

# Are Services Tradable?

## Evidence from U.S. Microdata\*

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### **Abstract**

The service sector 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. 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 that are tradable.

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

**JEL Classification Numbers:** F1.

# 1 Introduction

This paper evaluates the potential for international trade in service industries and evaluates the impact of trade liberalization in services on U.S. welfare. To date, empirical studies in international trade have focused almost exclusively on the impact and implications of international trade in the manufacturing sector.<sup>1</sup> 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. This is not the case. The service sector in the U.S. is large and many service activities are increasingly tradable.<sup>2</sup> As a result, understanding the implications of international trade increasingly requires a better comprehension of services trade.

The main impediment to research on international trade in the service sector is the lack of detailed official statistics.<sup>3</sup> 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. The intuition for our approach comes from Jensen and Kletzer (2006) and is quite simple – if we observe a mismatch between supply and demand at the region-level, we infer that there is trade between regions. To exploit this intuition, we extend the framework of Krugman (1980) and develop a partial equilibrium model of interregional trade. The model shows how returns to scale and trade costs interact

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<sup>1</sup>Some recent exceptions that consider international trade in a service industry context include Hoekman (2006) which surveys recent work on international trade in the service sector, Liu and Trefler (2008) which examines the impact of services outsourcing using on US worker employment outcomes, Hanson and Xiang (2008) which examines international movie distribution, and Breinlich and Criscuolo (2011) which uses UK establishment level data on service exporters.

<sup>2</sup>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 U.S. 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.

<sup>3</sup>The lack of detail in official international trade statistics for the service sector is striking. For the 70 percent of U.S. exports that are merchandise, there are more than 10,000 HS 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.

to determine the amount of interregional trade in an industry, conditional on the distribution of firms and expenditures across regions. It provides a simple, parsimonious mechanism that allows us to use the limited information we have to obtain detailed, industry-level estimates of trade costs.<sup>4</sup>

Our findings indicate that the average service industry is less tradable than the average manufacturing industry. The results also show there is significant dispersion in the estimated trade costs across both manufacturing and service industries. As a result, there is significant overlap in the estimated trade costs of business service industries (defined below) and manufacturing industries. Importantly, even though we classify a smaller fraction of business services as tradable, because the share of employment in the business service sector is double the manufacturing sector, *the number of workers in tradable business services is larger than total employment in the entire manufacturing sector.*

Second, we find the potential impact of trade liberalization in services to be larger than in manufacturing. This happens for two reasons. First, average trade barriers are much higher in services, so the scope for welfare gain is higher. Second, the service sector's share of economic activity is larger. This combination suggests that the potential welfare gains from liberalization in the service sector may be larger than gains available in the manufacturing sector. Therefore, 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 skill-intensive activities and, as a result, are consistent with U.S. comparative advantage.

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<sup>4</sup>While the nature of the data potentially limits the range of conclusions we can draw, we think the advantage of detailed, industry level estimates of trade costs is quite important for reasons we articulate below. Further, because the data requirements are quite modest, we expect that our methodology could be replicated in other countries.

This suggests that services liberalization would impose lower adjustment costs on the U.S. economy than those experienced in the manufacturing sector.

These results are derived from detailed, industry-level estimates of trade costs. We think using these detailed trade cost estimates is important because, as we show below using detailed establishment level microdata, there is considerable variation in producer characteristics (and we believe tradability) across industries, even in closely-related industry groups. For example, Payroll Services (NAICS 541214) appear tradable in that the industry has relatively large producers that are concentrated in a dozen or so regions. In contrast, Tax Preparation Services (NAICS 541213) do not appear tradable as the industry is characterized by a large number of relatively small, store-front operations that are ubiquitously located throughout the U.S. To examine the impact of trade liberalization on the U.S. labor market requires this detailed differentiation between which service activities are susceptible to international trade and which industries are not.

This variation in tradability across industries (even 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 trade costs for the service sector obtained from a standard gravity equation will provide a useful measure to evaluate the impact services liberalization. Typically, the impact of changes in trade barriers on trade volume are obtained by estimating gravity equations using data on bilateral trade flows. As an example, Anderson, Milot, Yotov (2012) apply this model to services trade in Canada, but are constrained by data limitations to consider only 9 highly-aggregated categories of services trade. 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.<sup>5</sup> Instead, in this paper, we develop a new methodology for estimating trade costs that does not require direct information on international trade flows.

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<sup>5</sup>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.<sup>6</sup> 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 establishments 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 exploits 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

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<sup>6</sup>The intuition behind this approach draws on Jensen and Kletzer (2006)

across regions. The model provides a simple, parsimonious mechanism that allows us to use the limited information we have (described in section 4) to obtain detailed, industry-level estimates of trade 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 United States

The service sector in the United States is large. Broadly defined, it includes utilities, wholesale and retail trade, transportation, business services, personal services and government, and accounts for about 80 percent of employment in the U.S. Because it is so large, the service sector is also very diverse. We find that, for our purposes, a narrower definition of the service sector is more useful. We focus on business services and personal services and exclude utilities, wholesale and retail trade, transportation, and government from our definition of the service sector.<sup>7</sup> Even this less expansive definition of the service sector accounts for roughly 50 percent of U.S. employment, see Table 1.

In addition to accounting for a large share of employment, the service sector is growing. Table 1 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.

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<sup>7</sup>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.

Services are also increasingly important in international trade. 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 the service sector’s share of exports, particularly in the U.S., where cross-border trade (exports plus imports) in services 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 (not shown). The U.S. has consistently maintained a positive trade balance in services. The trade surplus in services was \$172 billion in 2011 (triple the surplus in 1992). Below we argue this is consistent with U.S. comparative advantage.

While traditional traded services industries like transportation and tourism did contribute to the increase in services trade, most of the growth comes from business services – growth facilitated by falling telecommunications costs and increasing internet penetration globally. The Bureau of Economic Analysis (BEA) 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, so it roughly encompasses what we refer to as business services in this paper. Although all five of the categories grew from 1992 to 2007, other private services grew the fastest. Both imports and exports of other private services more than doubled, accounting for more than half of the increase in service exports and about half of the increase in service imports.

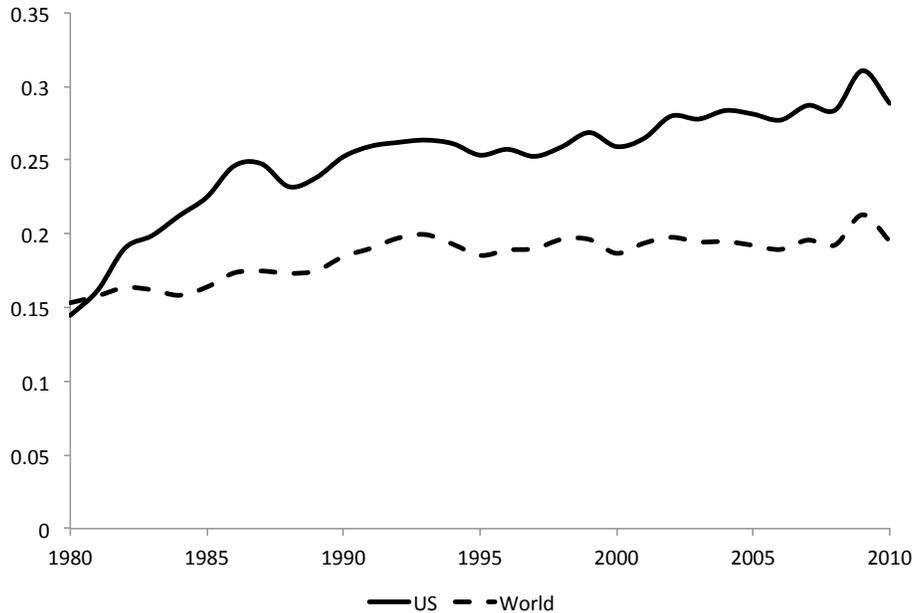


Figure 1: EXPORT SHARE OF SERVICES (WTO)

Together, the size of the service sector and its growing share of trade suggests that trade in services may have important implications for the domestic labor market. Yet, there is little empirical research on the service sector in general or trade in services in particular.<sup>8</sup> One reason for the lack of empirical research on the service sector is that official statistical data covering the service sector has become available only recently and is less detailed than that collected from manufacturers. International trade data for the service sector is also far less detailed and comprehensive than that for merchandise trade. For instance, 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 BEA recently began publishing services trade data for about 30 categories (up from 17 categories in 2005) with only limited 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

<sup>8</sup>The service sector is attracting the attention of macroeconomists concerned with growth, see for example Buera and Kaboski (2012). The burgeoning empirical literature exploiting plant and firm level microdata has historically focused on the manufacturing sector. See Foster et al. (2001) and Holmes and Schmitz Jr (1995) for notable exceptions.

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 aggregation in official statistics is problematic for studying the impact of services trade on U.S. employment. As detailed in the next section there is considerable variation in producer characteristics across industries in the service sector. For example, Motion Picture and Video Production (NAICS 512110) consist mainly of a small number of large producers mostly located in Los Angeles while Motion Picture Theaters (except Drive-Ins) (NAICS 512131) is characterized by a large number of relatively small producers ubiquitously distributed across the U.S. Similarly, Payroll Services (NAICS 541214) is characterized by relatively large producers located in a dozen or so regions, while Tax Preparation Services (541213) is characterized by a large number of relatively small, store-front operations distributed across all U.S. regions.

Because it does not capture variation within industry groups, official data on international trade in services are not detailed enough to develop reliable estimates of the share of economic activity in *potentially tradable* services and to examine the potential impact of trade in services on the U.S. economy. 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.

## **2.1 Service Sector Establishment Characteristics**

Because of the lack of disaggregated data on international trade in services, our strategy is to use detailed establishment level microdata from the 2007 Economic Census (EC) collected by the U.S. Census Bureau. The EC collects operating characteristics (e.g. employment, payroll, sales, location, and primary industry) from establishments for the vast majority of the private economy. However, it does not provide information on self-employed individuals,

employees of private households, railroads, agricultural production, and most government activities.

The unit of observation in the EC 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, activities are generally grouped together as a single establishment and the entire establishment is classified on the basis of its primary activity. Business establishments in the EC are grouped into industries based on the similarity of their production processes and classified according to the North American Industry Classification System (NAICS).

The EC covers eight NAICS service industry group: 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 at the end of the paper. For our analysis, we group industries into four broad sectors: 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 industries in utilities, mining and construction (NAICS 20s) as well as government (NAICS 90s).<sup>9</sup>

Table II presents information on the number, size, and average wage for establishments in each sector. Compared to manufacturing, the service sector is characterized by a relatively large number of small establishments. The mean establishment in business services employs about 15 workers, while 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 average wages than the manufacturing

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<sup>9</sup>Mining (21) and utilities (22) present disclosure issues in a number of industries and a number of establishments in construction (23) have a transient nature.

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.

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 personal services pay relatively low wages. However, these simple 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 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. Therefore, while the business service sector is characterized by a large number of small establishments, most workers are employed by large, high wage establishments.

## 2.2 Geography of Services Production

The existence of very large business service establishments challenges the traditional characterizations of the service sector as mostly small establishments serving local customers and at least presents the possibility that some of these large producers might be serving customers beyond their local market. In this section, we construct industry-level indexes

that compare the geographic concentration of production and demand within the U.S. and provide empirical evidence consistent with that conjecture.

A key dimension of our investigation is the geographical distribution of production. We assign establishments to regions using the BEA’s definition of Labor Market Areas (LMA) as our unit of geography. 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 because in many regions economic activity in a metropolitan area spans several counties (e.g. South Bend) and preferable to states because metropolitan areas sometimes span state boundaries (e.g. Washington D.C.). The 183 LMAs are mutually exclusive and exhaustive of the land area of the United States. We construct region level statistics on service producers using these 183 regions.

To characterize how geographically concentrated various industries are, we construct a measure of an industry’s geographic concentration ( $G_i$ ) described in Ellison and Glaeser (1997) for each industry in our sample.<sup>10</sup> In theory, the geographic concentration index compares the share of an industry’s production in a region to the region’s share of industry demand. In practice, we compute the geographic concentration index by taking the sum across regions of the square difference between the share of industry  $i$ ’s employment located in a region and that region’s share of total employment, specifically:

$$G_i = \sum_{i=1}^M (s_i - x_i)^2. \tag{1}$$

where  $s_i$  represents the share of industry employment in region  $i$  and  $x_i$  represents the share of total employment in region  $i$ . A high geographic concentration index signals that some regions produce significantly more, and others significantly less, than is consumed in the

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<sup>10</sup>We do not make the Herfindahl adjustment that Ellison and Glaeser (1997) use in their index of agglomeration because we are not interested in agglomeration (the co-location of different firms in the same industry), but are interested in pure geographic concentration (whether the concentration is due to one firm or a number of firms). If economic activity is concentrated because significant scale economies are captured within a firm, we do not want to discount this concentration.

TABLE III  
GEOGRAPHIC 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

region. We interpret this mismatch in the geographical distribution of demand and supply as consistent with trade across regions.

Table III presents descriptive statistics of the geographic concentration measure by sector. Manufacturing industries have the highest geographic concentration measure on average at 0.059. Business services industries have the next highest geographic concentration measure at 0.036, while personal services industries have the lowest average index at 0.015. This pattern conforms to our priors regarding manufacturing production as being relatively concentrated (and manufacturing output being quite tradable) and services production being more dispersed (and service output generally less tradable). However, while this is true on average, there is considerable variation across industries within sectors – indicating that some service sector industries are geographically concentrated and some manufacturing industries dispersed.

Figure 2 shows the dispersion in the geographic concentration measure across industries within 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 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. Table IV reports geographic con-

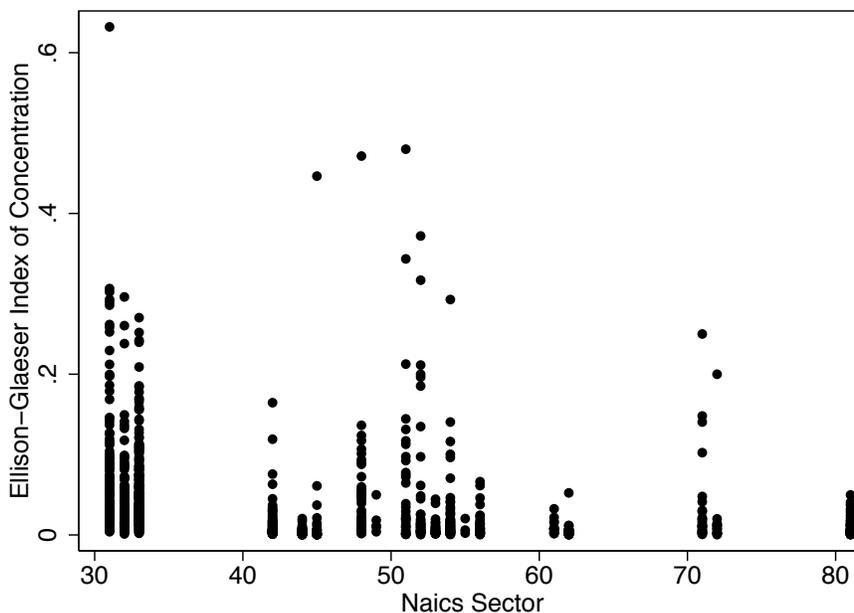


Figure 2: GEOGRAPHIC CONCENTRATION BY SECTOR

centration measures for the most and least concentrated manufacturing and business service industries.

Some of the manufacturing industries on the list, such as tobacco stemming and drying and several apparel production industries, are well-known examples of geographically concentrated industries. 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. For instance, 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 theaters and tax preparation – industries that are ubiquitously distributed across the U.S. and industries not associated with international trade.

TABLE IV  
5 MOST AND LEAST CONCENTRATED BUSINESS SERVICE AND MANUFACTURING INDUSTRIES

NAICS	Industry description	G 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

The results show that the manufacturing sector has, on average, more geographically concentrated industries but that some business service industries are as geographically concentrated as manufacturing. Because the business service sector is twice the size of the manufacturing sector, the share of economic activity in concentrated business services could be as large, or even larger, than the manufacturing sector. Table V reports the share of total employment by sector and concentration of production – quartiles based on the geographic concentration measure. The table shows that most employment in our sample is in industries that are not geographically concentrated (i.e. in the lowest geographic concentration quartile) and that business and personal services industries together account for the majority of employment. The distribution of employment in manufacturing is skewed towards geographically concentrated industries, while the reverse is true for the services sector. However, the share of employment in geographically concentrated business services is comparable to that in the manufacturing sector. Whether comparing the most geographically concentrated in-

dustries (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.

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

## 2.3 Discussion

We would like to push harder 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. While within region differences between demand and supply strongly suggests interregional trade, the underlying cause of this imbalance is still unclear. In addition to trade costs, other factors contribute to generating a gap between revenue and expenditure at the region level. For instance, conditional on trade costs, variation in consumer tastes or returns to scale will affect the degree of concentration in an industry. Other things equal, when consumers are sensitive to changes in price, consumption will mostly consist of local production. When the industry is characterized by high degree of returns to scale, production will be concentrated in a few large firms and interregional trade will be higher. Distinguishing these various channels requires imposing additional structure on the data.

In the following section, we develop a model of interregional trade that incorporates product differentiation, returns to scale and trade costs to examine how these factors influence the geographic distribution of service production. We believe that, in some cases, the impetus for concentration is not relevant. For instance, when evaluating an industry’s potential for international trade, it makes little difference whether it is driven by consumers taste, returns to scale or trade barriers. However, when studying the impact of changes in trade policies,

understanding the exact nature of barriers to trade will be crucial. Policymakers can influence levels of artificial barriers but can do little to change consumers tastes or change production technologies.

### 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 an industry, conditional on the distribution of firms and demand across regions. The model makes strong assumptions but provides a simple, parsimonious mechanism that allows us 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  $j = 1, 2, \dots, G$  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

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

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  $\sigma$  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

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

$E_i$  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:

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

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, the consumers' love variety that arise from the CES preferences implies that all varieties produced in equilibrium are consumed in every region.<sup>11</sup> 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:

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

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<sup>11</sup>The CES preferences imply that consumers are willing to purchase every varieties no matter what the price is. Because of this, our model may overstate the volume of trade between regions. Nevertheless, we use CES preferences because they provide convenient closed form solutions and are standard in the literature.

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:

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

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 regions that face high trade costs ( $\tau$ ) 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

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

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:

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

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. While it obviously arises from the strong assumptions we make, we find this property of the model particularly attractive for our estimation purpose because it provides a clear and 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,  $c = 1$ , and assume trade costs are dichotomous,  $\tau > 1$  if  $i \neq j$ ,  $\tau = 1$  otherwise. Using the pricing rule (5) we can show that the equilibrium value of export for a representative firm located in region  $j$  is given by

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

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 ( $\tau$ ). The appendix shows, as one would expect, 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

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

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 than 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 ( $\tau \rightarrow \infty$ ), aggregate revenue equals 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 ( $N$ ) across regions, the price elasticity of demand ( $\sigma$ ), and trade costs ( $\tau$ ). 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 estimate trade costs. For any given value of  $\sigma$  and  $\tau$ , 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

$$SES(\hat{\tau}, \hat{\sigma}) = \frac{\sum_j \|ES_j(\hat{\tau}, \hat{\sigma})\|}{2E}, \quad (10)$$

where  $ES_j$  denotes the excess supply in region  $j$  defined in (9). Equation (9) shows that the  $ES$  depends only on  $\tau^{\sigma-1}$  and not on the specific values of  $\tau$  and  $\sigma$ . Therefore, in the estimation, we fix the price elasticity of demand,  $\sigma = 5$ , and search over values of  $\tau$  until we find the value that minimizes the difference between the measured and simulated excess supply

$$u = \left\| \widehat{SES} - SES \right\|. \quad (11)$$

It is important to point out that for most of the analysis it does not really matter whether an industry is tradable because consumers are sensitive to changes in price or because there are large costs associated with serving consumers at a distance. We will come back to that point when we estimate the welfare impact of trade liberalization.

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 do this implicitly 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.

## 4 Measurement and Sample Characteristics

We use equation (10) to estimate trade costs for each 6 digits NAICS industries separately. This requires information on supply (or revenue  $R_j$ ), demand (or expenditure  $E_j$ ), number of firms ( $N_j$ ) for each industry-region as well as the share of excess supply for each industry ( $SES_j$ ). For each industry, we measure supply ( $R_j$ ) 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  $j$ .<sup>12</sup>

Our concept of geography treats each region as a dot in space (i.e. there is no distance within regions). To be consistent with this interpretation, we aggregate establishments in the same 6-digit NAICS industry and the same LMA into one "firm" based on ownership

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<sup>12</sup>Using value added as a measure of production would be problematic because we construct demand from revenue. A value-added demand measure would be difficult to interpret.

information contained in the Economic Census.<sup>13</sup> Thus, our measure of the number of firms in a region ( $N_j$ ) is the number of companies active in the same 6-digit NAICS industry in the LMA (region). Essentially, we assume consumers distinguish varieties across firms and regions, but not across-plants of the same firm within a region.

In addition, we also need region-specific measures of demand ( $E_j$ ). The geographic concentration measure described above implicitly uses a region's share of total employment as a measure of demand. A limitation of this approach 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 (2006) to construct region-specific measures of demand for each industry using the BEA's Input-Output Use tables.<sup>14</sup> Precisely, our measure of industry  $i$  demand in region  $j$  is defined as:

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

where  $s_t^o$  is the share of industry  $i$  output demanded by industry  $t$  (for all  $t = 1, \dots, T$  industries) and  $s_{tj}^e$  is the share of industry  $t$  employment located in region  $j$ .<sup>15</sup> We multiply the share of industry demand in the region by the value of total output in industry  $i$  across all regions  $j = 1, \dots, C$  to obtain our region-specific measure of demand.

Finally, 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 as follows

$$SES_j = \frac{\sum_j \|R_j - E_j\|}{2 \sum_j E_j}.$$

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<sup>13</sup>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.

<sup>14</sup>We use the 1997 Benchmark Input-Output Use tables published by the BEA. For more information, see [www.bea.gov/industry/io/benchmark](http://www.bea.gov/industry/io/benchmark).

<sup>15</sup>We use the location of employment instead of revenue because we include demand from the government sector and revenue data is not available.

In essence, we calibrate the model for each industry by choosing  $\tau$  to minimize the distance between the observed share of excess supply and the theoretical share of excess supply defined in (10).

## 4.1 Sample Characteristics

Table VI reports the average coefficient of variation for our measures of region supply ( $R$ ), region demand ( $E$ ), and number of producers in a region ( $N$ ). The measure is obtained by computing the coefficient of variation across-regions for each industry and then taking the simple average across industries. 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 share of excess supply ( $SES$ ) 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. Also, because the excess supply is akin to a current account value, it represents a lower bound for interregional trade. Table VI shows that the manufacturing sector has the highest mean  $SES$  measure, on average at least 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  $SES$  with about 36 percent of the average business service industry output consumed in a region other than where it is produced. The averages conceal considerable variation in excess supply measures across industries within sectors. For example, in personal services the average  $SES$  measure is relatively low with 28 percent of output consumed outside of the region where it is produced – but the standard deviation is quite large at 0.5. All sectors have significant inter-quartile ranges for the  $SES$  measure – indicating variation in  $SES$  across industries within each sector.

TABLE VI  
DESCRIPTIVE STATISTICS

NAICS	Sector description	Coefficient of variation			Excess Supply			Correlation
		R	E	N	Mean	Std Dev	IQR	SES, 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

The last column of Table VI reports the correlation between the geographic concentration measure and our measure of excess supply ( $SES$ ). 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 use variation in the distribution of demand and supply, number of firms and share of excess supply to obtain measures of trade costs for each industry. We then evaluate the model’s ability to match the data. For each 6 digit NAICS industry we estimate trade costs by minimizing the objective function defined in (10). Table VII presents the average and standard deviation for estimated trade cost ( $\tau$ ) 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 decreasing 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 considerable variation within sectors in the estimated trade costs. This points to the importance of using disaggregated data. Based on our estimates, it would not be correct to characterize all manufacturing industries as tradable and all business services

TABLE VII  
MEAN ESTIMATED TRADE COSTS

NAICS	Sector description	$\hat{\tau}$	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.

as nontradable. Within both sectors, some industries are tradable and others are not. As we will explain in detail in the next section, there is considerable overlap between the estimated trade costs of manufacturing and services industries. 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 excess supply. Recall, that the estimation choose trade costs to match the share of excess supply at the industry level, but does not target region level excess supplies. As can be seen in Table VII the correlation between actual and simulated region revenue is positive and large on average in all sectors. These correlations show that the model is able to replicate not only the overall trade share but also replicates the distribution of revenue across regions quite well.

Second, we evaluate the objective function (11) at the estimated trade costs ( $\hat{\tau}$ ). If the calibrated model perfectly replicates the world, the actual and simulated  $SES$  will be identical and, as a result, the value of the objective function will be equal to zero. At 0.03, the average value of the objective function is somewhat large. However, it is mainly driven by a few outliers industries that the model cannot replicate very well.

TABLE VIII  
RELATION BETWEEN TRADE COSTS AND FIXED COSTS

	All	Manufacturing	WRT	Bus. Srv.	Pers. Srv.
Fixed Costs ( $f$ )	0.256 (0.046)	0.320 (0.068)	0.158 (0.097)	0.252 (0.095)	0.457 (0.191)
SES	-1.092 (0.056)	-0.881 (0.081)	-1.21 (0.172)	-0.772 (0.186)	-1.609 (0.300)
Constant	1.265 (0.080)	1.218 (0.011)	1.142 (0.179)	1.212 (0.182)	1.713 (0.345)
R2	0.287	0.240	0.215	0.095	0.193
N	943	453	187	179	124

*Notes:* This table present coefficients estimates and standard deviation (in parentheses) from OLS regressions of estimated trade costs ( $\tau$ ) on estimated fixed production costs ( $f$ ) and share of excess supply ( $SES$ ).

Third, we evaluate how well the calibrated parameters 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  $\hat{f}_j = \hat{R}_j / \sigma N_j$ . We therefore estimate fixed production costs by taking the average across all regions within the industry as follow:  $\hat{f} = G^{-1} \sum_j \hat{f}_j$ . 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 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 an important determinant of trade flows.

Overall our simple model does a good job of capturing variation in the data and the estimates behave as predicted by the model.

## 6 Results

In this section we use our trade costs estimates to obtain three important sets of results. First, we obtain estimates for the share of U.S. employment in tradable service industries.

We find that while the average business service 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 service 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 trade barriers imposed in services and the relative importance of services in consumption lead to a much larger increase in welfare from a possible service sector liberalization. Third, we compare the characteristics of tradable and non-tradable industries. We find that tradable business services are more skill-intensive compared to non-tradable services and manufacturing. The relative skill intensity of tradable service activities combined with the relative skill abundance of the U.S. suggest that the U.S. has comparative advantage in the production of these services and would likely specialize in these activities if services trade were liberalized.

## **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. For instance, 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.

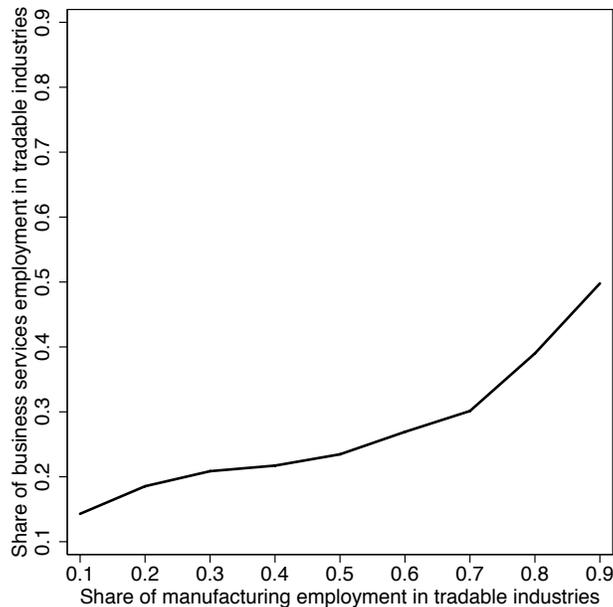


Figure 3: SHARE OF BUSINESS SERVICES EMPLOYMENT IN TRADABLE INDUSTRIES

The second metric reports 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 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.

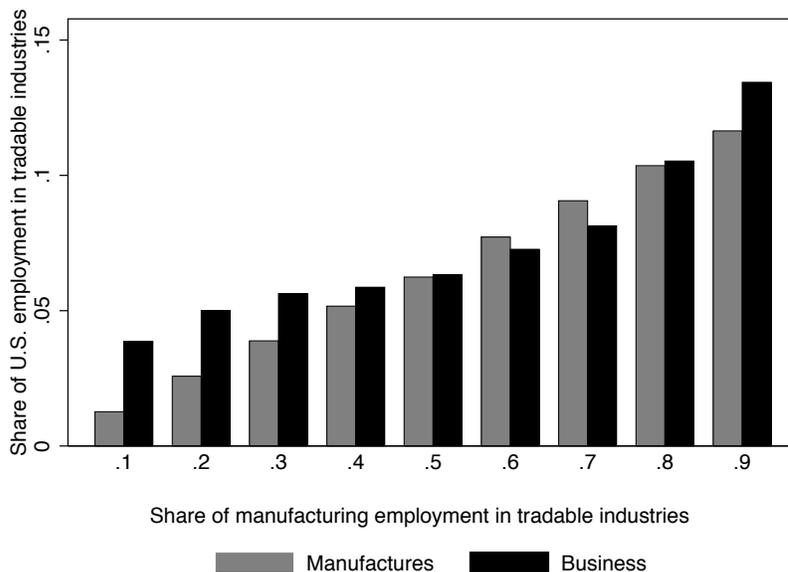


Figure 4: SHARE OF TOTAL EMPLOYMENT IN TRADABLE INDUSTRIES

## 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 et al. (2010). We use rough approximations of tariff equivalent barriers of 5.4% for manufacturing for the EU and 10.5% for manufacturing for the BRICs, 7% for services for the EU and 64% for services for the BRICs.

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 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  $\alpha_s$  represents the share of expenditure in sector  $s$ .

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.

Under the maintained assumptions, real wage in an industry 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

$$W = \sum_{s=3}^6 \widehat{P}_s^{-\alpha_s}, \quad (12)$$

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

The results are reported in Table IX. The within column shows the average within-industry changes in real wage for each sector. The overall column shows variation in welfare as defined in (12). These results suggest that the potential impact of trade liberalization in services is larger than in manufacturing. This happens for two reasons. First, average trade barriers are much higher in service sector, so the scope for welfare gain is higher. Second, the service sector's share of economic activity is larger. This combination suggests that the potential welfare gains from liberalization in the service sector are larger than gains available in the manufacturing sector.

TABLE X  
AVERAGE WAGE ACROSS SECTORS AND TRADABILITY

NAICS	Sector description	Non-tradable	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

### 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. We expect that industries that are not consistent with U.S. comparative advantage will experience greater dislocation in response to decreases in impediments to services trade. We examine the characteristics of tradable business service activities and see whether they are consistent with U.S. comparative advantage.

In Table X, we present information on the average wage which we use as a proxy for skill-intensity in production across sectors. We categorize industries as tradable and non-tradable based on their estimated trade costs. We classify 90% of manufacturing employment in tradable industries and use the associated trade costs to classify industries in other sector as tradable or non-tradable. We report average wages for each sector for industries classified as tradable and non-tradable. Industries classified as tradable have, on average, higher average wages than nontradable industries within the same sector. 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.

TABLE XI  
MEAN INDUSTRY WAGES AND INDUSTRY CHARACTERISTICS

Variable	(1)	(2)	(3)	(4)
SES	0.377 (0.030)			
Log trade costs ( $\tau$ )		-0.140 (0.032)		-0.143 (0.032)
Log fixed costs ( $f$ )			0.148 (0.032)	0.151 (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.

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

## 7 Conclusion

The service sector in the U.S. is large and services trade as measured in official statistics is increasing. Unfortunately, services trade data is only available at very high levels of aggregation. We develop the intuition that if we observe a mismatch between supply and demand at the region-level there is trade between regions. We extend the framework of Krugman (1980) and develop a partial equilibrium model of interregional trade and exploit detailed, highly reliable microdata on U.S. service establishments to identify cross-industry variation in the tradability of services. We obtain estimates of trade costs at the 6-digit NAICS level for major sectors of the economy.

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:

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

This equation makes clear that the volume of trade is monotonically increasing in fixed trade costs. Taking the derivative with respect to trade costs ( $\tau$ ) 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 inequality follows because  $\sigma > 1$  and  $A \in (0, 1)$ .

## D Description of Major Service Sectors

This appendix provides descriptions for the service industries included in the study.

## **NAICS 51: Information**

The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data. The main components of this sector are the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; the industries known as Internet service providers and Web search portals, data processing industries and the information services industries. For the purpose of developing NAICS, it is the transformation of information into a commodity that is produced and distributed by a number of growing industries that is at issue. The Information sector groups three types of establishments: (1) those engaged in producing and distributing information and cultural products; (2) those that provide the means to transmit or distribute these products as well as data or communications; and (3) those that process data. Cultural products are those that directly express attitudes, opinions, ideas, values, and artistic creativity; provide entertainment; or offer information and analysis concerning the past and present. Included in this definition are popular, mass-produced, products as well as cultural products that normally have a more limited audience, such as poetry books, literary magazines, or classical records.

## **NAICS 54: Professional, Scientific, and Technical Services**

The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries

and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services. This sector excludes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and record keeping, personnel, and physical distribution and logistics. These establishments are classified in Sector 56, Administrative and Support and Waste Management and Remediation Services.

## **NAICS 55: Management of Companies and Enterprises**

The Management of Companies and Enterprises sector comprises (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision making role of the company or enterprise. Establishments that administer, oversee, and manage may hold the securities of the company or enterprise. Establishments in this sector perform essential activities that are often undertaken, in-house, by establishments in many sectors of the economy. By consolidating the performance of these activities of the enterprise at one establishment, economies of scale are achieved. Government establishments primarily engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration. Establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and record keeping, personnel, and physical distribution and logistics are classified in Industry 56111, Office Administrative Services.

## **NAICS 56: Administrative and Support and Waste Management and Remediation Services**

The Administrative and Support and Waste Management and Remediation Services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. These essential activities are often undertaken in-house by establishments in many sectors of the economy. The establishments in this sector specialize in one or more of these support activities and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services. The administrative and management activities performed by establishments in this sector are typically on a contract or fee basis. These activities may also be performed by establishments that are part of the company or enterprise. However, establishments involved in administering, overseeing, and managing other establishments of the company or enterprise, are classified in Sector 55, Management of Companies and Enterprises. These establishments normally undertake the strategic and organizational planning and decision making role of the company or enterprise. Government establishments engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration.

## **NAICS 61: Educational Services**

The Educational Services sector comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated. They may also offer food and accommodation services to their students. Educational services are usually delivered by teachers or instructors that explain,

tell, demonstrate, supervise, and direct learning. Instruction is imparted in diverse settings, such as educational institutions, the workplace, or the home through correspondence, television, or other means. It can be adapted to the particular needs of the students, for example sign language can replace verbal language for teaching students with hearing impairments. All industries in the sector share this commonality of process, namely, labor inputs of instructors with the requisite subject matter expertise and teaching ability.

## **NAICS 62: Health Care and Social Assistance**

The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry. Excluded from this sector are aerobic classes in Subsector 713, Amusement, Gambling and Recreation Industries, and nonmedical diet and weight reducing centers in Subsector 812, Personal and Laundry Services. Although these can be viewed as health services, these services are not typically delivered by health practitioners.

## **NAICS 71: Arts, Entertainment, and Recreation**

The Arts, Entertainment, and Recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises: (1) establishments that are involved in

producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure time interests. Some establishments that provide cultural, entertainment, or recreational facilities and services are classified in other sectors. Excluded from this sector are: (1) establishments that provide both accommodations and recreational facilities, such as hunting and fishing camps and resort and casino hotels, are classified in Subsector 721, Accommodation; (2) restaurants and night clubs that provide live entertainment in addition to the sale of food and beverages are classified in Subsector 722, Food Services and Drinking Places; (3) motion picture theaters, libraries and archives, and publishers of newspapers, magazines, books, periodicals, and computer software are classified in Sector 51, Information; and (4) establishments using transportation equipment to provide recreational and entertainment services, such as those operating sightseeing buses, dinner cruises, or helicopter rides, are classified in Subsector 487, Scenic and Sightseeing Transportation.

### **NAICS 81: Other Services (except Public Administration)**

The Other Services (except Public Administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services. Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector. Excluded from this sector are establishments primarily engaged in retailing new equipment and

also performing repairs and general maintenance on equipment. These establishments are classified in Sector 44-45, Retail Trade.