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Measuring Tradable Services and the Task Content of Offshorable Services Jobs

J. Bradford Jensen and Lori G. Kletzer

8.1 Introduction

The services offshoring debate reached headline status several years ago, fueled in large part by the 2004 presidential campaign and the slow recovery of the labor market from the 2001 downturn. Services offshoring refers to the (potential) migration of jobs (but not the people performing them) across national borders, mostly from rich countries to poor ones, with imported products and activities flowing back to the United States. The literature on services offshoring remains in its infancy, although the number of contributions is expanding rapidly. A nonexhaustive list of recent contributions includes: Amiti and Wei (2004); Arora and Gambardella (2004); Bardhan and Kroll (2003); Bhagwati, Panagariya, and Srinivasan (2004); Blinder (2006, 2007); Brainard and Litan (2004); Bronfenbrenner and Luce (2004); Jensen and Kletzer (2006); Kirkegaard (2004); Mankiw and Swagel (2006); Samuelson (2004); and Schultze (2004). Despite the attention, relatively little is known about how many jobs may be at risk of relocation or how much job loss is associated with these business decisions.

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There are a few prominent projections. An early estimate of the likely scale of future job losses due to movement of jobs offshore is Forrester Research's "3.3 Million U.S. Services Jobs To Go Offshore" (McCarthy 2002).[1] Other estimates include: Deloitte Research estimates that by 2008 the world's largest financial service companies will have relocated up to two million jobs to low-cost offshore countries; Gartner Research predicts that by the end of 2004 10 percent of information technology (IT) jobs at U.S. IT companies and 5 percent of IT jobs at non-IT companies will have moved offshore; another Gartner Research survey revealed that three hundred of the Fortune 500 companies today do business with Indian IT services companies. Goldman Sachs estimates 300,000 to 400,000 services jobs have moved offshore in the past three years, and anticipates a monthly rate of 15,000 to 30,000 jobs, in manufacturing and services combined, to be subject to offshoring in the future. Bardhan and Kroll (2003) put out an estimate of fourteen million jobs potentially at risk.

In an earlier paper (Jensen and Kletzer 2006), we advanced a new empirical approach to identify, at a detailed level, service activities that are potentially exposed to international trade. The approach uses the geographic concentration of service activities within the United States to identify which service activities are traded domestically, and then classifies activities that are traded domestically as *potentially* tradable internationally. With the tradability classification, we developed estimates of the number of workers who are in tradable activities for all sectors of the economy. The paper offered comparisons of the demographic characteristics of workers in tradable and nontradable activities and employment growth in traded and nontraded service activities. The tradability designation also allowed an examination of the risk of job loss and other employment outcomes for workers in tradable activities.

While we believe we made an important contribution to identifying tradable activities using the notion of geographic concentration, we recognize the measure is not perfect. We note here several potential problems with the geographic concentration methodology. The first potential problem is that if something is tradable but not in an increasing returns activity, it might not be geographically concentrated. A second potential issue is that an activity might be geographically concentrated and occur predominantly in large cities, due to the specialization that is possible in a large (thick) market. These activities, such as acupuncturists and manicurists, are concentrated, but not tradable. A third issue arises for a set of activities that are often associated with hospitality industries, such as gaming supervisors, bellhops, and limousine drivers, where the activity is concentrated, location in a city that serves markets beyond the locality, and is tradable in the sense of foreigners accounting for a share of demand. Yet in this case these activities are not likely to be offshored because the nature

1. The Forrester projection was updated in 2004 to 3.4 million.

of the activity (say, legalized gambling in Atlantic City) is defined by the location itself.

This chapter offers an alternative method of understanding tradability, based on an analysis of the task and activity content of jobs. The literature on offshoring notes that movable jobs are those with little face-to-face customer contact, high information content, and the work process is Internet enabled and/or telecommutable (see Bardhan and Kroll 2003; Dossani and Kenney 2003; Blinder 2006). More informally, it is commonly believed that if "it can be sent down a wire (or wireless)," it is offshorable. Empirically, this investigation tries to bring these basic principles of the characteristics of potentially offshorable jobs to detailed microdata on occupations. The task content investigation offers us a second and independent measure of potential tradability, to be used to refine the understanding obtained from our geographical concentration measure. More specifically, we can ask if the jobs identified as potentially internationally tradable, using geographic concentration, involve task or job activities and characteristics that fit current notions of offshorability.

This chapter begins with a summary of the methodology and findings in Jensen and Kletzer (2006). The next step involves an operational assessment of how the basic principles of offshorability (high information content, remote from customer, Internet enabled) match up to the characteristics of "real" jobs. Detailed information on the content and context of jobs (occupations) is available from the Occupational Information Network (O*Net), a U.S. Department of Labor database of 450 occupations.[2] For each of hundreds of occupations, O*Net contains detailed qualitative information on job tasks, work activities (interacting with computers, processing information), and work context (face-to-face discussions, work with others, work outdoors). We develop an index to assess occupations based on important characteristics associated with offshorability, using the information available from the publicly available and downloadable O*Net production data set (version 11).

Briefly summarizing the results, based on job task content the occupational groups with large shares of employment in the highest potentially tradable group include: Business and Financial Operations (74.7 percent of employment); Computer and Mathematical Occupations (93.4 percent); Architecture and Engineering (80.8 percent); Life, Physical, and Social Sciences (75.9 percent); and Office/administrative support (64.3 percent). The notable nontradable occupational groups, with large shares of employment identified as least potentially tradable include: Education and Library (43.7 percent); Healthcare Practitioners (78 percent); Healthcare Support (94.4 percent); and Food Preparation (100 percent). Overall for the service occupations, 27.4 percent of May 2005 employment was in the most potentially tradable group, while 43.8 percent of employment was in occupations

2. The O*Net is the successor to the well-known Dictionary of Occupational Titles.

rated as least potentially tradable. There is a considerable overlap between the job task content measure of potential tradable and our geographic concentration measure. We also find a positive correlation between skill (measured as educational attainment) and potential tradability—occupations with a greater share of workers with a college degree are more highly ranked as offshorable/tradable. Similarly, the more highly ranked occupations, in regard to tradability, have higher average annual earnings than do the lowest-ranked occupations.

8.2 Geographical Concentration and Tradability: Empirical Approach

To develop a measure of tradable services, our earlier empirical approach relied on the basic economic intuition that nontraded services will not exhibit geographic concentration in production. Goods that are traded tend to be geographically concentrated (to capitalize on increasing returns to scale, access to inputs like natural resources, etc.), while goods that are not traded tend to be more ubiquitously distributed. We applied this same intuition to service production. With the identification of industries and occupations that appear to be traded within the United States, the inference is that service activities that can be traded within the United States are also potentially traded internationally.

The intuition is described in Krugman (1991, 65), where he notes:

> In the late twentieth century the great bulk of our labor force makes services rather than goods. Many of these services are nontradable and simply follow the geographical distribution of the goods-producing population—fast-food outlets, day-care providers, divorce lawyers surely have locational Ginis pretty close to zero. Some services, however, especially in the financial sector, can be traded. Hartford is an insurance city; Chicago the center of futures trading; Los Angeles the entertainment capital; and so on . . . The most spectacular examples of localization in today's world are, in fact, services rather than manufacturing. . . . Transportation of goods has not gotten much cheaper in the past eighty years . . . But the ability to transmit *information* has grown spectacularly, with telecommunications, computers, fiber optics, etc.

The idea is that when something is traded, the production of the activity is concentrated in a particular region to take advantage of some economies in production. As a result, not all regions will support local production of the good and some regions will devote a disproportionate share of productive activity to a good and then trade it.

8.2.1 Measuring Geographical Concentration

Measures of geographic concentration are a way to implement the intuition described by Krugman. Most measures of concentration use the region's share of employment in an industry relative to the region's share

of total employment. One issue with measures of concentration for our purposes is that they do not differentiate between the reasons activity is concentrated. In general, the reason for the concentration does not matter to us except for one instance. If a service is nontradable and demand for the service is concentrated (industries that use the nontraded service are geographically concentrated), the service industry will be geographically concentrated and we will infer that the service is tradable. To incorporate this case, we extend the intuition from the framework. If a nontradable industry provides intermediate inputs to a downstream industry, we would expect the geographical distribution of the nontraded intermediate industry to follow the distribution of the downstream industry. Instead of being distributed with income, the nontraded good is distributed in proportion to the demand for that industry.[3]

We focus here on a modified Gini coefficient of geographic concentration.[4] To build intuition, we start with industry:

$$G = | 1 - \sum_i (\sigma Y_{i-1} + \sigma Y_i) * (\sigma \mathrm{IDS}_{i-1} - \sigma \mathrm{IDS}_i) |,$$

where i is an index for regions (sorted by the region's share of industry employment), σY_i is the cumulative share of industry or occupation employment in region i, σY_{i-1} is the cumulative share of industry or occupation employment in the region $(i - 1)$ with the next lowest share of industry employment, and IDS_i is the region's share of demand for industry i.

8.2.2 Implementation

These measures were implemented using employment information from the 2000 Decennial Census of Population Public Use Micro Sample (PUMS) files. The geographic entity is the Consolidated Metropolitan Statistical Area or the Metropolitan Statistical Area where an individual reports working.[5] The use of worker-level data to investigate economic concentration is somewhat unusual. One advantage of this strategy is that it allows consideration of both industrial concentration and *occupational* concentration. The ability to identify both industries and occupations that are tradable is an important feature of the empirical strategy because many of the service activities that are reportedly being globally sourced

3. To address this issue, we modify the general measures of geographic concentration by developing an industry-region specific measure of the concentration of demand for an industry. We construct a downstream industry-weighted average demand for each industry-region using the input-output tables. More details on the construction of the weights are provided in Jensen and Kletzer (2006). The adjustment takes account of the concentration of downstream industry concentration and adjusts the "denominator" in the concentration measures accordingly.

4. Readers interested in the full discussion are directed to our 2006 paper.

5. For regions, we use the Place of Work Consolidated Metropolitan Area (POWCMA5) field on the Decennial PUMS. When POWCMA is coded as a nonmetropolitan area or a mixed metro/nonmetro area, we concatenate the Place of Work state code with the POWCMA5 code. For more information on the 5 percent sample PUMS, see: http://www.census.gov/Press-Release/www/2003/PUMS5.html.

are tasks within the service "production" process (for example, the banking relationship is not relocated offshore; rather, the customer service/call center component is moved); thus, occupations correspond more closely to these types of activities than do industries. In addition, occupations have job task content and activities, while industries (often similar to products) do not.

8.3 Classifying Industries and Occupations as Tradable vs. Nontradable

8.3.1 Industries

In our 2006 paper we discussed extensively how to determine a tradable versus nontradable distinction for industries and occupations. Given the large number of detailed industries and occupations, some grouping is in order, to make sense of the estimates. Starting with industry, where intuition tends to be stronger, we initially placed industries into three roughly equal groups: Gini class 1 (least geographically concentrated) when the industry Gini was less than .1; Gini class 2 when the industry Gini was between .1 and .3; Gini class 3 (most geographically concentrated) when the Gini coefficient was greater than or equal to .3. Approximately 36 percent of industries are in Gini class 1, about 37 percent are in Gini class 2, and 27 percent are in Gini class 3.

Figure 8.1 plots the Gini coefficients for all industries by two-digit North American Industry Classification System (NAICS) code. The pattern is generally consistent with our priors that tradable industries will be geographically concentrated. For example, industries in the goods-producing sectors of Agriculture, Mining, and Manufacturing are typically in the top two Gini classes. Only five of the ninety-two industries in these sectors are in Gini class 1: Cement and Concrete, Machine Shops, Miscellaneous Manufacturing n.e.c. (not elsewhere classified), Structural Metals and Tanks, and Printing and Related Activities. All of these industries seem to be either nontraded because of a high weight to value ratio (e.g., Cement and Concrete), or they are categories that include a range of potentially dissimilar activities (Miscellaneous manufacturing n.e.c.) that make them appear to be broadly geographically distributed. Most agriculture, mining, and manufacturing products are considered tradable; so as a first-order approximation, classifying the lowest geographical concentration category (Gini class 1) as nontradable seems appropriate for these sectors.[6] Using a Gini coefficient of .1 as the threshold for tradable seems to make sense in other sectors as well. Industries in the retail trade sector are primarily classified as nontradable. Industries in the Transportation sector are mostly classified as tradable. For Public Administration, most activities are nontradable

6. There is a positive correlation between Gini class and mean trade share.

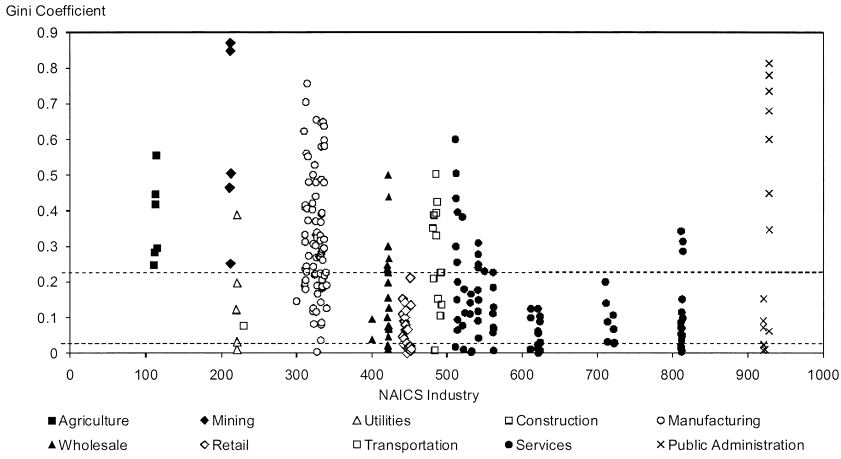

Fig. 8.1 Geographic concentration of industries

except for Public Finance and the military. For the Service sector, industries are balanced between nontradable and tradable. Table 8.1 provides a complete list of service industries by two-digit NAICS sector and the industry's Gini class.

8.3.2 Occupation Results

We constructed a similar demand-weighted Gini coefficient for each occupation, using the same Gini = .1 threshold for the nontradable/tradable categorization. Table 8.2 shows the share of employment by Major Standard Occupational Classification group by Gini class. The groupings largely are consistent with our priors. The occupational groups with large shares of employment classified as tradable include: Business and Financial Operations (68 percent); Computer and Mathematical Occupations (100 percent); Architecture and Engineering (63 percent); Legal (96 percent); and Life, Physical, and Social Sciences (83 percent). The notable nontradable occupational groups include: Education and Library (99 percent nontradable); Healthcare Practitioners (86 percent); Healthcare Support (97 percent); and Food Preparation (96 percent). On the goods production side, 90 percent of employment in Installation, Maintenance, and Repair is classified as nontradable, as is 80 percent of Production[7] and 89 percent of Transportation and Material Moving.[8]

7. The geographic concentration results are at first counterintuitive for production occupations given the manufacturing industry results. Production occupations are typically not industry-specific but instead functional activities and are thus distributed more broadly.

8. The inclusion of military-specific occupations (and industries) as geographically concentrated is not likely to be associated with offshorability (although perhaps tradability). The national security components of these occupations likely weigh against offshorability.

Table 8.1 Service industries, Gini coefficient class

2-digit NAICS	Industry description	Gini coefficient class
	Information	
51	Newspaper publishers	1
51	Radio and television broadcasting and cable	1
51	Libraries and archives	1
51	Wired telecommunications carriers	2
51	Data processing services	2
51	Other telecommunication services	2
51	Publishing except newspapers and software	2
51	Other information services	3
51	Motion pictures and video industries	3
51	Sound recording industries	3
51	Software publishing	3
	Finance and insurance	
52	Savings institutions, including credit unions	1
52	Banking and related activities	1
52	Insurance carriers and related activities	2
52	Nondepository credit and related activities	2
52	Securities, commodities, funds, trusts, and other financial investments	3
	Real estate and rental	
53	Video tape and disk rental	1
53	Other consumer goods rental	1
53	Commercial, industrial, and other intangible assets rental and leasing	2
53	Real estate	2
53	Automotive equipment rental and leasing	2
	Professional, scientific, and technical services	
54	Veterinary services	1
54	Accounting, tax preparation, bookkeeping, and payroll services	1
54	Architectural, engineering, and related services	2
54	Other professional, scientific and technical services	2
54	Legal services	2
54	Specialized design services	2
54	Computer systems design and related services	2
54	Advertising and related services	2
54	Management, scientific and technical consulting services	2
54	Scientific research and development services	3
	Management	
55	Management of companies and enterprises	2
	Administrative support	
56	Waste management and remediation services	1
56	Business support services	1
56	Services to buildings and dwellings	1
56	Landscaping services	1
56	Employment services	2
56	Other administrative and other support services	2
56	Investigation and security services	2
56	Travel arrangement and reservation services	2

Table 8.1 (continued)

2-digit NAICS	Industry description	Gini coefficient class
	Education	
61	Elementary and secondary schools	1
61	Colleges and universities, including junior colleges	1
61	Other schools, instruction, and educational services	1
61	Business, technical, and trade schools and training	2
	Health care and social services	
62	Hospitals	1
62	Nursing care facilities	1
62	Vocational rehabilitation services	1
62	Offices of physicians	1
62	Outpatient care centers	1
62	Offices of dentists	1
62	Offices of optometrists	1
62	Residential care facilities, without nursing	1
62	Child day care services	1
62	Home health care services	1
62	Other health care services	1
62	Office of chiropractors	1
62	Individual and family services	1
62	Community food and housing, and emergency services	2
62	Offices of other health practitioners	2
	Arts, entertainment, and recreation	
71	Bowling centers	1
71	Other amusement, gambling, and recreation industries	1
71	Museums, art galleries, historical sites, and similar institutions	2
71	Independent artists, performing arts, spectator sports, and related	2
	Accommodation	
72	Drinking places, alcoholic beverages	1
72	Restaurants and other food services	1
72	Recreational vehicle parks and camps, and rooming and boarding houses	1
72	Traveler accommodation	2
	Other services	
81	Beauty salons	1
81	Funeral homes, cemeteries, and crematories	1
81	Personal and household goods repair and maintenance	1
81	Automotive repair and maintenance	1
81	Barber shops	1
81	Religious organizations	1
81	Commercial and industrial machinery and equipment repair and maintenance	1
81	Drycleaning and laundry services	1
81	Car washes	1
81	Electronic and precision equipment repair and maintenance	1
81	Civic, social, advocacy organizations, and grantmaking and giving	1
81	Nail salons and other personal care services	2
81	Other personal services	2
81	Business, professional, political, and similar organizations	2

(*continued*)

Table 8.1 (continued)

2-digit NAICS	Industry description	Gini coefficient class
81	Labor unions	3
81	Footwear and leather goods repair	3
	Public administration	
92	Justice, public order, and safety activities	1
92	Administration of human resource programs	1
92	Other general government and support	1
92	Executive offices and legislative bodies	1
92	Military Reserves or National Guard	1
92	Administration of economic programs and space research	1
92	Administration of environmental quality and housing programs	1
92	Public finance activities	2
92	National security and international affairs	3
92	U.S. Armed Forces, branch not specified	3
92	U.S. Coast Guard	3
92	U.S. Air Force	3
92	U.S. Army	3
92	U.S. Navy	3
92	U.S. Marines	3

Geographic concentration is a notion that may be more suited to industry analysis than to occupation. From our reading of the offshoring literature, we note the informal discussion of job and task characteristics. We turn now to an implementation of these ideas.

8.4 Measuring Task Content of Potentially Tradable Services Occupations

The literature on offshoring posits that movable jobs are those with little face-to-face customer contact, high information content, and the work process is Internet enabled and/or telecommutable.[9] A great deal of attention is paid to Internet enabled, as the expansion of broadband and wireless (and the broad use of off the shelf software programs) having greatly reduced the transportation costs of information. Having developed a set of tradable services occupations, the next step is to consider the detailed characteristics of these jobs and whether the characteristics fit a description of offshorability. Based on these offshorability characteristics, van Welsum and Vickery (2005a, 2005b) perform a similar exercise for a selection of Organization for Economic Cooperation and Development (OECD) countries. Their methodology is based on subjec-

9. See Bardhan and Kroll (2003) for a list of attributes.

Table 8.2 **Share of occupation employment by Gini class coefficient, by major occupation category**

SOC	Description	Gini class 1	Gini class 2	Gini class 3
11	Management	34.48	61.15	4.37
13	Business/Financial Operations	31.73	65.96	2.32
15	Computer/Mathematical	0	73.07	26.93
17	Architecture/Engineering	36.04	58.31	5.65
19	Life, Physical, Social Sci.	16.32	58.61	25.08
21	Community/Social Svs.	100.00	0	0
23	Legal	3.78	96.22	0
25	Education and Library	99.54	0.46	0
27	Arts, Design, Entertain.	17.13	75.02	7.85
29	Healthcare Prac./Tech.	86.56	13.10	0.34
31	Healthcare Support	96.73	3.27	0
33	Protective Service	59.83	40.17	0
35	Food Prep./Serving	95.68	4.32	0
37	Building Maintenance	98.54	1.46	0
39	Personal Care Service	82.64	7.22	10.13
41	Sales and Related	75.41	21.82	2.77
43	Office/Admin. Support	93.14	6.66	0.20
45	Farm, Fish, Forestry	0	81.01	18.99
47	Construction/Extraction	61.37	36.18	2.45
49	Install., Maint., Repair	90.00	8.89	1.11
51	Production	80.30	17.15	2.55
53	Transport./Material Moving	89.20	5.86	4.95
55	Military Specific	0	0	100.00
	All occupations	71.66	24.86	3.47

tive judgments of the task content of jobs, not data on work activities or content.

The use here of Occupational Information Network (O*Net) is in the spirit of Autor, Levy, and Murnane (2003), who explored the spread of computerization using the Dictionary of Occupational Titles (DOT) to measure the routine versus nonroutine, and cognitive versus noncognitive aspects of occupations. The O*Net was developed by the U.S. Department of Labor as a replacement for the DOT.[10] Similar in theme to the DOT as a source of occupational information, O*Net reflects the expanded possibilities of contemporary information technology in that it is a database with information on job characteristics and worker attributes. Unlike the vast job-specific detail provided on 12,000+ occupations in the DOT, O*Net provides information on 1,100+ occupations, using language and assessment common across jobs. Unlike DOT, where professional analysts were the primary source of information, job incumbents provide the information, gathered by survey questionnaire. Occupations are organized at the

10. See Peterson and Mumford et al. (1999) for a history of the development of O*Net.

Standard Occupational Classification level. The O*Net is used in a variety of fields studying work and occupations, such as organizational behavior, applied psychology, career assessment, human resource management, and occupational psychology.[11] The O*Net is relatively foreign to research in economics. Blinder (2007) takes an approach similar in spirit to our discussion here.

The O*Net Content model identifies the most important types of information about work, jobs, and workers, and integrates the information into a structured system of six major categories:[12]

- Worker Characteristics (Abilities; Occupational Interests; Work Values; Work Styles)
- Worker Requirements (Skills and Knowledge; Education)
- Experience Requirements (Experience and Training; Skills and Entry Requirements; Licensing)
- Occupational Requirements (Generalized and Detailed Work Activities; Organizational Context; Work Context)
- Labor Market Characteristics (Labor Market Information; Occupational Outlook)
- Occupation-Specific Information (Tasks; Tools and Technology)

The first three categories (Worker Characteristics, Worker Requirements, Experience Requirements) are worker-oriented. The second three are work- (or job-) oriented categories, with Occupational Requirements as the focus of interest here. Occupational requirements are meant to identify requisite tasks, and are designed to cross occupations, at both a general and detailed level, while Occupation-Specific Information is meant to be quite detailed and literally occupation-specific.

The domain/category Occupational Requirements is designed to provide ". . . a comprehensive set of variables or detailed elements that describe what various occupations require" (National Center for O*Net Development 2006, 20). The focus is on typical activities required across occupations. Within the Generalized and Detailed Work Activities subdomain, we selected eleven measures to construct an index of offshorability/potential tradability.

On information content:

Getting information (+)
Processing information (+)
Analyzing Data or Information (+)
Documenting/Recording Information (+)

11. See http://online.onetcenter.org/ for information on acquiring the data.

12. The idea behind the six content areas is to provide multiple windows on the world of work. Information on the O*Net Context Model comes from the National Center for O*Net Development (2006). For a comprehensive discussion of O*Net from the practical and research perspectives, see Peterson and Mumford et al. (2001).

On Internet enabled:

Interacting with computers (+)

On face-to-face contact:

Assisting or Caring for Others (–)
Performing or Working Directly with the Public (–)
Establishing or Maintaining Interpersonal Relationships (–)

On the routine or creative nature of work:

Making Decisions and Solving Problems (–)
Thinking Creatively (–)

On the on-site nature of work:

Inspecting equipment, structures or material (–)

The sign in parentheses [(+) or (–)] denotes our prior on whether the characteristic is positively related to offshorability or negatively related.

Rating scales are used to quantify these characteristics. Multiple scales are provided, with "importance" and "level" as the predominant pair. "Importance" is the rating of answers to the question: "How important is this skill to performance on the job?" Answers vary from "not important" to "extremely important," on a scale of 1 to 5. "Level" is the rating of "What level of this skill is needed to perform this job?," ranging from low (level) to high (level), on a scale of 1 to 7.[13] An illustration might be useful, normalizing the two different scale ranges from 0 to 100. For the attribute "Performing or Working Directly with the Public," data entry keyers are assigned importance (I) = 43, and level (L) = 33 (for Security Guards, I = 74 and L = 62). Compared to data entry keyers, working with the public is more important to performance on the job for security guards, along with a higher level of the skill of working with the public. Tables 8.3, 8.4, and 8.5 provide summary information on importance, level, and the various work activities.

Table 8.3 provides summary statistics across occupations on the eleven work activities and their importance and level. The various attributes that involve working with information via computers have higher scores on importance than the attributes involving working directly with the public or assisting and caring for others. Importance of attributes appears to vary more across occupations than level.

Tables 8.4 and 8.5 describe in more detail some of the work activities for two specific occupations. In table 8.4, mathematical technicians are profiled; in table 8.5 bookkeeping, accounting, and auditing clerks are profiled. For each occupation, the tables list the work activities with the highest shares of

13. See Peterson and Mumford et al. (1999, 2001). Level allows a "not relevant to performance" rating, coded as 0.

Table 8.3 Summary statistics for work activities, across occupations

Work Activity	Mean	Standard deviation	Min	Max
Getting information				
Importance	0.815	0.097	0.366	1
Level	0.548	0.152	0.118	0.951
Inspecting equipment, structures, or material				
Importance	0.606	0.173	0.2	0.966
Level	0.391	0.158	0	0.855
Processing information				
Importance	0.651	0.156	0.2	1
Level	0.499	0.193	0.028	0.911
Analyzing data or information				
Importance	0.628	0.161	0.2	0.988
Level	0.451	0.194	0	0.951
Making decisions and solving problems				
Importance	0.729	0.144	0.24	0.996
Level	0.547	0.178	0.071	0.94
Thinking creatively				
Importance	0.603	0.183	0.2	0.992
Level	0.474	0.206	0.023	0.951
Interacting w/ computers				
Importance	0.604	0.243	0.2	1
Level	0.353	0.2	0	0.875
Documenting / recording information				
Importance	0.653	0.178	0.2	0.984
Level	0.436	0.179	0	0.8
Establishing and maintaining interpersonal relationships				
Importance	0.683	0.167	0.2	0.976
Level	0.583	0.177	0.028	0.897
Assisting and caring for others				
Importance	0.528	0.182	0.2	1
Level	0.378	0.192	0	0.961
Performing for or working directly w/ public				
Importance	0.56	0.221	0.2	0.984
Level	0.405	0.232	0	0.924

Source: Authors' calculations using O*Net data.

importance. It is notable that for both occupations, interacting with computers and various aspects of processing information are the highest (most important) work activities.

Our composite index of offshorability is the weighted sum of the eleven components, using our priors on the sign of the attribute in regard to offshoring potential. In constructing an index, it is not obvious how to weight importance and level. Starting from the observation that importance varies more than level across occupations, an index was created using a weight of three-quarters to importance and one-quarter to level. Higher values of the index indicate more offshorability potential, yielding a ranking

Table 8.4 **Work activities, 15-2091.00—mathematical technicians**

Importance	Work activity	Work activity description	Detailed work activity
100	Processing information	Compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data.	Compile numerical or statistical data; develop tables depicting data
92	Analyzing data or information	Identifying the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.	Analyze scientific research data or investigative findings
92	Getting information	Observing, receiving, and otherwise obtaining information from all relevant sources.	Collect scientific or technical data
88	Identifying objects, actions, and events	Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.	
88	Interacting with computers	Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.	Develop or maintain databases; use computers to enter, access, or retrieve data; use relational database or spreadsheet software
75	Making decisions and solving problems	Analyzing information and evaluating results to choose the best solution and solve problems.	Resolve engineering or science problems
75	Updating and using relevant knowledge	Keeping up-to-date technically and applying new knowledge to your job.	Use interpersonal communication techniques; use knowledge of investigational techniques; quantitative research methods
67	Communicating with supervisors, peers, or subordinates	Providing information to supervisors, co-workers, and subordinates by telephone, in written form, e-mail, or in person.	
67	Documenting/recording information	Entering, transcribing, recording, storing, or maintaining information in written or electronic/magnetic form.	

Source: National Center for O*Net Development.

Table 8.5 **Work activities, 43-3031.00—Bookkeeping, accounting, and auditing clerks**

Importance	Work activity	Work activity description	Detailed work activity
97	Interacting with computers	Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.	Use accounting or bookkeeping software; use computers to access data; use word processing software
82	Getting information	Observing, receiving, and otherwise obtaining information from all relevant sources.	
80	Processing information	Compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data.	Compile data for financial reports; compute financial data; compute taxes; detect discrepancies; maintain balance sheets; prepare bank deposits
74	Establishing and maintaining interpersonal relationships	Developing constructive and cooperative working relationships with others, and maintaining them over time.	
73	Organizing, planning, and prioritizing work	Developing specific goals and plans to prioritize, organize, and accomplish your work.	
65	Communicating with supervisors, peers, or subordinates	Providing information to supervisors, co-workers, and subordinates by telephone, in written form, e-mail, or in person.	
58	Documenting/recording information	Entering, transcribing, recording, storing, or Entering time sheet information; taking messages; maintaining information in written or electronic/ magnetic form.	
57	Making decisions and solving problems	Analyzing information and evaluating results to choose the best solution and solve problems.	

Source: National Center for O*Net Development.

of all occupations for which the attributes are available. After discussing results, we take note of some robustness checks.

The usefulness of the index is ordinal, not cardinal. Occupations are judged on their offshorability relative to each other, not compared to some absolute standard. Tables 8.6 and 8.7 report the top thirty and bottom thirty occupations, as ranked for job task content.[14] How good are the results? Occupations at the top of the list seem unsurprising: credit authorizers, data entry keyers, accountants, medical transcriptionists, market research analysts, bookkeeping, and account clerks. One of the columns in the table indicates occupations identified as tradable by geographic concentration, and there is a close match both at the top of the ranking, with most tradable, and at the bottom of the ranking with the least tradable. The O*Net information corrects some obvious misfits of geographic concentration: crossing guards, massage therapists, and manicurists (see table 8.7).

Paralleling our discussion of economic concentration, we explore whether to divide potentially tradable/offshorable from "sticky" and nontradable. Index values span a range of +1.777 (Mathematical technicians) to –2.21 (Barbers). Dividing the set of occupations roughly in thirds, we established "Index class 1" (low tradability) as index values less than –0.7, "Index class 2" (medium tradability) as values between –0.7 and zero (0.0), and "Index class 3" (high potential tradability) as values greater than or equal to zero. Each class contains approximately 152 to 154 occupations.

Table 8.8 reports shares of employment (for May 2005), for major (Standard Occupational Classification [SOC] two-digit) occupational groups, across the three index classes. The occupational groups with large shares of employment in the highest potentially tradable group include: Business and Financial Operations (74.7 percent); Computer and Mathematical Occupations (93.4 percent); Architecture and Engineering (80.8 percent); Life, Physical, and Social Sciences (75.9 percent); and Office/administrative support (64.3 percent). The notable nontradable occupational groups, with large shares in index class 1 (least potentially tradable) include: Education and Library (43.7 percent); Healthcare Practitioners (78 percent); Healthcare Support (94.4 percent); and Food Preparation (100 percent). Overall for the service occupations, 27.4 percent of May 2005 employment was in the most potentially tradable group, while 43.8 percent of employment was in occupations rated as least potentially tradable.

With three economic concentration classes and three task content classes, there is a natural question of how well the two measures match up. Overall, where the two measures can be constructed at the same detailed level, 41 percent of occupations match completely (index class 1 matches to Gini class 1; index class 2 matches to Gini class 2, etc.). Looking just at nontradable

14. The full listing of 457 service occupations, ranked by job task content, takes up fourteen printed pages, and is available from the corresponding author.

Table 8.6 **Most offshorable: Top thirty occupations, ranked by job task content offshorability index**

Index ranking	Occupation title	Employment May 2005	Median annual earnings May 2005 (US$)	Percent w/ HS diploma or less	Percent w/ BA or higher	Tradable by geographic concentration	Index value	Index class	SOC code
1	Mathematical Technicians	1,430	36,470			1	1.777	3	152091
2	Biochemists and Biophysicists	17,690	71,000			1	1.510	3	191021
3	Statisticians	17,480	62,450	0.0	100.0	1	1.309	3	152041
4	Title Examiners, Abstractors, and Searchers	64,580	35,120	57.4	2.1		1.304	3	232093
5	Credit Authorizers, Checkers, and Clerks	65,410	29,330	44.1	34.5	0	1.030	3	434041
6	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	79,050	25,310	61.0	0.0	0	1.026	3	435111
7	Data Entry Keyers	296,700	23,810	77.7	0.7	0	1.016	3	439021
8	Accountants and Auditors	1,051,220	52,210	2.0	92.2	1	1.010	3	132011
9	Medical Transcriptionists	90,380	29,080	34.3	0.4	0	0.999	3	319094
10	Actuaries	15,770	81,640	0.0	100.0	1	0.981	3	152011
11	Market Research Analysts	195,710	57,300	0.0	60.5	1	0.928	3	193021
12	Astronomers	970	104,670	0.0	100.0	1	0.923	3	192011
13	Bookkeeping, Accounting, and Auditing Clerks	1,815,340	29,490	21.5	18.0	1	0.915	3	433031

14	Mechanical Drafters	74,650	43,350	0.0	0.0	0	0.909	3	173013
15	Economists	12,470	73,690	0.0	100.0	1	0.905	3	193011
16	Mathematicians	2,930	80,920	0.0	100.0	1	0.905	3	152021
17	Sociologists	3,500	52,760	0.0	100.0	1	0.905	3	193041
18	Operations Research Analysts	52,530	62,180	0.0	100.0	1	0.886	3	152031
19	Survey Researchers	21,650	31,140			1	0.883	3	193022
20	Credit Analysts	61,500	50,370	29.3	56.8	1	0.881	3	132041
21	Payroll and Timekeeping Clerks	205,600	31,360	42.3	8.4	0	0.873	3	433051
22	Cartographers and Photogrammetrists	11,260	48,250	14.9	29.5	0	0.840	3	171021
23	Statistical Assistants	18,700	28,950	2.2	62.0	0	0.828	3	439111
24	Paralegals and Legal Assistants	217,700	41,170	10.9	29.1	1	0.809	3	232011
25	Geographers	810	63,550	0.0	100.0	1	0.802	3	193092
26	Computer Systems Analysts	492,120	68,300	1.1	64.1	1	0.773	3	151051
27	Financial Examiners	22,160	63,090	2.2	94.9	1	0.755	3	132061
28	Petroleum Engineers	14,860	93,000	0.0	100.0	1	0.753	3	172171
29	Budget Analysts	53,510	58,910	0.0	96.4	1	0.742	3	132031
30	Court Reporters	17,130	41,640	0.8	4.1	1	0.734	3	232091

Table 8.7 **Least offshorable: Bottom 30 occupations, ranked by job task content offshorability index**

Index ranking	Occupation title	Employment May 2005	Median annual earnings May 2005 (US$)	Percent w/ HS diploma or less	Percent w/ BA or higher	Tradable by geographic concentration	Index value	Index class	SOC code
428	First-Line Supervisors/Managers of Fire Fighting and Prevention Workers	53,490	60,840	55.5	4.7	0	–1.390	1	331021
429	First-Line Supervisors/Managers of Retail Sales Workers	1,083,890	32,840	93.1	2.7	0	–1.412	1	411011
430	Amusement and Recreation Attendants	232,030	15,920	97.8	1.9	0	–1.421	1	393091
431	Cooks, Short Order	203,350	17,230	99.9	0.0	0	–1.449	1	352015
432	Wholesale and Retail Buyers, except farm products	132,900	42,870	63.0	15.4	1	–1.475	1	131022
433	Coaches and Scouts	145,440	25,990	0.7	91.1	0	–1.479	1	272022
434	Respiratory Therapy Technicians	22,060	38,200			0	–1.493	1	292054
435	Musicians and Singers	50,410		26.3	41.4	1	–1.500	1	272042
436	Chefs and Head Cooks	115,850	32,330	58.5	4.7	1	–1.502	1	351011
437	Transportation Attendants, except Flight Attendants and Baggage Porters	24,810	19,290			0	–1.506	1	396032
438	Bartenders	480,010	15,850	74.6	0.4	0	–1.508	1	353011
439	Craft Artists	4,300	22,430	51.5	18.2	1	–1.528	1	271012

440	Lifeguards, Ski Patrol, and other recreational protective service workers	107,620	16,910	94.1	0.6	0	–1.544	1	339092
441	Dancers	16,240		81.5	15.5	1	–1.578	1	272031
442	Choreographers	16,150	32,950	40.0	40.0	1	–1.585	1	272032
443	Animal Trainers	8,320	24,800	65.1	5.3	0	–1.585	1	392011
444	Self-Enrichment Education Teachers	141,650	32,360	31.7	38.4	0	–1.607	1	253021
445	Child Care Workers	557,680	17,050	62.9	15.0	0	–1.617	1	399011
446	Models	1,430	22,700			1	–1.620	1	419012
447	Preschool Teachers, except Special Education	348,690	21,990	43.1	16.9	0	–1.626	1	252011
448	Fitness Trainers and Aerobics Instructors	189,220	25,840	59.1	22.6	1	–1.646	1	399031
449	Surgical Technologists	83,680	34,830	15.3	9.0	0	–1.681	1	292055
450	Crossing Guards	69,390	20,050	96.4	0.0	0	–1.709	1	339091
451	Massage Therapists	37,670	32,890	10.2	24.7	0	–1.719	1	319011
452	Gaming Dealers	82,320	14,260	87.5	0.0	1	–1.753	1	393011
453	Actors	59,590		60.2	11.9	1	–1.890	1	272011
454	Manicurists and Pedicurists	42,960	18,280	57.1	0.0	0	–1.962	1	395092
455	Hairdressers, Hairstylists, and Cosmetologists	338,910	20,610	6.0	0.0	1	–1.981	1	395012
456	Flight Attendants	99,590	46,680	48.2	16.8	0	–2.065	1	396031
457	Barbers	13,630	21,760	27.1	0.0	0	–2.210	1	395011

Table 8.8 **Share of occupational employment by offshoring index, by major occupation group, May 2005 employment totals**

SOC two-digit code	Description	Index class 1	Index class 2	Index class 3
11	Management	11.4	73.6	15.1
13	Business/financial operations	8.6	16.7	74.7
15	Computer/mathematical	0.0	6.6	93.4
17	Architecture/Engineering	0.9	18.2	80.8
19	Life, physical, social sciences	9.1	14.9	75.9
21	Community/social services	55.1	44.9	0.0
23	Legal	0.0	60.9	39.1
25	Education and library	43.7	52.4	3.9
27	Arts, design, entertainment	37.6	48.2	14.2
29	Health care practitioners/technicians	78.0	18.5	3.5
31	Health care support	94.4	2.8	2.8
33	Protective service	93.2	5.3	1.5
35	Food preparation/serving	100.0	0.0	0.0
37	Building maintenance	94.0	6.0	0.0
39	Personal care service	99.4	0.6	0.0
41	Sales and related	46.3	48.4	5.2
43	Office/administrative support	1.6	34.1	64.3
	All occupations	43.8	28.9	27.4

Source: O*Net.

occupations, 48 percent of the occupations classified as nontradable using the economic concentration measure are also classified as nontradable using the job task content measure. Similarly, 55 percent of the most tradable occupations, by Gini, are most tradable by job task content.

An alternative measure of fit simply counts the number of geographically concentrated tradable occupations within each task content class. In the highest task content class (most tradable/offshorable by task content), 51.6 percent of those occupations are tradable by geographic concentration. In the middle task content class, 35.6 percent of occupations are tradable by the first of our measures, and in the lowest (least offshorable/tradable) task content class, 21.2 percent of occupations were previously denoted tradable by geographic concentration.

Potential offshorability and skill is of interest. The O*Net data offer information on educational attainment, based on Bureau of Labor Statistics (BLS) data on fractions of jobholders with varying levels of education. Tables 8.6 and 8.7 offer two categories: percent with a high school diploma or less and percent with a Bachelor of Arts (BA) degree or more. Using the BA category, the rank correlation between educational attainment and relative offshorability, calculated from the full ranking of occupations, is +0.306—occupations with a greater share of BA holders are more highly ranked as offshorable. The top quartile of jobs in the ranking has a mean per-

centage of BA+ degree holders of 61 percent; the second quartile, 53.7 percent; the third quartile, 47.3 percent; and the bottom quartile, 29.1 percent. The least offshorable jobs are the least formally educated and have lower median annual earnings.

We have located just two other analyses that order occupations by an assessment of offshorability. Consistent with its organizational interest in occupational growth projections, the Bureau of Labor Statistics has developed a list of forty detailed occupations deemed "susceptible to a significant risk of offshoring" (United States Department of Labor 2006, 12). Of these forty occupations, thirty-nine are services occupations (the exception is aircraft mechanics and service technicians). With varying degree of "fit," thirty-eight of these thirty-nine occupations are noted for their offshorability by our index. Graphic designers and switchboard operators are included in the BLS list, with our index ranking these two occupations close to the middle of the 457. All the rest of the BLS occupations are fairly highly ranked by our index. The BLS list is not ranked; it is simply offered as a list of susceptible occupations, presumably with some more susceptible than others.[15]

Blinder (2007) explores a subjective index based on two characteristics: (a) can the work be delivered to a remote location, and (b) must the job be performed at a specific (U.S.) location? In his subjective measure, Blinder concentrates on one characteristic of the delivery of services, the separation of customer and supplier that he labels "impersonally-delivered services." Basically, impersonally-delivered services can be delivered electronically, incorporating the vast improvement in Information and Communication Technologies (ICT). His measure does not incorporate any attributes related to the kind of work sent down the wire, such as information content or Internet enabled. Most importantly, in terms of the area of traditional U.S. comparative advantage, Blinder does not consider the creativity or routineness of work.[16] In an area that needs more exploration, there are many high-skill and high-value (creative) services, that while transmittable electronically, pose opportunities for American workers and firms to penetrate foreign markets.

Using both production and nonproduction occupations, Blinder estimates that thirty to forty million workers are currently in potentially tradable jobs, based on May 2005 employment levels. Objective measures may well be preferred, given the number of occupations (> 450) and desire for replication.

15. The BLS methodology is similar in spirit to ours, considering characteristics of digital transmission, repetitive tasks, and little face-to-face interaction. Occupational analysts provided judgments on these characteristics. Further refinements included excluding occupations where technology or automation could account for a dampening of employment growth. See U.S. Department of Labor (2006).

16. The routineness of work, or the codification of tasks, is a characteristic emphasized by Autor, Levy, and Murnane (2003).

Drawing a line in our full ranking of services occupations, between offshorable and not offshorable, is admittedly arbitrary. One starting point, entirely subjective, draws a line around the offshore rank of 236 (Real estate brokers) and suggests 38 million potentially offshorable jobs; 55 million not (below the line).[17]

Our focus here is on services occupations. One natural question is where the other major occupational groups lie within this ranking. The average Production occupation, with an index value of –0.310, lies at rank 214, just below Sales Engineers. The average Farming, Forestry, and Fishing occupation, with an index value of –0.441, lies at rank 238, just below Hotel, Motel, and Resort Desk Clerks. Similarly, the average Transportation and Material Moving Occupation, with index value –0.456, lies at rank 247, just below Psychiatric Technicians. Finally, Installation, Maintenance, and Repair Occupations, with an average index value of –0.568, lies at rank 269, just below Nursing Instructors.

8.4.1 Robustness and Limitations of Our Methodology

We conducted two robustness checks of our weighting scheme. In the first, we dropped the two routine/creativity measures. These two measures may be noisy proxies for the task characteristics of "highly codified" and "nonroutine." Dropping the two measures produced a ranking that was highly correlated with our preferred index, with both the rankings and the value of the indices correlated at a level of 0.92.

In a second set of robustness checks, we tried different weights on importance and level. We use two alternatives: a more neutral weighting scheme of 50–50, and another where the weights were .75 on level and .25 on importance (the reverse of our preferred index). Our results are quite robust to weights. The value of the indices is correlated at a level of .98 and the rankings produced are virtually similar, where occupations are within 1 to 3 places of each other across indices (if different).

Our index is objective in the sense of producing a ranking that we simply report; we make no additional judgments, of a subjective nature, about any individual occupation. We do not use any additional information to change the ranking from that generated by our weighting of the individual components. Clearly, our choice of job task characteristics to include in the index is subjective, as it is based on our reading of the general discussion of offshoring. Our goal is to produce a ranking that can be reproduced or challenged in future research by considering a broader range of factors.

17. In May 2005, employment in the major occupational groups of interest here, SOC 11–43, summed to 98.3 million. Due to some data limitations, our analysis sample of services occupations sums to an employment level of 93 million. Total nonfarm employment was 130.3 million in May 2005.

8.5 Conclusions

In previous work we developed a measure of tradability based on the geographic concentration of production. In this chapter we offer a second measure of tradability, built from common notions of job characteristics related to offshorability. We find a selection of tradable occupations do indeed have characteristics of offshorability (Internet enabled, high information content, no face-to-face customer contact). The calculated index of offshorability offers strong potential for understanding jobs (tasks) at risk. The two measures of tradability and offshorability offer a combined potential to do the same. These two measures have their weaknesses, and it makes good sense to proceed in this area with a portfolio of indicators, for which we now have two items, rather than any one measure alone.

There is an important question of timing of potential offshoring, which is largely an unknown. It is clear that advancing technology will continue to increase the feasibility of providing services from remote locations. For now and perhaps the foreseeable future, however, most high-value work will require creative interaction among employees, interaction that is facilitated by physical proximity and personal contact. Moreover, in many fields, closeness to customers and knowledge of local conditions are also of great importance. The "how soon" question is very important for understanding the potential costs of adjustment. A process that takes twenty years to establish itself on a real scale allows for more adjustment than offshoring over a five-year period.

In our earlier paper, we provided evidence that service activities employ workers with higher education and more skill than nontradable (service) activities and manufacturing. Our results here are consistent, with higher average levels of educational attainment for the most highly-ranked occupations. This seems to suggest that tradable services are consistent with U.S. comparative advantage in high skill production. Unlike Blinder's view that only personally delivered services are likely to stay in the United States, we consider it important to understand how tradable services can be consistent with U.S. comparative advantage. With the expectation that as technology and policy allow for more trade in these activities, the United States should gain world market share in these activities, not lose it.[18] In this spirit, we note that the components of our index are not intended to convey strong priors about the direction of trade; that is, whether services are likely to be offshored or inshored. The occupations at the top of our list, with some of the highest levels of educational attainment, may well be those where tradability leads to inshoring and export potential.

18. Though over the longer-term, if the United States ceases to make investments in education and training, it is possible that it would cease to have comparative advantage in high-skill activities.

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Comment

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I enjoyed reading this installment in Brad Jensen and Lori Kletzer's research to understand implications of offshoring service activities for U.S. labor markets. This chapter builds on their earlier work that introduced a creative new approach for measuring tradability in services. They use domestic geographic concentration by industry and occupation to identify which service activities are traded domestically, inferring that these activities also have the potential to be traded internationally—that is, to be vulnerable to offshoring. In this chapter, they take a sensible step toward addressing some of the criticisms of their initial indicators by combining the geographic concentration metrics with indicators about the task content of service activities. Although still subject to shortcomings, some of which I will discuss later, this innovative and informative research makes a valuable contribution to the services offshoring literature. In my comments, I will briefly describe the broader context so as to highlight their contribution, discuss some concerns with the methodology, and outline some additional issues I hope the authors will consider in future work.

A few years ago there was a surge of fear about service jobs moving abroad. Widely publicized stories suggested that a substantial share of the American workers in services, who had not previously considered their jobs to be tradable, may be swimming in the same sea of competition as their counterparts in manufacturing, with low-wage foreign workers. While these fears abated somewhat as unemployment rates declined, the recent deterioration in U.S. economic performance has brought them back to center stage.

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