THE TRADABILITY OF SERVICES: GEOGRAPHIC CONCENTRATION AND TRADE COSTS[i]

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Abstract

We develop a methodology for estimating the "tradability" of goods and services using data on U.S. establishments. Our results show that the average service industry is less tradable than the average manufacturing industry. However, there is considerable within-sector variation in estimated tradability and many service industries are as tradable as manufacturing. Tradable service industries account for a significant share of economic activity and workers employed in those industries have relatively high average wages. Counterfactual analysis indicates that the potential welfare gains from policy liberalization in service trade are of the same order of magnitude as liberalization in the manufacturing sector.

Keyword*:* Service sector, international trade, imperfect competition, microdata, trade liberalization.

JEL Classification: F1.

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1 Introduction

The service sector, broadly defined, accounts for about 80 percent of employment in the United States. Moreover, according to official statistics, international trade in services is expanding rapidly; service exports more than doubled over the past decade and now account for about 30 percent of United States' exports. Many other developed economies have service sectors of similar size and importance. Because of the growing importance of the service sector, a number of international trade agreements currently being negotiated are considering important commitments to liberalize service trade.[1]

Yet in spite of the service sector's importance and growing trade share, empirical studies in international trade have focused almost exclusively on the manufacturing sector.[2] In this paper, we begin to explore the *potential* scope and implications of service trade. We develop a methodology for estimating the "tradability" of goods and services to obtain detailed, industry-level estimates of trade costs. We use our estimates to explore the scope of tradable service activities and find that the average service industry is less tradable than the average manufacturing industry. However, there is considerable variation in estimated tradability within sectors and many service industries are as tradable as manufacturing industries. Further, we find tradable service industries account for a significant share of economic activity and workers employed in those industries have relatively high average wages. Finally, counterfactual analysis indicates that the potential welfare gains from policy liberalization in service trade are of the same order of magnitude as those from liberalization in the manufacturing sector. Our results provide evidence that there is considerable scope for trade in services and that the welfare gains from trade liberalization in services could be significant.

A key impediment to analyzing the service sector is the lack of information. The data available for the service sector is not as detailed or as rich as that available for the manufacturing sector.[3] As a result, current work on services is limited to case studies or analysis using aggregated bilateral trade data.[4] Since there is no

[1] For example the Trans-Pacific Partnership, the Transatlantic Trade and Investment Partnership, and the International Services Agreement.

[2] Notable exceptions include Liu and Trefler (2008) which examines the impact of services outsourcing using data on U.S. worker employment outcomes. Hanson and Xiang (2008) examines international movie distribution. Breinlich and Criscuolo (2011) uses U.K. establishment level data on service exporters. Hoekman (2006) provides a survey of other recent works on international trade in the service sector. The burgeoning empirical literature exploiting plant and firm level microdata has historically focused on the manufacturing sector, though Foster et al. (2001) and Holmes and Schmitz Jr (1995) examine the service sector.

[3] International trade data for the service sector is also far less detailed and comprehensive than that for merchandise trade. For instance, the U.S. Census Bureau publishes information on imports and exports of goods for more than 10,000 product categories. In stark contrast, the BEA recently began publishing service trade data for about 30 categories (up from 17 categories in 2005) with only limited geographic coverage. Bilateral trade data among countries for the service sector is only available for very broad categories of services. For additional information on the availability and limitations of service trade data, see Feenstra et al. (2010).

[4] See, for instance, Anderson et al. (2011), Egger et al. (2012), Francois et al. (2007), and Nordås (2010)

reason to expect that all *industries* within a *sector* share the same characteristics, a number of fundamental questions about trade in the services sector remain open: (i) Which service industries are tradable? (ii) How much economic activity in the service sector is tradable? (iii) What are the distinguishing characteristics, if any, of tradable service industries? Answers to these important questions require *industry-level* estimates of tradability which, by definition, cannot be obtained using aggregate bilateral trade flows.

In the next section, we present establishment-level statistics for the service sector in the United States that reveal significant heterogeneity across industries over a range of producer characteristics. One key and striking feature of the data is the variation across industries in the geographical concentration of services production, even in closely-related industry groups. For example, Payroll Services (NAICS 541214) has relatively large producers that are concentrated in about a dozen regions. In contrast, Tax Preparation Services (NAICS 541213) is characterized by a large number of relatively small, store-front operations located throughout the United States. Because both payroll services and tax preparation services are consumed broadly in the United States, we believe the variation in geographic concentration of production across the industries provides important insight into how feasible and/or profitable it is to deliver different services at a distance.

The variation in these statistics across industries (within a sector) suggests the high level of aggregation in official trade statistics is problematic for studying the impact of service trade on the U.S. economy. Such a classification is important to a range of empirical analyses (e.g., studying the effect of international trade on employment dynamics, labor market outcomes, or productivity growth; trying to estimate the impact of fiscal stimulus on the domestic economy).[5] Because official international trade statistics for the service sector do not capture variation within industry groups, they are not detailed enough to develop reliable estimates of the share of economic activity in *tradable* services or to examine the potential impact of trade in services on the U.S. economy. Given that it is unlikely that more detailed official trade data on the service sector will become available in the near future, we develop a new methodology that uses available data for identifying which activities are tradable.

To address the need for industry level estimates of trade costs, we develop a novel empirical strategy that uses cross-industry variation in the geographical concentration of production to estimate the tradability of goods and service industries. Our empirical approach does *not* require data on international trade flows.

[5]The service sector is attracting the attention of macroeconomists concerned with growth, for example, Buera and Kaboski (2012).

Instead, as described in section 4, we use information on production and demand for regions of the United States constructed from detailed microdata covering nearly all establishments in the U.S. private sector. Our methodology extends the intuition in Jensen and Kletzer (2006) and Jensen (2011) that a mismatch between supply and demand in a region is an indicator of trade between regions. We formalize this intuition using a simple model that features increasing returns to scale, taste for variety, trade costs and region-level heterogeneity in production costs. The empirical framework highlights a simple, parsimonious mechanism that allows us to use the limited information available to obtain industry-level measures of trade costs.

As we explain in section 3, the theoretical model provides a closed form solution for a region's "excess supply," the difference between local production and local demand, as a function of the observable distributions of demand and productions costs, and an unobserved index of tradability. We use that equation to estimate trade costs *separately* for more that nine hundred industries spanning the service and manufacturing sectors. Because policy barriers to trade in services within the U.S. are, in general, relatively limited, we interpret the measures of trade costs as suggestive of the *technological* impediments associated with trading services across regions. If an activity is not traded within the U.S., we deem it unlikely to be traded internationally when firms face additional costs. However, if an activity is traded within the U.S., we consider it *potentially* tradable internationally, i.e. it appears technically feasible to deliver the activity across regions.

The empirical results presented in section 5 suggest that while the average service industry is less tradable than the average manufacturing industry, there is considerable within-sector variation in estimated tradability. In particular, there is significant overlap in the estimated trade costs of *business* service industries (defined below) and manufacturing industries. Based on our estimates, it would be incorrect to characterize all manufacturing industries as tradable and all service industries as non-tradable. Many service industries appear to be as tradable as manufacturing industries. These results emphasize the importance of using detailed, industry level data.

In section 6, we use the detailed trade cost measures to evaluate the potential scope for international trade in services, explore the potential impact of trade liberalization in services on U.S. welfare, and examine tradable service industries worker characteristics. First, we use the trade cost measures to estimate the share of U.S. employment in tradable service industries. Our findings indicate that a significant share of economic activity occurs in tradable service industries. Even though we classify a smaller share of industries in the business service sector as tradable, because the share of employment in the business service sector is double that in the manufacturing sector, we find – depending on the threshold we use to divide industries into

tradable and non-tradable – employment in tradable business services could be as large as that in tradable manufacturing.

Second, we use our estimated trade cost measures to explore counterfactual welfare analysis. The potential increase in welfare from removing barriers in the business service sector depends on the cutoff we use to separate industries into tradable and nontradable categories and the extent of the liberalization (i.e. how large is the decrease in trade costs). But, under reasonable assumptions, our results suggest that the potential welfare gains from liberalization in the business service sector are of the same magnitude as (and may even be larger than) gains available from liberalization in the manufacturing sector. While somewhat surprising, this finding is a direct implication of the scope of tradable service activities and current barriers to service trade. So while services are on average less tradable than manufacturing industries, because the service sector is so large, the impact is of similar magnitude. Further, given that average trade barriers appear to be much higher in services than goods, the scope for gains from liberalization in services may be much higher.

Last, to gain a sense of the possible implications of service sector trade liberalization on developed economy labor markets, we examine crude evidence regarding the factor intensity of tradable service production. We find that workers in business service industries we categorize as tradable have significantly higher average wages than workers in other service sectors or the manufacturing sector. We interpret this variation in wages as evidence that tradable business services are skill-intensive activities. Therefore, if there were service sector liberalization, we would expect, all else equal, relatively skill-abundant regions to specialize in these activities.

2 The Service Sector in the United States

In this section, we present descriptive statistics ranging from establishment-level information to sector-level aggregates to describe important features of the service sector in the United States. We provide statistics on the importance of the service sector to the U.S. economy, describe the growing significance of services in U.S. international trade flows, and examine service sector establishment characteristics. We pay particular attention to the geographic distribution of service production within the United State as this is a key feature of the data that we utilize to construct detailed trade cost measures.

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: Authors' calculation using data from 1997 and 2007 Economic Census and 2007 Census of Government.

2.1 Share of Employment

The service sector in the United States is large and diverse. 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 United States. 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). [6] Table 1 shows even this less expansive definition of the service sector accounts for roughly 70 percent of United States' employment.

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 manufacturing sector decreased more than 20 percent and now accounts for about 10 percent of U.S. employment.

2.2 Establishment Characteristics

We turn to establishment level microdata from the 2007 Economic Census (EC) collected by the U.S. Census Bureau to provide a more detailed view of the services sector in the United States. The EC collects operating characteristics (e.g. employment, payroll, sales, location, and primary industry) from establishments for the vast majority of the private economy.[7] In particular, it contain information on 10 NAICS service industry groups: Information (51); Finance and Insurance (52); Real Estate and Rental and Leasing

[6] We exclude industries in utilities, mining and construction (NAICS 20s) as well as government (NAICS 90s). 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.

[7] However, it does not provide information on self-employed individuals, employees of private households, railroads, agricultural production, or most government activities.

TABLE II
ESTABLISHMENT CHARACTERISTICS

NAICS	Sector Description	Mean		Co-worker Mean		Number
		Employment	Wage ($000s)	Employment	Wage ($000s)	of Plants
3	Manufacturing	45.22	39.49	782.6	46.01	300,058
4	Wholesale and Retail	13.79	27.85	268.5	34.02	1,628,905
5	Business Services	14.92	42.01	1,402.0	52.66	2,042,238
6-8	Personal Services	17.69	27.66	578.7	28.87	1,915,688

Notes: This table presents establishment mean and co-worker mean employment and wage by sector. We compute means in two steps. First we get the average for each industry, then we take the mean across industries within each sector. This implies that, within each sector, industries receive the same weight regardless of their relative size. Data from 2007 Economic Census.

(53); 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); Accommodation and Food Services (72); Other Services (except Public Administration) (81). Descriptions of each of these sectors is contained in an appendix at the end of the paper.

The unit of observation in the EC is the establishment or plant – a single physical location at which business is conducted, or services or industrial operations are performed. It is not necessarily identical with a firm (or enterprise), which may consist of one or more establishments. When two or more activities are carried out 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).

Table II presents information on the number, average size, and average wage of 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. Average wages in business services are slightly higher than in 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 personal services pay relatively low wages. However, these simple averages conceal considerable heterogeneity in the size distribution of service establishments.

Column 5 of Table II 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 that where the average manufacturing worker is employed. In addition, as seen in the last column, 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, the average service sector worker is employed by a large, high wage establishment.

2.3 Trade in Services

We are accustomed to thinking of trade in goods. Visualizing how commodities and manufactured goods are shipped all over the world is not difficult. However, when we speak of trade in services, it may be more difficult to conceptualize exactly what this means because services are often intangible. A useful introduction to how services are traded is provided in the General Agreement on Trade in Services (GATS) definitions of trade in services, which refers to 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)

While mode 3 trade in services is large and important, most of the factors of production are located near consumers and often only headquarters services or some intellectual property is being delivered at a distance. Our methodology relies on the mismatch of *local* production and consumption to identify tradable activities and, as such, will not identify provision of headquarters services or intellectual property as trade in services. We leave this topic for future research and in this paper focus on activities where the factors of production are *not* co-located with consumers.

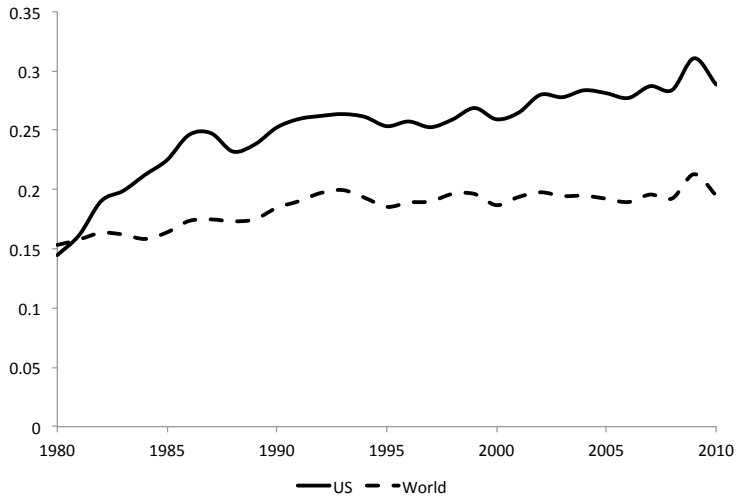

Figure 1: EXPORT SHARE OF SERVICES (Source: WTO)

Services have historically been considered "nontradable" because of the assumed need for face-to-face contact for many services. Yet, because of a broad range of technological changes (e.g. information technology and the ability to digitize knowledge), many services are now more easily delivered over a distance than in the past. Features of the particular service (e.g. how easily digitized is the service) will influence how costly it is to deliver the service at a distance. When physical presence is required for much of the service delivery, producers and consumers are likely to be co-located.[8] When it is instead possible to digitize some or most of the "service" (e.g. architectural designs), we are more likely to see remote production with some travel to support the service provision. Decreases in telecommunication costs and travel costs have also likely contributed to the growth in services trade.

As illustrated in Figure 1, official statistics show increases in services' share of exports in the United States and for the world. There is a steady increase in the service sector's share of exports, particularly in the United States, 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 service imports account for about 16 percent of U.S. imports (not shown).

The rapid growth in U.S. service trade has been driven predominantly by activities similar to what we characterize as "business services." While traditional traded service industries like transportation and tourism did contribute to the increase in service trade, most of the growth comes from what the Bureau of

[8]Of course, the decision to trade is function of both the associated costs and the value of the final service. While, a haircut, a low unit value service may not be traded, a high unit value surgery can be provided remotely (e.g. the Lindbergh Operation).

Economic Analysis (BEA) classifies as "other private services." Other private services include 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 categories of service trade 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.

2.4 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 presents the possibility that some of these large producers might be serving customers beyond their local market. To describe how geographically concentrated various industries are, we construct a measure of an industry's geographic concentration, described in Ellison and Glaeser (1997), for each industry in our sample:[9]

$$G = \sum_{i=1}^{M} (s_i^p - s_i^d)^2, \tag{1}$$

where s_i^p represents the share of industry production in region i, s_i^d represents the share of industry demand in region i and M denotes the number of regions. A high geographic concentration index signals that some regions produce a significantly higher share of the industry's output, and others significantly lower, than is consumed in the region. We interpret this mismatch in the geographical distribution of demand and supply as consistent with trade across regions.

In theory, the geographic concentration index compares regions' share of industry production to their share of industry demand. In this section, we compute the geographic concentration index by taking the sum across regions of the square difference between the share of the industry's employment located in a region and the region's share of aggregate employment (a simple proxy for local demand). We use 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.

[9]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	Concentration Index (G)			Number of Industries
		Mean	Std. dev.	IQR	
3	Manufacturing	0.057	0.061	0.052	464
4	Wholesale and Retail	0.021	0.052	0.014	187
5	Business Services	0.036	0.070	0.023	180
6-8	Personal Services	0.015	0.034	0.010	124

Notes: This table presents mean, standard deviation and interquartile range (IQR) across industries for the concentration index (G) defined in equation (1). The last column shows the number of industries within each sector. There are 955 NAICS 6 digit industries overall.

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.

Table III presents descriptive statistics of the geographic concentration measure by sector. Manufacturing industries have the highest geographic concentration measure on average at 0.057. Business service industries have the next highest geographic concentration measure at 0.036, while personal service industries have the lowest average index at 0.015. This pattern conforms to our priors that manufacturing production is relatively concentrated (and manufacturing output is quite tradable), while service production is more dispersed (and service output is generally less tradable). However, while this is true on average, there is considerable variation across industries within sectors. In particular, the high standard deviations across industries within each sector indicate that some industries are geographically concentrated and some industries dispersed.

Figure 2 shows the dispersion in the geographic concentration measure across industries within sectors. Each dot represents an industry and provides information on the sector to which it belongs as well as the degree of geographic concentration. It is interesting to note that both manufacturing and services have industries with dispersed production. The figure clearly shows that manufacturing industries are more geographically concentrated on average than industries in other sectors. Personal services (NAICS industries 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 distributed with population (and thus have low measures of geographic concentration). But in the business service sector, while many industries exhibit low levels of geographic concentration, a number of business service industries (NAICS industries in the 50s) are as geographically concentrated as manufacturing industries.

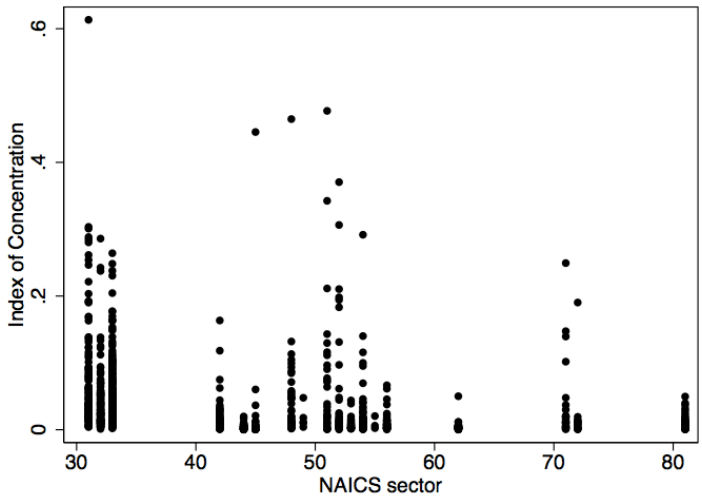

Figure 2: GEOGRAPHIC CONCENTRATION BY SECTOR

Table IV reports geographic concentration measures for the most and least concentrated manufacturing and business service industries. Manufacturing industries such as "Tobacco stemming and drying" and several apparel producing industries are well-known examples of geographically concentrated industries. These industries are also well-known for being traded. In manufacturing, the industries with low levels of geographic concentration are characterized by high transport cost to value ratios and typically have low trade shares, for example ready-mix concrete and quick printing.

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. The least concentrated business service industries include movie theaters and tax preparation – industries where producers are distributed throughout the United States.

These 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 as, 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

TABLE IV

5 MOST AND LEAST CONCENTRATED MANUFACTURING AND BUSINESS SERVICE INDUSTRIES

NAICS	Industry description	G Index
312210	Tobacco Stemming and Redrying	0.613
512199	Other Motion Picture and Video Industries	0.477
523110	Investment Banking and Securities Dealing	0.370
512110	Motion Picture and Video Production	0.343
523210	Securities and Commodity Exchanges	0.306
315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing	0.304
315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors	0.301
541360	Geophysical Surveying and Mapping Services	0.292
314110	Carpets and Rugs	0.288
325110	Petrochemical Manufacturing	0.286
327320	Ready-Mix Concrete Manufacturing	0.003
332322	Sheet Metal Work Manufacturing	0.003
339950	Sign Manufacturing	0.003
337212	Custom Architectural Woodwork and Millwork Manufacturing	0.002
323114	Quick Printing	0.001
511110	Newspaper Publishers	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

Notes: This table presents the NAICS code, description and concentration index (G, defined in equation (1)) for the top 5 most concentrated and least concentrated manufacturing and business services industries. The industries are rank in decreasing order of geographic concentration.

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 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.

Overall, the simple statistics presented in this section indicate that service trade is not such a rare activity and is increasingly important. In addition, the geographical distribution of employment in the service sector shows a significant mismatch between local production and local consumption in some service industries. We interpret the mismatch between local production and local consumption as suggestive evidence of trade in services – i.e. the output that is not consumed locally is "traded" to a different region. In the next section, we formalize this intuition in a simple model of trade between regions.

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	0.040	0.049	0.032	0.135
4	Wholesale and Retail	0.160	0.050	0.010	0.004	0.224
5	Business Services	0.174	0.067	0.029	0.033	0.303
6-8	Personal Services	0.287	0.036	0.008	0.007	0.338
	Total	0.635	0.193	0.096	0.076	1.000

Notes: This table shows the distribution of employment across sector of economic activity and quartiles of geographic concentration. The first quartile contains the least concentrated while the fourth is the most concentrated industries. Each cell contains the share of employment in that category of activity and concentration. The column totals in the last row provide information on the distribution of sales across concentration levels while the row totals in the last column provide information on the distribution of employment across sectors.

3 Econometric Strategy

In this section, we develop a model of interregional trade that incorporates heterogeneity in production costs across regions (e.g. Eaton and Kortum (2002) and Helpman et al. (2008)), returns to scale in production (e.g. Krugman (1980)), and trade costs as determinants of the amount of interregional trade in an industry, conditional on the distribution of supply and demand across regions. The model makes strong assumptions but allows us to use the limited information we have to obtain detailed, industry-level measures for "tradability". It is important to emphasize that the choice of model is guided by our preference for simplicity and transparency. Our goal is to provide an example of how to use information on the geographic dispersion of production and demand to obtain estimates of tradability when bilateral data on international transactions is unavailable. The proposed strategy is very general and could be applied to a number of models.

3.1 Theoretical Framework

Consider a closed economy composed of a fixed number of regions $i = 1, 2, ..., M$ each populated with a mass of identical consumers (L_i). Workers have no taste for leisure and provide their unit of labor to the market at the prevailing wage. Preferences are defined over the consumption of differentiated varieties of goods and services. There are S industries in the economy indexed by $s = 1, 2, .., S$. Aggregate utility in

region i is given by

$$U_i = \prod_{s=1}^{S} Q_{is}^{\alpha_s}, \quad \text{with} \quad \alpha_s > 0, \quad \sum_s \alpha_s = 1, \quad \text{where}$$
$$Q_{is} = \left(\sum_{v=1}^{V_{is}} q_{isv}^{\frac{\sigma_s - 1}{\sigma_s}} \right)^{\frac{\sigma_s}{\sigma_s - 1}}, \quad \text{with} \quad \sigma_s > 1.$$

The upper tier of the preference function has the typical Cobb-Douglas form. The second tier is a CES function over each industry where q_{isv} is the quantity of variety v in industry s consumed in region i, σ_s is the price elasticity of demand in industry s and V_{is} denotes the number of varieties available for consumption in industry s in region i.

The consumer's problem can be solved in two steps. First, a well known property of the Cobb-Douglas preferences is that the expenditure on each industry is given by α_s. Second, for each industry, the consumption of each variety is chosen to minimize the cost of the aggregate bundle Q_{is}, so that region i's optimal expenditure on a variety v of industry s is

$$r_{isv} = \alpha_s E_i \left(\frac{p_{isv}}{P_{is}} \right)^{1-\sigma_s}, \quad \text{where} \quad P_{is} = \left(\sum_{v=1}^{V_{is}} p_{isv}^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} \tag{2}$$

denotes the price of a unit of the aggregate bundle Q_{is}, E_i is the income in region i and p_{isv} is region i's price of variety v in industry s. Equation (2) makes clear that each industry can be analyzed independently as the optimal demand for varieties in one industry does not depend on other industries' characteristics. This is a useful property of the specified preferences that we exploit in the empirical analysis below.

For simplicity, we assume that production cost functions have the same properties in all industries. Production is subject to increasing returns to scale. Firms in region j industry s need to invest a fixed number of units of output, f_{js}, before they can bring their production to the market. Afterwards, they face a constant marginal cost of production per unit produced. For convenience, we normalize physical units in each industry such that marginal costs are equal to one unit of labor. We assume varieties are tradable across regions at some cost. For simplicity, trade barriers take the iceberg form so that when firms ship $\tau_{ijs} \geq 1$ units of product s from region j to region i only one unit arrives.

The presence of fixed production costs implies firms find it optimal to produce a variety different from all other varieties produced in the industry. Under the maintained assumptions, the total cost function for a

representative firm in region j, industry s, is given by:

$$C_{js} = \left(f_{js} + \sum_{i=1}^{M} \tau_{ijs} q_{ijs} \right) w_j,$$

where q_{ijs} is the demand for a representative region j's variety in region i in industry s and w_j is a measure of region j's wage rate. This measure can be more broadly interpreted as "productivity" and captures, for example, differences in access to inputs or variation in workers' skills that result in variation in production costs across regions.

We assume industries are characterized by monopolistic competition so that profit maximization implies the equilibrium price of a variety in industry s produced in region j sold in region i is:

$$p_{ijs} = \left(\frac{\sigma_s}{\sigma_s - 1} \right) w_j \tau_{ijs}. \tag{3}$$

Firms charge a constant markup above marginal production costs. Factory gate (f.o.b) prices vary across regions because of variation in regions' production costs (w_j), while consumer (c.i.f) prices for a given variety vary across regions because of differences in trade costs (τ_{ijs}).

We assume there are no fixed export costs such that each variety produced in equilibrium is sold in every market. Therefore, the number of firms in region j industry s, N_{js}, is also the number of varieties produced in region j, industry s, available for consumption in every other region. It follows that the equilibrium price index is given by:

$$P_{i,s} = \left(\frac{\sigma_s}{\sigma_s - 1} \right) \left(\sum_{j=1}^{M} N_{js}\, w_j^{1-\sigma_s}\, \tau_{ijs}^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} \tag{4}$$

Using the equilibrium expenditure (2), pricing rule (3) and price index (4), revenue and profits for a representative firm in region j can be expressed as:

$$r_{js} = w_j^{1-\sigma_s} \sum_{i=1}^{M} \alpha_s E_i \tau_{ijs}^{1-\sigma} \left(\sum_{l=1}^{M} N_{ls}\, w_l^{1-\sigma_s} \tau_{ils}^{1-\sigma_s} \right)^{-1}, \quad \text{and} \quad \pi_{js} = \frac{r_{js}}{\sigma_s} - f_{js} \tag{5}$$

Equation (5) clearly shows how revenue and profits depend on the distribution of demand, producers, production costs and trade costs across regions. The model is consistent with the observation that some regions do not produce in equilibrium because fixed production costs can drive profits below zero, in which case

firms would exit the industry. Finally, under the maintained assumptions, a firm's decisions in one industry depend exclusively on that industry's organization and not on other industries.

3.2 Empirical Approach

We use this simple framework to identify trade costs from the data for any industry s. Because firms' behavior in one industry is independent of other industries' characteristics, we estimate the model separately for each industry, and to simplify notation we drop the industry subscript (s). Using equilibrium expenditure (2), pricing rule (3) and price index (4), we can show that equilibrium value of sales from region j in region i (or export whenever $i \neq j$) is given by:

$$R_{ij} = N_j \, w_j^{1-\sigma} \, \tilde{E}_i \, \tau_{ij}^{1-\sigma} \left(\sum_{l=1}^{M} w_l^{1-\sigma} N_l \tau_{il}^{1-\sigma} \right)^{-1}, \tag{6}$$

where $\tilde{E}_i \equiv \alpha_s E_i$ represents region i's expenditure. Equation (6) clearly shows that sales depend on the producing region's number of firms (N_j) and productivity (w_j), the importing region's demand ($\tilde{E}_i$) and trade costs (τ_{ij}), and a market access term that comprises the number of firms (N_l) and productivity of each region (w_l), as well as bilateral trade costs between the producing region and all other regions (τ_{il}). As one would expect, sales are monotonically decreasing in bilateral trade costs.[10]

Our data is very detailed. For each region-industry pair we observe the number of firms and total revenue and can construct a measure of demand. *However, we do not observe trade flows between regions.* Instead, we use our measures of demand and supply to impute information on trade by computing the share of excess supply (ES) for each region. The ES is defined as the difference between supply and demand in the region-industry. In terms of the model, the excess supply for region j is given by

$$ES_j = R_j - \tilde{E}_j, \quad \text{where} \quad R_j = \sum_{i=1}^{M} R_{ij}.$$

The ES is positive when revenue in a region is greater then 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 supply and the region is a net importer.

[10] It can be shown that $\frac{\partial R_{ij}}{\partial \tau_{ij}} = -(\sigma - 1) \left(1 - \frac{N_j \tau_{ij}^{-\sigma}}{\sum_{l=1}^{M} N_l \tau_{il}^{1-\sigma}} \right) \frac{R_{ij}}{\tau_{ij}} < 0$. The inequality follows because the term in parentheses is bounded between zero and one.

We can use the model to obtain an expression for region revenue from (6) by taking the sum of sales across importing regions as follows

$$R_j = \sum_{i=1}^{M} R_{ij} = \omega_j \sum_{i=1}^{M} \left[\tilde{E}_i \, \phi_{ij} \left(\sum_{l=1}^{M} \omega_l \phi_{il} \right)^{-1} \right] \tag{7}$$

where $\omega_j \equiv N_j w_j^{1-\sigma}$ and $\phi_{ij} \equiv \tau_{ij}^{1-\sigma}$. Equation (7) shows that region revenue depends on the distribution of demand across regions $\tilde{E}_i$ and the parameters ω_j and ϕ_{ij}.

The parameter ω_j contains information on the number of varieties produced in each region and production costs in the region and can be interpreted as regional productivity. In our model, all else equal, a region will generate more revenue (and larger ES) if it faces lower production costs or has more producers – in other words if ω_j is large. In the next section, we describe how we proxy for ω_j. The parameter ϕ_{ij} contains information on trade costs (τ_{ij}) and the elasticity of demand (σ). Consistent with the well-known result from the economic geography literature, a region's ES depends on the "ϕ-ness of trade" but not trade costs and tastes separately.[11]

Our strategy is to find the set of ϕ_{ij} such that the predicted share of excess supply, given the observed distribution of demand ($\widetilde{E}_i$) and proxies for region productivity (ω_j), is as close as possible to the actual share of excess supply. Since we have only one observation for the excess supply in each region-industry (183 observations per industry) we cannot identify bilateral trade costs from our data (33,306 parameters) without making additional assumptions. We follow two approaches. First, we assume trade costs are dichotomous (i.e., $\phi_{ij} = \phi < 1$ if $i \neq j$ and $\phi_{ii} = 1$). This is equivalent to assuming that firms face two markets, their own and the rest of the "world". In that case, trade costs can be interpreted as the additional costs associated with delivering goods or services at a distance instead of face-to-face. Second, we relax this assumption and assume instead that bilateral trade costs are a function of distance as is typical in the gravity literature and let $\phi_{ij} = 1 + \phi \, d_{ij}$. These assumptions greatly simplify the estimation because we only need to find one parameter (ϕ) for each industry.

We estimate the parameter ϕ from the data by minimizing the difference between the measured and predicted *share* of excess supply in the industry (SES). For any given value of ϕ, we can use the model and the data to obtain a "simulated" distribution of revenue across regions and calculate the simulated share of

[11] It is important to point out that for most of our 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 return to this point when we estimate the welfare impact of trade liberalization.

excess supply in the industry:

$$SES(\phi) = \frac{\sum_j |R_j(\phi) - \tilde{E}_j|}{2\sum_j R_j(\phi)}. \tag{8}$$

Because the relationship between the excess supply and trade costs is non-linear we use the simulated method of moments to search over values of $\phi > 0$ to find the value that minimizes the objective function $u = (SES(\widehat{\phi}) - SES)^2$. We estimate the parameter ϕ *separately* for each industry.

3.3 Measurement

Estimating trade costs for each 6-digit NAICS industry using the relationship described in Equation (8) requires information on revenue (R_j), expenditure ($\widetilde{E}_j$), and productivity (ω_j) for each industry-region as well as the share of excess supply for each industry (SES_j). In this section we describe the measures we use for each variable and present descriptive statistics of the sample.

3.3.1 Regions

As in the section on descriptive statistics, we use BEA's 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. The 183 LMAs are mutually exclusive and exhaustive of the land area of the United States. We believe that the LMA is the most appropriate geographic concept for our analysis. While other geographic definitions are available in the data (e.g. zip code, county, state), we believe that the LMA is the most consistent with the notion of a "geographic market." This methodology could be applied to data from different levels of aggregation.

3.3.2 Region Revenue

For each industry, we measure supply in each region j (R_j) by taking the sum of revenue over all plants in an industry in a region so that $R_j = \sum_{k=1}^{N_j} r_{jk}$ where r_{jk} is the revenue of the k^{th} plant in region j.[12] In constructing region revenue this way, we are implicitly assuming that the U.S. is closed to international trade. Clearly this simplification induces some mis-measurement in revenue as many industries produce to serve

[12]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.

demand outside the U.S. While this does introduce some noise, exports-to-sales ratios for U.S. industries are not particularly large. [13]

3.3.3 Region Expenditure

In addition to region revenue, we also need region-specific measures of demand (E_j) for each industry. The geographic concentration measure described above (equation 1) uses a region's share of total employment as the 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. For instance, if a particular industry t is an important consumer of industry s's output, and industry t is geographically concentrated in region j, we would like to adjust demand for industry s's output in region j to reflect more than just region j's share of employment.

To make this adjustment, we follow Jensen and Kletzer (2006) to construct region-specific measures of demand for each industry using the BEA's Input-Output Use tables.[14] Precisely, our measure of industry s's demand in region i is defined as:

$$E_{si} = \left(\sum_t s_{st}^D s_{it}^{Emp} \right) R_s$$

where s_{st}^D represents the share of industry s output demanded by each industry t (for all $t = 1, ..., T$ industries and government and final demand), s_{it}^{Emp} represents the share of industry t employment located in region i (or the share of government employment in region i or the share of population (representing final demand) in region i), and R_s is aggregate revenue in industry s.[15] Essentially, the term in parentheses gives the adjusted share of demand for industry s in region i and multiplying this term by total revenue in the industry gives expenditure in regions i.

3.3.4 Region Productivity

The final variable in the model we need to measure is region productivity (ω_j). In the model, ω_j is a function of the number of varieties in a region and production costs in the region. While we have access to the number of unique establishments in each region and the number of unique firms operating in a region, it is

[13] In the manufacturing sector exports-to-sales ratios average around only 20 percent, and in the service sector the exports-to-sales ratios in aggregate appear much lower (below 4 percent in business services).

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

[15] We use the location of employment instead of revenue because we include demand from the government sector and final demand, and revenue data are not available for these activities.

not clear that either corresponds directly to the number of unique varieties of a product or a service produced in a region. Firms may produce more than one product or service (or more than one variety of product or service) from a single establishment; in addition, firms may operate several establishments that produce identical varieties of a product or service. We simplify this measurement issue considerably and set the number of varieties for each region to 1 (i.e. $N_{ij} = 1$ for all i and j).[16]

We proxy for region production costs using a measure of labor productivity in the region. For each industry, we divide revenue in a region by payroll. This measure adjusts for differences in production workers' hours and for worker skill (and productivity) variation across regions. [17]

3.4 Sample Characteristics

Table VI reports the average coefficient of variation for our measures of region supply (R), region demand (E), and region productivity (ω). 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 others large net exporters. Also, because the excess supply is akin to a current account balance, 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

[16] We did produce trade cost measures using proxies for ω_j that included the number of establishments. These measures were relatively noisy. However, using these noisier trade costs for the analysis in section 5 produced qualitatively similar results.

[17] The assumption that wages reflect worker-level variation in skill follows the study of Fox and Smeets (2011), who report that in their data variation in wage bill explains as much productivity dispersion across firms as human capital measures. We also experimented with the simpler revenue per worker measure. Overall, the results are very similar so that the wage adjustment is not critical to our results.

TABLE VI
DESCRIPTIVE STATISTICS

NAICS	Sector description	Coefficient of variation			Excess Supply			Correlation
		R	E	ω	Mean	Std Dev	Coef of Var	(SES, G index)
3	Manufacturing	3.91	1.66	5.18	0.59	0.16	0.28	0.62
4	Wholesale and Retail	3.13	1.63	2.09	0.33	0.18	0.54	0.59
5	Business Services	4.06	1.70	6.26	0.36	0.16	0.46	0.70
6-8	Personal Services	2.84	1.59	0.94	0.28	0.15	0.54	0.66
	Total	3.67	1.65	3.96	0.46	0.21	0.46	0.64

Notes: This table presents summary statistics for the main variables used to calibrate the model.

percent of output consumed outside of the region where it is produced – but the standard deviation is quite large at 0.15. All sectors have significant inter-quartile ranges for the SES measure – indicating variation in SES across industries within each sector.

The last column of Table VI reports the correlation between the geographic concentration measure G described in equation (1) 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 consistent with our intuition that highly geographically concentrated production is associated with higher trade shares.

4 Estimated Trade Costs

For each 6-digit NAICS industry, we choose the value of the parameter, ϕ, that minimizes the difference between actual and simulated SES as described in equation 8. In the case of the dichotomous distance ("without distance"), trade costs (τ) are implicitly defined as $\phi_{ij} = \tau^{1-\sigma}$, $\forall\, i \neq j$, and 1 otherwise. In the case of the continuous distance ("with distance"), they are defined as $\phi_{ij} = (1 + \tau\, d_{ij})^{1-\sigma}$, $\forall\, i \neq j$, and 1 otherwise. Table VII presents the average and standard deviation for trade costs (τ) and the predicted share of excess supply for each sector under each functional form of trade costs.[18]

For most of our analyses in section 6, we can use ϕ as the measure of trade costs. However, for the welfare analysis reported in section 6, we need to separate ϕ into its components τ and σ. Because estimates of the elasticity of demand are not available at the industry level for a broad range of service industries, we make the simplifying assumption that $\sigma = 6$ which, from the model, implies a reasonable markup of 20

[18]The full set of 6-digit NAICS industry-level trade costs is available from the authors upon request.

TABLE VII
ESTIMATED TRADE COSTS – AVERAGES BY SECTORS

NAICS	Desc.	SES	"Without" Distance			"With" Distance			Number of
			$\widehat{\tau}$	$\mathrm{S}\widehat{E}S$	u	$\widehat{\tau}$	$\mathrm{S}\widehat{E}S$	u	Industries
3	Mnf.	0.57	1.30	0.50	0.01	0.90	0.51	0.01	435
		(0.15)	(0.53)	(0.11)	(0.02)	(1.50)	(0.11)	(0.02)	
4	W&R	0.33	2.45	0.32	0.00	4.96	0.32	0.00	186
		(0.18)	(0.86)	(0.15)	(0.01)	(3.81)	(0.15)	(0.01)	
5	Bus. Srv.	0.36	2.37	0.34	0.00	4.37	0.34	0.00	178
		(0.16)	(0.80)	(0.14)	(0.01)	(3.26)	(0.14)	(0.01)	
6-8	Pers. Srv.	0.28	2.68	0.27	0.00	5.84	0.27	0.00	124
		(0.15)	(0.74)	(0.14)	(0.00)	(3.57)	(0.14)	(0.00)	

Notes: This table presents results from estimating trade costs separately for each of the 923 NAICS 6 digit industries. We use two approaches that differ in how we model trade costs. The dichotomous distance assumes that trade costs are the same everywhere. In terms of the model, equation (6), $\phi_{ij} = \tau^{1-\sigma}$, $\forall\, i \neq j$, and 1 otherwise. In the case of the continuous distance we assume that $\phi_{ij} = (1 + \tau\, d_{ij})^{1-\sigma}$, $\forall\, i \neq j$, and 1 otherwise. In both cases we assume that $\sigma = 6$, which, from the model, implies markups of about 20 percent. For each sector, the table presents the mean across industries for measured share of excess supply (SES), the estimated trade costs, and a measure of the model's fit (Obj.).

percent. Choosing other estimates for σ that do not vary across industries would change the level measures of τ, but would not change the ranking of industries across estimated trade costs.

The results' qualitative properties are independent of the assumptions on distance so we comment on both sets of measures at the same time. Table VII shows that, at the sector level, mean estimated trade costs are decreasing in the mean observed share of excess supply. Consistent with our priors, the manufacturing sector has the lowest average estimated trade costs while personal services have the highest. However, there is considerable variation within sectors in the estimated trade costs. In all cases, the within-sector standard deviation in estimated trade costs is large relative to the average. These results point to the importance of using disaggregated data.

The model generally does well in matching the share of excess supply. As can be seen in the table, the measured and predicted shares are generally quite close. The column labeled "u" provides a more precise measure of fit. It reports the within sector average square of the deviation between measured and predicted shares of excess supply – the objective function we minimize in the optimization process.

Figure 3 provides a detailed view of the within-sector dispersion in estimated trade costs. Each dot represents an industry in industry-trade cost space. The figure shows that many manufacturing industries have relatively low trade costs (seen in the concentration of dots in the lower left hand corner of both panels of Figure 3). These measures match our priors that the manufacturing sector has many highly tradable

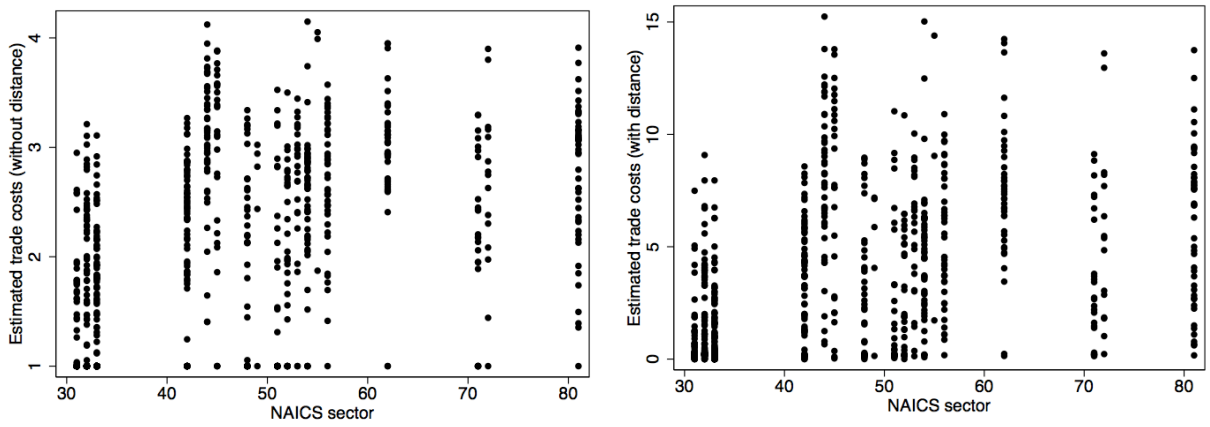

Figure 3: ESTIMATED TRADE COSTS BY SECTOR

industries.[19] The upper right portion of each panel in Figure 3 also shows that a number of service industries have relatively high trade costs. Last, if we focus on the middle of both panels, we see that most sectors have a large number of industries with intermediate trade costs.

These measures demonstrate that it would not be correct to characterize all manufacturing industries as tradable and all services as non-tradable. Within both sectors, some industries are tradable and others are not. We can see this overlap in a few examples. For example in the manufacturing sector, NAICS 327320 Ready Mix Concrete Manufacturing has a trade cost estimate of 3.2 ("without" distance) and 9.08 ("with" distance) while NAICS 335912 Primary Battery Manufacturing has a trade cost estimate of 1 ("without" distance) and 0.25 ("with" distance). In the service sector, NAICS 541940 Veterinary Services has a trade cost estimate of 4.15 ("without" distance) and 15.02 ("with" distance) while NAICS 541360 Geophysical Surveying and Mapping Services has a trade cost estimate of 1 ("without" distance) and 0.188 ("with" distance). As we explain in detail in the next section, there is considerable overlap between the estimated trade costs of manufacturing and service industries. The dispersion is particularly large within personal services, indicating that the average is influenced by a small number of industries with relatively low trade costs; for example, NAICS 713110 Amusement and Theme Parks has a trade cost estimate of 1 ("without" distance) and 0.21 ("with" distance) and NAICS 713920 Skiing Facilities has a trade cost estimate of 1 ("without" distance) and 0.13 ("with" distance).[20]

[19]The low trade costs (and associated high levels of geographic concentration) might also be due in part to the fact that there are many more industry categories relative to employment or output in the manufacturing sector than in other sectors. The more disaggregated industry classifications could lead to higher levels of measured geographic concentration.

[20]Both these industries are examples of mode 2 (consumption abroad) trade in services.

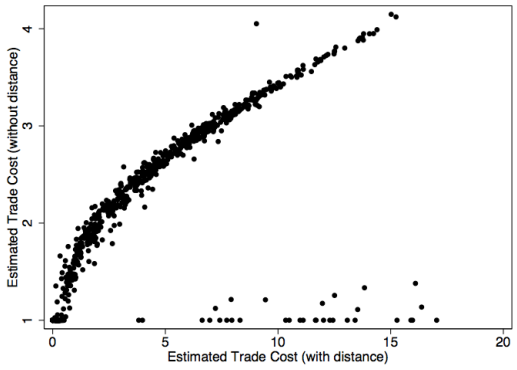

Figure 4: ESTIMATED TRADE COSTS (WITH AND WITHOUT DISTANCE)

Overall, as shown in Figure 4, the correlation between the two measures is quite strong; Table VIII reports the correlation is about 0.96. While the correlation is quite high, the measures "with" distance contain a number of outliers, which can be seen at the bottom of Figure 4. We estimate tradability for 955 industries. For 32 industries (29 in manufacturing and 3 in business services) where the share of excess supply is very high and the number of firms in the industry is relatively low, the model delivers high measures of τ. These counter-intuitive results (i.e., high levels of geographic concentration and high estimated trade costs) appear to result from specific characteristics of the underlying data that the model does not appear to accommodate very well – the number of producing regions is below 55 for all of these industries and below 25 for most. We exclude these outlier industries from the rest of the analysis. We note that, as detailed below, this works against finding evidence of tradability in the service sector as the majority of outliers are manufacturing industries with high estimated trade costs – removing them substantially lowers the average estimated trade costs in the manufacturing sector.

Figure 5 plots the estimated trade costs against the share of excess supply for each industry. In both models, there is a clear negative association between measured trade costs and share of excess supply at the industry level. The model "without" distance shows a negative association between trade costs and measured share of excess supply until the latter reaches about 0.4. When the share of excess supply exceeds 0.4, the estimates form a cloud with a large mass at the lower bound ($\tau = 1$). In the case "with" distance (in the right panel) the mapping between trade costs and share of excess supply continues to exhibit a negative pattern throughout the whole range of excess supply. This is suggestive evidence that including distance has an important impact on estimated trade costs in some industries.

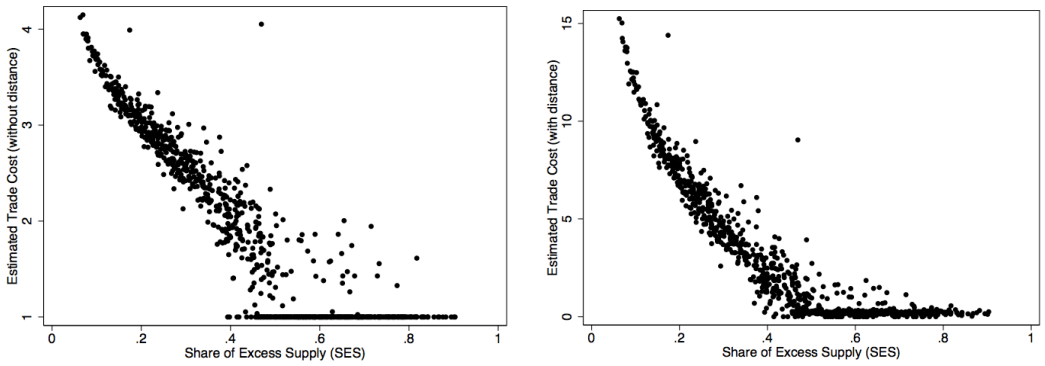

Figure 5: ESTIMATED TRADE COSTS AND SHARE OF EXCESS SUPPLY

As a check of the results, we compute simple correlations between our trade cost measures and other indicators of "tradability." The results are presented in Table VIII. The table is divided into two panels. Panel A presents correlations computed for the entire set of industries. It shows that the correlation between the estimated trade costs and the share of excess supply (the moment from which the trade cost is identified) is high in both cases. As mentioned before, the correlation between the two sets of measures is also high. The correlation between the index of geographic concentration (discussed in section 2) and the number of regions without any producers, another measure of geographic concentration, is also negative and large as expected. Panel B presents the same statistics and additional measures for manufacturing industries separately because detailed information on trade is not available broadly for industries in the service sector. Overall the correlations are as expected. Industries with a higher share of plants that export internationally or higher share of revenue from foreign sales tend to have lower estimated trade costs.[21]

5 Analysis

We investigate a number of important issues regarding the potential impact of increased trade in services using our detailed trade costs measures. First, to examine the economic importance of trade in services, we produce estimates for the share of U.S. employment in tradable service industries. Second, we evaluate the impact of trade liberalization in services on welfare and compare the welfare gains to gains from further liberalization in the manufacturing sector. Last, to investigate the potential for dislocation from increased

[21] While the association has the expected sign, the magnitude is not as large as expected. This may be due to the fact that the estimation is not as precise in that sector, possibly due to a higher share of revenue being exported internationally in the manufacturing sector.

TABLE VIII
CORRELATIONS BETWEEN MEASURES OF TRADE COSTS AND TRADABILITY INDICATORS

Panel A: All industries (N=923)				
Variables	$\widehat{\tau}$ ("W/out" dist.)	SES	G Index	Nb. Reg. w/out Prod.
SES	-0.91			
G Index	-0.50	0.63		
Nb of Regions without Producers	-0.76	0.86	0.54	
$\widehat{\tau}$ ("With" dist.)	0.96	-0.88	-0.45	-0.69
Panel B: Manufacturing industries only (N=435)				
Variables	$\widehat{\tau}$ ("W/out" dist.)	SES	Shr. Rev. Exp.	Shr. of Exp.
SES	-0.74			
Exports / Sales	-0.17	0.23		
Share of Exporters	-0.33	0.37	0.48	
$\widehat{\tau}$ ("With" dist.)	0.95	-0.72	-0.20	-0.33

Notes: This table presents correlations between estimated trade costs and other indicators of tradability. Panel A includes the full set of industries. Panel B is restricted to manufacturing industries as exports/sales and number of exporters are not available for all service industries.

trade in services, we compare the characteristics of tradable and non-tradable industries with a focus on skill intensity.

5.1 Share of Employment in Tradable Industries

To gain a sense of how much economic activity is in tradable service activities, we compare the share of total employment in tradable manufacturing and tradable service industries using a range of thresholds to determine whether an industry is "tradable." We vary the threshold for tradability by choosing the trade cost that results in, for example, 10 percent of manufacturing sector employment being classified in tradable industries and then use that trade cost threshold to determine the set of industries in other sectors that are ''tradable." The threshold trade cost for tradability varies as we change the share of manufacturing employment that is in tradable industries. We present results for the share of employment within each sector that is tradable in the left panel of Figure 6 and the share of total private employment that is tradable for each sector in the right panel of Figure 6.

The left panel in Figure 6 shows the share of employment within each sector in industries classified as tradable for three sectors: business services (BSRV), wholesale and retail trade (WRTW), and personal services (PSRV). If we assume 80 percent of employment in the manufacturing sector is in industries that are tradable and use that trade cost threshold as the cutoff for tradability in other sectors, we find that 20 percent of employment in the wholesale and retail trade sector, 30 percent of business services employment, and 10 percent of personal services employment are in tradable industries. If most of manufacturing sector

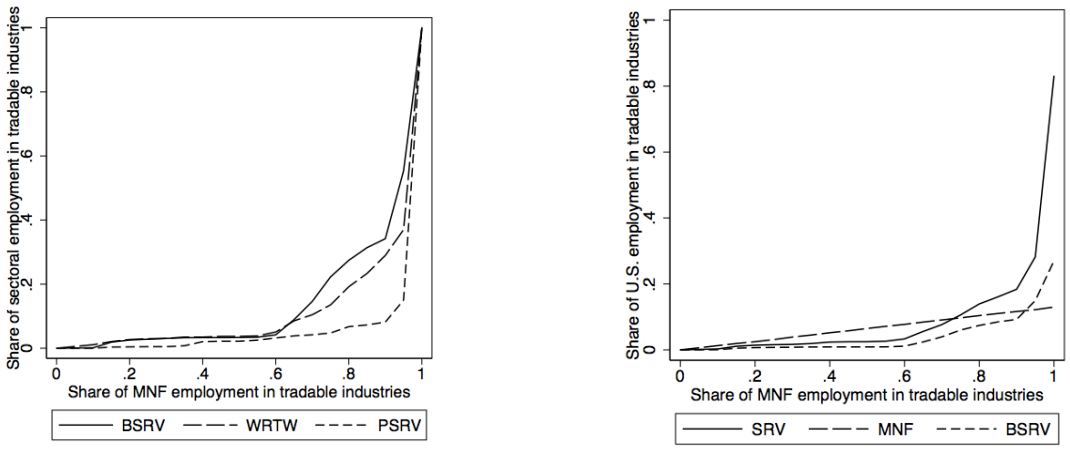

Figure 6: SHARE OF EMPLOYMENT IN TRADABLE INDUSTRIES

employment is considered to be in tradable industries, say 90 percent, then about half of business service sector employment is in tradable industries.

The right panel in Figure 6 reports the share of total private sector employment in tradable industries by sector and shows that if we assume that 70 percent (or more) of manufacturing employment is in tradable industries, a larger fraction of U.S. employment is in tradable service industries (shown by the SRV line, which combines business services and personal services) than in tradable manufacturing industries. If we assume that 90 percent of employment in the manufacturing sector is in tradable industries, we classify more employment in tradable business services than in tradable manufacturing industries. 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 – under plausible assumptions about the tradability of manufacturing – to more employment being in tradable business services than in tradable manufacturing.

5.2 Welfare

In this section, we use the model and our detailed trade cost measures to estimate the welfare implications of two scenarios of changes in trade barriers. To construct counter-factual estimates of welfare changes requires several simplifying assumptions. First, because some industries are tradable and others are not, we do not expect a reduction in trade barriers to affect all industries. Hence, we assume that a reduction in trade barriers will only affect welfare in industries that are tradable. We classify industries as tradable using, as

before, the share of employment in tradable manufacturing industries as a threshold and produce welfare change estimates for a range of tradability thresholds.

Second, we need to make assumptions regarding σ. To this point, our analyses have not depended on the decomposition of tradability, ϕ, into trade costs, τ, and elasticity of demand, σ. However, when looking at the impact of trade costs on welfare, the decomposition does matter. Holding tradability fixed, a 10 percentage point increase in trade costs will not have the same impact if ϕ is mostly trade costs or mostly preferences. Therefore we need estimates of the elasticity of demand for each industry in order to compute the impact of changes in trade barriers on welfare. Unfortunately, obtaining such measures for the service industries is not trivial. Hence, we again simply assume that $\sigma = 6$ for all industries. This is a useful starting point because it allows us to compare the impact of changes in trade costs across different sectors while shutting down potential variation in preferences.

Under the maintained assumptions in the model, we can evaluate changes in welfare as follows: $\%\Delta W = \sum_s \alpha_s \left(lnP_s^1 - lnP_s^0\right)$, where P_s^t is the aggregate price index, defined in equation (2), at time t. Since we interpret our measures of trade costs as predominantly technological constraints, they are not reduced by changes in trade policies. Therefore, the pre-liberalization equilibrium is a case in which firms in tradable industries face a tariff equivalent barrier to trade *in addition to* technological barriers to trade (represented by our trade cost measures). The post-liberalization case removes the tariff equivalent barrier to trade.

For the subset of tradable industries (defined by the manufacturing threshold), we estimate the welfare gains from trade liberalization by computing:

$$\%\Delta W_\Omega = \sum_{s \in \Omega} \alpha_s \left(ln\widehat{P}_s^1 - ln\widehat{P}_s^0\right), \tag{9}$$

where Ω denotes the subset of industries classified as tradable. Industries classified as non-tradable are not affected by trade liberalization and have no impact on welfare. For industries classified as tradable, we compute the price index for the pre- and post-liberalization equilibria, $\widehat{P}_s^0$ and $\widehat{P}_s^1$ respectively. To obtain industry-level measures of the price indexes, we first estimate the price index for each region-industry, then take the average across all regions within the industry. The share of expenditure for each sector is obtained by taking the ratio of total revenue in the sector to total revenue across all sectors. We evaluate the impact of trade liberalization on welfare for two cases, first for the case where the change in trade barriers is equivalent

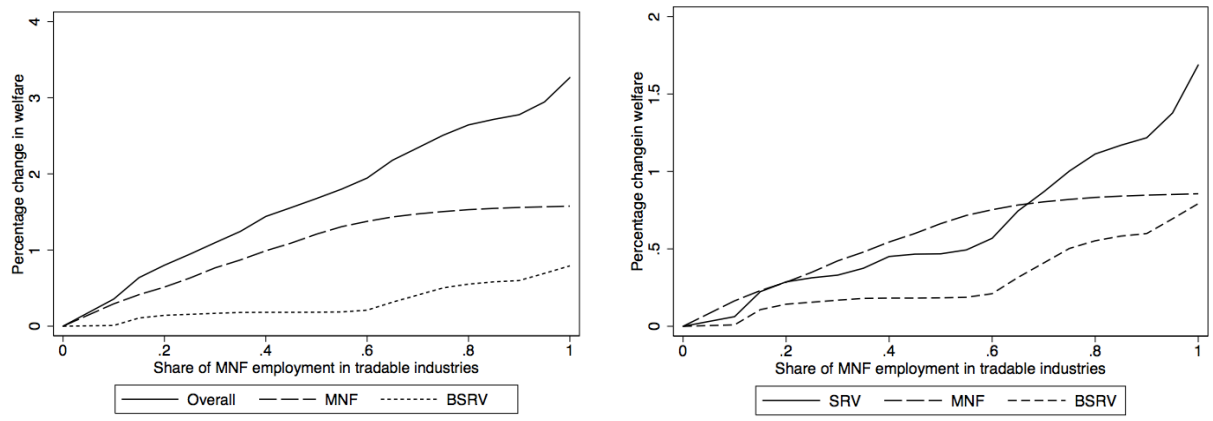

Figure 7: THE ESTIMATED IMPACT OF TRADE LIBERALIZATION ON WELFARE

in the manufacturing sector and the service sector and second where the reductions in trade barriers differ across sectors.

In our first experiment, we evaluate the effect of a symmetric reduction in tariff equivalent trade barriers. In the pre-liberalization equilibrium, we impose a trade barrier equivalent to 10 percent of the average trade cost across all industries to each tradable industry. In the post-liberalization equilibrium, we remove this 10 percent tariff equivalent barrier. The results are presented in the left panel of Figure 7. The overall welfare impact of trade liberalization ranges between 0 and 3 percent, depending on the assumed tradability. The share of welfare change associated with manufacturing diminishes from 100 percent to about 50 percent as the level of tradability increases. For a similar level of liberalization across sectors, services overall account for about half the welfare gains, with business services accounting for about a quarter.

The right panel of Figure 7 presents the estimated welfare gains for an asymmetric reduction in tariff equivalent trade barriers. This scenario involves a liberalization twice the size in the service sector compared to the manufacturing sector. This is probably a conservative (under-) estimate of the disparity in trade barriers between services and manufacturing.[22] We specifically estimate removing a tariff equivalent to 10 percent of the average estimated trade cost in the service sector and removing a tariff equivalent of 5 percent from the manufacturing sector. The graph shows the manufacturing line shifts down while business services remain the same. The figure also presents an estimate of the impact for the entire service sector. The results show

[22]Though difficult to measure, existing barriers to trade in services are probably significantly higher than in the manufacturing sector. For instance, Hufbauer et al. (2010) estimate tariff equivalent impediments in services for BRIC countries (Brazil, Russia, India, and China) to be about 60 percent compared with about 12 percent for manufactures. They estimate developed economy barriers to manufactures to average about 4 percent and they estimate developed economy barriers to services trade to be about 7 percent.

TABLE IX
AVERAGE WAGE ACROSS SECTORS AND TRADABILITY

NAICS	Sector description	Non-tradable	Tradable	Total
3	Manufacturing	41.20	42.18	42.17
4	Wholesale and retail	25.31	36.42	32.42
5	Business Services	33.23	48.75	44.39
6-8	Personal Services	26.95	29.87	28.36

Notes: This table presents average industry wage rates by sector of activity and estimated tradability. For this exercise we assume that 90 percent of manufacturing employment is in tradable industries.

that when the liberalization in services is twice the size of that in manufacturing, the impact of service liberalization on welfare is larger than that in manufacturing when most of the manufacturing sector is considered tradable. This simple exercise suggests that if service trade barriers are significantly higher than remaining barriers to goods trade, the relative welfare impact from services liberalization is likely to be even greater.

5.3 Comparative Advantage

In this section, we consider the implications of service trade liberalization for the location of tradable services production. We focus on the business service sector because a larger share of employment in business services is in tradable industries. Further, because the business service sector is large in many developed economies, changes in the location of service production could have important implications for the domestic labor market. We examine the skill intensity of production across sectors as an indicator for which countries are likely to expand/contract services production after services liberalization. We use average wages as a proxy for skill intensity. If the factor intensity of tradable business services is significantly different from other sectors, it is likely to influence which countries specialize in tradable business service production in the face of liberalization.

Table IX presents information on average wages across sectors. We categorize industries as tradable and non-tradable based on their estimated trade costs. We use the trade cost threshold associated with 90 percent of manufacturing employment in tradable industries to classify industries in other sectors 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 non-tradable 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.

TABLE X
MEAN INDUSTRY WAGES AND ESTIMATED TRADE COSTS

Variable	(1)	(2)	(3)
SES	0.439		
	(0.030)		
Log trade costs ("Without" dist.)		-0.437	
		(0.030)	
Log trade costs ("With" dist.)			-0.454
			(0.029)
R^2	0.193	0.191	0.206
S.e. of regression	0.899	0.900	0.891

Notes: This table presents OLS regression results of industry mean wages on trade cost measures. Sample size is 923.

Table X presents ordinary least squares (OLS) regression results on the relationship between trade costs and average wages 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 shares of excess supply are also associated with higher average wages.

Our results suggest that tradable business services are relatively skill-intensive. Since the U.S. and other developed economies are relatively skill-abundant, tradable business services appear consistent with these countries' comparative advantage. As a result, these countries are likely to face less dislocation, and might even expand business services production, if services trade were liberalized globally.

6 Conclusion

The service sector in the U.S. is large and service trade appears to be increasing. In large part because of the growing importance of the service sector and trade in services, a number of international trade agreements are negotiating commitments to liberalize service trade. Yet, in spite of its empirical importance, service trade data is only available at relatively high levels of aggregation.

To address this data gap, we 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 measures of trade costs at the 6-digit NAICS level for over 900 industries covering most sectors of the economy. Our approach relies on several strong, simplifying assumptions. In particular, the monopolistic competition model may be a poor approximation of the market structure for some industries. Further, assuming away variation in the elasticity of substitution across industries could

lead to measurement error in the trade cost estimates. In this sense our investigation is a starting point; we leave for future research examining the implications of our modeling and measurement choices.

We find that while the level of geographic concentration in business service industries is lower, on average, than manufacturing, many business service industries exhibit geographic concentration in production and have estimated trade costs similar to industries in the manufacturing 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 policy impediments in the business service sector could 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 better understand and measure policy impediments to services trade.

Beyond our analytical results, our trade cost measures for the service sector are potentially useful for a range of research topics. In particular, empirical analysis of the impact of international trade on labor market outcomes and income inequality, even the impact of fiscal stimulus on domestic growth, all require reliable estimates – at a fairly detailed level – of how much economic activity is subject to international competition. Our disaggregated industry estimates address this need. Further, because the data requirements are quite modest, we expect that our methodology could be replicated in other countries.

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Appendix

A 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 52: Finance and Insurance

The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:

1. Raising funds by taking deposits and/or issuing securities and, in the process, incurring liabilities. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or

purchasing securities. Putting themselves at risk, they channel funds from lenders to borrowers and transform or repackage the funds with respect to maturity, scale, and risk. This activity is known as financial intermediation.

2. Pooling of risk by underwriting insurance and annuities. Establishments engaged in this activity collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments. Fees are based on the expected incidence of the insured risk and the expected return on investment.

3. Providing specialized services facilitating or supporting financial intermediation, insurance, and employee benefit programs.

In addition, monetary authorities charged with monetary control are included in this sector.

NAICS 53: Real Estate and Rental and Leasing

The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks. This sector also includes establishments primarily engaged in managing real estate for others, selling, renting and/or buying real estate for others, and appraising real estate. These activities are closely related to this sector's main activity, and it was felt that from a production basis they would best be included here. In addition, a substantial proportion of property management is self-performed by lessors.

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 72: Accommodation and Food Services

The Accommodation and Food Services sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services establishments because the two activities are often combined at the same establishment.

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.