An academic travels to a foreign country to speak at a conference)

Since this paper is about *international trade* of services, we choose to concentrate on modes 1, 2 and 4. Because mode 3 commercial presence involves foreign direct investment and hiring local workers to produce the output, we think the impact of this type of trade in services on US labor market outcomes is likely to be indirect (and therefore more difficult to measure).

B Services trade data

The BEA collects information on trade in services and presents aggregate data on international services transactions through three publication programs: (1) cross-border trade in services data in the international transactions accounts; (2) sales of services through affiliates of multinationals, some portion of which represent cross-border trade; and (3) benchmark input-output tables. The cross-border trade in services publication program provides the basis for all of BEA's services trade data. As a result, this publication program provides the best sense of what trade data BEA collects:

> *The estimates of cross-border transactions cover both affiliated and unaffiliated transactions between U.S. residents and foreign residents. Affiliated transactions consist of intra-firm trade within multinational companies—specifically, the trade between U.S. parent companies and their foreign affiliates and between U.S. affiliates and their foreign parent groups. Unaffiliated transactions are with foreigners that neither own, nor are owned by, the U.S. party to the transaction. Cross-border trade in private services is classified into the same five, broad categories that are used in the U.S. international transactions accounts—travel, passenger fares, "other transportation," royalties and license fees, and "other private services." (Survey of Current Business, November 2001)*

Affiliated transactions are collected through BEA's U.S. Direct Investment Abroad and Foreign Direct Investment in the U.S. programs. Comprehensive benchmark surveys are collected every 5 years and less comprehensive collections are conducted annually. BEA collects data on U.S. international transactions in private services with unaffiliated foreigners through 11 surveys. These surveys fall into three broad categories: (1) The surveys of "selected" services, which cover mainly business, professional, and technical services; (2) the specialized surveys of services, which cover construction, engineering, architectural, and mining services, insurance services, financial services, and royalties and license fees; and (3)

the surveys of transportation services. These collection programs are the principal source of BEA's estimates of trade in services but the estimates of some services are based on data from a variety of other sources, including U.S. Customs and Border Protection and surveys conducted by other Federal Government agencies, private sources, and partner countries

C The volume of trade

This appendix shows that the volume of trade is increasing in fixed costs, decreasing in trade costs and that, conditional on trade volume, fixed production costs and trade costs are positively related. For simplicity, assume that trade costs are dichotomous and equal to $\tau, \forall i \neq j$ and $\tau = 1$ if $i = j$ and that the wage rate is the same in all regions $w_j = w$. In that case, from (8), the value of exports from i to j can be expressed as:

$$x_j^* = \sigma f w^{-\sigma} \tau^{1-\sigma} \sum_{i \neq j} E_i \left[\tau^{1-\sigma}(L - L_i) + L_i \right]^{-1}.$$

This equation makes clear that the volume of trade is monotonically increasing in fixed trade costs. Taking the derivative with respect to trade costs (τ) yields:

$$\frac{\partial x_j}{\partial \tau} = (1-\sigma)(1-A)\frac{x_j}{\tau} < 0, \quad \text{where} \quad A = \tau^{1-\sigma} \frac{\sum_{i \neq j} E_i (L - L_i)(\tau^{1-\sigma}(L - L_i) + L_i)^{-2}}{\sum_{i \neq j} E_i (\tau^{1-\sigma}(L - L_i) + L_i)^{-1}}.$$

Totally differentiating this equation with respect to both trade costs and fixed costs results in:

$$\frac{\partial \tau / \tau}{\partial f / f} = \frac{1}{(\sigma - 1)(1 - A)} > 0.$$

The inequalities follows because $\sigma > 1$ and $A \in (0, 1)$.