# How Many Jobs Can be Done at Home?

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### Abstract

Evaluating the economic impact of "social distancing" measures taken to arrest the spread of COVID-19 raises a fundamental question about the modern economy: how many jobs can be performed at home? We classify the feasibility of working at home for all occupations and merge this classification with occupational employment counts. We find that 37 percent of jobs in the United States can be performed entirely at home, with significant variation across cities and industries. Applying our occupational classifications to 85 other countries reveals that lower-income economies have a lower share of jobs that can be done at home.

## 1   Introduction

Evaluating the economic impact of "social distancing" measures taken to arrest the spread of COVID-19 raises a number of fundamental questions about the modern economy: How many jobs can be performed at home? What share of total wages are paid to such jobs? How does the scope for working from home vary across cities, industries, and countries?

To answer these questions, we classify the feasibility of working at home for all occupations and merge this classification with occupational employment counts for the United States. Our feasibility measure is based on responses to two Occupational Information Network (O*NET) surveys covering "work context" and "generalized work activities." For example, if answers to those surveys reveal that an occupation requires daily "work outdoors" or that "operating vehicles, mechanized devices, or equipment" is very important to that occupation's performance, we determine that the occupation cannot be performed from home.[1]

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[1]See the Appendix for a more detailed description of our classification based on O*NET survey responses. Using our replication package, researchers can modify this classification scheme to produce results based on their own assessment of the plausibility of working at home for each type of job.

We start in Section 2 by merging this classification of O*NET occupations with information from the U.S. Bureau of Labor Statistics (BLS) on the prevalence of each occupation in the aggregate U.S. economy as well as in particular metropolitan statistical areas and 2-digit NAICS industries. In Section 3, we then merge our classification with occupational employment data for many countries provided by the International Labour Organization (ILO) to reveal an increasing relationship between the share of jobs that can be done at home and the level of a country's economic development. Section 4 reviews the related literature, and Section 5 concludes.

# 2    Results for the United States

Our classification implies that 37 percent of U.S. jobs can plausibly be performed at home. We obtain our estimate by identifying job characteristics that clearly rule out the possibility of working entirely from home, neglecting many characteristics that would make working from home difficult.[2] Our estimate is therefore an upper bound on what might be feasible and greatly exceeds the share of jobs that in fact have been performed entirely at home in recent years. According to the 2018 American Time Use Survey, less than a quarter of all full-time workers work at all from home on an average day, and even those workers typically spend well less than half of their working hours at home. Workers in occupations that can be performed at home typically earn more. If we assume all occupations involve the same number of hours of work, the 37 percent of U.S. jobs that can plausibly be performed at home account for 46 percent of all wages.

There is significant variation in this percentage across cities and industries. Table 1 reports the top five and bottom five metropolitan statistical areas (from among the 100 largest, by employment) in terms of the share of jobs that could be done at home. More than 45 percent of jobs in San Francisco, San Jose, and Washington, DC could be performed at home, whereas this is the case for 30 percent or less of the jobs in Fort Myers, Grand Rapids, and Las Vegas. Figure 1 depicts the geographic distribution of our unweighted measure of the share of jobs that can be done at home across metropolitan areas. As shown in Table 2, whereas most jobs in finance, corporate management, and professional and scientific services could plausibly be performed at home, very few jobs in agriculture, hotels and restaurants, or retail could be. The full results for all metropolitan areas and industries, together with our classifications of occupations, are available at https://github.com/jdingel/DingelNeiman-workathome.

As an alternative to our baseline classification, we each manually assigned values of 0, 0.5, or 1 to each 5-digit SOC code based on introspection. Averaging our two judgments resulted in values of 0, 0.25, 0.5, 0.75, and 1.[3] Using this alternative measure, we find the following: Approximately 32 percent of all U.S. jobs, accounting for 42 percent of overall

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[2]For example, our classification codes 98 percent of the 8.8 million teachers in the U.S. as able to work from home, which seems sensible given the large number of schools currently employing remote learning. Re-coding these teaching jobs as unable to be performed from home would, in the aggregate, reduce our estimate of the share of jobs that can be done at home by about six percentage points.

[3]Our two assessments about whether an occupation could be done at home or not agreed in about 85 percent of the cases, and our disagreements were only rarely greater than 0.5.

Table 1: Share of jobs that can be done at home, by metropolitan area

|  | Unweighted | Weighted by wage |
|---|---|---|
| *Top five* | | |
| San Jose-Sunnyvale-Santa Clara, CA | 0.51 | 0.66 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 0.50 | 0.64 |
| Durham-Chapel Hill, NC | 0.46 | 0.57 |
| Austin-Round Rock, TX | 0.46 | 0.58 |
| San Francisco-Oakland-Hayward, CA | 0.45 | 0.58 |
| | | |
| *Bottom five* | | |
| Grand Rapids-Wyoming, MI | 0.29 | 0.37 |
| Lancaster, PA | 0.29 | 0.36 |
| Bakersfield, CA | 0.29 | 0.36 |
| Stockton-Lodi, CA | 0.29 | 0.33 |
| Cape Coral-Fort Myers, FL | 0.28 | 0.34 |

Figure 1: Share of jobs that can be done at home
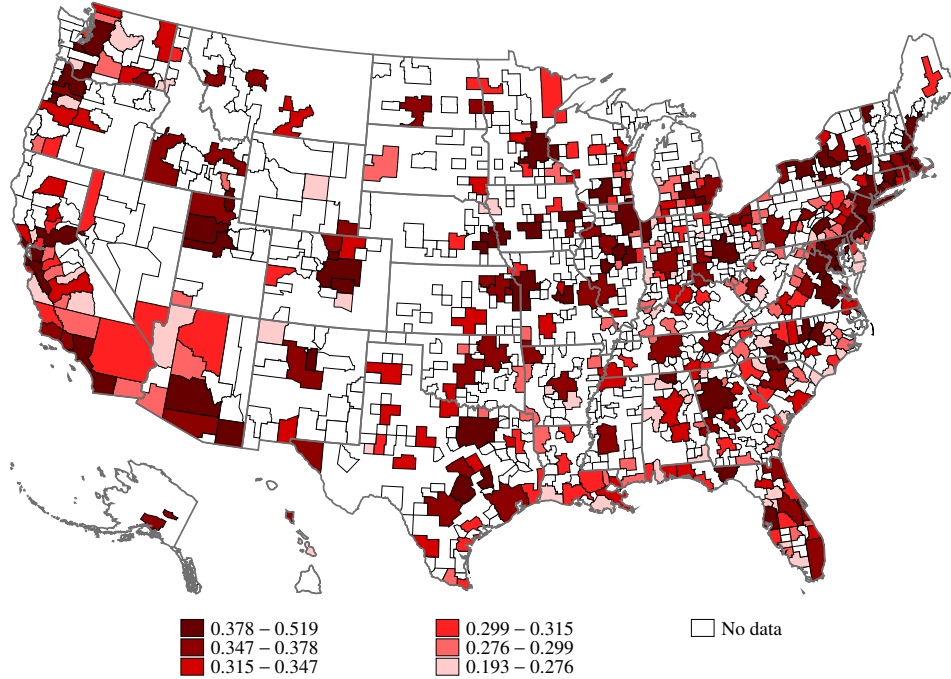


wages, can be performed almost entirely at home.

The city- and industry-level results generated by this alternative classification, which are included in our replication package, are very similar to those presented in Table 1, Table 2,

Table 2: Share of jobs that can be done at home, by industry

|  | Unweighted | Weighted by wage |
|---|---|---|
| *Top five* | | |
| Educational Services | 0.83 | 0.71 |
| Professional, Scientific, and Technical Services | 0.80 | 0.86 |
| Management of Companies and Enterprises | 0.79 | 0.86 |
| Finance and Insurance | 0.76 | 0.85 |
| Information | 0.72 | 0.80 |
| | | |
| *Bottom five* | | |
| Transportation and Warehousing | 0.19 | 0.25 |
| Construction | 0.19 | 0.22 |
| Retail Trade | 0.14 | 0.22 |
| Agriculture, Forestry, Fishing and Hunting | 0.08 | 0.13 |
| Accommodation and Food Services | 0.04 | 0.07 |

Table 3: Share of jobs that can be done at home, by occupation's major group

|  | Occupation | O*NET-derived baseline | Manual alternative |
|---|---|---|---|
| 15 | Computer and Mathematical Occupations | 1.00 | 1.00 |
| 25 | Education, Training, and Library Occupations | 0.98 | 0.85 |
| 23 | Legal Occupations | 0.97 | 0.84 |
| 13 | Business and Financial Operations Occupations | 0.88 | 0.92 |
| 11 | Management Occupations | 0.87 | 0.84 |
| 27 | Arts, Design, Entertainment, Sports, and Media Occupations | 0.76 | 0.57 |
| 43 | Office and Administrative Support Occupations | 0.65 | 0.51 |
| 17 | Architecture and Engineering Occupations | 0.61 | 0.88 |
| 19 | Life, Physical, and Social Science Occupations | 0.54 | 0.36 |
| 21 | Community and Social Service Occupations | 0.37 | 0.50 |
| 41 | Sales and Related Occupations | 0.28 | 0.21 |
| 39 | Personal Care and Service Occupations | 0.26 | 0.00 |
| 33 | Protective Service Occupations | 0.06 | 0.00 |
| 29 | Healthcare Practitioners and Technical Occupations | 0.05 | 0.06 |
| 53 | Transportation and Material Moving Occupations | 0.03 | 0.00 |
| 31 | Healthcare Support Occupations | 0.02 | 0.00 |
| 45 | Farming, Fishing, and Forestry Occupations | 0.01 | 0.00 |
| 51 | Production Occupations | 0.01 | 0.00 |
| 49 | Installation, Maintenance, and Repair Occupations | 0.01 | 0.00 |
| 47 | Construction and Extraction Occupations | 0.00 | 0.00 |
| 35 | Food Preparation and Serving Related Occupations | 0.00 | 0.00 |
| 37 | Building and Grounds Cleaning and Maintenance Occupations | 0.00 | 0.00 |

and Figure 1. Table 3 reports the share of jobs that can be performed at home by major group of occupation for both measures. The reported shares are generally quite similar across the two methods.

For a small set of occupations, however, the two methodologies do reach opposite conclusions. Appendix Table A.1 reports the 5-digit occupation codes for which the two measures differ by 0.8 or more.[4] Our baseline classification based on O*NET survey responses says that fundraisers, for example, cannot work from home, whereas our manual classification says that they can. Our baseline classification codes mail clerks as able to work from home, whereas the manual classification says that they cannot.

# 3    Results for countries other than the United States

To produce estimates for other countries, we merge our classification of whether each 6-digit SOC can be done at home based on the U.S. O*NET surveys with the 2008 edition of the international standard classification of occupations (ISCO) at the 2-digit level. The ISCO standard for classifying occupations was adopted by the ILO, which compiles information on employment in each 2-digit ISCO for a large number of countries. We employ a crosswalk between the SOC and ISCO schemes from the U.S. BLS.

The mapping of (6-digit) SOCs to (2-digit) ISCOs is many-to-many, so determining the share of jobs that can be done from home in any ISCO is not trivial. To summarize, our classification of whether a 6-digit SOC can be done at home is determined entirely using only U.S. data, our mapping of 6-digit SOCs to 2-digit ISCOs is common to all countries, and the weighted average for each 2-digit ISCO is country-specific. For more details, see the Appendix and the replication package.
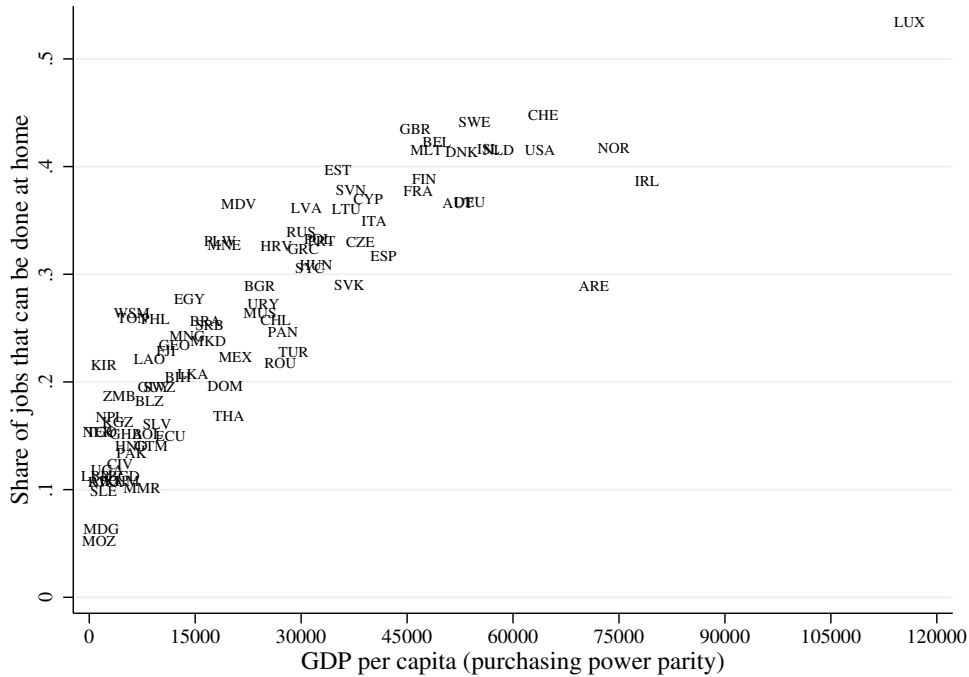
Figure 2 plots our measure of the share of jobs that can be done at home in each country against its per capita income. We compute the jobs share using the most recent employment data available from the ILO after restricting attention to countries that report employment data for 2015 or later.[5] The income measure is GDP per capita (at current prices and translated into international dollars using PPP exchange rates) in 2019, obtained from the International Monetary Fund. The figure reveals a clear positive relationship between income levels and the shares of jobs that can be done from home. While fewer than 25 percent of jobs in Mexico and Turkey could be performed at home, this share exceeds 40 percent in Sweden and the United Kingdom.[6] Note that our classification assesses the ability to perform a particular occupation from home based on U.S. data and that the nature of an occupation likely varies across economies with different income levels. With that caveat, the striking pattern in Figure 2 suggests that developing economies and emerging markets may face an even greater challenge in continuing to work during periods of stringent social distancing.

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[4]Since the O*NET-derived measure is defined for 6-digit occupations, this measure is not necessarily 0 or 1 at the 5-digit level. We aggregate 6-digit occupations weighting by employment counts.

[5]The full table of results is available as a CSV file in our replication package.

[6]The share for the United States in Figure 2 is 41 percent. This differs from the 37 percent reported in the main text due to the different weights implicit in our use of ILO data rather than BLS data.

Figure 2: Share of jobs that can be done at home, by GDP (PPP) per capita

*Share of jobs that can be done at home* (y-axis, from 0 to .5)

*GDP per capita (purchasing power parity)* (x-axis, from 0 to 120000)

# 4  Related literature

Our coding of occupational characteristics to determine how flexibly certain jobs can be relocated has clear roots in the exercise in Blinder (2009) that assessed the "offshorability" of jobs. While our approach is similar, we cannot simply use Blinder's index because the feasibility of working from home is quite distinct from offshorability. For example, Blinder and Krueger (2013) write, "we know that all textile manufacturing jobs in the United States are offshorable." Textile manufacturing jobs, of course, cannot be performed at home using current production technologies.

Our work also relates to Mas and Pallais (2020), who offer a detailed and helpful overview of the prevalence, features, and demand for alternative working arrangements, including the ability to work from home. Citing the Quality of Worklife Survey and the Understanding American Study, they report that less than 13 percent of full- and part-time jobs have a formal "work-from-home" arrangement, even though twice that amount work often from home.[7] According to Mas and Pallais, the "median worker reports that only 6 percent of their job could be feasibly done from home," but plenty of jobs, including those in "computer and mathematical" and "business and financial operations" can do a majority of their work

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[7]A recently released paper by the United Kingdom Office for National Statistics (2020) reports that while 27 percent of the U.K. workforce said they've previously worked from home, only about 5 percent said they mainly work from home. Whether people have actually worked from home differs conceptually from the focal question of this paper, which is whether these people could feasibly work from home.

from home. We note that, in the context of the response to COVID-19, there is an important distinction between being able to do most and all of one's work at home.

Saltiel (2020) estimates the share of jobs that can be done from home in ten developing economies using surveys of occupations in those ten lower-income contexts. Following our approach, he uses information on workers' tasks in the Skills Toward Employability and Productivity (STEP) survey to define the feasibility of working from home. The advantage of using these data is that it addresses the concerns raised by defining the feasibility of performing a job at home based on the U.S. economic context.[8] Saltiel (2020) finds that few jobs can be done at home, ranging from 5 to 23 percent across the ten economies, and reports a positive correlation between this share and GDP per capita. Five of the economies covered by Saltiel (2020) also appear in our Section 3 results. Our results for Bolivia, Georgia, and Macedonia are within a few percentage points of the numbers Saltiel reports. Our results for Ghana and Laos are notably higher, 14 and 21 percent versus roughly 5 and 9 percent, respectively. In addition to differences in the O*NET and STEP survey questions, these differences may be attributable to the ILO data and STEP survey differing in temporal (2017 vs 2012-2013) and geographic (national vs urban) coverage.

Mongey and Weinberg (2020) use our occupational classification to study the characteristics of individuals who cannot work at home. They find that these individuals are more likely to be non-white, lower-income, rent their dwellings, lack a college degree, and lack employer-provided health insurance. Baker (2020) and Koren and Pető (2020) also use O*NET survey data to construct measures of which occupations cannot be done at home or will be affected by social distancing.

Two recent papers use online surveys to produce real-time measures of working from home for the United States during the first week of April 2020. Brynjolfsson et al. (2020) report that nearly half of the individuals they surveyed said they were working from home. Bick and Blandin (2020) report that more than 60 percent of their respondents' work hours were performed at home. Though these figures are higher than our estimate of the share of U.S. jobs that can be performed entirely at home, these numbers are not necessarily comparable: in the short run, we expect many employees to perform parts of their jobs at home rather than being wholly furloughed or laid off. In addition, those who can work from home may be overrepresented in online surveys.

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[8]Gottlieb, Grobovsek and Poschke (2020) apply our classifications of occupations to labor force and household surveys in 57 countries. In line with our findings, they report that smaller shares of jobs can be done at home in poorer economies. They note, however, that small family farms in principle could operate while limiting social interactions and obeying stay-at-home orders. Classifying all farming jobs as such substantially increases the estimated share of jobs that can be done at home in some poor economies with large agricultural employment shares. Stratton (2020) applies our classifications to data for Australia. Barbieri, Basso and Scicchitano (2020) use the Italian equivalent of the O*NET surveys and a similar set of questions to produce a work-from-home measure for Italy. Boeri, Caiumi and Paccagnella (2020) combine O*NET information, a survey of the Italian Statistical Office and INAP, and their own assessment to estimate how many jobs can potentially be carried out remotely for six European economies.

# 5 Conclusion

Due to COVID-19, many employees are unable to travel to work. Identifying which jobs cannot be performed from home may be useful as policymakers try to target social insurance payments to those that most need them. Likewise, the share of jobs that could be performed at home is an important input to predicting the economy's performance during this or subsequent periods of social distancing. We note, however, that it is not straightforward to use these values to estimate the share of output that would be produced under stringent stay-at-home policies. An individual worker's productivity may differ considerably when working at home rather than her usual workplace. More importantly, there are likely important complementarities between jobs that can be performed at home and those that cannot. Incorporating our measures together with these richer considerations is a fruitful avenue for future research.

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Appendix for
# "How Many Jobs Can be Done at Home?"

### Jonathan I. Dingel    Brent Neiman

This Appendix describes how we classified U.S. occupations base on O*NET survey responses and how we mapped our classifications to other countries via the international standard classification of occupations.

## A.1    Classifying occupations based on O*NET surveys

Our baseline U.S. results use the responses to two O*NET surveys to designate any given occupation, based on the standard occupational classification (SOC) code, as able or unable to be performed at home. We then merge this information with BLS data on the number and wages of workers in each SOC in the country as a whole as well as in metropolitan areas and industries.

If any of the following conditions in the "Work Context" survey responses are true, we code the occupation as one that cannot be performed at home:

- Average respondent says they use email less than once per month (Q4)
- Majority of respondents say they work outdoors every day (Q17)
- Average respondent says they deal with violent people at least once a week (Q14)
- Average respondent says they spent majority of time wearing common or specialized protective or safety equipment (Q43)
- Average respondent says they spent majority of time walking or running (Q37)
- Average respondent says they are exposed to minor burns, cuts, bites, or stings at least once a week (Q33)
- Average respondent says they are exposed to diseases or infection at least once a week (Q29)

If any of the following conditions in the "Generalized Work Activities" survey responses are true, we code the occupation as one that cannot be performed at home:

- Performing General Physical Activities is very important (Q16A)
- Handling and Moving Objects is very important (Q17A)
- Controlling Machines and Processes [not computers nor vehicles] is very important (Q18A)
- Operating Vehicles, Mechanized Devices, or Equipment is very important (Q20A)
- Performing for or Working Directly with the Public is very important (Q32A)
- Repairing and Maintaining Mechanical Equipment is very important (Q22A)
- Repairing and Maintaining Electronic Equipment is very important (Q23A)
- Inspecting Equipment, Structures, or Materials is very important (Q4A)

Table A.1: Occupations for which survey-derived and alternative measures differ considerably

|  | Occupation | O*NET-derived baseline | Manual alternative |
|---|---|---|---|
| 13-1130 | Fundraisers | 0.00 | 1 |
| 13-2080 | Tax Examiners, Collectors and Preparers, and Revenue Agents | 0.00 | 1 |
| 19-3050 | Urban and Regional Planners | 0.00 | 1 |
| 41-3040 | Travel Agents | 0.00 | 1 |
| 43-2020 | Telephone Operators | 0.00 | 1 |
| 43-4180 | Reservation and Transportation Ticket Agents and Travel Clerks | 0.00 | 1 |
| 13-2070 | Credit Counselors and Loan Officers | 0.10 | 1 |
| 17-3020 | Engineering Technicians, Except Drafters | 0.17 | 1 |
| 39-3010 | Gaming Services Workers | 0.85 | 0 |
| 25-2050 | Special Education Teachers | 0.92 | 0 |
| 27-2020 | Athletes, Coaches, Umpires, and Related Workers | 0.93 | 0 |
| 25-2010 | Preschool and Kindergarten Teachers | 1.00 | 0 |
| 25-4020 | Librarians | 1.00 | 0 |
| 25-4030 | Library Technicians | 1.00 | 0 |
| 27-4020 | Photographers | 1.00 | 0 |
| 33-9020 | Private Detectives and Investigators | 1.00 | 0 |
| 39-3030 | Ushers, Lobby Attendants, and Ticket Takers | 1.00 | 0 |
| 39-9010 | Childcare Workers | 1.00 | 0 |
| 39-9040 | Residential Advisors | 1.00 | 0 |
| 43-1010 | First-Line Supervisors of Office and Administrative Support Workers | 1.00 | 0 |
| 43-5020 | Couriers and Messengers | 1.00 | 0 |
| 43-9050 | Mail Clerks and Mail Machine Operators, Except Postal Service | 1.00 | 0 |
| 43-9070 | Office Machine Operators, Except Computer | 1.00 | 0 |

## A.2 Mapping to international occupational codes

This section describes how we map 6-digit SOCs to 2-digit ISCOs. Ideally, each SOC would map to a unique ISCO, so that we could simply calculate the ISCO share as a weighted average of SOC shares, using the SOCs' U.S. employment counts as the weights. However, given the many-to-many mapping, this approach would put disproportionate weight on those SOCs that happen to map to a larger number of ISCOs. To address this issue, when an SOC maps to multiple ISCOs, we allocate the SOC's U.S. employment weight across the ISCOs in proportion to the ISCOs' employment shares in the "target" country.[1] Since 2-digit ISCO employment shares vary by country, the reported share of jobs that can be done from home in each 2-digit ISCO differs across countries.

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[1]For instance, if a particular SOC has 100 U.S. employees and is associated with two ISCOs that have respective totals of 3000 and 1000 employees in a country, we allocate 75 of the SOC's U.S. employees to the larger ISCO and 25 to the smaller one. Those values of 75 and 25 are then used as that SOC's weight when calculating the average across all SOCs within each ISCO for that country.