Research & Policy
INSIGHTS

Publication 101 December 2020

COVID-19 Induced Automation: An Exploratory Study of Critical Occupations

Chun Song
Purdue Center for Regional Development &
Department of Agricultural Economics

Lionel J. Beaulieu
Purdue Center for Regional Development &
Department of Agricultural Economics

Indraneel Kumar
Purdue Center for Regional Development

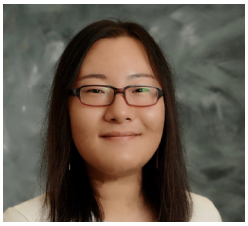
PURDUE UNIVERSITY
Center for Regional Development

COVID-19 Induced Automation: An Exploratory Study of Critical Occupations

Abstract

The COVID-19 pandemic may stimulate the use of automation especially for critical occupations. In this report, we evaluate the potential for each detailed SOC occupation being automated due to the COVID 19 by two dimensions: its susceptibility disease exposure and the capacity being automated prior to the pandemic. We classify each occupation and visualize its chance of pandemic-induced automation. We also calculate the number and share of essential workers who might face such pandemic-induced automation in Indiana counties. These findings contribute to the early assessment of the potential impact of COVID-19 on the labor market through the automation process.

Authors



Song Chun
Research Assistant/Ph.D. candidate

Linoel "Bo" Beaulieu
Professor of Rural & Regional Development

Indraneel Kumar
Principal Regional Planner

Key Findings

The following occupations were found to have a **High Exposure Index** and a **High Automation Index** and are the most at risk for pandemic-induced automation. These jobs made up **7%** of Indiana jobs in 2018.

- Pharmacy Technicians
- Maintenance & Repair Workers
- Food Servers
- Dishwashers
- Janitors & Cleaners
- Waiters and Waitresses
- Cashiers
- Nonfarm Animal Caretakers

Many occupations found to be of the highest risk for pandemic-induced automation are predominately employed in the essential industry

23%
of Indiana jobs as of 2018 are at high risk of pandemic-induced automation

17%
of all the occupations in Indiana are at high risk of pandemic-induced automation

MARION COUNTY
has the largest number of Essential Industry jobs as of 2018

MARTIN COUNTY
has the largest share of Essential Industry jobs as of 2018

Background

The COVID-19 pandemic might induce the use of automation procedures and robots to replace human workers, especially those individuals who are engaged in critical occupations with higher risks of exposure due to job-related functions. In the recent past, researchers have examined the impacts of automation on low, middle, and high-skill occupations. The general findings are that automation (robotics, artificial intelligence, computerization, etc.) can boost productivity and create new jobs. But at the same time, it may cause polarization of wages and replace occupations, especially more routine low and middle-income jobs. (Acemoglu & Restrepo, 2018; Frey & Osborne, 2017; Autor & Salomons, 2018; Kumar et al., 2020).

Amid COVID-19, companies and hospitals are now expanding their use of robots to enforce social distancing and reduce the number of workers that have to physically come in contact with co-workers while carrying out their job responsibilities. For example, Walmart[1] is utilizing "cleaning" robots to scrub floors and "stock" robots to refill shelves. In addition, fast food restaurants are expanding their installation of kiosks[2] while hospitals[3] are deploying robots to measure patient's body temperature and distribute hand sanitizers. Although such adoption has been widely observed prior to the pandemic, COVID 19 seems to have accelerated this process.

While the coronavirus will eventually taper off and the coping strategies adopted as a result of the pandemic may be just as short-lived, some suggest that the pandemic is likely to alter consumer preference[4] over the long run, potentially re-defining work and expanding the demand for robot workers in the near future. Economists have noted the cyclical nature of automation. For example, a recent Brookings Institution analysis[5] has pointed out that the coronavirus might lead to a recession, which is likely to bring about a spike in labor-replacing technologies. All these open new opportunities for automation, but at the same time, cast challenges for workers in certain occupations if the adoption of these innovations translates into jobs being replaced on a permanent basis.

In light of the impact that COVID-19 may have on the manner in which work is performed, this report serves as a preliminary assessment of pandemic-induced automation and its impact on various occupations in Indiana by taking the following steps. We do so by undertaking the following steps. First, a proximity and contagious disease risk-based assessment of occupations is developed. Next, the propensity of occupations being automated along two strands – the disease-risk associated with a given occupation and the capacity for the job to be automated – is analyzed . Then, a quadrant plot is produced as a way to visualize and distinguish occupations that have higher versus lower tendencies for pandemic-induced automation. Lastly, the number and share of essential workers who might face such pandemic-induced automation in Indiana counties are calculated. We now turn to a more detailed description of the study methodology, our data analysis, as well as presentation and discussion of results.

[1] https://www.cnn.com/2020/04/07/business/grocery-stores-robots-automation/index.html

[2] https://modernrestaurantmanagement.com/are-kiosks-safer-during-coronavirus-outbreak/

[3] https://www.theguardian.com/technology/2020/may/31/the-five-robots-helping-to-tackle-coronavirus

[4] https://www.bbc.com/news/technology-52340651

[5] https://www.brookings.edu/blog/the-avenue/2020/03/24/the-robots-are-ready-as-the-covid-19-recession-spreads/

Method

The pandemic-induced automation measure begins with each SOC 5-digit occupation code[6]. We evaluate the position of each occupation along two dimensions: (1) The Exposure Index which measures how susceptible an occupation is to close contact with other humans and proximity to infection and disease, and hence, the possible exposure to contagious and virulent diseases such as the coronavirus-based SARS, MERS, and COVID-19; and (2) The Automation Index which measures the likelihood of computerization of each occupation, irrespective of its pandemic-related risk.

The Exposure Index

The Exposure Index measures the risk of a worker in a given occupation being exposed to other humans and hence, the possibility of contracting contagious diseases. The original data are obtained from the O*NET (Occupational Information Network). The O*NET database includes ratings of work characteristics for individual occupations. We use the O*NET ratings of two important work characteristics that could make a particular occupation more susceptible to the pandemic: (1) the risk of being exposed to diseases or infections based upon the nature of a person's occupation; and (2) physical proximity of a person's job to other co-workers.

To calculate the Exposure Index, we first match each O*NET occupation to the relevant SOC occupation. This is because O*NET is more detailed than SOC. For each SOC, there are usually multiple O*NET occupations. For example, SOC 29-1071 is a Physician Assistant, which is further classified into O*NET 29-1071.00, Physician Assistants, and 29-1071.01, Anesthesiologist Assistants. Whereas BLS gathers employment and wage data at the level of SOC, O*Net develops occupational characteristics, such as knowledge, skills, abilities, work conditions, etc., at a more granular level. Therefore, we use the average of O*NET for each SOC. In total, we have information on 775 SOC 5-digit occupations. Next, we calculate the average of the following two scores as the Exposure Index. These two scores have also been accounted for in a recent study in evaluating the health impact of the pandemic on different occupations (Zipper, 2020).

Risk of exposure to diseases and infections. This scale has a range of 0 to 100, where 0 means the job has no exposure; 25 indicates the person has the potential to be exposed once a year or more but not every month; 50 signifies that exposure could occur once a month or more but not every week; 75 implies that such exposure could be once a week or more but not every day; and 100 specifies that the risk of exposure could be a daily concern. Acute care nurses, dental hygienists, family, and general practitioners, and general internists score 100 points on the exposure to disease or infection scale.

TABLE 1. Example of How the Exposure Index Is Calculated

SOC	O*NET	Disease Exposure	Average	Physical Proximity	Average	Exposure Index
29-1071 Physician Assistant	29-1071.00 Physician Assistants	94	93	88	88.5	$\frac{(88.5 + 93)}{2} = 90.8$
	29-1071.01 Anesthesiologist Assistants	92		89		

[6] The Standard Occupational Classification (SOC) system is used to sort workers into occupational categories. All workers are grouped into one of approximately 775 detailed occupations according to their occupational definition. Our list of SOC occupations is obtained from Emsi (Economic Modeling Specialists International). Emsi follows BLS's SOC structure with slight modifications. For more information see https://kb.emsidata.com/methodology/emsi-soc/.

Physical proximity to other people. This metric provides a score for each detailed occupation (5-digit Standard Occupation Code or SOC) ranging from 0 to 100, with a higher score indicating that the person's job involves greater contact with others and as such, is at a higher risk of exposure. Specifically, a 0 score means the individual is working in an isolated environment (at least 100 feet apart from others), 25 indicates working in a private office, 50 translates to work activities that are conducted in a shared office, 75 implies that co-workers are located at arm's length, and 100 means the individual is nearly touching other humans. Choreographers, dental hygienists, physical therapists, and sports medicine physicians score 100 on this scale. Slaughterers and meat packers, an occupational group that experienced high rates of COVID-19 infection in both in rural Indiana and the U.S., tend to score higher (with the score 73) on this scale as well.

The Exposure Index is the average of the two ratings mentioned above. Table 1 illustrates one example of how the Exposure Index is calculated for each SOC occupation.

The Automation Index

The automation index for each occupation is obtained from Emsi (Economic Modeling Specialists International). This method starts with estimated task time shares, derived from O*NET work activities, and links with each occupation based on Frey and Osborne's "computerization probabilities" (2017). Then, it is weighted by the number of U.S. workers classified in each occupation as of 2018. A higher automation score signifies that a job has a greater propensity of being automated.

We then visualize and distinguish the position of each occupation along the two dimensions: Exposure Index and Automation Index using a quadrant plot. The results are presented in the next section[7].

Results

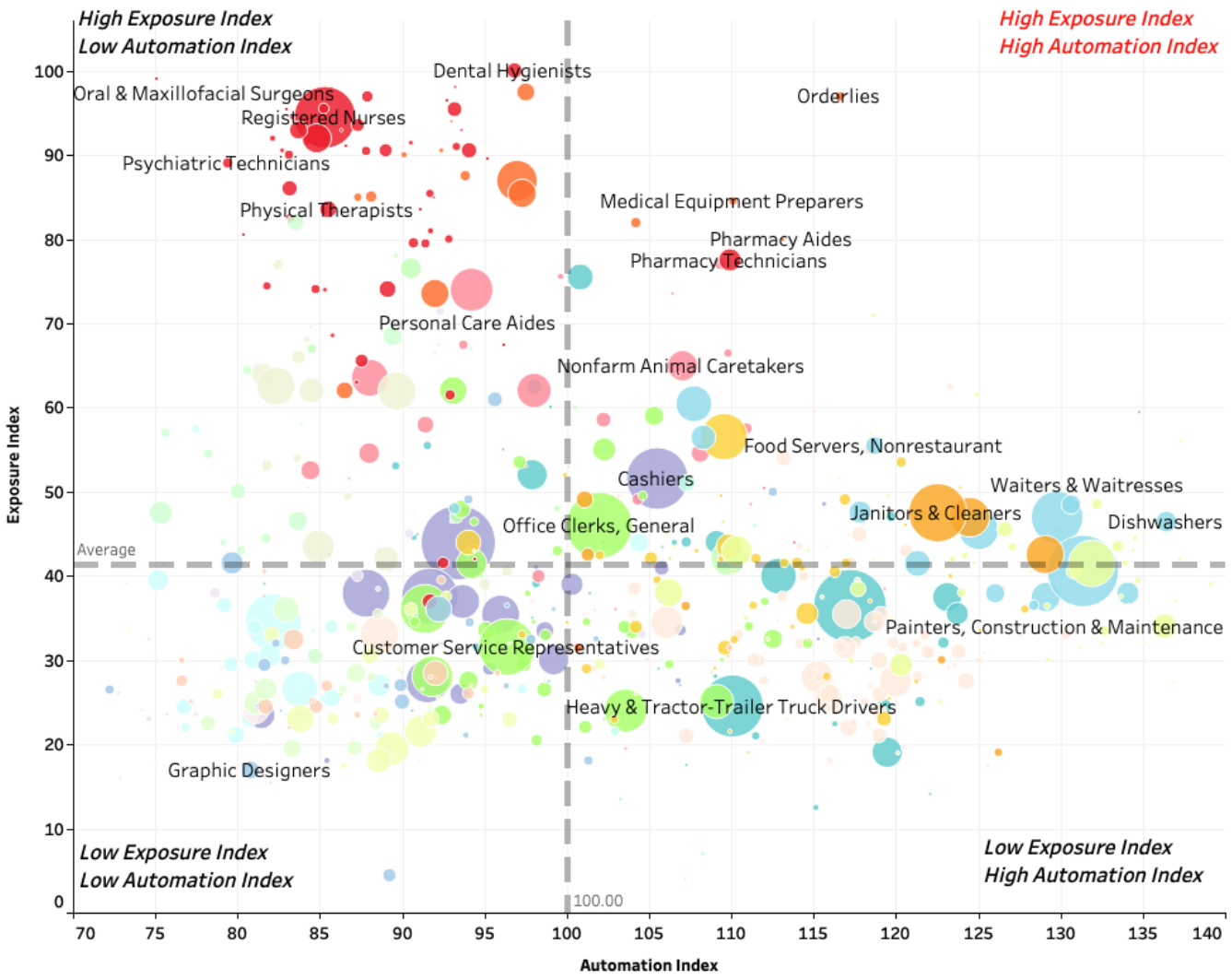
In the quandrant plot (see Figure 1), each bubble represents an occupation and its position along two dimensions. The horizontal axis shows the Automation Index while the vertical axis represents the Exposure Index. Recall that this Exposure Index is the average of (1) risk of exposure to diseases and infections, and (2) physical proximity.

The dashed grey reference lines display the average along each dimension. The average is 41.4 for the Exposure Index, and 100 for the Automation Index. Note that the Automation Index (developed by Emsi) scores the U.S. average as 100, which means an occupation scoring higher has a higher automation propensity than the one scoring less than 100. These two reference lines separate the plot into four quadrants. The top-right quadrant highlights those occupations that have a higher than average scores along both dimensions. We define those occupations as those with high pandemic-induced automation probability. The argument is that if a certain occupation is highly susceptible to a contagious disease (like COVID-19) and is already at risk of being automated before the pandemic, then the chances are strong that it will be automated as a response to the pandemic. There is a total of 124 occupations that fall into this category.

The size of the bubble refers to the number of jobs associated with a given occupation in Indiana as of 2018. Thus, a larger number of jobs in the state are noted for Laborers with 98,660 jobs, Heavy & Tractor-Trailer Truck Drivers with 71,424 jobs, Registered Nurses with nearly 69,000 jobs, and so on. The color of the bubble represents the two-digit SOC codes associated with each occupation. A total of 22 occupation groups is highlighted in different colors in Figure 1.

[7] For details of how the index is calculated, see https://kb.emsidata.com/glossary/automation-index/

FIGURE 1. Pandemic-induced Automation Quadrant for Indiana



KEY: SOC 2 DIGITS

- Architecture & Engineering
- Arts, Design, Entertainmnet, Sports, & Media
- Building & Grounds Cleaning & Maintenance
- Business & Financial Operations
- Community & Social Service
- Computer & Mathematical
- Construction & Extraction
- Education, Training, & Library
- Farming, Fishing, & Forestry
- Food Preparation & Serving Related
- Healthcare Practitioners & Technical
- Healthcare Support
- Installation, Maintenance, & Repair
- Legal
- Life, Physical, & Social Science
- Management
- Office & Administrative Support
- Personal Care & Service
- Production
- Protective Service
- Sales & Related
- Transportation & Material Moving

The following are some key observations from the Figure 1 quadrant plot:

(1) Janitors and Cleaners, Waiters & Waitress, Dishwashers, Cashiers, Food Servers, and Maintenance and Repair Workers have both high Exposure Index and high Automation Index, suggesting a relatively high propensity for pandemic-induced automation. These occupations also tend to pay lower wages, something that could limit their ability to obtain the PPE necessary to better protect them from exposure and infections.

Also, worth noting is that these occupations encompass a sizable number of workers (as shown by the large bubble size). So, it is important to account for such potential automation shock to the labor force currently employed in these occupations. The table below highlights a select

TABLE 2. Selected Occupations with High Exposure Index and High Automation Index

Occupation	Exposure Index	Automation Index	2018 Indiana Jobs	SOC 2 digits
Pharmacy Technicians	78	110	9,337	Healthcare Practitioners & Technical
Waiters & Waitresses	47	130	49,820	Food Preparation & Serving Related
Food Servers	56	119	6,466	Food Preparation & Serving Related
Dishwashers	47	136	7,594	Food Preparation & Serving Related
Maintenance & Repair Workers	57	110	39,891	Installation, Maintenance, & Repair
Janitors & Cleaners	48	123	62,867	Building & Grounds Cleaning & Maintenance
Nonfarm Animal Caretakers	65	107	17,938	Personal Care & Service
Cashiers	52	106	70,609	Sales & Related

number of occupations located in the High Exposure Index – High Automation Index quadrant. These jobs listed in the table account for 7% of all jobs in Indiana in 2018.

(2) The majority of the Health Care Practitioner and Health Care Support occupations (marked in red colors) are of high disease risk (located on the top left corner in the quadrant) but score low on the automation index, meaning that these occupations are less likely to be automated. However, exceptions are noted for Orderlies and Pharmacy Technicians, both with high exposure risk and high automation indices, and thus more likely to face pandemic induced automation.

(3) The lion's share of Food Preparations, Building & Ground Cleaning occupations show a high pandemic-induced automation index and a high disease risk.

(4) A sizable proportion of transportation occupations, which employ a large number of workers in Indiana, have high automation scores but are at low exposure risk. As a result, they have a lower propensity for being automated as an outcome of COVID-19. Note that the transportation industry is undergoing technology-induced automation, such as connected and automated vehicles or self-driving cars and trucks.

A list of the top 20 occupations in each quadrant, sorted by the total number of jobs in Indiana as of 2018, can be found in the Appendix.

The spatial distribution of the Essential Industry across Indiana

Having identified occupations that are more susceptible to pandemic-induced automation, we now turn our attention to industry sectors, evaluating the potential impacts of the pandemic on essential industry sectors across the state along with the number of at-risk occupations that are employed in essential industry sectors. The definition of essential industries is consistent with those noted in the guidelines developed by the U.S Department of Homeland Security. Essential industry jobs account for 78% of total jobs in the nation and 82% of jobs in Indiana, as of 2018. But a substantial variation exists in terms of the number of essential jobs across Indiana's 92 counties. Figure 2 presents the number of industry-related jobs identified as essential by county in 2018 while Figure 3 specifies the share of all jobs in a county classified as essential.

Main observations from the maps:

- Marion County has the largest number of Essential Industry jobs as of 2018.
- The share of Essential Industry jobs exceeds 90% in Gibson, Pike, Martin, Warren, Pulaski counties, and over 95% in Martin County.

In Gibson County, the top five sectors in essential industries include motor vehicle manufacturing, motor

FIGURE 2. The Number of Essential Industry Jobs

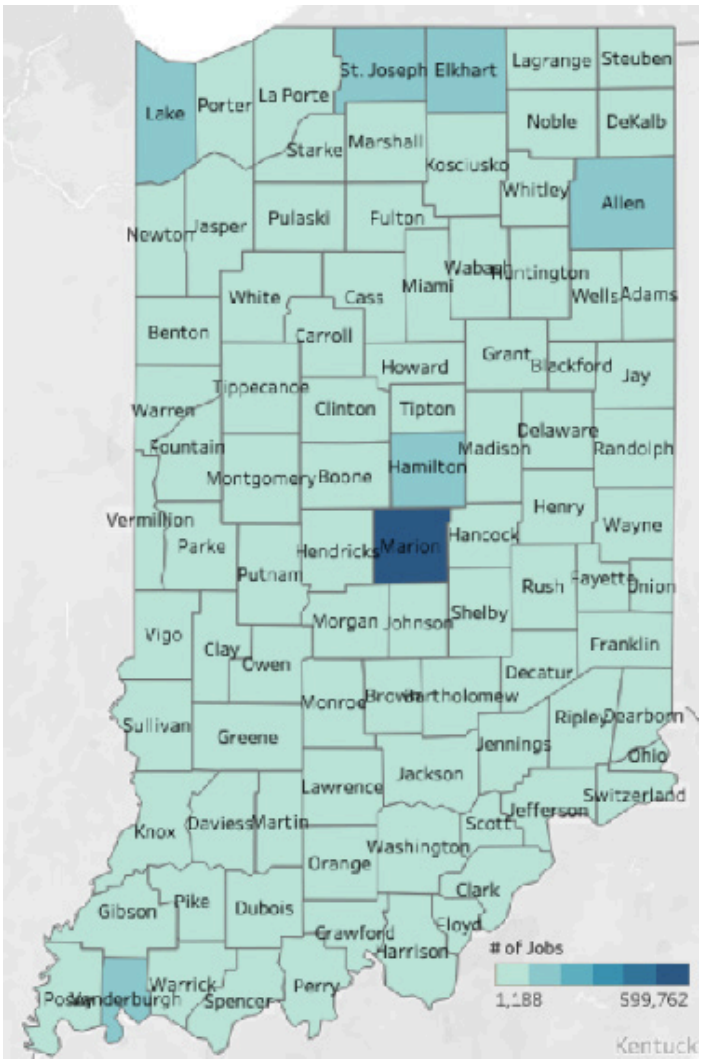
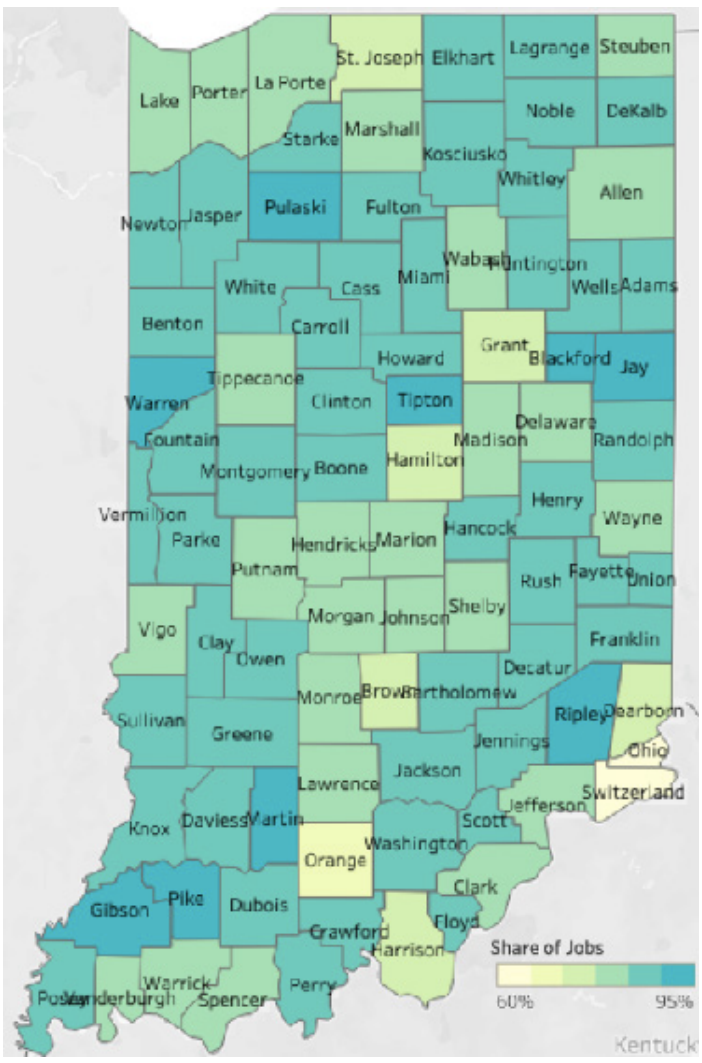


FIGURE 3. The Share of Essential Industry Jobs



vehicle parts manufacturing, employment services, restaurants and other eating places, and coal mining. Toyota Motor Manufacturing, Inc. (TMMI) is located in Gibson County and produces sports utility vehicles. Gibson County also has underground mines of bituminous coal. Pike County's top industries included electric power generation and transmission, hospitals and nursing care facilities, local government, and specialized freight trucking. More than 50% of essential industry jobs in Martin County are in the federal government civilian sector. Note that Crane Naval Research Facility is located in Martin County and as a result, a significant number of research and development professionals as well as defense contractors work in Martin County. The top five sectors in Pulaski County include public education and hospital facilities, motor vehicle body and general machinery manufacturing, animal, and crop production. Similarly, top sectors in Warren County include fabricated metal manufacturing, public education and health facilities, general medical and surgical hospitals, local government, and crop production. It is evident that counties have different leading industries within the essential industry rubric. Martin and Gibson's counties are exceptions in that they have a large employer from the defense and automobile industry, respectively. It is important to note that Emsi provides estimates for the place of work employment, and hence jobs are place-specific, but workers might be living in neighboring counties.

We also explore how many at-risk occupations identified above are employed in the essential industry sectors. For all the occupations identified as High Automation-High Exposure (located in the top right quadrant), we indicate the number of jobs that are associated with these essential industries. Notice that the same occupation can be employed both in non-essential and essential industries.

TABLE 3. High Automation-High Exposure Occupations Employed in Essential Industries in Indiana

At-risk Occupations	Employed in Essential Industries (2018)	All jobs (2018)	% Essential / All jobs	Median Hourly Earnings	Typical Entry Level Education
Combined Food Prep & Serving Workers	87,527	94,238	92.9%	$9.00	No formal educational credential
Office Clerks, General	67,507	80,813	83.5%	$15.40	High school diploma or equivalent
Janitors & Cleaners	53,832	62,867	85.6%	$12.20	No formal educational credential
Cashiers	44,657	70,609	63.2%	$9.70	No formal educational credential
Waiters & Waitresses	42,222	49,820	84.7%	$9.20	No formal educational credential
Construction Laborers	38,307	38,613	99.2%	$15.80	No formal educational credential
Maintenance & Repair Workers, General	31,695	39,891	79.5%	$18.60	High school diploma or equivalent
Cooks, Restaurant	24,697	28,961	85.3%	$11.20	No formal educational credential
Landscaping & Groundskeeping Workers	24,245	27,190	89.2%	$12.60	No formal educational credential
Maids & Housekeeping Cleaners	21,996	28,872	76.2%	$10.20	No formal educational credential
First-Line Supervisors of Food Prep. & Serving Workers	19,694	23,384	84.2%	$14.10	High school diploma or equivalent
Electricians	17,481	17,657	99.0%	$26.30	High school diploma or equivalent
Security Guards	16,890	20,546	82.2%	$11.90	High school diploma or equivalent
Bus Drivers, School or Special Client	12,074	12,759	94.6%	$12.80	High school diploma or equivalent
Industrial Machinery Mechanics	11,448	11,569	99.0%	$24.10	High school diploma or equivalent
Tellers	9,725	9,728	99.9%	$13.20	High school diploma or equivalent
Driver/Sales Workers	9,118	10,031	90.9%	$9.50	High school diploma or equivalent
Cooks, Institution & Cafeteria	8,722	11,084	78.7%	$11.70	No formal educational credential
Pharmacy Technicians	8,478	9,337	90.8%	$14.80	High school diploma or equivalent
Hosts & Hostesses	7,855	8,769	89.6%	$9.10	No formal educational credential

Table 3 shows the top 20 occupations sorted by total employment in the essential industries.

- Combined, food preparation occupations have the largest number of employees in the essential industry in Indiana.
- Most of the jobs require low entry-level education and are paid relatively lower wages.
- Construction Laborers, Tellers, Electricians are almost entirely employed in essential industries.

To sum up the findings, our initial analysis suggests that food preparation and service occupations, as well as cleaning-related occupations, have a higher chance of pandemic-induced automation, while medical and health care professionals, although they face high disease exposure risk, are less likely to be automated. Of course, this study is exploratory and does not account for constraints, such as the financial capacity of the firms given that automation is a capital-intensive undertaking, and public policy non-intended distortions, such as the Paycheck Protection Program (PPP), extended unemployment benefits, and others.

Conclusion

This report represents a preliminary assessment of the propensity of different occupations to be automated because of COVID-19. There have been some initial assessments of the labor market response to COVID-19. For example, unemployment (Cajner et al., 2020), vacancy creation (Bernstein, et al., 2020), labor force participation (Coibion et al., 2020), and job postings (Kahn et al., 2020). Studies have also modeled how the virus affects regions in different ways. These impacts are largely short-term, and none focus on the potential automation trend. However, the extent to which the pandemic will accelerate automation is a study that will require longer-term observation, data collection, and analysis of the trend.

> *Our initial analysis suggests that food preparation and service occupations, as well as cleaning-related occupations, have a higher chance of pandemic-induced automation, while medical and health care professionals, although they face high disease exposure risk, are less likely to be automated.*

Acknowledgement

We thank Dr. Roberto Gallardo for his helpful comments.

References

Acemoglu, D., & Restrepo, P. (2018). Artificial intelligence, automation and work. National Bureau of Economic Research, No. w24196.

Autor, D., & Salomons, A. (2018). Is automation labor-displacing. In Productivity growth, employment, and the labor share. BPEA Conference.

Bernstein, J., Richter, A. W., & Throckmorton, N. (2020). COVID-19: A view from the labor market. SSRN.h

Cajner, T. C.-P. (2020). Tracking labor market developments during the COVID-19 pandemic: A preliminary assessment. SSRN. Retrieved from SSRN.

Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). Labor markets during the COVID-19 crisis: A preliminary view. National Bureau of Economic Research. No. w27017.

Frey, B. C., & Osborne, A. M. (2017). The future of employment: How susceptible are jobs to computerisation? Technological forecasting and social change, 114, 254-280.

Kahn, L., Lange, F., & Wiczer, D. (2020). Labor Demand in the time of COVID-19: Evidence from vacancy postings and UI claims. National Bureau of Economic Research. No. w27061.

Kumar, I., Beaulieu, L., Zhalnin, A., & Song, C. (2020). Occupational Competitiveness Analysis of the US Transportation and Logistics Cluster. Transportation Research Record, 2674(1), 249-259.

Zipper, R. (2020, July). Should I stay (home) or go (to work)? Jobs with COVID-19 risk in Indiana's counties. Retrieved from InContext: http://www.incontext.indiana.edu/2020/july-aug/article1.asp

Appendix

Top 20 Occupations in each Quadrant from Figure 1 (Sorted by Number of Jobs in Indiana)

SOC	Occupation	Quadrant	Indiana Jobs (2018)
43-9061	Office Clerks, General	High Exposure Index, High Automation Index	80,813
41-2011	Cashiers	High Exposure Index, High Automation Index	70,609
37-2011	Janitors & Cleaners	High Exposure Index, High Automation Index	62,867
35-3031	Waiters & Waitresses	High Exposure Index, High Automation Index	49,820
49-9071	Maintenance & Repair Workers, General	High Exposure Index, High Automation Index	39,891
47-2061	Construction Laborers	High Exposure Index, High Automation Index	38,613
35-2014	Cooks, Restaurant	High Exposure Index, High Automation Index	28,961
37-2012	Maids & Housekeeping Cleaners	High Exposure Index, High Automation Index	28,872
37-3011	Landscaping & Groundskeeping Workers	High Exposure Index, High Automation Index	27,190
35-1012	First-Line Supervisors of Food Preparation & Serving Workers	High Exposure Index, High Automation Index	23,384
33-9032	Security Guards	High Exposure Index, High Automation Index	20,546
39-2021	Nonfarm Animal Caretakers	High Exposure Index, High Automation Index	17,938
47-2111	Electricians	High Exposure Index, High Automation Index	17,657
53-3022	Bus Drivers, School or Special Client	High Exposure Index, High Automation Index	12,759
35-3011	Bartenders	High Exposure Index, High Automation Index	12,019
49-9041	Industrial Machinery Mechanics	High Exposure Index, High Automation Index	11,569
35-2012	Cooks, Institution & Cafeteria	High Exposure Index, High Automation Index	11,084
53-3031	Driver/Sales Workers	High Exposure Index, High Automation Index	10,031
43-3071	Tellers	High Exposure Index, High Automation Index	9,728
29-2052	Pharmacy Technicians	High Exposure Index, High Automation Index	9,337

53-7062	Laborers & Freight, Stock, & Material Movers, Hand	Low Exposure Index, High Automation Index	98,660
35-3021	Combined Food Preparation & Serving Workers, Including Fast Food	Low Exposure Index, High Automation Index	94,238
53-3032	Heavy & Tractor-Trailer Truck Drivers	Low Exposure Index, High Automation Index	71,424
43-3031	Bookkeeping, Accounting, & Auditing Clerks	Low Exposure Index, High Automation Index	35,234
53-3033	Light Truck or Delivery Services Drivers	Low Exposure Index, High Automation Index	23,852
43-5071	Shipping, Receiving, & Traffic Clerks	Low Exposure Index, High Automation Index	20,994
51-9061	Inspectors, Testers, Sorters, Samplers, & Weighers	Low Exposure Index, High Automation Index	19,981
51-9198	Helpers--Production Workers	Low Exposure Index, High Automation Index	19,230
51-4041	Machinists	Low Exposure Index, High Automation Index	18,821
53-7051	Industrial Truck & Tractor Operators	Low Exposure Index, High Automation Index	18,413
35-2021	Food Preparation Workers	Low Exposure Index, High Automation Index	16,906
53-7064	Packers & Packagers, Hand	Low Exposure Index, High Automation Index	15,777
47-1011	First-Line Supervisors of Construction Trades & Extraction Workers	Low Exposure Index, High Automation Index	15,107
51-4072	Molding, Core making, & Casting Machine Setters, Operators, & Tenders, Metal & Plastic	Low Exposure Index, High Automation Index	14,873
51-4031	Cutting, Punching, & Press Machine Setters, Operators, & Tenders, Metal & Plastic	Low Exposure Index, High Automation Index	14,114
47-2141	Painters, Construction & Maintenance	Low Exposure Index, High Automation Index	11,046
47-2073	Operating Engineers & Other Construction Equipment Operators	Low Exposure Index, High Automation Index	9,717
53-7061	Cleaners of Vehicles & Equipment	Low Exposure Index, High Automation Index	9,447
41-2021	Counter & Rental Clerks	Low Exposure Index, High Automation Index	9,375
51-9111	Packaging & Filling Machine Operators & Tenders	Low Exposure Index, High Automation Index	9,337
41-2031	Retail Salespersons	High Exposure Index, Low Automation Index	103,018
29-1141	Registered Nurses	High Exposure Index, Low Automation Index	68,772
39-9021	Personal Care Aides	High Exposure Index, Low Automation Index	34,308

31-1014	Nursing Assistants	High Exposure Index, Low Automation Index	32,100
25-9041	Teacher Assistants	High Exposure Index, Low Automation Index	27,867
25-2021	Elementary School Teachers, Except Special Education	High Exposure Index, Low Automation Index	26,630
39-9011	Childcare Workers	High Exposure Index, Low Automation Index	25,311
39-5012	Hairdressers, Hairstylists, & Cosmetologists	High Exposure Index, Low Automation Index	21,936
25-2031	Secondary School Teachers, Except Special & Career/Technical Education	High Exposure Index, Low Automation Index	19,406
43-4171	Receptionists & Information Clerks	High Exposure Index, Low Automation Index	18,408
53-3041	Taxi Drivers & Chauffeurs	High Exposure Index, Low Automation Index	17,138
29-2061	Licensed Practical & Licensed Vocational Nurses	High Exposure Index, Low Automation Index	16,419
31-9092	Medical Assistants	High Exposure Index, Low Automation Index	15,411
31-1011	Home Health Aides	High Exposure Index, Low Automation Index	14,666
43-6013	Medical Secretaries	High Exposure Index, Low Automation Index	13,547
49-1011	First-Line Supervisors of Mechanics, Installers, & Repairers	High Exposure Index, Low Automation Index	11,714
25-2022	Middle School Teachers, Except Special & Career/Technical Education	High Exposure Index, Low Automation Index	11,401
25-3021	Self-Enrichment Education Teachers	High Exposure Index, Low Automation Index	10,847
21-2011	Clergy	High Exposure Index, Low Automation Index	9,610
25-2011	Preschool Teachers, Except Special Education	High Exposure Index, Low Automation Index	9,272
41-9022	Real Estate Sales Agents	Low Exposure Index, Low Automation Index	59,229
43-4051	Customer Service Representatives	Low Exposure Index, Low Automation Index	58,733
11-1021	General & Operations Managers	Low Exposure Index, Low Automation Index	57,547
43-6014	Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	Low Exposure Index, Low Automation Index	44,361
41-1011	First-Line Supervisors of Retail Sales Workers	Low Exposure Index, Low Automation Index	42,655
41-4012	Sales Representatives, Wholesale & Manufacturing, Except Technical & Scientific Products	Low Exposure Index, Low Automation Index	34,231

43-1011	First-Line Supervisors of Office & Administrative Support Workers	Low Exposure Index, Low Automation Index	30,593
51-1011	First-Line Supervisors of Production & Operating Workers	Low Exposure Index, Low Automation Index	26,758
41-3021	Insurance Sales Agents	Low Exposure Index, Low Automation Index	26,727
11-9141	Property, Real Estate, & Community Association Managers	Low Exposure Index, Low Automation Index	24,146
41-9091	Door-To-Door Sales Workers, News & Street Vendors, & Related Workers	Low Exposure Index, Low Automation Index	21,495
13-2052	Personal Financial Advisors	Low Exposure Index, Low Automation Index	20,255
13-1111	Management Analysts	Low Exposure Index, Low Automation Index	19,343
41-9021	Real Estate Brokers	Low Exposure Index, Low Automation Index	17,266
41-1012	First-Line Supervisors of Non-Retail Sales Workers	Low Exposure Index, Low Automation Index	14,107
13-1071	Human Resources Specialists	Low Exposure Index, Low Automation Index	13,666
27-4021	Photographers	Low Exposure Index, Low Automation Index	13,033
23-1011	Lawyers	Low Exposure Index, Low Automation Index	12,925
15-1151	Computer User Support Specialists	Low Exposure Index, Low Automation Index	12,687
13-1161	Market Research Analysts & Marketing Specialists	Low Exposure Index, Low Automation Index	11,295