

How Many U.S. Jobs Might Be Offshorable?

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Abstract: Using detailed information on the nature of work done in over 800 BLS occupational codes, this paper ranks those occupations according to how easy/hard it is to offshore the work—either physically or electronically. Using that ranking, I estimate that somewhere between 22% and 29% of all U.S. jobs are or will be potentially offshorable within a decade or two. (I make no estimate of how many jobs will actually be offshored.) Since my rankings are subjective, two alternatives are presented—one is entirely objective, the other is an independent subjective ranking. It is found that there is little or no correlation between an occupation’s “offshorability” and the skill level of its workers (as measured either by educational attainment or wages). However, it appears that, controlling for education, the most highly offshorable occupations were already paying significantly lower wages in 2004.

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To date, more political heat than intellectual light has been shed on the phenomenon that has come to be called “offshoring,” that is, the migration of employment from the U.S. (and other rich countries) to other (mostly poorer) countries.¹ This unfortunate situation may be inevitable, given the political sensitivity of the subject and the thinness of the factual base.² For example, no one really knows how many U.S. jobs have been offshored to date, although the patchy evidence seems to point to a small number outside of manufacturing.³ Naturally, we know much less about the *potential* for offshoring in the future.

It would be nice to know more—or at least to have some reasonable ballpark estimates. For example, the implications for public policy are likely quite different depending on whether offshoring will eventually affect 3 million American jobs or 30 million. A few guesstimates of the number of jobs that might be vulnerable to offshoring have been made; several are discussed below. But they are rough, reach disparate conclusions, and are typically not comprehensive—that is, they do not cover the totality of jobs. This paper remedies the last of these three shortcomings and, hopefully, at least mitigates the first two.

More specifically, and subject to many caveats that will be developed later, this paper provides a ranking of all occupations in the 2004 U.S. workforce by their “offshorability.” It then uses this index to offer several new, and hopefully more accurate, estimates of the number of jobs that are *potentially* vulnerable to offshoring. It also

¹ To clarify terminology which is often confused, “offshoring” refers to movement of jobs to other countries, whether or not that movement is within the same firm or to a different firm. In the latter case, it is also “outsourcing,” but much outsourcing is purely domestic.

² Regarding some of the politics, see Mankiw and Swagel (2006). Regarding the lack of data, see for example National Academy of Public Administration (2006) or Sturgeon *et al.* (2006).

³ See, for example, the compendium of estimates in National Academy of Public Administration (2006), Chapter 4.

shows, as Blinder (2006) had speculated, that the degree of “offshorability” of an occupation has very little correlation with either its educational requirements or its current median wage.

1. Antecedents

In a recent paper (Blinder, 2006), I argued that the migration of service sector jobs from the United States and other rich countries to other (mostly poorer) nations, while a minor phenomenon to date, is likely to become a major one in the coming decades—perhaps extensive enough to constitute a “new industrial revolution.” While the movement of manufacturing jobs abroad is a decades-old story, the phenomenon of *service sector* offshoring is a relatively new wrinkle that has been enabled by two major developments of fairly recent vintage: stunning advances in computerized telecommunications technology (e.g., the Internet), and the entry of several “new” countries (principally India and China) into the global economy since the 1990s, and especially in this decade.

In thinking about the potential for offshoring, I argued, it is critical to distinguish between two very different sorts of services, which I labeled *personally-delivered* (or just “personal”) and *impersonally delivered* (or just “impersonal”). The first category encompasses a bewildering variety of jobs, ranging from janitors and child care workers on the low-wage end to surgeons and CEOs on the high-wage end. Similarly, the second category includes both low-end jobs like call center operators and high-end jobs like scientists. The key attribute on which to focus, I argued, is not the job’s skill or its educational requirements, but rather whether the service “can be delivered [to its end user] electronically over long distances with little or no degradation in quality” (Blinder

(2006), p. 114). Impersonal services like data entry and writing computer code can be so delivered—with ease. Personal services like driving a taxi or arguing a case in court cannot. Thus, in large measure, only impersonal services are tradable—and thus potentially vulnerable to offshoring. Personal services, which require physical presence and/or face-to-face contact with end users, are not

The distinction between personal and impersonal services is closely related to, but not identical to, the one emphasized by Autor, Levy, and Murnane (2003)—namely, how rule-based (and thus how susceptible to computerization) a task is. Other things equal, jobs that can be broken down into simple, routinizable tasks are easier to offshore than jobs requiring complex thinking, judgment, and human interaction. However, there is a wide variety of complex tasks that involve high levels of skill and a great deal of human judgment that can also be offshored with modern telecommunication facilities. Think, for example, of statistical analysis, computer programming, manuscript editing, and security analysis, to name just a few. I believe the personal/impersonal distinction is more germane to the offshoring issue than is the question of routinizability—although the two criteria overlap quite a bit.⁴

Of course, the distinction between personal and impersonal services is really a continuum, not a sharp dichotomy. Data entry may fall at one extreme (completely impersonal) while child care falls at the other (completely personal), but in between lies a long list of occupations that fall at neither pole. For example, the services of an architect or a college professor probably *can* be delivered electronically over long distances; but we believe that the quality of those services is degraded notably when that happens. The central objective of this paper is to create an empirical counterpart to the conceptual

⁴ For more on this debate, see Blinder, Levy, and Murnane (2006).

continuum, and then to use that continuum to estimate the *potential outer limits* of offshoring. Precisely where to draw the line between jobs that are too personal to be moved offshore and those that are not is far from clear, however. So several alternatives will be presented. But one thing is certain. Since information and communications technology (ICT for short) keeps getting both better and cheaper, the scope for offshoring will increase inexorably. Wherever we draw the line this year, it will be further out next year.

In Blinder (2006, pages 120-122), I was either brave or foolish enough to offer a “ballpark figure of the number of U.S. jobs threatened by offshoring” (p. 120). The reason was simple, and was stated in the introduction: The appropriate policy responses (if any) to this problem probably depend on how many jobs might be susceptible to offshoring. My brave-but-crude guesstimate of the number of potentially offshorable jobs was 42-56 million, of which 14 million are in manufacturing and 28-42 million (a large range, to be sure) are in the various non-manufacturing (“service,” for short) sectors. In round numbers, the total represents roughly 30-40% of all the jobs in the United States at present.⁵ That is a very large number. But remember that I was guesstimating the number of jobs that *might* be *offshorable*, not the number that actually *would* be *offshored*. For a wide variety of reasons, the latter will surely be much smaller than the former--just as millions of production jobs in manufacturing are still located in the United States despite decades of offshoring. One main purpose of this paper is to reassess and refine my original crude guesstimate. In so doing, I ask whether a number as large as 30-40% of the U.S. workforce is at all believable.

⁵ The 30-40% figure includes manufacturing jobs. The *service* jobs that are potentially vulnerable to offshoring amounted to about 20-30% of total U.S. employment in 2004.

There are several reasons to wonder. First, I based the crude offshorable/non-offshorable classification only on the *industry* of employment. For example, I judged educational and health care services to be mostly immune to offshoring, while manufacturing jobs are vulnerable. In some cases, that is sound reasoning—e.g., political considerations make government jobs highly unlikely to be offshored. But in many other cases, the offshorability of a job depends much more on the *occupation* than on the industry. For example, I believe I was correct to classify the health-care sector as mostly non-offshorable. After all, very few doctors and even fewer nurses will ever see their jobs performed from abroad (or so I assume).⁶ But there are a number of specific services within the vast health-care sector that can be, and to some extent already have been, offshored. Think, for example, of medical transcription, handling health-care records, and processing health insurance claims. At the other end of the spectrum, I made the standard assumption that essentially all manufacturing jobs are potentially offshorable. However, the jobs of top managers and their close assistants are probably not in much danger of moving offshore. Nor are most jobs in advertising, sales, and marketing. The offshorability of a particular job, it seems to me, depends much more on the *occupation* than on the *industry* of employment—which is how I approach the question in this paper.

Second, I made no effort in Blinder (2006)--and no pretense--to be precise. For example, I used only the coarsest one-digit industrial classification. A more serious estimate needs to dig much deeper into the details. In this study, I use six-digit occupation codes, as explained below.

⁶ See Levy and Yu (2006) for a discussion of offshoring of radiology, which they view as an urban myth.

Third, a number of other studies of the potential for offshoring have yielded quite different, and often much lower, estimates than mine.⁷ For example:

- A series of well-publicized studies by Forrester Research, beginning in 2002, predicted that about 3.4 million U.S. service jobs would be lost to offshoring by 2015.⁸

That is a very small number in a workforce of over 140 million jobs. Notice however that, unlike my estimates or those that follow, Forrester's is projecting *actual offshoring*, not *potential offshorability*. The latter is a multiple of the former.

- A well-known paper by the McKinsey Global Institute (2005), based on detailed studies of eight "representative sectors" in rich countries around the world, estimated that only about 11% of *worldwide* private-sector service employment might potentially be offshored to developing countries within about the next five years. On their basis (excluding government service jobs), my earlier estimate would translate to about 31-47% of U.S. private-sector service jobs—three or four times as much. That's quite a discrepancy. Notice, however, three features of McKinsey's estimates. First, their time frame is only five-years; I think we need to look ahead much further than that (more on this below). Second, their analysis applies only to job losses to *developing* countries (a minor point). Third, they included rich countries from around the world, while I believe the potential for offshoring is substantially greater in English-speaking countries than in non-English-speaking countries. Each of these adjustments leads to a lower estimate. But, all that said, the gap between McKinsey's 11% and my 31-47% seems far too great to be explained away by such "details."

⁷ Such differences are, of course, hardly surprising when one is *speculating* about the *future* rather than analyzing data on the past.

⁸ See, for example, McCarthy (2004).

- Looking at occupations rather than at industries, Bardhan and Kroll (2003) estimated that about 11% of *all U.S.* jobs in 2001 were vulnerable to offshoring. This 11% figure compares directly to my 30-40%. One main reason for the large difference is that Bardhan and Kroll restricted themselves to “occupations where at least some [offshore] outsourcing has already taken place or is being planned” (p. 6). In my view, service-sector offshoring is in its infancy at present, and is mostly a prospective phenomenon. We must look ahead.
- Jensen and Kletzer (2006) employed a creative but questionable methodology that used geographical concentration in the United States to estimate how “tradable” each occupation was in 2000. (I will have more to say about this methodology below.) They estimated that 38% of U.S. workers were in “tradable occupations”—a number that is very close to my high-end estimate of 40%.
- Van Welsum and Vickery (2005) based their estimates of offshorability for a variety of OECD countries on the intensity of use of ICT by industry. Their estimate for the U.S. in 2002 was about 20% of total employment.

2. Ground Rules

This paper seeks to sharpen my previous--admittedly crude--estimate of potential offshoring of U.S. employment. But before going further, I need to clarify some of the ground rules.

First, *the task is to estimate the number of jobs that are potentially offshorable*, meaning that Americans performing those jobs face potential competition from, say, Indian or Chinese workers. As just suggested, only a fraction of these offshorable jobs will actually be offshored.

Second, I am trying, in a loose sense, to *forecast offshorability some unspecified number of years into the future*, perhaps a decade or two. As mentioned earlier, we can be quite confident that ICT will continue to improve year after year. It also seems a safe bet that the number of well-qualified workers in China, India, and elsewhere who are effectively integrated into the global economy will increase dramatically over time. For example, while there are already reports of shortages of Indian workers with the skills required by such industry leaders as Infosys, Tata Consulting, and Wipro (and consequent upward pressure on wages), the number of Indians who can in principle be trained for such jobs over the next two decades is enormous. So we clearly need to look ahead rather than to focus myopically on the present.

Third, however, the projections that underlie this paper are based on what might be called *extrapolating normal technological progress*, not on any breakthrough technologies that are highly conjectural at this point. More concretely, I assume that the electronic communications technologies we have today (telephone, Internet, video conferencing, voice recognition systems, etc.) will improve steadily, and perhaps dramatically, over time. But I assume that we do *not* experience dramatic breakthroughs into areas and methods not presently foreseen—no “beam me up, Scott,” if you will. For example, one day Princeton students may get their Economics 101 lectures from a true-to-life hologram of a professor who is actually in Bangalore, where he earns a fraction of my salary. While that strikes me as within the realm of the possible, I certainly don’t know that it will ever happen. So, for purposes of this paper, I assume that college teaching (and many other such) jobs are *not* offshorable. This example and others like it illustrate one important respect in which the estimates of offshorability in this paper,

large as they are, are actually conservative. We know that some college teaching is delivered by television already. With better ICT, why can't the broadcast originate in India?⁹ But I assume it will not.

Fourth, and in a similar vein, I make no attempt to forecast future changes in the occupational distribution of U.S. employment—even though we know there will be some large ones. For example, while the BLS projects that total U.S. employment will grow by 13% from 2004 to 2014, its projected growth rates across the major occupations—which I define arbitrarily as those employing at least 250,000 people in 2004—range from over 50% (e.g., home health aids and medical assistants) to as low as -36% (e.g., file clerks and sewing machine operators).¹⁰ But I ignore such projections and *focus on the mix of jobs that actually existed in 2004*. So the specific question addressed in this paper is this: How many of the 2004 U.S. jobs are or might become potentially offshorable within, say, a decade or two?

Fifth, this paper creates and presents a two-digit “offshorability” index number for each of 817 occupations. But *the scale is ordinal, not cardinal*. For example, by assigning an index number of 100 to keyboard data entry and an index number of 95 to medical transcription, I do *not* mean to imply that transcription is 5% less offshorable than data entry--whatever that might mean. I only mean to assert that data entry is *more* offshorable than medical transcription. The reader should therefore not think that, say, the “distance” between 95 and 100 is, in any meaningful sense, smaller than the distance between 95

⁹ This particular example is also driven by Baumol's disease. The relative cost of delivering higher education is rising year after year, which will force colleges and universities into an increasingly desperate search for cost-saving innovations.

¹⁰ The BLS employment projections can be found at www.bls.gov.

and 87. Nor should such numbers be interpreted as probabilities that various occupations will in fact be offshored.¹¹

Sixth, and finally, the rankings presented below are largely *subjective rather than objective*. I would have preferred, and originally set out to create, a purely objective ranking—as Kletzer (2006) did. But I concluded that this was impossible to do in any sensible way. Nonetheless, as a point of reference, I present an alternative, purely objective, ranking of occupations in Section 5, where I compare it with my preferred subjective ranking. As will be seen, the correlation between the two is quite low.

This last issue merits further explanation. Subjective rankings have some obvious and serious shortcomings. Among the most important of these are the facts that subjective judgments are probably not replicable, and that they run the danger that the analyst might (even subconsciously) rig the data to conform to his or her beliefs. So I started out by trying to use the O*NET data (described in the next section) to develop a strictly objective index of offshorability—meaning that, whatever subjective judgments might go into it, at least they were not mine. I even had a role model for this task: Kletzer’s (2006) creative attempt to use geographical concentration of employment to measure how “tradable” each occupation is. But I quickly encountered two huge problems.

One was that Kletzer’s mechanical classification procedure leads to some results that are plainly wrong, if not indeed bizarre—the sorts of decisions that “only a computer could make.” For example, lawyers and judges rank among her most tradable occupations (rated “96% tradable,” just below computer programmers); and even such demonstrably

¹¹ In principle, I would like to generate such probabilities based on actual offshoring to date. But the available data on offshoring are too scant to support such probability estimates, even if the underlying environment was stationary—which it is not.

non-tradable occupations as farmer and postmaster are ranked as “65% tradable.”¹² At the other end of the spectrum, her objective procedure classifies such eminently offshorable occupations as data entry keyers, telephone operators, and billing clerks as virtually impossible to move offshore (“7% tradable”).¹³ I point out these examples not to criticize Kletzer, whose approach is both clever and objective, but to illustrate the kinds of results that a mechanical procedure—devoid of human judgment--can produce.

My own hopes of using the job descriptions in the O*NET database to create a more reasonable objective ranking of occupations were quickly dashed by considerations such as the following. Two key defining characteristics of jobs that cannot be offshored are (a) that the job must be performed at a specific U.S. work location (e.g., working on a farm or at an amusement park) and (b) that the job requires face-to-face personal communication and/or contact with end users of the service (e.g., a taxi driver or a surgeon). Regarding the latter, one of the many “work activities” included in the O*NET database (explained further below) is “communicating with persons outside the organization.” That sounds promising—until you realize that such communication can be “in person, in writing, or by telephone or email,” and that O*NET rates this work activity as an important component of such highly-offshorable jobs as editor and telemarketer. A human being, of course, understands that communications with an editor are most likely to be via email and communications with a telemarketer are certainly telephonic. A computer does not.

¹² In my *subjective* 0-100 ranking of offshorability, computer programmers and data entry keyers are the two most offshorable occupations (rating = 100). Lawyers, judges, farmers, and postmasters are all rated completely non-offshorable (rating 25 or below).

¹³ On my subjective scale, telephone operators are given a 95 and billing clerks a 90.

For these reasons and others, I decided that there was no reasonable alternative to a subjective, judgmental ranking of “offshorability.” However, Section 5 nonetheless reports on the attempt (just mentioned) to construct a purely objective ranking. In addition, Section 5 also describes a second, independent subjective ranking, done by an experienced human resources professional. While neither matches my own ranking, the latter comes much closer.

3. Using the O*NET Data to Create an Index¹⁴

The O*NET, an online service developed for (but not by) the U.S. Department of Labor,¹⁵ is the successor to the better-known Dictionary of Occupational Titles, which was last revised in 1991. In the version I used (release 10.0, June 2006), O*NET contains at least partial information on more than 950 U.S. occupations, most of which correspond closely to the Labor Department’s Standard Occupational Classification (SOC). Data were missing for two of the 801 SOC codes and, for reasons to be explained shortly, I added eighteen synthetic occupations by subdividing some of the codes. Thus my database consisted of 817 detailed occupations. The six-digit occupational breakdown is quite detailed in some areas. For example, “Education Administrators” (SOC 11-903) are subdivided into “preschool and child care center/program,” “elementary and secondary school,” “postsecondary,” and “all other.” Secretaries (SOC 43-601) are broken down into “executive secretaries and administrative assistants,” “legal secretaries,” “medical secretaries,” and “secretaries except legal, medical, and executive.”

For each occupation, O*NET offers a short verbal description, a (sometimes lengthy) list of common job titles associated with that occupation, the median hourly wage rate,

¹⁴ Readers uninterested in the details and wanting to get to the results more quickly can skip this section. But I do not encourage that because, as they say, “the devil is in the details.”

¹⁵ Found at <http://online.onetcenter.org>

employment in 2004, the educational attainment of people in that occupation and, most important for my purposes, a wealth of detailed descriptive information on the nature of the job, including:

- *Tasks* typically performed by people in that occupation--a variable number of open-ended categories, specific to each occupation;
- *Knowledge* required by the occupation--in 33 fixed categories; examples: clerical, mathematics;
- *Skills* required by the occupation--in 35 fixed categories; examples: time management, persuasion;
- *Abilities* needed to do the job--in 52 fixed categories; examples: oral expression, stamina;
- *Work activities* that typify the job--in 41 fixed categories; examples: getting information, assisting and caring for others;
- *Work context* in which the job normally is performed--in fixed 57 categories; examples: face-to-face discussions, spend time standing;
- *Interests* of people on that job--in 6 fixed categories; examples: social, artistic;
- *Work styles* that are typical on that job--in 16 fixed categories; examples: persistence, integrity;
- *Work values* in the occupation--in 6 fixed categories; examples: relationships, independence;
- *Work needs* for the job--in 21 fixed categories; examples: variety, authority.

To illustrate how this mass of data was used to assign an index number of offshorability to each occupation, I will use one occupation from each end of the offshorability scale--data entry keyers (index=100) and child care workers (index=0)--as examples. Remember that the central question is whether the service is amenable to electronic delivery and, if so, whether its quality is seriously degraded when so delivered. So, for example, it is literally impossible to deliver child care (which requires close

physical contact) or farm labor (which is tied to a particular geography) over long distance. As mentioned earlier, college teaching probably can be so delivered, but we believe (or is it that *we hope?*) that electronic delivery is vastly inferior to face-to-face delivery. So all of these jobs are classified as highly non-offshorable, that is, assigned indexes near zero. At the other end of the spectrum, keyboard data entry, writing computer code, and answering queries in a call center are naturally and easily delivered electronically with little or no loss of quality. So these jobs are classified as highly offshorable, that is, given indexes at or near 100.

The top-line written descriptions of the two occupations in O*NET tells us, e.g., that the job of a data entry keyer is to “operate data entry device, such as keyboard or photo composing perforator. Duties may include verifying data and preparing materials for printing.”¹⁶ These activities are so clearly offshorable that we need hardly inspect the copious detail that follows. Similarly, the job of a child care worker is described as to “attend to children at schools, businesses, private households, and child care institutions. Perform a variety of tasks such as dressing, feeding, bathing, and overseeing play.” These activities clearly cannot be provided electronically over long distance.

But most occupations are less easily classified, requiring us to peer more deeply into the O*NET database. (Think, for example, of file clerks, customer service representatives, or scientists.) After spending some time studying the various types of data available in O*NET, we concluded that most of the relevant information is to be found under “tasks” and “work activities.”¹⁷ For example, what O*NET classifies as “knowledge” (e.g., knowledge of chemistry), “skills” (e.g., writing), and “abilities” (e.g.,

¹⁶ All such quotations come from pages of the O*NET website.

¹⁷ This is not a royal “we.” My research assistant, Yanliang Miao, and I spent many hours developing and discussing the classifications. His assistance was invaluable.

inductive reasoning), are all quite important to knowing how well-qualified any given person is for a specific occupation. But they are pretty much irrelevant to whether the job can be performed offshore. For example, are jobs requiring good deductive reasoning skills harder or easier to offshore?¹⁸

Although “tasks” and “work activities” sound similar in English, they are quite different in O*NET terminology. Under “tasks,” O*NET describes, in free-form prose, the main things that a person in that occupation does on the job. So, for example, the two top tasks for child care workers are to:

- “Support children’s emotional and social development, encouraging understanding of others and positive self-concepts
- Care for children in institutional setting, such as group homes, nursery schools, private businesses, or schools for the handicapped”

whereas the two top tasks for data entry keyers are to:

- “Compare data with source documents, or re-enter data in verification format to detect errors
- Compile, sort and verify the accuracy of data before it is entered.”

In the O*NET, tasks like these are specific to each occupation, rather than standardized. Thus, the list of 20 tasks performed by child care workers and the list of nine tasks performed by data entry keyers have no elements in common. O*NET “tasks” provide a great deal of useful texture about what actually goes on in each occupation. But because they are not standardized, they do not provide comparable data across occupations.

By contrast, the 41 “work activities” do comprise a standardized list, identical for every occupation, but with dramatically different relative importances (which O*NET

¹⁸ On the criteria employed by Autor *et al.* (2003), such jobs would presumably be rated as harder to routinize and computerize. This illustrates one respect in which their criteria and mine are different. For example, the job of a scientist working for a pharmaceutical company is offshorable but probably not routinizable.

ranks on a 0-100 scale) across occupations.¹⁹ So, for example, “assisting and caring for others” has an importance of 84 for a child care worker, but only 4 for a data entry keyer. On the other hand, “interacting with computers” has an importance of 75 for a data entry keyer, but just 15 for a child care worker. Several of these work activities—whose importances are rated for almost every occupation—carry useful hints about whether the job can or cannot be performed offshore. Some examples of work activities that clearly identify personal, and hence non-offshorable, services are (with the importances of each activity for child care workers versus data entry keyers, respectively, indicated in parentheses): “assisting and caring for others” (84 vs. 4), “establishing and maintaining interpersonal relationships” (68 vs. 25), “coaching and developing others” (49 vs. 0), and “communicating with persons outside the organization” (41 vs. 8).²⁰ We leaned heavily on these and a few other work activities in ranking the offshorability of occupations. The principle was always the same: The more personal a service is, or the more closely tied to a specific geographical location, the harder it is to offshore.

Finally, there is a bit of information to be gleaned from O*NET’s “work contexts,” though not as much as one might think from the English-language word phrase. For example, three of the work contexts are: “contact with others,” “face-to-face discussions,” and “deal with external customers.” All three sound highly germane to the distinction between personal and impersonal services—until you realize that both “contact with others” and “dealing with external customers” can be telephonic, and that “face-to-face discussions” can be with fellow workers rather than with customers. This

¹⁹ The O*NET also reports the *level* of the activity needed for each job—e.g., both editors and order clerks must be able to write, but editors must be able to write at a much higher level. More on this later.

²⁰ Note, however, that much of the communication might be electronic.

illustrates once again why it is so hazardous to construct a purely mechanical index of offshorability.

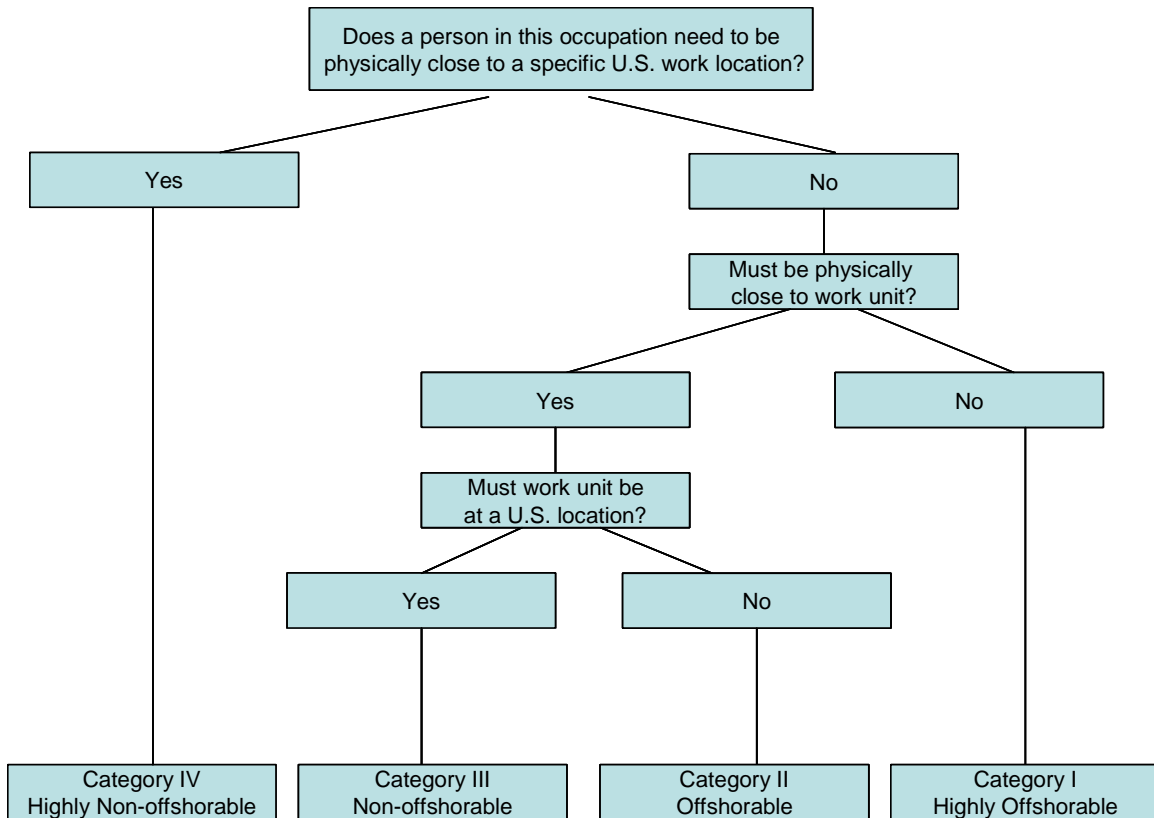
So, instead, we eyeballed the O*NET data on each occupation, paying particular attention to the job description, tasks, and work activities, to assign an admittedly subjective two-digit index number of offshorability to each occupation. We actually did this in two stages.

The first stage is illustrated by the flow diagram in Figure 1. We first asked whether the worker is required to be at a *specific work location in the United States* in order to perform the job—as is the case, for example, for a child care worker, a farmer, an attendant at an amusement park, or a dentist. If the answer was “yes,” we classified that job as “highly non-offshorable,” or in Category IV, and assigned it an offshorability rank between 0 and 25. In everything that follows, all the Category IV jobs, and there were a lot of them,²¹ are treated as virtually impossible to offshore. Doctors, nurses, taxi drivers, and college professors are all placed in Category IV.

If the answer to the first question was “no,” we next asked whether the worker had to be *physically close to his or her work unit*. For example, a factory worker must be in the factory, whether that factory is in the U.S. or abroad. But a proofreader or an editor can work virtually anywhere; in particular, he or she need not be at the publisher’s offices or printing plant. If the answer to this second question was “no,” we classified the job as “highly offshorable,” or in Category I, and assigned it an offshorability index between 76 and 100. So, for example, data entry keyers, computer programmers, reservation agents, actuaries, and mathematicians all fall in Category I.

²¹ Specifically, 533 occupations out of the total of 817.

FIGURE 1
The Four Broad Occupational Categories



Those were the easy cases. If the job required workers to be physically present with their work units (e.g., a factory worker must be in the factory), we next asked *whether the entire work unit had to be in the United States*. If the answer was “yes,” we classified that job as “non-offshorable,” or in Category III, and assigned it an offshorability rank between 26 and 50. So, for example, shipping clerks, radio and TV announcers, and oil field workers all fell into Category III. But if the answer was “no,” meaning that the whole work unit could be moved abroad, we classified the job as “offshorable,” or in Category II, and assigned a rank between 75 and 51. Prominently, almost all factory jobs fall into Category II, as do physicists, artists, medical technologists, and credit analysts.

Table 1 summarizes the four broad offshoring categories, indicating the number of SOC occupations and the number of workers (in 2004) in each. Notice that a majority of both U.S. occupations and U.S. workers fall into Category IV, and thus, for purposes of this paper, are classified as totally immune to offshoring.²² Similarly, only a small minority of jobs and employment fall into Category I, the easiest-to-offshore category. The interesting cases come in Categories II and III—which, in total, comprise 22.6% of the U.S. workforce. That is where the dividing line must be drawn.

Table 1
The Four Main Occupational Categories

Category	Description	Number of Occupations	Number of Workers (millions)	Offshorability Index
I	Highly offshorable	59	8.2	100-76
II	Offshorable	151	20.7	75-51
III	Non-offshorable	74	8.8	50-26
IV	Highly non-offshorable	533	92.6	25-0
All		817	130.3	100-0

The next step was to assign a specific two-digit number to each occupation in Categories I, II, and III.²³ As suggested already, we based these rankings on our own knowledge of what makes a service personal and on information relevant to that point found in the O*NET database. In particular, several of the O*NET work activities mentioned earlier suggest a strong need for face-to-face contact with end users. O*NET also rates the importance of these activities (and others) to the occupation. When O*NET assigned high importance to work activities that define personally-delivered services, we

²² Recall that I rule out breakthrough technologies that might make, for example, college teaching offshorable. Also note that, in calling these occupations “totally immune” to offshoring, I am considering only direct effects. No occupation is immune to indirect effects that work through, e.g., changes in relative wages and employment patterns.

²³ We did not bother to assign numbers to the occupations classified in Category IV because these inherently-domestic jobs are not treated as potentially offshorable under *any* definition.

gave that occupation a low ranking on the 0-to-100 offshorability scale. To illustrate our procedures, consider two occupations with which most readers will have at least some vague familiarity: financial analysts and sales managers.

O*NET lists the following as the three most important “tasks” that financial analysts perform on the job. (I abbreviate slightly)

- “Assemble spreadsheets and draw charts and graphs, using computer.
- Analyze financial information to produce forecasts for use in making decisions.
- Maintain knowledge and stay abreast of developments.”

These and other items that rank high on O*NET’s list do not suggest much need for physical presence. But, as mentioned earlier, work activities are more useful because they are directly comparable from one occupation to another.

According to O*NET, the five most important work activities for financial analysts (with importances in parentheses) are: analyzing data or information (96), getting information (94), interacting with computers (92), processing information (92), and communicating with supervisors, peers, or subordinates (87). None of these are hallmarks of personal services. And the work activities that point most strongly toward face-to-face interactions--like establishing and maintaining interpersonal relationships (84), coordinating the work of others (62), selling or influencing others (62), assisting and caring for others (40), and performing for or working directly with the public (28)—are assigned lower importances. On this basis, we assigned an offshorability index of 76 to financial analysts, placing this occupation right at the borderline of Categories I and II. In consequence, financial analyst jobs will be rated as potentially offshorable under any reasonable definition.

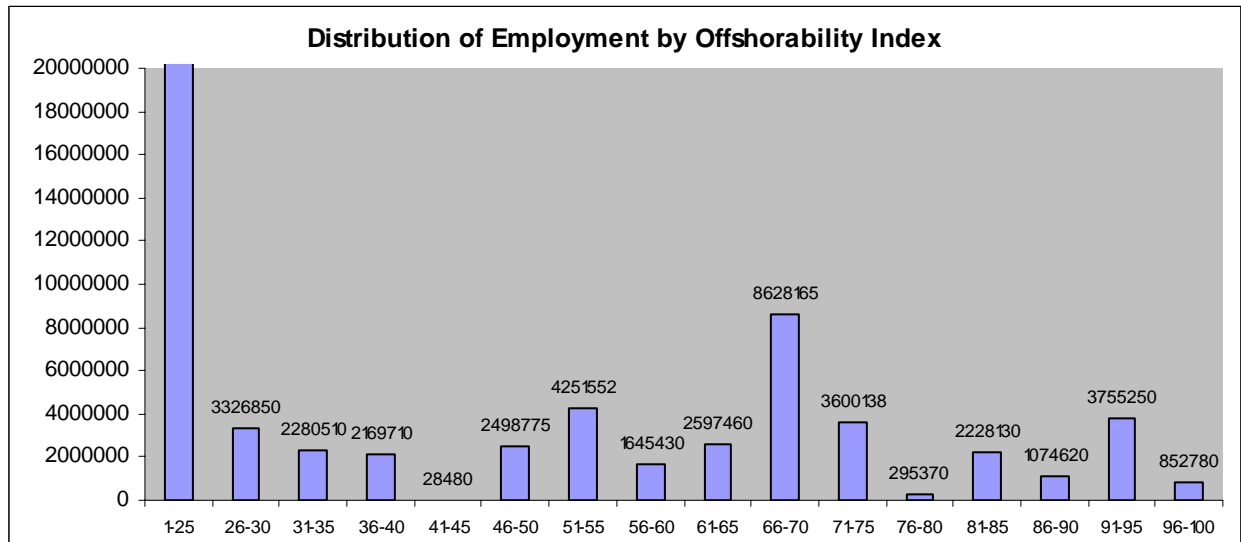
Now turn to sales managers. The three top O*NET tasks are:

- “Resolve customer complaints
- Monitor customer preferences to determine focus of sales efforts.
- Direct and coordinate activities involving sales”

which do suggest some advantage to face-to-face contact. And the top five work activities are: communicating with persons outside the organization (86), organizing and prioritizing work (86), communicating with supervisors, peers, or subordinates (85), interacting with computers (85), and making decisions and solving problems (85). This list does not give us clear guidance. But some of the most clearly personal work activities—like establishing and maintaining interpersonal relationships (84), selling or influencing others (78), guiding, directing, and motivating subordinates (74), performing for or working directly with the public (74), and assisting and caring for others (49)--are ranked as important for sales managers by O*NET. On this basis, we assigned sales managers an offshorability index of 26, which put them right at the borderline of Categories III and IV. Only an extremely aggressive definition of offshorability will deem this occupation to be offshorable.

Just a few more explanatory remarks are in order before I display the results. First, to create a kind of benchmark, we ranked a “standard manufacturing job” as 68. The consequence of this arbitrary decision is that there is a notable spike in the frequency distribution of the index in the 66-70 range, as is apparent in Figure 2.

FIGURE 2



Second, rather than assign a single rank to every job in some of the big and diverse occupations, I divided several of them up. Customer Service Representatives (SOC code 43-4051; 2004 employment = 516,925) constitute a good example.²⁴ Some customer reps do their work over the telephone or computer, while others are required to travel extensively for face-to-face meetings with customers. Rather than treat this heterogeneous group as a single occupation with a single ranking, we divided it into four equal parts, assigning one part to Category I, one part to Category II, and so on. Thus, the appendix actually lists “Customer Service Representatives” three times, placing 129,231 jobs into each category. This augmentation of the data base added 18 synthetic occupations, 10 of which do not show up in the appendix because they fall into Category IV.²⁵

²⁴ The other occupations that were subdivided are: Office clerks, general; Office and administrative support specialists, all other; Computer support specialists; Secretaries, except legal, medical, and executive; Interpreters and translators; Financial managers; Receptionists and information clerks; Accountants and auditors; Lawyers; and Legal support workers, all other.

²⁵ This is why Table 1 includes 817 occupations when there are actually only 799.

Third, in several instances there are natural hierarchies of related occupations. For example, we rated managers as less offshorable than the people they manage. Similarly, lawyers were deemed to be less offshorable than paralegals, who in turn were less offshorable than other legal support workers. In these cases, offshorability declines as skill level rises. But, in the sciences and engineering, we made just the opposite judgment—e.g., computer scientists were assumed to be more offshorable than computer engineers, who were in turn considered more offshorable than computer operators.

With all this as background, the long table in the appendix displays the two-digit codes that we assigned to all 284 occupations in Categories I, II, and III, plus seven “close calls” (index=25) that we wound deciding to put into Category IV. (The other 526 occupations in Category IV will not be considered further.) Remember, these rankings are ordinal, not cardinal. But to help readers get a “feel” for the nature of the scale, and to make it easy to second-guess my choices, Table 2 displays the offshorability index for the 22 largest occupations, which are those with at least 300,000 workers in 2004.

4. Counting the Potentially Offshorable Jobs

With the rank ordering of all occupations in the appendix in hand, assessing the number of jobs that are potentially vulnerable to offshoring is a simple matter of counting—once a dividing line between jobs that are offshorable and jobs that are not has been selected. Of course, no one knows precisely where to draw that line. And, as already mentioned, the line is sure to move down (on my 0-100 scale) over time. So I offer three choices here, corresponding to “conservative,” “moderate,” and “aggressive” definitions of which jobs are potentially offshorable and which are not. Of course, every reader can use Figure 2, or the data in the appendix, to draw the line wherever he or she pleases.

Table 2**Major Occupations Ranked by Offshorability^a**

Occupation	SOC code	Category	Index number	Number of Workers
Computer programmers	15-1021	I	100	389,090
Telemarketers	41-9041	I	95	400,860
Computer systems analysts	15-1051	I	93	492,120
Billing and posting clerks and Machine operators	43-3021	I	90	513,020
Bookkeeping, accounting, And auditing clerks	43-3031	I	84	1,815,340
Computer support specialists	15-1041	I and II	92/68	499,860
Computer software engineers, Applications	15-1031	II	74	455,980
Computer software engineers, systems software	15-1032	II	74	320,720
Accountants ^b	13-2011	II	72	591,311
Welders, cutters, solderers, and brazers	51-4121	II	70	358,050
Helpers—production workers	51-9198	II	70	528,610
First-line supervisors/managers of production and operating workers	51-1011	II	68	679,930
Packaging and filling machine operators and tenders	51-9111	II	68	396,270
Team assemblers	51-2092	II	65	1,242,370
Bill and account collectors	43-3011	II	65	431,280
Machinists	51-4041	II	61	368,380
Inspectors, testers, sorters, samplers, and weighers	51-9061	II	60	506,160
General and operations managers	11-1021	III	55	1,663,810
Stock clerks and order fillers	43-5081	III	34	1,625,430
Shipping, receiving, and traffic clerks	43-5071	III	29	759,910
Sales managers	11-2022	III	26	317,970
Business operations specialists, all other	13-1199	IV	25	916,290

Source: Bureau of Labor Statistics and author's judgments

^a There are a few other occupations in the BLS database with employment over 300,000; but for reasons explained in the text, I distributed these across categories.

^b SOC code 13-2011 is actually "Accountants and Auditors." I assumed that accountants comprise three-quarters of the occupation, and that auditors are Category IV jobs.

My most conservative estimate includes only the occupations in Categories I and II, a group that comprises offshorability index numbers from 100 down to 51. It thus (see the table in the appendix) draws the dividing line between such occupations as Paralegals and Legal Assistants,²⁶ and Office Machine Operators (Except Computer), which are classified as just barely offshorable, and Travel Agents and File Clerks, which are classified as not quite offshorable. By this definition, which strikes me as clearly too restrictive, some 210 occupations comprising 22.2% of U.S. employment in 2004 (about 28.9 million jobs) are potentially offshorable. Note that even this extremely conservative estimate is roughly double McKinsey's number (11%).

But we really do not believe that, e.g., travel agents and file clerks are immune to offshoring. So my *moderate* estimate pushes the dividing line down into Category III, classifying all jobs with ranks 37 and higher as potentially offshorable. By this definition, Aerospace Engineers and a fraction of Secretaries, Except Legal, Medical, and Executive barely qualify as offshorable, while oil field workers (several different occupations), Broadcast Technicians, and Media and Communication Equipment Workers (All Other) just miss. Drawing the line here classifies 240 occupations, comprising 25.6% of the workforce (or 33.4 millions jobs in 2004), as offshorable. Finally, my most *aggressive* definition counts all the Category III jobs as potentially offshorable, thereby drawing the dividing line between rank 26 (such occupations as Watch Repairers; Mail Clerks and Mail Machine Operators, Except Postal Service; and Sales Managers) and rank 25 (which includes Photographers; Architects, Except Landscape and Naval; and Advertising Sales Agents). This division of the workforce, which strikes me as possibly too aggressive but

²⁶ Lawyers is one of the occupations that we subdivided, placing half of them at the bottom of Category II (index=51) and the rest in Category IV.

not wildly so, classifies 284 occupations, comprising 29.0% of all jobs (or a total of 37.8 million), as potentially offshorable. I include it here as a possible representation of a reasonable outer limit, after a decade or two of “normal” technical progress has occurred. And remember, I am trying to estimate *offshorability*, not to forecast actual *offshoring*. Just as the U.S. still has textile workers and steel workers today (although many fewer than it once had), only a fraction of the offshorable jobs will actually be moved offshore.

Thus, I have offered three possible dividing lines. My own best guess is that something like 26-29% of America’s 2004 jobs are or eventually will be potentially offshorable. This figure is just below the lower end of my “guesstimate” in Blinder (2006). Perhaps more important, by using the job titles and numbers in the appendix, each reader can make his or her own judgment about where to draw the line. What is virtually certain is that the offshorable occupations comprise a great many people holding a wide variety of jobs.

Finally, although I do not attempt to forecast future changes of the U.S. occupational distribution, it may be worth reporting that the rank correlation between my offshorability index and the BLS’s projected job growth from 2004 to 2014 is almost exactly zero.²⁷ To me, this surprising result suggests caution in using the BLS projections. Occupations that are highly offshorable may grow more slowly than the BLS currently anticipates.²⁸

5. Two Cross Checks

I have already explained why I favor the use of subjective over objective rankings of offshorability. But, as mentioned earlier, some readers may feel uneasy about relying on personal, subjective judgments--and for good reasons. As an initial cross-check,

²⁷ This correlation is computed using BLS employment projections for 2004-2014 released on December 7, 2005; they are available at <http://www.bls.gov/news.release/ecopro.nr0.htm>.

²⁸ However, in making these projections, the BLS does try to take account of offshoring. See BLS (2006).

therefore, I present in this section an alternative ranking, derived in an entirely mechanical way from numbers in the O*NET database—which makes it, among others things, perfectly replicable.

To create this objective index, I began by selecting five O*NET attributes that indicate that the occupation is likely to require face-to-face interaction with customers and/or is difficult to deliver remotely. They are:

1. establishing and maintaining personal relationships
2. assisting and caring for others
3. performing for or working directly with the public
4. selling or influencing others
5. social perceptiveness

Each of these five attributes, which I index by $i=1,\dots,5$, are clearly *negative* indicators of offshorability.

For each job, O*NET rates both the “importance” and the “level” required of each such attribute²⁹—which I henceforth denote as I_i and L_i respectively. Take “assisting and caring for others” (item 2 on the preceding list) as an example; child care workers have $I_2=84$ and $L_2=65$, while data entry keyers have $I_2=4$ and $L_2=9$. Arbitrarily assigning a Cobb-Douglas weight of two-thirds to importance and one-third to level, I define each occupation’s composite score for *non*-offshorability, S , as the sum of five components:

$$S_j = \sum_{i=1}^5 (I_{ij}^{2/3} L_{ij}^{1/3}) \quad .$$

Since lower values of S_j indicate that occupation j is easier to offshore, it is straightforward to transform the S_j scores into an objective ranking of every occupation by its offshorability. Once this is done, the question is: How well do these purely objective rankings correlate with my original subjective rankings?

²⁹ Because complete data are available for only 259 of the 291 occupations listed in the appendix, my objective ranking is limited to these 259 occupations.

The answer is: not very well. Specifically, computed over the 259 occupations that can be ranked objectively given the availability of O*NET data, the rank correlation is only +0.16. While that number is positive, it is not very high. Such a low correlation is, of course, open to at least two very different interpretations. My preferred interpretation is that it illustrates how unreliable any mechanical ranking of offshorability is. But a skeptic might use the same fact to cast doubt on my subjective ranking.

So which interpretation is more reasonable? Table 3 offers some suggestive evidence by displaying the nine occupations (out of the total of 259) for which the subjective and objective rankings differ by *at least 200 ranks*. That is a colossal difference--larger, I believe, than you would ever get from any two sensible human beings. And in every case, my subjective ranking seems far more plausible than the mechanically-derived objective ranking.³⁰

Table 3
Largest Discrepancies between Subjective and Objective Rankings

Occupation	Subjective Ranking	Objective Ranking
Network Systems and Data Communications Analysts	24	225
Film and Video Editors	8	215
Travel guides	34	246
Telemarketers	8	208
Reservation and Transportation Ticket Agents and Travel Clerks	14	256
Proofreaders and Copy Markers	8	234
Furniture Finishers	207	7
Gas Plant Operators	242	41
Photographic Process Workers	229	11

Note: A low number connotes high offshorability. For example, according to the subjective ranking, telemarketers are (tied for) the 8th most offshorable occupation.

³⁰ Travel Guides (SOC 39-6022) may appear to be an exception to this rule. But according to the O*NET, the job of travel guides is to “plan, organize, and conduct long distance cruises, tours, and expeditions for individuals and groups.” This is quite different from another closely related occupation, Tour Guides and Escorts (SOC39-6021), which requires more close personal contact, and hence is classified as not offshorable.

As a second cross-check, I hired a human resources professional with more than 12 years of field experience in personnel matters to create her own offshorability index for each of the same 799 occupations.³¹ To ensure that the two rankings would be as independent as possible, I did *not* instruct her to approach the task in the same way as we did—as illustrated, e.g., by the flow diagram in Figure 1. However, I did tell her that:

1. The key attributes that determine whether or not an occupation is offshorable are (a) whether it is tied to a specific U.S. geographical location, and (b) whether face-to-face, personal contact with the end-user is important.
2. It was not necessary to assign scores to occupations that she deemed impossible to move offshore (corresponding roughly to my Category IV).

Item 1, of course, merely defines the task; I wanted her to use essentially the same *criteria* for offshorability as I did. Item 2 is strictly a time saver, and she in fact took this option for 58.6% of the occupations. (I took it for 64.4%.) Other than that, she was instructed to use her own judgment, based on her own knowledge and experience—and, of course, she used the same O*NET data that we used. So, for example, the human resources professional did not see our rankings; she was not told the process by which we arrived at them; and we did not discuss her rankings with her as she was developing them. I was even careful not to offer any examples that might influence her views—except for some obvious cases (like keyboard data entry and child care) that I used to illustrate the principles involved. Thus I view the two subjective rankings as being about as independent as can be.

³¹ Recall that I had 817 occupations because I decided to subdivide several of the SOC codes. She did not. So the comparisons that follow are all based on 799 occupations.

Because there are so many “zeroes” in each ranking, there is no single statistic by which the “correlation” between the two rankings can be assessed. So I offer instead a variety of comparisons.

I begin by simply coding all the rankings into either “no” for totally non-offshorable jobs (my Category IV) or “yes” for potentially offshorable jobs, that is, for the occupations that are assigned a numerical ranking (my Categories I-III). To derive the simplest, nonparametric measure of association, I then use this “yes, no” classification to create the two-by-two contingency table shown below as Table 4. The χ^2_1 test statistic for the null hypothesis of *independence* between the two rankings in this contingency table is over 158, which rejects the null hypothesis at well beyond the .0001 level. But how well correlated are they? Maxwell (1970, p. 652) suggests using the *kappa coefficient*, “which may be interpreted in the same way as a correlation coefficient.”³² For the data in Table 4, $\kappa=.79$. So, based only on this crude binary treatment of the data, the two rankings are highly correlated.

Table 4
Two-by-Two Contingency Table

	No (514)	Yes (285)
No (468)	385	83
Yes (331)	129	202

Turning to some of the details, among the 468 occupations that she judged to be virtually impossible to offshore (“no” in the top row of the contingency table above), I

³² Denote the four elements of the contingency table as:

a	b
c	d

Then kappa is defined as $\kappa = [(a+d)/N - \Delta]/[1 - \Delta]$, where N is the number of observations (so that $a+b+c+d=N$), and $\Delta = (a+c)(a+b)/N^2 + (d+c)(d+b)/N^2$. It is clear from this formula that $\kappa=1$ when all data are on the diagonal ($a+d=N$, $c=b=0$), and that $\kappa=0$ when the data are equally distributed in the table ($a=b=c=d=N/4$).

concluded in 385 cases, or 82.2%. Across the 83 cases of disagreement (17.7%), my average offshorability index (on the 26-100 scale that I used) was 55.5, which is sizable; so some of these discrepancies do represent substantial differences of opinion.³³ Among the 514 occupations that I placed in Category IV (“no” in the lefthand column of Table 4), she rated 385 (74.9%) as totally non-offshorable, too. Across the 129 cases of disagreement (25.1%), her average offshorability score (on the 1-100 scale that she used) was just 29.3, which is low.³⁴

There are 202 cases in which both of us judged the occupation to be at least conceivably offshorable (“yes, yes” in the contingency table above), and therefore both assigned a numerical rating. Within that subset, the rank correlation between our two subjective rankings was +0.38.

Finally, whereas Table 3 displays nine cases in which my subjective ranking differed from the objective ranking by at least 200 ranks, there are no discrepancies that large between my rankings and those of the human resources professional.³⁵

So is the replicability bottle half full or half empty? I leave it to the reader to judge. On the one hand, the human resource professional’s subjective rankings are far closer to my own than are the mechanically-derived objective rankings (rank correlation 0.38 versus 0.16), and the two of us agreed on the “yes, no” classification in roughly 80% of the cases. On the other hand, a rank correlation of 0.38 is pretty far from perfect agreement. After all, these truly are subjective judgments. That said, I am confident that more effort to specify in detail, and therefore to homogenize, the criteria used to assess

³³ As a point of reference, I assigned a score of 55 to Medical Scientists, Except Epidemiologists and to Logisticians.

³⁴ As a point of reference, she assigned a score of 30 to Radio and TV Announcers and to a number of types of postsecondary teachers.

³⁵ There are, however, 27 cases in which our respective rankings differed by at least 100 ranks.

offshorability would have produced greater agreement. My vote, therefore, is: more than half full.

6. Skills and Offshorability

One major point of Blinder (2006) was that jobs that are and are not offshorable are to be found all along the skill spectrum. It is not obvious, I argued, that there is much correlation between the skill or education level that typifies a job and its vulnerability to offshoring. It is possible to use the (subjective) index of offshorability created in this paper to test this “no-correlation hypothesis” because BLS data also provide for each occupation the two measures that economists normally use to rate labor-market skill: wage rates and educational attainment.

Regarding wages, the median wage in 2004 is available for each of the 291 occupations that are ranked by my offshorability index. Regarding educational attainment, O*NET also reports BLS data on the fractions of holders of each job (between the ages of 25 and 44) in 2004 whose education fell into each of the following three ranges:

- E1 = the fraction with “high school or less” education
- E2 = the fraction with “some college” education
- E3 = the fraction with a “bachelor’s degree or higher”.

There are clearly only two independent variables here, and I turned them into two different scalar measures of educational attainment as follows:

- $E4 = E3 - E1$
- $E5 = 10E1 + 14E2 + 18E3$

Measure E4 shows the balance (positive or negative) between college graduates (or more) and high school graduates (or less). In principle, this measure runs from +1.0 to -1.0; and in practice, the actual data come close to filling that entire span—ranging from a high of

+0.97 to a low of -0.88. The measure E5 is an approximation to average years of education created by treating “high school or less” as 10 years, “some college” as 14 years, and “bachelor’s degree or higher” as 18 years. E4 and E5 are conceptually different, and are measured in very different units. But when I transform each set of cardinal numbers into ordinal rankings, the rank correlation between the two is nearly perfect—greater than 0.999. So it does not matter which measure is used.

What, then, is the rank correlation between an occupation’s offshorability (according to our subjective ranking) and its educational attainment, as measured by either its E4 or E5 ranking? The answer is just +0.08. There are two messages here. First, this rank correlation is very small, indicating that the “no correlation hypothesis” of Blinder (2006) comes pretty close to the truth. Second, however, it is positive, not negative. A common presumption seems to be that jobs requiring *low* levels of education are more vulnerable to offshoring than jobs requiring *high* levels. But the estimated rank correlation points, albeit very weakly, in the opposite direction, indicating that occupations with higher educational attainment are (slightly) more offshorable.

The other way to measure skill is by wages. To assess the correlation between skill and offshorability in this alternative way, I calculated the rank correlation between offshorability and wages. It is essentially zero (actually 0.01), this time literally suggesting no correlation.

Leamer’s (2006) notion of the contestability of jobs raises another natural question: Are workers in highly-offshorable occupations already paying a wage penalty because of potential competition from abroad? Notice that the issue here is one of *contestability* rather than *competition*. By 2004, only a very small number of service jobs had actually

been offshored. So, in estimating the effect of offshorability on wages, I am looking mostly for the impact of *potential offshorability* rather than of *actual offshoring*.

This line of thought suggests that we should expect to find such an effect only on the wages of workers in the most offshorable occupations. However, in looking for such an effect, we must at least control for educational attainment. So I ran the following log-wage equation across the 291 ranked occupations:

$$\ln(w_i) = \alpha + \beta(E5_i) + \gamma \mathbf{OD}_i + \varepsilon_i,$$

where **OD** is a vector of offshorability dummies. Specifically, I created a set of seven dummy variables indicating offshorability indexes ranging from 26 to 35 (group one), from 36 to 45 (group two), and so on, up to the top group (for offshorability), which comprised ranks 86 and higher.³⁶ Choosing group one as the omitted category, and hence as the reference group, the regression shows statistically insignificant estimated coefficients for all of the offshorability dummies *except* the highest (pertaining to ranks 86-100, and comprising 5.7 million workers), which gets a highly significant coefficient of -0.138 (with a t-ratio of 2.10, and a p-value of 0.04).³⁷ Thus, controlling for education,³⁸ only the 5.7 million most offshorable jobs seem to be paying a wage penalty—estimated to be about 14%--at present.

7. Conclusions

Based on detailed, though subjective, analysis of the characteristics of jobs, I have derived and presented here a new index of the “offshorability” of 291 U.S. occupations. Using this index, I estimate that the outer limit of potential offshorability encompasses

³⁶ Because the sample also includes seven Category IV occupations with an offshorability index of 25, the regression also includes an eighth dummy variable just for this group.

³⁷ The estimated coefficient for the group six dummy (ranks 76-85) was -0.118 with a t-ratio of 1.42 (implying a p-value of 0.16). The other coefficients were all smaller than this, with t-ratios below 1.

³⁸ The estimated coefficient on E5 (“years of education”) was 0.152, with a t-ratio of 19.1.

between 22% and 29% of all the jobs in the 2004 U.S. workforce, with the upper half of that range perhaps more likely than the lower half. Contrary to conventional wisdom, the more offshorable occupations are not low-end jobs, whether measured by wages or by education. The correlation between skill and offshorability is almost zero. And there is some suggestive evidence that, controlling for education, holders of the most highly-offshorable jobs were already paying a notable wage penalty in 2004.

My hope is that the index provided here will prove useful to researchers interested in many of the issues raised by offshoring, and that it will not only be used, but also improved upon, by others.

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APPENDIX **Ranking of 291 Occupations by Offshorability**

Occupation (SOC code)	Rank	Offshorability Index	Employment	Cumulative Sum
Computer Programmers(151021)	1	100	389090	389090
Data Entry Keyers(439021)	1	100	296700	685790
Electrical and Electronics Drafters(173012)	3	98	30270	716060
Mechanical Drafters(173013)	3	98	74650	790710
Computer and Information Scientists, Research(151011)	5	96	25890	816600
Actuaries(152011)	5	96	15770	832370
Mathematicians(152021)	5	96	2930	835300
Statisticians(152041)	5	96	17480	852780
Mathematical Science Occupations, All Other(152099)	9	95	7320	860100
Film and Video Editors(274032)	9	95	15200	875300
Medical Transcriptionists(319094)	9	95	90380	965680
Telemarketers(419041)	9	95	400860	1366540
Telephone Operators(432021)	9	95	29290	1395830
Proofreaders and Copy Markers(439081)	9	95	18070	1413900
Numerical Tool and Process Control Programmers(514012)	9	95	17860	1431760
Customer Service Representatives A (434051)*	16	94	516925	1948685
Reservation and Transportation Ticket Agents and Travel Clerks(434181)	16	94	160120	2108805
Word Processors and Typists(439022)	16	94	153580	2262385
Office Clerks, General A (439061)*	16	94	749343	3011727.5
Office and Administrative Support Workers, All Other A(439199)*	16	94	71818	3083545
Computer Systems Analysts(151051)	21	93	492120	3575665
Editors(273041)	21	93	96270	3671935
Technical Writers(273042)	21	93	46250	3718185
Interpreters and Translators(273091)****	21	93	21930	3740115
Desktop Publishers(439031)	21	93	29910	3770025
Insurance Claims and Policy Processing Clerks(439041)	21	93	239120	4009145
Computer Support Specialists A (151041)**	27	92	124965	4134110
Network Systems and Data Communications Analysts(151081)	27	92	185190	4319300
Information and Record Clerks, All Other(434199)	27	92	288730	4608030
Computer Specialists, All Other(151099)	30	90	116760	4724790
Architectural and Civil Drafters(173011)	30	90	101040	4825830
Drafters, All Other(173019)	30	90	20870	4846700
Survey Researchers(193022)	30	90	21650	4868350
Writers and Authors(273043)	30	90	43020	4911370
Billing and Posting Clerks and Machine Operators(433021)	30	90	513020	5424390
Statistical Assistants(439111)	30	90	18700	5443090
Economists(193011)	37	89	12470	5455560
Fine Artists, Including Painters, Sculptors, and Illustrators(271013)	37	89	10390	5465950
Multi-Media Artists and Animators(271014)	39	87	23790	5489740
Cartographers and Photogrammetrists(171021)	40	86	11260	5501000
Graphic Designers(271024)	40	86	178530	5679530
Travel Guides(396022)	40	86	3120	5682650
Insurance Underwriters(132053)	43	85	98970	5781620
Animal Scientists(191011)	43	85	3000	5784620
Commercial and Industrial Designers(271021)	43	85	31650	5816270
Bookkeeping, Accounting, and Auditing Clerks(433031)	46	84	1815340	7631610
Biochemists and Biophysicists(191021)	47	83	17690	7649300
Microbiologists(191022)	47	83	15250	7664550

Biological Scientists, All Other(191029)	47	83	26200	7690750
Medical Records and Health Information Technicians(292071)	47	83	160450	7851200
Operations Research Analysts(152031)	51	82	52530	7903730
Atmospheric and Space Scientists(192021)	52	81	7050	7910780
Credit Authorizers, Checkers, and Clerks(434041)	53	80	65410	7976190
Fabric and Apparel Patternmakers(516092)	53	80	9650	7985840
Food Scientists and Technologists(191012)	55	79	7570	7993410
Mathematical Technicians(152091)	56	78	1430	7994840
Designers, All Other(271029)	57	77	12410	8007250
Correspondence Clerks(434021)	57	77	17990	8025240
Financial Analysts(132051)	59	76	180910	8206150
Financial Managers(113031)**	60	75	353963	8560113
Database Administrators(151061)	60	75	99380	8659493
Receptionists and Information Clerks(434171)**	60	75	362800	9022293
Computer Operators(439011)	60	75	129160	9151453
Pressers, Textile, Garment, and Related Materials(516021)	60	75	78620	9230073
Sewing Machine Operators(516031)	60	75	233130	9463203
Shoe and Leather Workers and Repairers(516041)	60	75	7680	9470883
Shoe Machine Operators and Tenders(516042)	60	75	3850	9474733
Sewers, Hand(516051)	60	75	11090	9485823
Textile Bleaching and Dyeing Machine Operators and Tenders(516061)	60	75	21660	9507483
Textile Cutting Machine Setters, Operators, and Tenders(516062)	60	75	21420	9528903
Textile Knitting and Weaving Machine Setters, Operators, and Tenders(516063)	60	75	42760	9571663
Textile Winding, Twisting, and Drawing Out Machine Setters, Operators, and Tenders(516064)	60	75	47670	9619333
Textile, Apparel, and Furnishings Workers, All Other(516099)	60	75	24740	9644073
Computer Software Engineers, Applications(151031)	74	74	455980	10100053
Computer Software Engineers, Systems Software(151032)	74	74	320720	10420773
Computer Hardware Engineers(172061)	76	73	78580	10499353
Fashion Designers(271022)	76	73	12980	10512333
Accountants and Auditors(132011)**	78	72	788415	11300748
Chemical Engineers(172041)	78	72	27550	11328298
Engineers, All Other(172199)	78	72	152940	11481238
Industrial Engineering Technicians(173026)	78	72	73310	11554548
Mechanical Engineering Technicians(173027)	78	72	46580	11601128
Dispatchers, Except Police, Fire, and Ambulance(435032)	78	72	172550	11773678
Biomedical Engineers(172031)	84	71	11660	11785338
Materials Engineers(172131)	84	71	20950	11806288
Electronics Engineers, Except Computer(172072)	86	70	130050	11936338
Industrial Engineers(172112)	86	70	191640	12127978
Mechanical Engineers(172141)	86	70	220750	12348728
Customer Service Representatives B (434051)*	86	70	516925	12865653
Office Clerks, General B (439061)*	86	70	749343	13614995
Office and Administrative Support Workers, All Other B (439199)*	86	70	71818	13686813
Tool and Die Makers(514111)	86	70	99680	13786493
Welders, Cutters, Solderers, and Brazers(514121)	86	70	358050	14144543
Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic(514191)	86	70	26310	14170853
Lay-Out Workers, Metal and Plastic(514192)	86	70	10970	14181823
Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic(514193)	86	70	40550	14222373
Metal Workers and Plastic Workers, All Other(514199)	86	70	49650	14272023
Semiconductor Processors(519141)	86	70	44720	14316743
Helpers--Production Workers(519198)	86	70	528610	14845353
Marine Engineers and Naval Architects(172121)	100	69	6550	14851903

Secretaries, Except Legal, Medical, and Executive A (436014)***	100	69	436095	15287998
Cutters and Trimmers, Hand(519031)	100	69	28360	15316358
Molders, Shapers, and Casters, Except Metal and Plastic(519195)	100	69	41250	15357608
Tire Builders(519197)	100	69	19860	15377468
Tax Preparers(132082)	105	68	58850	15436318
Computer Support Specialists B (151041)**	105	68	374895	15811213
First-Line Supervisors/Managers of Production and Operating Workers(511011)	105	68	679930	16491143
Coil Winders, Tapers, and Finishers(512021)	105	68	23190	16514333
Structural Metal Fabricators and Fitters(512041)	105	68	93490	16607823
Fiberglass Laminators and Fabricators(512091)	105	68	30560	16638383
Computer-Controlled Machine Tool Operators, Metal and Plastic(514011)	105	68	136490	16774873
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic(514021)	105	68	87290	16862163
Forging Machine Setters, Operators, and Tenders, Metal and Plastic(514022)	105	68	33850	16896013
Rolling Machine Setters, Operators, and Tenders, Metal and Plastic(514023)	105	68	37500	16933513
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic(514031)	105	68	265480	17198993
Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic(514032)	105	68	43180	17242173
Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Pl(514033)	105	68	101530	17343703
Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic(514034)	105	68	71410	17415113
Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic(514035)	105	68	29140	17444253
Metal-Refining Furnace Operators and Tenders(514051)	105	68	17960	17462213
Pourers and Casters, Metal(514052)	105	68	14340	17476553
Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic(514072)	105	68	157080	17633633
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic(514081)	105	68	98120	17731753
Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders(514122)	105	68	45220	17776973
Tool Grinders, Filers, and Sharpeners(514194)	105	68	18180	17795153
Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers(516091)	105	68	23040	17818193
Chemical Plant and System Operators(518091)	105	68	58640	17876833
Chemical Equipment Operators and Tenders(519011)	105	68	50610	17927443
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders(519012)	105	68	41250	17968693
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders(519021)	105	68	41480	18010173
Grinding and Polishing Workers, Hand(519022)	105	68	44890	18055063
Mixing and Blending Machine Setters, Operators, and Tenders(519023)	105	68	129440	18184503
Cutting and Slicing Machine Setters, Operators, and Tenders(519032)	105	68	78030	18262533
Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders(519041)	105	68	80420	18342953
Packaging and Filling Machine Operators and Tenders(519111)	105	68	396270	18739223
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders(519121)	105	68	100830	18840053
Painters, Transportation Equipment(519122)	105	68	52650	18892703
Painting, Coating, and Decorating Workers(519123)	105	68	27830	18920533
Cementing and Gluing Machine Operators and Tenders(519191)	105	68	25650	18946183
Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders(519192)	105	68	15250	18961433
Cooling and Freezing Equipment Operators and Tenders(519193)	105	68	9640	18971073

Etchers and Engravers(519194)	105	68	10050	18981123
Paper Goods Machine Setters, Operators, and Tenders(519196)	105	68	107560	19088683
Production Workers, All Other(519199)	105	68	296340	19385023
Physicists(192012)	145	67	15160	19400183
Artists and Related Workers, All Other(271019)	145	67	5290	19405473
Payroll and Timekeeping Clerks(433051)	145	67	205600	19611073
Procurement Clerks(433061)	145	67	71390	19682463
Brokerage Clerks(434011)	145	67	70110	19752573
Order Clerks(434151)	145	67	259760	20012333
Chemists(192031)	151	66	76540	20088873
Materials Scientists(192032)	151	66	7880	20096753
Physical Scientists, All Other(192099)	151	66	23800	20120553
Electrical and Electronic Equipment Assemblers(512022)	151	66	207270	20327823
Electromechanical Equipment Assemblers(512023)	151	66	57200	20385023
Engine and Other Machine Assemblers(512031)	151	66	49430	20434453
Bill and Account Collectors(433011)	157	65	431280	20865733
Team Assemblers(512092)	157	65	1242370	22108103
Model Makers, Metal and Plastic(514061)	157	65	8120	22116223
Patternmakers, Metal and Plastic(514062)	157	65	6850	22123073
Foundry Mold and Coremakers(514071)	157	65	15890	22138963
Credit Analysts(132041)	162	64	61500	22200463
Electrical Engineers(172071)	162	64	144920	22345383
Art Directors(271011)	162	64	29350	22374733
Assemblers and Fabricators, All Other(512099)	162	64	258240	22632973
Jewelers and Precious Stone and Metal Workers(519071)	162	64	28100	22661073
Timing Device Assemblers, Adjusters, and Calibrators(512093)	167	62	2460	22663533
Machinists(514041)	168	61	368380	23031913
Budget Analysts(132031)	169	60	53510	23085423
Model Makers, Wood(517031)	169	60	2280	23087703
Patternmakers, Wood(517032)	169	60	2000	23089703
Inspectors, Testers, Sorters, Samplers, and Weighers(519061)	169	60	506160	23595863
Medical and Clinical Laboratory Technicians(292012)	173	59	142330	23738193
Bindery Workers(515011)	173	59	64330	23802523
Bookbinders(515012)	173	59	7660	23810183
Prepress Technicians and Workers(515022)	173	59	72050	23882233
Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders(519051)	173	59	28140	23910373
Medical and Clinical Laboratory Technologists(292011)	178	58	155250	24065623
Job Printers(515021)	178	58	50580	24116203
Printing Machine Operators(515023)	180	57	192520	24308723
Upholsterers(516093)	180	57	41040	24349763
Cabinetmakers and Bench Carpenters(517011)	180	57	121660	24471423
Sawing Machine Setters, Operators, and Tenders, Wood(517041)	180	57	60280	24531703
Woodworking Machine Setters, Operators, and Tenders, Except Sawing(517042)	180	57	94690	24626393
Woodworkers, All Other(517099)	180	57	10550	24636943
Natural Sciences Managers(119121)	186	56	40400	24677343
General and Operations Managers(111021)	187	55	1663810	26341153
Computer and Information Systems Managers(113021)	187	55	259330	26600483
Industrial Production Managers(113051)	187	55	153950	26754433
Wholesale and Retail Buyers, Except Farm Products(131022)	187	55	132900	26887333
Purchasing Agents, Except Wholesale, Retail, and Farm Products(131023)	187	55	267410	27154743
Logisticians(131081)	187	55	52220	27206963
Medical Scientists, Except Epidemiologists(191042)	187	55	73670	27280633

Life Scientists, All Other(191099)	187	55	12790	27293423
Agricultural and Food Science Technicians(194011)	187	55	19340	27312763
Biological Technicians(194021)	187	55	67080	27379843
Chemical Technicians(194031)	187	55	59790	27439633
Media and Communication Workers, All Other(273099)	187	55	25660	27465293
Aircraft Structure, Surfaces, Rigging, and Systems Assemblers(512011)	187	55	22820	27488113
Stationary Engineers and Boiler Operators(518021)	187	55	43110	27531223
Engineering Managers(119041)	201	54	187410	27718633
Production, Planning, and Expediting Clerks(435061)	201	54	287980	28006613
Advertising and Promotions Managers(112011)	203	53	41710	28048323
Marketing Managers(112021)	203	53	166470	28214793
Legal Support Workers, All Other(232099)*****	205	52	28424	28243217
Lawyers(231011)*****	206	51	105838	28349055
Paralegals and Legal Assistants(232011)	206	51	217700	28566755
Camera Operators, Television, Video, and Motion Picture(274031)	206	51	22530	28589285
Securities, Commodities, and Financial Services Sales Agents(413031)	206	51	251710	28840995
Office Machine Operators, Except Computer(439071)	206	51	87900	28928895
Cost Estimators(131051)	211	50	204330	29133225
Financial Specialists, All Other(132099)	211	50	122320	29255545
Network and Computer Systems Administrators(151071)	211	50	270330	29525875
Travel Agents(413041)	211	50	88590	29614465
Switchboard Operators, Including Answering Service(432011)	211	50	194980	29809445
File Clerks(434071)	211	50	229830	30039275
Human Resources Assistants, Except Payroll and Timekeeping(434161)	211	50	161870	30201145
Administrative Services Managers(113011)	218	49	239410	30440555
Training and Development Managers(113042)	218	49	28720	30469275
Human Resources Managers, All Other(113049)	218	49	57830	30527105
Purchasing Managers(113061)	218	49	69300	30596405
Transportation, Storage, and Distribution Managers(113071)	218	49	84870	30681275
Producers and Directors(272012)	218	49	59070	30740345
Actors(272011)	224	48	59590	30799935
Interviewers A, Except Eligibility and Loan(434111)	224	48	100895	30900830
Photographic Processing Machine Operators(519132)	224	48	53970	30954800
Electrical and Electronic Engineering Technicians(173023)	227	47	165850	31120650
Electro-Mechanical Technicians(173024)	227	47	15130	31135780
Engineering Technicians, Except Drafters, All Other(173029)	227	47	78300	31214080
Compensation, Benefits, and Job Analysis Specialists(131072)	230	46	97740	31311820
Loan Interviewers and Clerks A (434131)	230	46	115850	31427670
Furniture Finishers(517021)	232	43	24610	31452280
Communications Equipment Operators, All Other(432099)	233	41	3870	31456150
Broadcast News Analysts(273021)	234	40	6680	31462830
Life, Physical, and Social Science Technicians, All Other(194099)	235	39	63810	31526640
Customer Service Representatives C (434051)*	236	38	516925	32043565
Secretaries, Except Legal, Medical, and Executive B (436014)***	236	38	436095	32479660
Office Clerks, General C (439061)*	236	38	749343	33229002
Office and Administrative Support Workers, All Other C (439199)*	236	38	71818	33300820
Aerospace Engineers(172011)	240	37	81100	33381920
Audio and Video Equipment Technicians(274011)	241	36	40390	33422310
Broadcast Technicians(274012)	241	36	30730	33453040
Radio Operators(274013)	241	36	1190	33454230
Sound Engineering Technicians(274014)	241	36	12680	33466910

Media and Communication Equipment Workers, All Other(274099)	241	36	17200	33484110
Derrick Operators, Oil and Gas(475011)	241	36	13270	33497380
Rotary Drill Operators, Oil and Gas(475012)	241	36	15500	33512880
Service Unit Operators, Oil, Gas, and Mining(475013)	241	36	19530	33532410
Continuous Mining Machine Operators(475041)	241	36	9000	33541410
Mine Cutting and Channeling Machine Operators(475042)	241	36	6080	33547490
Mining Machine Operators, All Other(475049)	241	36	2450	33549940
Rock Splitters, Quarry(475051)	241	36	3600	33553540
Roof Bolters, Mining(475061)	241	36	4140	33557680
Roustabouts, Oil and Gas(475071)	241	36	33570	33591250
Helpers--Extraction Workers(475081)	241	36	25550	33616800
Extraction Workers, All Other(475099)	241	36	9060	33625860
Geological and Petroleum Technicians(194041)	257	35	11130	33636990
Earth Drillers, Except Oil and Gas(475021)	257	35	18800	33655790
Explosives Workers, Ordnance Handling Experts, and Blasters(475031)	257	35	4800	33660590
Nuclear Technicians(194051)	260	34	6050	33666640
Stock Clerks and Order Fillers(435081)	260	34	1625430	35292070
Medical Appliance Technicians(519082)	260	34	10810	35302880
Ophthalmic Laboratory Technicians(519083)	260	34	26740	35329620
Photographic Process Workers(519131)	260	34	28000	35357620
Sailors and Marine Oilers(535011)	260	34	31090	35388710
Ship Engineers(535031)	260	34	13240	35401950
Environmental Science and Protection Technicians, Including Health(194091)	267	33	32460	35434410
Library Technicians(254031)	267	33	115770	35550180
Pharmacy Technicians(292052)	269	32	266790	35816970
Food Batchmakers(513092)	270	31	89400	35906370
Astronomers(192011)	271	30	970	35907340
Radio and Television Announcers(273011)	271	30	41090	35948430
Shipping, Receiving, and Traffic Clerks(435071)	273	29	759910	36708340
Gas Plant Operators(518092)	273	29	10530	36718870
Petroleum Pump System Operators, Refinery Operators, and Gaugers(518093)	273	29	40470	36759340
Plant and System Operators, All Other(518099)	273	29	13920	36773260
First-Line Supervisors/Managers of Helpers, Laborers, and Material Movers, Hand(531021)	277	28	176030	36949290
First-Line Supervisors/Managers of Transportation and Material-Moving Machine and Vehicle Operators(531031)	277	28	221520	37170810
Weighers, Measurers, Checkers, and Samplers, Recordkeeping(435111)	279	27	79050	37249860
Food Cooking Machine Operators and Tenders(513093)	279	27	43100	37292960
Sales Managers(112022)	281	26	317970	37610930
Mail Clerks and Mail Machine Operators, Except Postal Service(439051)	281	26	148330	37759260
Camera and Photographic Equipment Repairers(499061)	281	26	3160	37762420
Watch Repairers (499064)	281	26	3080	37765500
Business Operations Specialists, All Other(131199)	285	25	916290	38681790
Architects, Except Landscape and Naval(171011)	285	25	96740	38778530
Health and Safety Engineers, Except Mining Safety Engineers and Inspectors(172111)	285	25	25330	38803860
Music Directors and Composers(272041)	285	25	8610	38812470
Photographers(274021)	285	25	58260	38870730
Advertising Sales Agents(413011)	285	25	153890	39024620
Postal Service Mail Sorters, Processors, and Processing Machine Operators(435053)	285	25	208600	39233220

Notes:

*This occupation consists of jobs spanning virtually every industry in an economy and defies easy classification. We assigned one quarter of the jobs in this occupation to each of our four offshorability categories.

**These occupations consist of jobs spanning different industries and different levels of skill and offshorability. We divided each such occupation between Category I and Category IV jobs.

***These occupations were divided into Category II, III, and IV jobs..

****These occupations were divided between Categories I and Category IV.

*****A small proportion of legal positions are offshorable. In recognition of this, we divided these two occupations between Category II and Category IV.