Are Services Tradable? Evidence from US Microdata*

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Abstract

The service sector broadly defined accounts for 80 percent of employment in the United States. While services trade increased significantly between 1997 and 2007 (both imports and exports more than doubled), limitations in official service trade data preclude using service trade statistics to examine trends at a detailed level. We develop a model of trade across regions that incorporates firm heterogeneity, increasing returns to scale and trade costs. From this framework, we infer the trade costs consistent with the geographic distribution of production. We estimate the parameters of the model using service sector establishment level microdata collected by the U.S. Census Bureau. We produce preliminary estimates of trade costs and find variation in the estimates of trade costs across industries. Further, we find that industries with lower trade costs exhibit a higher correlation between regional productivity and our measure of trade across regions. The results suggest that when trade costs are not prohibitive, production is undertaken by regions with higher productivity and exported to regions with lower productivity.

Keywords: Service sector, Trade, Comparative Advantage, Imperfect Competition

JEL Classification Codes: F1

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1. INTRODUCTION

The service sector broadly defined accounts for 80 percent of employment in the United States. Table I shows that even a more refined definition of services that includes only business and personal services (and excludes government, retail and wholesale trade, transportation, and utilities) accounts for roughly 50 percent of US employment.[1] Business services employment grew almost 30 percent over the period 1997-2007 and personal services employment grew over 20 percent over the same period. In contrast, the manufacturing sector accounts for about 10 percent of employment and employment in the manufacturing sector decreased more than 20 percent between 1997 and 2007.

International trade in services is growing rapidly. Services now account for 30 percent of US exports and about 17 percent of US imports. Between 1997 and 2007, service imports and exports both more than doubled. Other private services (a category composed of business, professional, and technical services) accounted for more than half of the growth in both service imports and exports. The size of the business services sector in the U.S. (it is more than twice as large as the manufacturing sector) and the growth of international trade in services (and other private services in particular) point to the importance of understanding how trade in services affects the U.S. economy. Further, understanding the impact of international trade on the U.S. economy requires looking beyond the manufacturing sector. [2]

Yet, relative to the body of empirical research covering the manufacturing sector, there is little empirical research on the service sector in general or trade in services in particular. Hoekman (2006) presents a survey of the literature on trade in services.[3]

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

[2] The large share of employment in services and growing international trade in services has increased policy attention to the impact of trade in services. For example, the American Recovery and Reinvestment Act of 2009 (a.k.a. the stimulus package) extends Trade Adjustment Assistance (TAA) to service workers and firms for the first time. Previously TAA had been restricted to firms or workers impacted by trade in goods. Policy-makers across government will now need to make decisions regarding administering programs such as which industries and workers are affected by trade in services.

[3] Other recent papers on trade in services include Liu and Trefler (2008) which examines the impact of services outsourcing using on US worker employment outcomes and Hanson and Xiang (2008) which examines international movie distribution.

One reason for the lack of empirical research on the service sector is that the official statistical data covering the service sector is far less robust than for the manufacturing sector. The basic input and output information collected from service producers is less detailed than that collected from manufacturers. Trade in services data is far less detailed and comprehensive than that for merchandise trade. As a point of comparison, the Census Bureau publishes information on imports and exports of goods for more than 13,000 product categories while the Bureau of Economic Analysis publishes services trade data for about 30 categories (with only limited geographic coverage).[4] The lack of detailed data on international trade in services and the growing need to evaluate the impact of trade in services point to the need for more detailed information on which service activities are tradable and being traded.

In this paper, we try to overcome the scarcity of data on international trade in services by using establishment level microdata on service production collected by the US Census Bureau for the year 1997. We focus our efforts on using information on the service sector that we consider very robust – we develop a model that exploits information on the number of producers, the revenue of producers, the location of producers, and regional demand to generate estimates of the underlying productivity dispersion across regions and cross-region trade. We focus on these measures because we believe these data are well reported across a broad range of service industries.

A key insight we exploit is that geographic concentration of production is an indicator of tradability.[5] A striking empirical result is the variation across industries in the geographical concentration of services production. Some industries are heavily concentrated in particular regions (e.g. software publishing is concentrated in Seattle and Silicon Valley) while other industries exhibit little or no concentration in production (e.g. movie theaters and doctors' offices). If the location of production is different than the location of demand, this is strong evidence of tradability. The concentration of production could arise from either increasing returns in service production in conjunction with tradability or due to the

[4] Beyond the lack of detail, because services trade is collected through surveys (as opposed to the administrative systems used to capture merchandise trade) there may be reasons to question the accuracy of the data. For example, see Government Accountability Office report "U.S. and India Data on Offshoring Show Significant Differences," 2005.

[5] The intuition behind this approach draws on Jensen and Kletzer (2005).

concentration of demand. We discuss in detail in the paper how we control for the concentration of demand and focus on the interaction of increasing returns to scale and tradability. We expect that when increasing returns to scale are present in an industry that is tradable, productive establishments (and regions) will be larger. Thus, as in manufacturing, productivity heterogeneity in the presence of tradability will lead to greater revenue dispersion across plants and regions.

To obtain a more accurate estimate of the relative tradability of service sectors we obtain structural estimates of the trade cost parameter for each service sector. Our empirical framework is based on the multi-region version of the Melitz (2003) model presented in Helpman, Melitz and Rubinstein (2008). The model incorporates firm heterogeneity, returns to scale, and trade costs into a multi-region economy. From this framework, we can infer the trade costs consistent with the geographic distribution of production and scale of producers. In essence our empirical strategy is to use information on the geographic distribution of demand for and production of services within the US to obtain structural estimates of trade costs.

Our methodology has two stages. In the first stage, we use plant level information on dispersion in producer revenue to obtain a measure of the average productivity in each region. We find that industries vary in the dispersion of productivity across regions. Some of the industries we examine exhibit significant variation in productivity across regions. Related to this, we find the same industries exhibit greater variation in the size of producers across regions.

In the second stage, we estimate trade costs using information on excess supply at the regional level. We define excess supply as local production in excess of local demand. The estimates of trade costs provide information on the tradability of service industries. We find variation in the estimates of trade costs across industries, though these estimates are sensitive to the choice of the elasticity of substitution. Further, we find that industries with lower estimated trade costs exhibit a higher correlation between regional productivity and regional excess supply. The results suggest that when trade costs are not prohibitive, production is undertaken by regions with higher productivity and are exported to regions with lower productivity. In industries where we infer prohibitive trade costs, we find that average excess

supply is quite small and that there is little or no correlation between regional productivity and region excess supply.

While our data covers domestic production for the US, we believe that our methodology provides useful insights into international trade in services. We exploit detailed, highly reliable, establishment level data on service producers to identify cross-industry variation in the tradability of services. While the nature of the data potentially limits the range of conclusions we can draw, it increases the confidence we have in them. We do expect that our estimates of trade costs will prove useful indicators of US firms' international activities.[6]

The structure of the paper is as follows. Section 2 provides stylized empirical facts that characterize service industries in the US and guide the development of our model. The theory is presented in Section 3. In Section 4 we explain the data and the estimation procedure. We present and discuss the results in Section 5. Section 6 concludes.

2. A FIRST LOOK AT THE DATA

The key insight we exploit in this paper is that a concentration of production is evidence of tradability of services whereas ubiquitous production is evidence of significant impediments to tradability. In this section, we present some simple statistics to characterize the variation across industries in the distribution of production and demand and variation in the size distribution across regions in select service industries.

We use detailed establishment level microdata from the 1997 Census of Service Industries collected by the U.S. Census Bureau to develop these statistics. The Census of Services covers 8 NAICS sectors: Information (51); Professional, Scientific, and Technical Services (54); Management of Companies and Enterprises (55); Administrative and Support and Waste Management and Remediation Services (56); Educational Services (61); Health Care and Social Assistance (62); Arts, Entertainment, and Recreation

[6] Future work will examine the relationship between our estimates of trade costs and service firms' international export participation for industries where the Census Bureau collects service establishment export data (NAICS 51, 54, and 56).

(71); Other Services (except Public Administration) (81).[7] The Census of Services collects information on principal industry, location, employment, payroll, and sales for establishments in all the sectors. We assign establishments to regions using the Bureau of Economic Analysis' definition of Labor Market Areas (LMA) as our unit of geography.[8] The 183 LMAs are mutually exclusive and exhaustive of the land area of the United States. To minimize our initial disclosure request, this draft includes information on a subset of six-digit NAICS service industries we believe represent a range of industry characteristics; we focus on Newspaper Publishing (511110), Software Publishing (511210), Motion Picture and Video Distribution (512120), 512131 Motion Picture Theaters (except Drive-Ins) (512131), Tax Preparation Services (541213), Payroll Services (541214), Offices of Physicians (except Mental Health Specialists) (621111), Medical Laboratories (621511), General Medical and Surgical Hospitals (622110), Beauty Salons (812112), Drycleaning and Laundry Services (except Coin-Operated) (812320).

The first measure we present is the number of regions without a producer. Table II shows that there is considerable variation across industries in the number of regions without a producer. For example, the Movie Picture and Video Distribution industry has producers in only 78 regions while newspaper publishers, physicians' offices, and hospitals are present in all 183 regions. We interpret industries that are produced in a small number of regions and consumed broadly (as movies and videos are likely to be) as likely to be traded between regions and thus tradable.[9] Industries that are produced in all regions may be characterized by prohibitive trade costs, a lack of scope for differentiation, constant returns to scale, or a combination of these factors.

Table II also reports the ratio of the region's share of industry output to the region's share of total output for the region that has the largest share of industry output. This statistic is a rough measure of the ratio of local production to local demand. Again, we see that production in some industries (e.g. Software Publishing, Motion Picture and Video Distribution, and Payroll Services) is concentrated in regions and

[7] Descriptions of the activities included in each sector are provided in the Appendix.
[8] LMAs are collections of counties usually, but not always, centered on Metropolitan Statistical Areas. See U.S. Bureau of Economic Analysis (1995) for detailed information
[9] We recognize that demand might be concentrated – which could result in concentrated production with significant impediments to trade – and address this issue in more detail later in the paper.

that the local production is multiples of local demand. For other industries (e.g. Newspaper Publishing, Movie Theaters, and Physicians' Offices), the region's that produce the largest amount of output are basically serving local demand. Again, these simple statistics imply regions are producing more than they are consuming in some industries. We take this as suggestive evidence that these regions are exporting the excess supply to consumers in other regions – indicating that these industries are tradable.

Last, we present information on the variation in establishment size across regions. We construct the revenue-weighted mean establishment size (in revenue) for each region. This measure basically represents the size of the producer of the average dollar of output in each region. We present the coefficient of variation of this measure. Again, we see that there are industries where there is significant variation in the average size of producers across regions. For example, Software, Motion Picture Distribution and Payroll Services have high coefficients of variation. There is a group with intermediate coefficients of variation that includes Newspapers, Physicians' Offices, and Medical labs and a group with low coefficients of variation. The significant variation in plant size across regions that characterizes some industries is likely to be due to low trade costs, high variation in fixed costs across regions, or high variation in producer productivity across regions. For industries where the coefficient of variation is low, this is likely due to low variation in productivity across regions, low variation in fixed costs across regions, or high trade costs. Intermediate levels of variation might be suggestive of the presence of some but not all of these factors. In the following section we develop a model that incorporates producer heterogeneity in productivity, differentiated products, multiple regions, and trade costs to examine how these factors influence the geographic distribution of service production.

3. THEORY

Given the characteristics of the service sector presented in the previous section, we need a framework that incorporates the following basic features: Firms are heterogeneous within and across regions, demand and supply are not equal and some regions do not produce. In this section we use a multi-region version of the

Melitz (2003) model similar to the framework of Helpman, Melitz and Rubinstein (2008) to determine the equilibrium trade balance given the distribution of plant across regions.

Consider a closed economy composed of a fixed number of regions $j \in \{1, 2, \ldots, C\}$. Preferences are assumed to be the same across regions and utility is defined over the consumption of differentiated service varieties.[10] The utility of the representative consumer in region i is given by

$$U_i = \left(\sum_{j=1}^{C} \sum_{k=1}^{\tilde{N}_{ij}} q_{ijk}^{\rho} \right)^{1/\rho}, \quad \rho \in (0,1), \tag{1}$$

where q_{ijk} is the quantity of variety k produced in region j and consumed in region i, and $\tilde{N}_{ij}$ is the number of varieties produced in region j available for consumption in region i. The parameter ρ governs the elasticity of substitution across varieties, which is equal to $\varepsilon = 1/(1-\rho)$. We assume the elasticity is the same in all regions.

Given the preferences in (1), the quantity demanded in region i of variety k produced in region j is

$$q_{ijk} = E_i P_i^{\varepsilon - 1} p_{ijk}^{-\varepsilon}, \tag{2}$$

where E_i denotes the total value of expenditure in the industry in region i, p_{ijk} is region i''s price of variety k produced in region j and P_i is the ideal price index in region i, which is defined as

$$P_i = \left(\sum_{j=1}^{C} \sum_{k=1}^{\tilde{N}_{ij}} p_{ijk}^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}}. \tag{3}$$

There is a mass, N_j, of firms in region j each producing a single variety of the differentiated service. All varieties are unique such that there is a mass $N^T \equiv \sum_{j=1}^{C} N_j$ of distinct varieties produced in the economy. We assume that the differentiated service is tradable across regions at a cost. This implies that some varieties consumed are produced domestically while others are imported. For simplicity, we use the

[10] The service is interpreted as consisting of a *narrowly* defined activity that addresses specific needs and admits a fair amount of differentiation (e.g. beauty salons, software publishing or tax preparation).

Samuelson iceberg cost formulation and assume that if τ_{ij} units are shipped from region j to region i only one unit arrives. Given the preferences of consumers and assumptions on the production function, as long as the trade cost is not prohibitive, all varieties are sold in all markets. Therefore the mass of varieties produced in region j and consumed in region i is equal to the number of producers in region j, which implies that $\tilde{N}_{ij} = N_j$.

A firm in region j produces one unit of output using a cost-minimizing input bundle that costs αw_j where w_j denotes the price of the input bundle and α denotes the number of bundles the firm requires to produce one unit of output. The cost w_j is common to all firms in the region reflecting differences in factor prices across regions while α is specific to the firm and captures variation in productivity across producers in the same region. We index firms by their productivity, which we define as $\varphi = 1/\alpha$ and denote the set of producing firms in region j by Θ_j. Production is subject to increasing returns to scale. Before beginning production firms must invest a fixed number of bundles, F_j, to set up the production unit. The cost of this investment, $F_j w_j$, is common to all firms in a region but vary across regions because of difference in factor input prices and input requirements. This implies that a firm in region j with productivity φ faces the following total cost function:

$$\Gamma_j(\varphi) = \left(F_j + \frac{q}{\varphi} \right) w_j . \tag{4}$$

Hence, total costs are increasing in the fixed production cost (F) and the cost of an input bundle (w) but decreasing in firm productivity (φ).

There is monopolistic competition in the service sector. We assume that producers are numerous enough that they ignore the impact of their actions on the aggregate variables – the Chamberlinian "large group" assumption. Profit maximization therefore implies that the price of a variety produced in region j by a firm with productivity φ and sold to a consumer in region i is

(5) $$p_{ij}(\varphi) = \left(\frac{\varepsilon}{\varepsilon - 1}\right)\frac{w_j \tau_{ij}}{\varphi} \qquad \text{with } \tau_{ij} = \begin{cases} \tau & \text{if } i \neq j \\ 1 & \text{otherwise} \end{cases}$$

This implies that the equilibrium profit of a productivity φ firm located in region j is given by

(6) $$\pi_j(\varphi) = \frac{1}{\varepsilon}\left(\frac{\varepsilon w_j}{\varepsilon - 1}\right)^{1-\varepsilon} M_j \varphi^{\varepsilon - 1} - w_j F_j .$$

where M_j is common to all firms in region j and represent the firm's market access defined as

(7) $$M_j = \sum_{i=1}^{C} E_i P_i^{\varepsilon - 1} \tau_{ij}^{1-\varepsilon} .$$

This term captures the closeness to demand as perceived by producers. All else equal, firms located in regions that are closer to other regions (low trade costs τ_{ij}), that trade with larger regions (high E_i), or trade with less competitive (high P_i) regions will have higher market access and enjoy greater revenues.

Firms are profit maximizers and engage in production only if they make non-negative profits. Equation (6) can be solved for the minimum level of productivity required to attain profitability. The productivity profitability threshold in region j is given by

(8) $$\varphi_j = \frac{\varepsilon^{\frac{\varepsilon}{\varepsilon - 1}}}{\varepsilon - 1}\left(\frac{w_j^{\varepsilon} F_j}{M_j}\right)^{\frac{1}{\varepsilon - 1}} .$$

The first term is common to all regions and depends only the elasticity of substitution (ε). The second term is region specific and depends on input costs (w), fixed production costs (F) and the firm's market access (M). Other things equal, regions where the input costs or fixed input requirement are high are characterized by relatively high productivity thresholds. Further regions that are generally "far" from the demand also have high thresholds. From (7), the market access is increasing in the income of regions (E) and decreasing in competitiveness (P) and trade cost. All else equal, this implies that an increase in trade cost will increase the productivity profitability threshold in all regions. However, from (3), an increase in trade cost will also increase the price index, thereby increasing the firm's market access. Since the two effects of a change in trade costs on market access work in opposite direction, the overall impact on the

threshold is ambiguous and depends on the values of the parameters of the model.[11] Finally, a region will produce some differentiated services if and only if the most productive firm in that region can enter the industry profitably, which requires $\varphi_j \leq \sup\{\Theta_j\}$.

Combining the optimal demand (2) and the pricing rule (5), and taking into account the output lost in transportation, the equilibrium revenue of a firm with productivity φ located in region j is

$$r_j(\varphi) = \left(\frac{\varepsilon - 1}{\varepsilon}\right)^{\varepsilon-1} w_j^{1-\varepsilon} M_j \varphi^{\varepsilon-1}. \tag{9}$$

Conditional on productivity, firm revenue is increasing in firm market acess and decreasing in input cost and trade costs, because an increase in trade costs decreases the firm's market access. Total revenue in region j is

$$R_j = N_j \sum_{\varphi \in \Theta_j} r_j(\varphi) = \left(\frac{\varepsilon - 1}{\varepsilon}\right)^{\varepsilon-1} w_j^{1-\varepsilon} M_j N_j \tilde{\varphi}_j, \tag{10}$$

where Θ_j denotes the set of producer in region j and $\tilde{\varphi}_j$, is a measure of average firm productivity in region j defined as

$$\tilde{\varphi}_j = \frac{1}{N_j} \sum_{\varphi \in \Theta_j} \varphi^{\varepsilon-1}. \tag{11}$$

Hence the overal revenue in a region, R, is decreasing in the cost of inputs (w), increasing in the firm's market access (M), and in the number (N) and average productivity of firms in the region ($\tilde{\varphi}$).

Using the total revenue defined in (10) it follows that the excess supply (ES) in region j, defined as the difference between the total value of revenue (R) and the total value of expenditure (E) in region j is given by

[11] For instance, consider an industry where trade costs suddenly become prohibitive. In this case local demand can only be satisfied by local production. In regions that were not producing prior to the increase in trade cost, the threshold must go down. Conversely, a marginal decrease in trade cost in an industry characterized by high productivity dispersion is likely to lead to an increase in the productivity threshold and lead to exit of marginally profitable firms in some regions.

(12) $$ES_j = R_j - E_j = \left(\frac{\varepsilon - 1}{\varepsilon}\right)^{\varepsilon - 1} w_j^{1-\varepsilon} M_j N_j \tilde{\varphi}_j - E_j .$$

Of course if the differentiated service is the only source of income for consumers, then revenue equals expenditure and the excess supply is equal to zero. However, in reality regions produce more than one good or service, so that revenue and expenditure in an industry are not equal in general and the excess supply is not always equal to zero. To accommodate this fact we take expenditure (E) in each region as given.

If labor is homogenous across regions and is the only input in the production process then the cost of an input bundle, w, can be interpreted as the wage rate in region j.[12] In this case, from the total cost function defined in (4), it follows that the demand for labor in region j is given by

(13) $$L_j = N_j \left[F_j + \left(\frac{\varepsilon}{1-\varepsilon}\right)^{\varepsilon} M_j w_j^{-\varepsilon} \tilde{\varphi}_j \right].$$

The demand for labor is increasing in the number of producers, the fixed input requirement, the firm market access, and the average productivity and decreasing in the input cost. Finally, using the pricing rule defined in (5) we can solve for the price index P in region i

(14) $$P_i = \left(\frac{\varepsilon}{\varepsilon - 1}\right) \left[\sum_{j=1}^{C} (w_j \tau_{ij})^{1-\varepsilon} N_j \tilde{\varphi}_j \right]^{\frac{1}{1-\varepsilon}} .$$

This completes the characterization of the economy.

4. EMPIRICS

In this section we describe the construction of the various measures we use in the estimation and present preliminary results.

[12] This simplifying assumption seems reasonable for the service sector where wages are likely to represent the largest input cost.

4.1 Region Demand and Excess Supply

We use establishment level Census data on the universe of US service producers to obtain a measure of output in each region by taking the sum of revenue over of all plants in an industry in a region. The revenue (or supply) in region j is

$$R_j = \sum_{k=1}^{N_j} r_{jk} , \tag{15}$$

where r_{jk} is the revenue of the k^{th} plant in region j.

Constructing our measure of region expenditure is more involved because we need to take into account how industry composition in a region affects demand for a particular service industry. Following Jensen and Kletzer (2005), we construct region-specific measures of demand for each industry using the BEA's Input-Output Use tables.[13] First, we compute the share of industry demand for the service in region j by taking the sum over all industry t = 1, …, T (includes industries across all sectors) of the product of the share of the output demanded by industry t (s_t) and the share of industry t's employment located in region j (λ_{tj}).[14] Then, to obtain the expenditure (or demand) we multiply the share of industry demand in the region by the total revenue in the industry. Our measure of demand in region i can be expressed as

$$E_i = \left(\sum_{t=1}^{T} s_t \lambda_{tj} \right) \sum_{j=1}^{C} R_j , \tag{16}$$

where R is defined in (15). Using the measure of supply and demand, given in (15) and (16) respectively, we can compute the excess supply defined in (12).

To evaluate the quality of our excess supply measure, we take the sum across region. In theory this sum should be equal to zero. In the data however it is positive in all industries. This may be the result of measurement error in the data or the omission of international trade. However, as can be seen from Table

[13] We use the 1997 Benchmark Input-Output Use tables published by the BEA. (For more information, see http://www.bea.gov/industry/io_benchmark.htm).

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

III, the ratio of the sum of excess supplies across regions to overall production in the industry is quite small. The average across industries is equal to about one-tenth of one percent.

Table III also reports the coefficient of variation in the excess supply measure across regions. Industries where tradability is high should be characterized by a high degree of dispersion since some regions will be large net importers and other large net exporters. In Table III, the industries are in decreasing order of the coefficient of variation of excess supply. The ranking corresponds to our priors with Motion Picture and Video Distribution, Software Publishers and Payroll Services at the top of the list and Beauty Salons, General Medical and Surgical Hospitals, and Offices of Physicians at the bottom of the list.

Finally, we use the excess supply measure to obtain a lower bound for the fraction of output traded across regions.[15] This measure is defined as the sum across regions of the absolute value of the excess supplies divided by 2 times the revenue in the industry. As can be seen from the last column of Table III, the lower bound is much higher for Motion Picture and Video Distribution and Software Publishers compared to Beauty Salons and Offices of Physicians. According to this rough estimate, more than 60 percent of the output in the Motion Picture and Video Distribution and more than 40 percent in Software and Payroll Services is sold in a region other then where it is produced.

4.2 Productivity

To estimate trade costs, we need a measure of average firm productivity in each region, $\tilde{\varphi}_j$. According to the model, conditional on firm market access (M) and input cost (w), firm revenue is increasing in productivity. Further, conditional on productivity, firm revenue is increasing in the regional firm's market access and decreasing in input cost (w). We can therefore obtain an estimate of firm productivity by looking at the dispersion in firm revenue controlling for region specific effects and input costs. From the firm-level revenue function (9) it follows that the log revenue of a firm k in region j can be expressed as

[15] This is a lower bound because our measure does not capture intra-industry trade.

(17) $$\ln r_{jk} = \beta_j + \beta \ln w_j + e_{jk}.$$

where $\beta_j = (\varepsilon - 1)\ln(1 - 1/\varepsilon) + \ln M_j$ is a region fixed effect common to all producers in region j and $e_{jk} = (\varepsilon - 1)\ln(\varphi_{jk})$ capture the effect of plant level productivity on revenue.

We evaluate (14) separately for each of the service sectors. The estimated coefficients we obtain are not interesting and are not presented. What is important, however, is the residuals we obtain since these are estimates of firm productivity and can be used to construct our measure of regional average productivity, $\tilde{\varphi}_j$. Using equation (11) we obtain our measure of average productivity by taking the mean over the exponent of the residuals. Hence the estimated productivity in region j is

(18) $$\hat{\tilde{\varphi}}_j = \frac{1}{N_j}\sum_{k=1}^{N_j} \exp(\hat{e}_{jk}).$$

This measure captures only deviation from regional average and orthogonal to input costs. Basically, if all firms in a given region are more productive the model will attribute that higher average to regional characteristics (e.g. market access) and will not be included in the measure of productivity.[16] This simple specification gives us a measure of establishment level productivity.

As can be seen in Table IV, at both the firm level and the regional level our constructed measure of productivity is positively correlated with other, more standard, measures of productivity such as revenue per worker and value added (revenue less payroll) per worker. Our constructed measure of regional productivity is superior to the more standard revenue per worker and value added per worker measure in that it removes the impact of location on measured productivity.[17]

[16] Note that while the mean of the residuals is equal to zero by construction, the average productivity is not equal to zero. Suppose for instance that the residuals are normally distributed with mean $\mu = 0$ and variance σ^2. Then, by definition, the exponent of the residuals, $\hat{\varphi}^{\varepsilon-1}$ are distributed lognormal with mean $\exp(\sigma^2/2)$ and variance $[\exp(\sigma^2) - 1]\exp(\sigma^2)$. Therefore the mean of $\hat{\varphi}^{\varepsilon-1}$ is not zero as long as there is variation in the residuals (i.e. $\sigma^2 \neq 0$). Note however that the median, which is given by $\exp(\mu)$, is equal to zero in this example.

[17] However as a robustness check we also use the other measures of productivity.

4.3 Trade cost and Elasticity

The next step is to obtain an estimate for the trade cost at the industry level. By definition we can interpreted trade cost as an inverse measure of tradability and use it to produce a ranking of industries according to the tradability of its output.

An interesting result that we obtain from the model is that the region, revenue and price index do not depend on the distribution of productivity across producers but only on the number (N) and the average productivity of firms in each region ($\tilde{\varphi}$). This implies that we need use only region level information to estimate the industry's trade costs. Substituting for the market access M_j, using equation (7), and for the price index, using equation (14), in the excess supply equation (12) we obtain

$$(19) \qquad ES_j = \left(\frac{\varepsilon - 1}{\varepsilon}\right)^{3(\varepsilon-1)} w_j^{1-\varepsilon} N_j \tilde{\varphi}_j \sum_{i=1}^{C} \left[\frac{E_i \tau_{ij}^{1-\varepsilon}}{\sum_{j=1}^{C} (w_j \tau_{ij})^{1-\varepsilon} N_j \tilde{\varphi}_j} \right] - E_j + u_j .$$

Therefore, a region's excess supply (ES) depends on the observable distributions of production cost (w), expenditure (E), number of producers (N), and average productivity ($\tilde{\varphi}$) across regions as well as two unknowns we wish to estimate: the transport cost (τ) and the elasticity of substitution (ε).

4.3.1 Estimating Trade Cost Only

In a first approach we calibrate the value of the elasticity of substitution (ε) and estimate only the trade cost parameter (τ). In the baseline specification we set the elasticity to 2.5. We choose this value based on estimates of the elasticity of demand obtained in the manufacturing sectors.[18] To the best of our knowledge accurate estimates for the elasticity of substitution in service industries at a disaggregated level are not available. Rearranging (19), taking logs and adding an error term (u) yields

[18] For isntance, Broda and Weinstein (2006) using data on the U.S. report that for the period between 1990 and 2001 report an average elasticity was around 5 for four-digit (SITC) Rauch-differentiated goods.

(20) $$\Re_j = \sum_{i=1}^{C} E_i \left[\tau_{ij}^{1.5} \sum_{k=1}^{C} \tau_{ik}^{1.5} X_k \right]^{-1} + u_j ,$$

where $\Re_j = R_j / (\beta X_j)$, $X_j = N_j \tilde{\varphi}_j w_j^{1-\varepsilon}$ and $\beta = [(\varepsilon - 1)/\varepsilon]^{3(\varepsilon-1)} \cong 0.1$.

Results from estimating equation (20) using NLS are presented in Table V. The point estimates are large in general. Most are precisely estimated. The industries are ordered from low to high estimated trade costs. In general the ranking corresponds to our priors and to the simple descriptive statistics presented earlier in the paper. Motion Picture and Video Distribution and Payroll Services have small and imprecisely estimated trade costs. Software Publishers, Movie Theaters, and Tax Preparation Services have intermediate trade costs. The other industries have larger trade costs. According to the estimates, trade costs in the Offices of Physicians industry are more than 10 times greater than for Software Publishers.

As a robustness check we look at the impact of changes in the elasticity on the estimated value of the transport cost and the ranking of industry from non tradable to tradable. Table V present the estimates for trade costs obtain using a calibrated value of 5 for the elasticity of demand. The magnitudes of the estimated are very different than those obtained using an elasticity of 2.5. Further, the ranking of industries from tradable to non tradable is very different; almost reversed. Further there is much less dispersion in the coefficients. Finally, we could not estimate all trade cost, some of the estimation procedures failed to meet the convergence criteria and we do not present the results in those cases. When we use elasticities of 1.5 or 10 the results are not well behaved at all. Most of the estimation procedures fail to converge and for those that do converge the estimates are not statistically significant at conventional levels.

The two most important messages of these preliminary results are: (i) there seems to be enough variation in the data to estimate the trade costs, (ii) the estimated value of the trade cost parameter depends on the value of the elasticity of demand. This implies that the results presented in Table VI should be interpreted with extreme caution since to get a proper ordering of sector across degrees of

tradability, the elasticity of substitution should be allowed to vary across sectors. Therefore, in a second approach we will estimate the transport cost and the elasticity of substitution jointly.

4.3.2 Estimating Trade Costs and the Elasticity of Demand

When we try to estimate the trade costs and the elasticity of demand jointly using NLS, the procedure generally fails to converge. More work is required on this front.

4.4 Trade Costs, Excess Supply and Region Productivity

As another check on our estimated trace cost parameters, we examine the relationship between region productivity and region excess supply. Our intuition suggests that when trade costs are not prohibitive, regions that are more productive should undertake more production and export. Table VI reports the correlation of region excess supply and region productivity. Table VI shows that industries with low trade costs have, in general, higher correlations between productivity and region excess supply. The last columns in Table VI report a regression of the normalized excess supply in a region on normalized region productivity. Table VI reports that, again, in industries where our estimates of trade costs are low, excess supply varies significantly more with variation in cross-region productivity than in industries where trade costs are estimated to be high. The results suggest that when trade costs are not prohibitive, production is undertaken by the regions that have higher productivity and are exported to regions that have lower productivity. In industries where we infer prohibitive trade costs, we find that average excess supply is quite small and that there is little or no correlation between regional productivity and region excess supply.

4.5 Selection

As mentioned earlier, some of the regions do not produce. This implies that we cannot use all regions in the estimation procedure and, if the error term is correlated with the independent variables, results in

sample selection bias. We use a two stage procedure due to Heckman (1976, 1979) to control for sample selection.

A region produces only if the most productive firm in the region is profitable. Define the related latent variable z as follow

$$z_j = \frac{1}{\varepsilon}\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1} \frac{M_j \varphi_j^{\varepsilon-1}}{w_j^{\varepsilon} F_j}. \tag{22}$$

This variable is the ratio of the variable profit (defined as r/ε) to fixed production costs for the most productive firm in region j. Region j produces if and only if $z_j > 1$. We do not observe fixed production cost but assume that they are function of observable regional characteristics (κ), so that $\ln F_j = \beta \ln \kappa_j + v_j$ where v captures all other unspecified factor affecting fixed production costs. We assume that the residual term is distributed standard normal, $v_j \sim N(0,1)$ and that the conditional expectation of the error term in equation (20) is given by $E(u \mid v) = \gamma v$. Using this fixed cost specification in (22) and taking log, the lattent variable can be expressed as

$$\ln z_j = \chi_j - \varepsilon \ln w_j + \beta \ln \kappa_j + v_j \tag{23}$$

where $\chi_j = (\varepsilon-1)\ln[(\varepsilon-1)/\varepsilon] - \ln(\varepsilon) - \ln M_j - (\varepsilon-1)\ln\varphi_j$ is a region fixed effect. While we do not observe z_j, we observe whether or not a region produces. Define the indicator variable T_j to equal 1 if the region produces and zero otherwize and let η_j denote the probability that a region produces then

$$\eta_j = \text{Prob}(T_j = 1 \mid \text{observed variables}) = \Phi(\chi_j - \varepsilon \ln w_j + \beta \ln \kappa_j + v_j) \tag{24}$$

where $\Phi(\cdot)$ is the cdf of the unit-normal distribution.

To obtain consistent estimate for the trade cost in equation (20), we first estimate equation (24) using a Probit model and obtain an estimate of the probability that a region is a producer, $\hat{\eta}_j$. We then use this estimated probability to construct the inverse Mills ratio $\hat{\lambda}_j = \phi(\hat{z}_j)/\Phi(\hat{z}_j)$ where $\phi(\cdot)$ and $\Phi(\cdot)$

respectively denote the pdf and cdf of the standard normal distribution, and $\hat{z}_j = \Phi^{-1}(\hat{\eta}_j)$. We then include this term in (20) to obtain the second stage estimating equation

$$\Re_j = \sum_{i=1}^{C} E_i \left[\tau_{ij}^{1.5} \sum_{k=1}^{C} \tau_{ik}^{1.5} X_k \right]^{-1} + \gamma \hat{\lambda}_j + u_j . \tag{25}$$

Because we do not want the identification of our second stage estimates to rely on the normality assumption for the unobserved production costs, we also need to select valid variables to exclude for the second stage. Our theoretical model suggests that factors that affect fixed production costs but do not affect variable costs satisfy this exclusion restriction. Since capital is a main component of fixed costs they will be increasing in real estate cost. We use a region's population density and land cost as proxy for these costs. Further in industries where fixed costs are high the entry and exit rate are likely to be lower, so we include averages over a ten year period of the entry and exit rates in each region.

More work is required….

4.6 Returns to scale

Up to now we have not used the information on the distribution of workers across regions and said nothing about fixed production cost. It turns out that we can use the former to get an estimate of the latter. However this is only under some relatively strong assumption. Basically the estimation strategy we present assumes that labor is the only input in the production process. For some sectors, such as beauty salons or tax preparation this assumption is not too far from the mark. However, in other relatively capital intensive sectors this is not the case.

Substituting for the market access M_j using equation (7), and for the price index using equation (13) in equation (14) and rearranging we can express the fixed production cost as follow

(26) $$F_j = \frac{L_j}{N_j} - \left(\frac{\varepsilon}{1-\varepsilon}\right)^{\varepsilon} w_j^{-\varepsilon} \tilde{\varphi}_j \sum_{i=1}^{C} \left[\frac{E_i \tau_{ij}^{1-\varepsilon}}{\sum_{j=1}^{C} (w_j \tau_{ij})^{\varepsilon-1} N_j \tilde{\varphi}_j} \right].$$

Since we observe the distribution of workers, producers, wage, productivity and income, we can use the estimates for trade cost and the elasticity of demand to obtain estimates for the fixed cost. There is no estimation involved, it is only a matter of replacing the variables using the data and the estimates for the parameters.

To be completed…

5. SIMULATED METHOD OF MOMENTS

Given the complexity of the estimating equation and the small number of observations, we intend to explore obtaining structural estimates for the parameters using the simulated method of moments (SMM).

5.1 SMM Estimation Procedure

The simulated method of moments (SMM) estimator minimizes the distance between a vector of moments computed from the actual and simulated data. Let $\boldsymbol{\theta}$ denote the vector of parameters to be estimated and $M(\boldsymbol{\theta})$ a vector of moments. The SMM estimation procedure works as follows. First, we calculate the vector of moments with the actual data $M(\boldsymbol{\theta})$. These have been described earlier in section 2. Second, for a given vector of model parameters $\tilde{\boldsymbol{\theta}}$ simulate the model for H realizations of the random vector **T** and obtain artificial data. Third, for each of the H realizations calculate the vector of moments with the simulated data $M_h(\tilde{\boldsymbol{\theta}})$. Fourth, we compare the vectors of moments from the actual and simulated data and search over the parameter space until $\tilde{\boldsymbol{\theta}}$ is the solution to the following minimization problem:

$$\underset{\tilde{\theta}}{\arg\min}[M(\theta)-H^{-1}\sum_h M_h(\tilde{\theta})]'\Omega[M(\theta)-H^{-1}\sum_h M_h(\tilde{\theta})]$$

The matrix Ω provides the optimal weighting of each of the moment in the optimization procedure. The weight is inversely proportional to the standard deviation of the data moments such that more precisely estimated moments are given more weight in the estimation.

5.2 Moments

At least one moment condition per estimated parameter is required for the system to be identified. There is a large set of moments to choose from in the data and the econometric theory does not provide a clear guide in the choice of an optimal set of moments to use. Therefore moments are selected based on two criteria. First, they should capture the essential characteristics of the industry that the model tries to explain. Second, they should provide enough information to identify the structural parameters of the model. In other words, variations in parameter values should result in different values for the simulated moments.

To be completed….

6. CONCLUSION

To be completed…

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APPENDIX

This appendix provides descriptions for the service industries included in the study.[19]

NAICS 51: Information

The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.

The main components of this sector are the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; the industries known as Internet service providers and Web search portals, data processing industries and the information services industries.

For the purpose of developing NAICS, it is the transformation of information into a commodity that is produced and distributed by a number of growing industries that is at issue. The Information sector groups three types of establishments: (1) those engaged in producing and distributing information and cultural products; (2) those that provide the means to transmit or distribute these products as well as data or communications; and (3) those that process data. Cultural products are those that directly express attitudes, opinions, ideas, values, and artistic creativity; provide entertainment; or offer information and analysis concerning the past and present. Included in this definition are popular, mass-produced, products as well as cultural products that normally have a more limited audience, such as poetry books, literary magazines, or classical records.

NAICS 54: Professional, Scientific, and Technical Services

The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

This sector excludes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and record keeping, personnel, and physical distribution and logistics. These establishments are classified in Sector 56, Administrative and Support and Waste Management and Remediation Services.

NAICS 55: Management of Companies and Enterprises

The Management of Companies and Enterprises sector comprises (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision making role of the company or enterprise. Establishments that administer, oversee, and manage may hold the securities of the company or enterprise.

[19] The source of these descriptions is http://www.census.gov/econ/census02/data/us/US000.HTM.

Establishments in this sector perform essential activities that are often undertaken, in-house, by establishments in many sectors of the economy. By consolidating the performance of these activities of the enterprise at one establishment, economies of scale are achieved.

Government establishments primarily engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration. Establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and record keeping, personnel, and physical distribution and logistics are classified in Industry 56111, Office Administrative Services.

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

The Administrative and Support and Waste Management and Remediation Services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. These essential activities are often undertaken in-house by establishments in many sectors of the economy. The establishments in this sector specialize in one or more of these support activities and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.

The administrative and management activities performed by establishments in this sector are typically on a contract or fee basis. These activities may also be performed by establishments that are part of the company or enterprise. However, establishments involved in administering, overseeing, and managing other establishments of the company or enterprise, are classified in Sector 55, Management of Companies and Enterprises. These establishments normally undertake the strategic and organizational planning and decision making role of the company or enterprise. Government establishments engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration.

NAICS 61: Educational Services

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

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

NAICS 62: Health Care and Social Assistance

The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.

Excluded from this sector are aerobic classes in Subsector 713, Amusement, Gambling and Recreation Industries, and nonmedical diet and weight reducing centers in Subsector 812, Personal and

Laundry Services. Although these can be viewed as health services, these services are not typically delivered by health practitioners.

NAICS 71: Arts, Entertainment, and Recreation

The Arts, Entertainment, and Recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises: (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure time interests.

Some establishments that provide cultural, entertainment, or recreational facilities and services are classified in other sectors. Excluded from this sector are: (1) establishments that provide both accommodations and recreational facilities, such as hunting and fishing camps and resort and casino hotels, are classified in Subsector 721, Accommodation; (2) restaurants and night clubs that provide live entertainment in addition to the sale of food and beverages are classified in Subsector 722, Food Services and Drinking Places; (3) motion picture theaters, libraries and archives, and publishers of newspapers, magazines, books, periodicals, and computer software are classified in Sector 51, Information; and (4) establishments using transportation equipment to provide recreational and entertainment services, such as those operating sightseeing buses, dinner cruises, or helicopter rides, are classified in Subsector 487, Scenic and Sightseeing Transportation.

NAICS 81: Other Services (except Public Administration)

The Other Services (except Public Administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.

Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector.

Excluded from this sector are establishments primarily engaged in retailing new equipment and also performing repairs and general maintenance on equipment. These establishments are classified in Sector 44-45, Retail Trade.

TABLE I

U.S. EMPLOYMENT ACROSS SECTORS (2007)

NAICS Code	Sector Description	Employment	Share of Total Employment	Employment Growth (1997-2007)
21	Mining	703,129	0.50%	38%
22	Utilities	632,432	0.50%	-10%
23	Construction	7,399,047	5.50%	31%
31-33	**Manufacturing**	**13,333,390**	**9.90%**	**-21%**
42	Wholesale trade	6,295,109	4.70%	9%
44-45	Retail trade	15,610,710	11.50%	12%
48-49	Transportation and warehousing	4,435,760	3.30%	52%
51-56	**Business Services**	**33,430,809**	**24.70%**	**29%**
51	Information	3,428,262	2.50%	12%
52	Finance and insurance	6,562,546	4.90%	12%
53	Real estate and rental and leasing	2,249,353	1.70%	32%
54	Professional, scientific, and technical services	8,121,171	6.00%	51%
55	Management of companies and enterprises	2,915,644	2.20%	11%
56	Administrative and support and waste remediation services	10,153,833	7.50%	38%
61-81	**Personal Services**	**34,595,857**	**25.60%**	**23%**
61	Educational services	562,210	0.40%	75%
62	Health care and social assistance	16,859,513	12.50%	24%
71	Arts, entertainment, and recreation	2,070,524	1.50%	30%
72	Accommodation and food services	11,587,814	8.60%	23%
81	Other services (except public administration)	3,515,796	2.60%	8%
	Federal Government	2,462,000	1.80%	--
	State and Local Government	16,400,000	12.10%	--

Notes: From 1997 Economic Census and Census of Government.

TABLE II

SERVICE SECTOR CHARACTERISTICS

Naics Code	Industry Description	Number of Producers	Number of regions without producers	Ratio of share of industry revenue to share of GDP in highest revenue region	Coefficient of variation across regions of average Plant Size
511110	Newspaper Publishers	8,729	0	1.03	1.34
511210	Software Publishers	10,786	4	5.87	4.84
512120	Motion Picture and Video Distribution	692	105	10.9	4.08
512131	Motion Picture Theaters (except Drive-Ins)	5,665	0	0.96	0.58
541213	Tax Preparation Services	11,570	0	1.20	0.58
541214	Payroll Services	2,438	12	7.24	4.59
621111	Offices of Physicians (except Mental Health Specialists)	172,343	0	0.83	1.25
621511	Medical Laboratories	4,375	6	1.01	1.51
622110	General Medical and Surgical Hospitals	5,466	0	0.89	0.48
812112	Beauty Salons	67,903	0	0.87	0.55
812320	Drycleaning and Laundry Services (except Coin-Operated)	25,643	0	0.92	0.90

Notes: This table presents some characteristics of the service industries. The number of producers is defined as the number of plant reporting positive sales of the service in the U.S excluding the small establishments knows as Administrative records. Plant size is defined as the revenue weighted average plant revenue, which measures the size of the plant producing the average dollar of output.

TABLE III

REGIONAL EXCESS SUPPLY

Naics Code	Industry Description	Sum of excess supply as a fraction of industry revenue	Coefficient of variation of excess supply	Sum of positive excess supply as a fraction of industry demand
512120	Motion Picture and Video Distribution	0.00046	15522	0.657
511210	Software Publishers	0.00063	4103	0.413
541214	Payroll Services	0.00129	4062	0.463
512131	Motion Picture Theaters (except Drive-Ins)	0.00046	1692	0.107
621511	Medical Laboratories	0.00126	764	0.228
541213	Tax Preparation Services	0.00129	518	0.123
812320	Drycleaning and Laundry Services (except Coin-Operated)	0.00107	443	0.111
511110	Newspaper Publishers	0.00127	435	0.094
812112	Beauty Salons	0.00131	368	0.122
622110	General Medical and Surgical Hospitals	0.00133	285	0.085
621111	Offices of Physicians (except Mental Health Specialists)	0.00133	242	0.072

Notes: This table present some characteristics of the excess supply defined in (12). The lower bound for the share of revenue exported is obtain by taking the sum of the absolute value of the excess supply minus the measurement error divided by two times the overall production in the economy.

TABLE IV

PLANT PRODUCTIVITY

Naics Code	Industry Description	Plant Level Productivity		Region Level Productivity	
		Revenue/worker	Value added/worker	Revenue/worker	Value added/worker
511110	Newspaper Publishers	0.25	0.23	0.38	0.37
511210	Software Publishers	0.64	0.65	0.20	0.18
512120	Motion Picture and Video Distribution	0.69	0.70	0.31	0.31
512131	Motion Picture Theaters (except Drive-Ins)	0.43	0.46	0.01	0.01
541213	Tax Preparation Services	0.04	0.02	-0.09	-0.05
541214	Payroll Services	0.07	0.07	0.08	0.03
621111	Offices of Physicians (except Mental Health Specialists)	0.11	0.08	0.20	0.31
621511	Medical Laboratories	0.06	0.05	0.10	0.13
622110	General Medical and Surgical Hospitals	0.27	0.23	-0.01	-0.05
812112	Beauty Salons	0.16	0.06	-0.07	-0.16
812320	Drycleaning and Laundry Services (except Coin-Operated)	0.04	-0.002	0.31	0.30

Notes: This table present correlation coefficient between plant level productivity defined in (15) and two other measures of productivity: revenue per worker and value added per worker.

TABLE V

ESTIMATING TRADE COSTS

Naics Code	Industry Description	Sample Size	Elasticity equal to 2.5			Elasticity equal to 5		
			Trade Costs (τ)		R^2	Trade Costs (τ)		R^2
512120	Motion Picture and Video Distribution	78	2.87	(4.49)	0.92	not converged		
541214	Payroll Services	171	4.73	(3.39)	0.64	15.71	(12.6)***	0.30
511210	Software Publishers	179	12.38	(2.72)***	0.88	8.51	(1.15)***	0.59
512131	Motion Picture Theaters (except Drive-Ins)	183	12.93	(0.98)***	0.90	7.92	(1.18)***	0.87
541213	Tax Preparation Services	183	17.60	(1.20)***	0.92	5.81	(0.19)***	0.89
511110	Newspaper Publishers	183	52.91	(7.41)***	0.95	8.25	(1.77)***	0.93
812320	Drycleaning and Laundry Services (except Coin-Operated)	183	71.77	(4.73)***	0.98	5.58	(0.22)***	0.96
621511	Medical Laboratories	177	77.98	(11.01)***	0.89	7.91	(0.79)***	0.85
812112	Beauty Salons	183	81.92	(7.10)***	0.96	5.74	(0.22)***	0.95
621111	Offices of Physicians (except Mental Health Specialists)	183	123.59	(9.77)***	0.98	7.38	(0.29)***	0.98
622110	General Medical and Surgical Hospitals	183	$5.4e^{16}$	$6.8e^{37}$	0.95	not converged		

Notes: This table presents results from estimating trade costs using NLS estimation. In these regressions calibrate the value of the elasticity of substitution to 2.5 than 5. The sample size varies because we included only region that produce. The "not converged" comment indicates that the convergence criterion for the NLS procedure was not met. We omit the results in those cases. The *, **, and *** denote statistical significance at 10, 5 and 1 percent respectively.

TABLE VI

PLANT PRODUCTIVITY AND REGIONAL EXCESS SUPPLY

Naics Code	Industry Description	Correlation between Excess Supply and Productivity	Normalized Excess Supply Normalized Productivity		R^2
511110	Newspaper Publishers	0.37	0.369	(0.0689) ***	0.136
511210	Software Publishers	0.45	0.458	(0.0686) ***	0.203
512120	Motion Picture and Video Distribution	0.66	1.048	(0.1413) ***	0.436
512131	Motion Picture Theaters (except Drive-Ins)	0.04	0.041	(0.0742)	0.002
541213	Tax Preparation Services	-0.05	-0.055	(0.0742)	0.003
541214	Payroll Services	0.45	0.469	(0.0709) ***	0.206
621111	Offices of Physicians (except Mental Health Specialists)	0.03	0.031	(0.0743)	0.001
621511	Medical Laboratories	0.47	0.487	(0.0678) ***	0.229
622110	General Medical and Surgical Hospitals	-0.04	-0.038	(0.0743)	0.001
812112	Beauty Salons	0.13	0.133	(0.0737) *	0.018
812320	Drycleaning and Laundry Services (except Coin-Operated)	0.08	0.078	(0.0741)	0.006

Notes: This table presents results of the correlation coefficient between region excess supply and region productivity and regression results with the dependent variable region excess supply. The sample size varies because we included only region that produce. The *, **, and *** denote statistical significance at 10, 5 and 1 percent respectively.