

# 2018 Annual Survey of Manufacturers (ASM) Robotics Capital Expenditures and Use

Virtual Robotics Workshop

June 23, 2020

Disclaimer: Any views expressed are those of the authors and not necessarily those of the Census Bureau. The Census Bureau has reviewed this data product for unauthorized disclosure of confidential information and has approved the disclosure avoidance applied. Approval ID: CBDRB-FY2020-312.

# ASM Overview

- The purpose of the ASM is to provide key intercensal measures of manufacturing activity, products, and location for the public and private sectors. The ASM provides the best current measure of current U.S. manufacturing industry outputs, inputs, and operating status.
- The ASM provides statistics on employment, payroll, worker hours, payroll supplements, cost of materials, selected operating expenses, value added by manufacturing, capital expenditures, inventories, and energy consumption. It also provides estimates of value of shipments for 1,390 classes of manufactured products.
- Sample size- The ASM is a sample survey of approximately 50,000 establishments.
- Reporting Unit, Coverage and Applicable Sectors- Manufacturing establishments with one or more paid employees or nonemployers that use leased employees for manufacturing are classified in NAICS sector 31-33.
- Information from <https://www.census.gov/programs-surveys/asm/about.html>

# Motivation for collection

- Recently dramatic increases in the technical capabilities of artificial intelligence (AI) and robotics.
- No current firm or establishment data on:
  - how and when robotics, AI and other advanced technologies contribute to productivity.
  - the conditions under which these technologies complement or substitute for labor.
  - how these technologies affect new firm formation.
  - how they shape regional economies.
- Goal was to collect establishment (plant-level) measures of robotics stock and flow.

# Cognitive Testing

- Accounting records do not always align with economic concepts.
  - Original concept for stock had be abandoned (book value depreciated to zero before end of useful life).
  - Flow measure may include related costs (installation, training) .
  - See Buffington, Miranda, and Seamans (2018) for details.
- Final content reflects findings from testing including expanded definition, examples, limits of scope, and two count questions (one stock, one flow)
- Introduced as a special inquiry (very last question in the instrument)

# Final Content

## **INDUSTRIAL ROBOTIC EQUIPMENT**

Industrial robotic equipment (or industrial robots) are automatically controlled, reprogrammable, and multipurpose machines used in industrial automated operations.

Industrial robots may be mobile, incorporated into stand-alone stations, or integrated into a production line.

An industrial robot may be part of a robotic cell (or work cell) or incorporated into another piece of equipment.

Industrial robots are commonly used in operations such as welding, material handling, machine tending, dispensing, cleanroom, and pick and place.

# Final Content

Report capital expenditures in thousands of dollars. Estimates are acceptable.

	Check if none	2018
1. Capital expenditures in 2018 for new and used industrial robotic equipment, including software, installation, and other one-time costs	<input type="checkbox"/>	

# Final Content

Report the number of robots. Estimates are acceptable.

	Check if none	2018
2. Number of industrial robots IN OPERATION at this plant in 2018	<input type="checkbox"/>	

If you are unable to provide the number of industrial robots IN OPERATION in 2018, please explain.

	Check if none	2018
3. Number of industrial robots PURCHASED for this plant in 2018	<input type="checkbox"/>	

If you are unable to provide the number of industrial robots PURCHASED in 2018, please explain.

# ASM Response Rates

- The Unit Response Rate (URR) for the 2018 ASM was 56%. This rate is lower than in previous years, primarily due to a shortened collection period.
- The Total Quantity Response Rate (TQRR) is defined as the percentage of the estimated (weighted) item total that is obtained from directly reported data or from sources determined to be equivalent quality to reported data. The 2018 TQRR was 60% for value of shipments, and 69% for total payroll.
- Nonresponse is defined as the inability to obtain requested data from an eligible survey unit. Two types of nonresponse are often distinguished.
  - Unit nonresponse is the inability to obtain any of the substantive measurements about a unit. In most cases of unit nonresponse, the Census Bureau was unable to obtain any information from the survey unit after several attempts to elicit a response.
  - Item nonresponse occurs either when a question is unanswered or unusable.



# Post Collection Summary

- Item Non Response:
  - CEXR -
  - Robot Counts -
- Respondent challenges to report counts/cap ex.
- Low/High CEX Robot values.
- Learning from write-in data.
  - Issues consistent with cognitive testing analysis.
  - We use this to impute for missing data.
- Count data: Missing vs Zero.
  - Also used for imputation.

# CEX Traditional Imputation Approach

- Nonresponse is handled by estimating or *imputing* missing data. Imputation is defined as the replacement of a missing or incorrectly reported item with another value derived from logical edits or statistical procedures.
- The primary methods for imputing missing basic data items (such as receipts, sales, payroll, and employment) are:
  - Using administrative data
  - Deriving the missing data item from the establishment's other data (either reported or administrative)
  - Deriving the missing data item using prior ASM or economic census data
  - Obtaining the information from another census survey
- Sampled establishments that did not report product data are assigned products in a hot-deck imputation process. In this process the products from a similar establishment (called the donor) are assigned to the establishment missing the product data (the recipient).
- From <https://www.census.gov/programs-surveys/asm/technical-documentation/methodology.html>

# CEX Traditional Imputation Approach (cont.)

- However, CEX is a complex that can move independently from our typical payroll, costs, and receipts.
- The capex complex is completely off the grid so to speak at the moment, evaluation, editing, and imputation done offline and data added through mass corrections.
- The basic idea for the imputation is to use regression models that incorporate PAYANN, RCPTOT, and CSTMTOT (current year values). Many of the largest companies are evaluated and researched to determine at least a company level total and then updates are made down to the individual establishments. Knowing how to account for reported zeroes is also a part of the overall evaluation and something that can narrow down to the establishment level of large companies.
- It is a challenge to get accurate. While we are aware of the value coming out of ACES and at least big picture tend to track similarly, there are enough differences in how the data are collected and imputed, that the totals can also be legitimately different for various reasons.

# Experimental Product Imputation

- In process.
- Impute missing robot use using write-in data and check boxes.
- Impute CEXR delinquents/item non-response (no write-in):
  - Propensity score (to determine if robot expenditures).
    - Based on size, industry, location, CEX, firm age, establishment age, robot presence.
  - Regression models to impute value.
- Impute count.
  - Poisson regression (count data) model.
  - Not explored actual values (rare to see count and no CEXR).
  - uses of count data? Currently no experimental product based on Count values

# Experimental Data: First Look

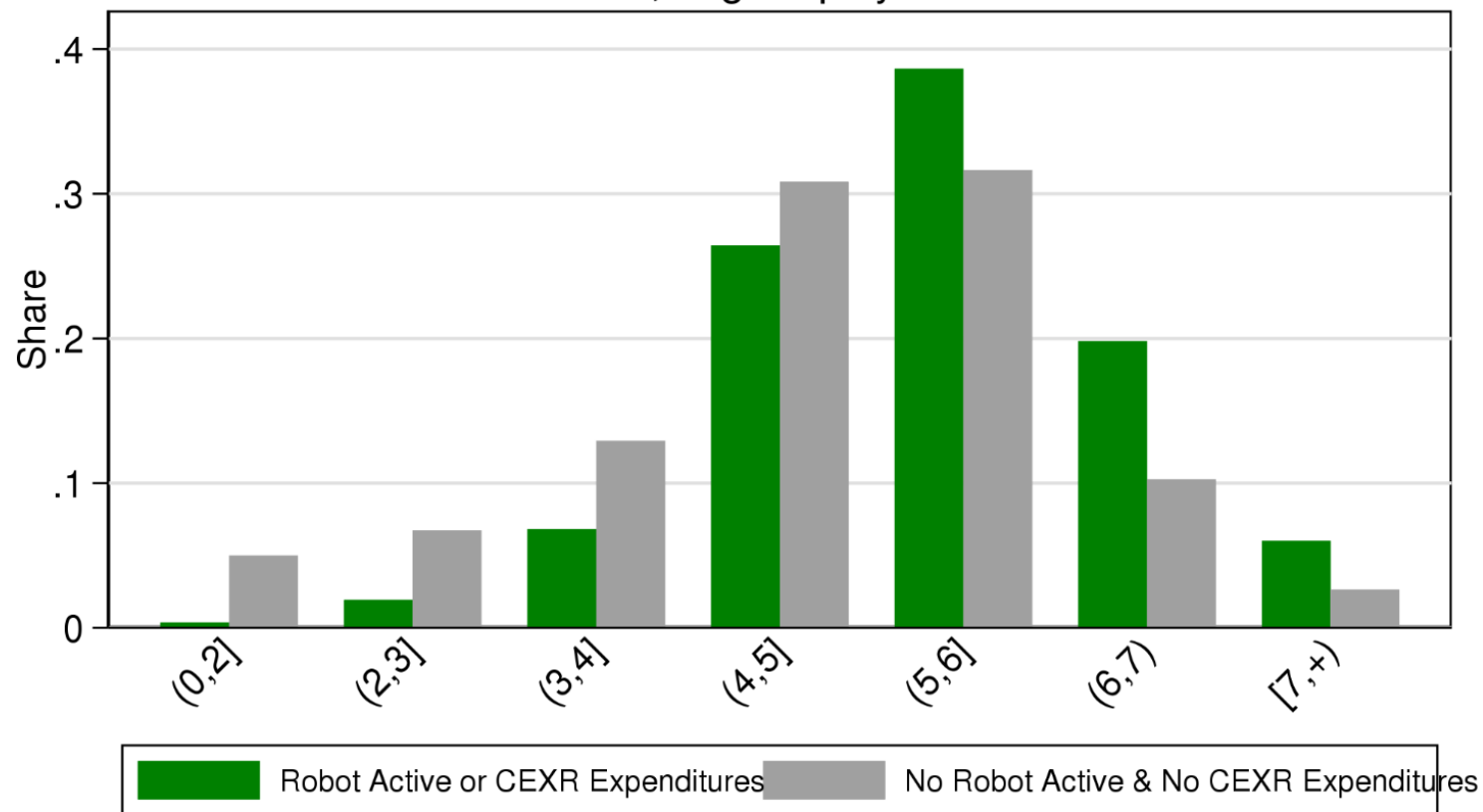
# Robotics estimates

- Establishment level collection (not firm sample). Estimates based on physical location.
- NOT REPRESENTATIVE of the firm.
- Geographic estimates are possible → we'll see some.
- No imputation for non response yet.
- The ASM has a "mail" and "non-mail" component, and our work pertains to the mail component (up to 10% of smaller firms by detailed NAICS).
- This is a preliminary look!!!

# First Look tables

- Robot Adoption.
- Robot Exposure (worker weighted).
- Other?

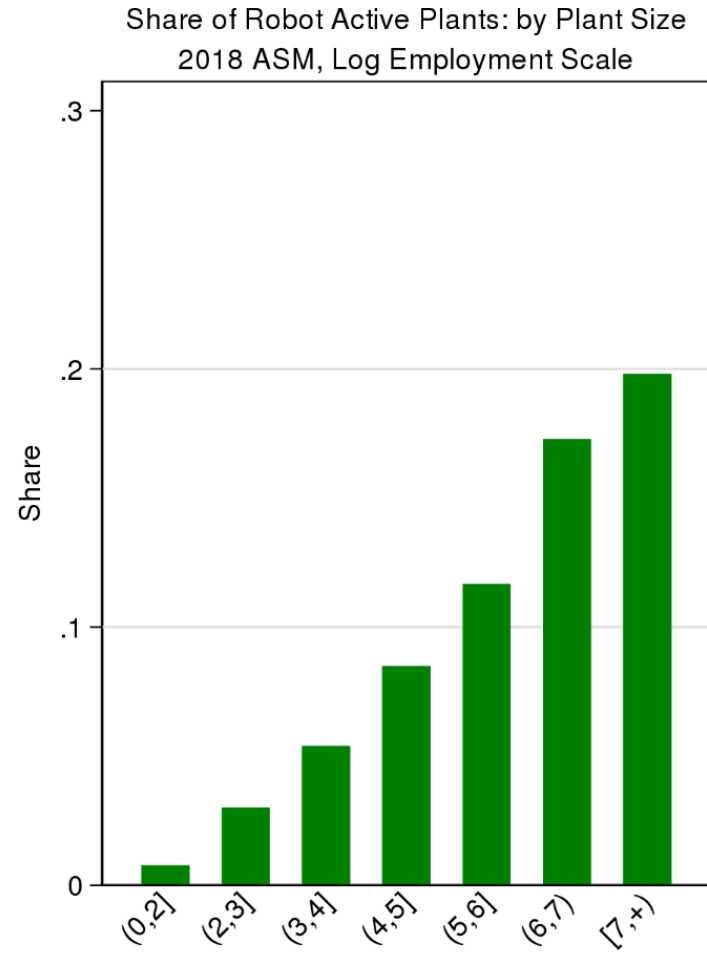
## Plant Size Distribution: Robot Adopters vs Not 2018 ASM, Log Employment Scale



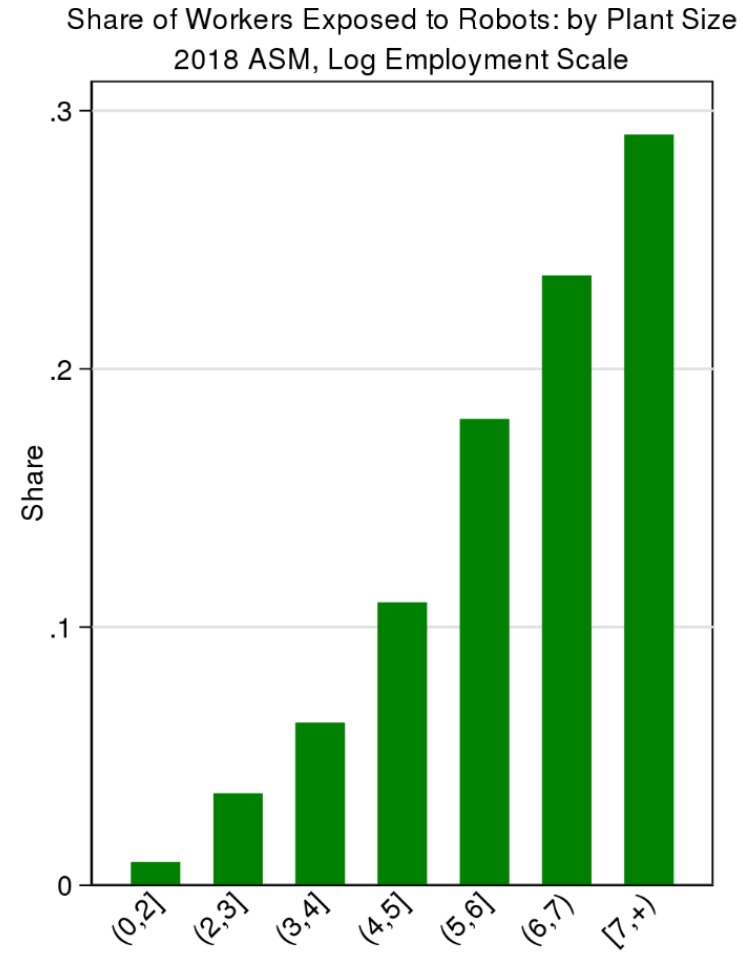
Note: Not imputed for delinquents or missing data. Source: Annual Survey of Manufactures.  
Own Calculations. Preliminary.



# Share of Robot Active Plants and Workers Exposed to Robots: by Plant Size



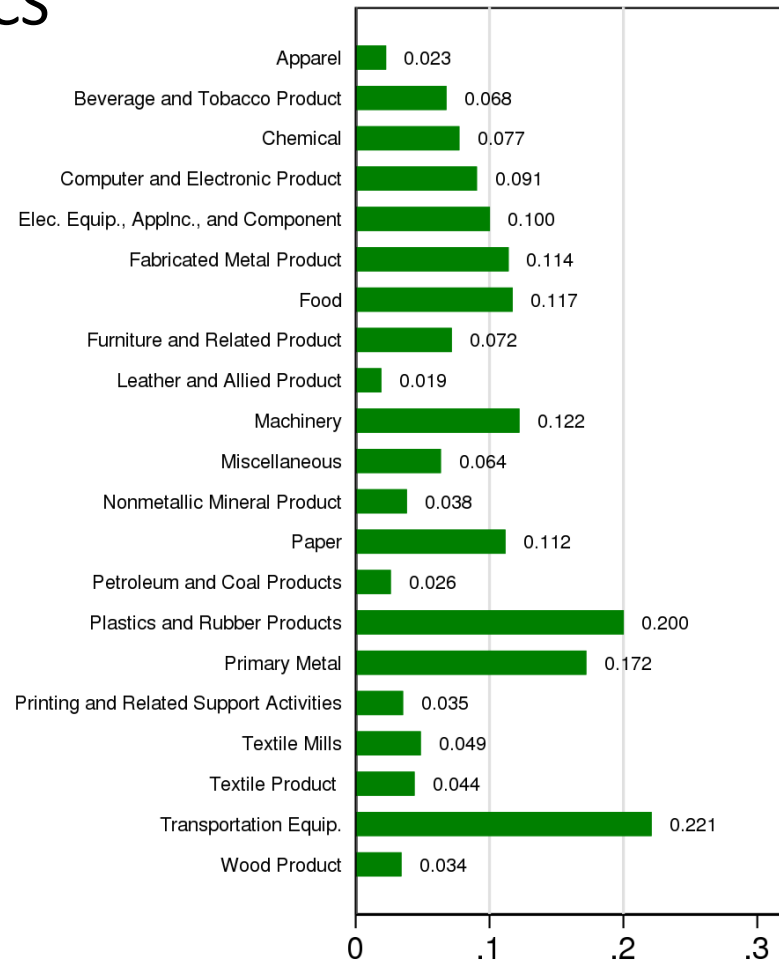
Note: Not imputed for delinquents or missing data.  
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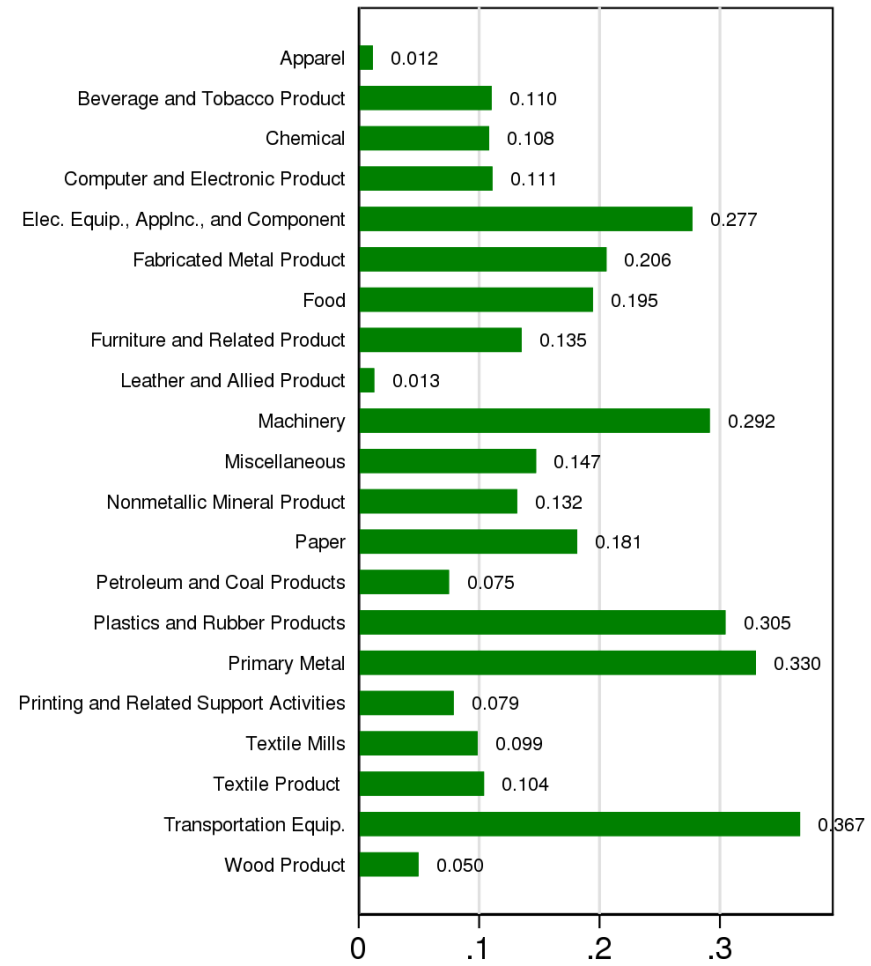
# By 3-Digit NAICS

## Share of Plants Using Robots 2018 ASM



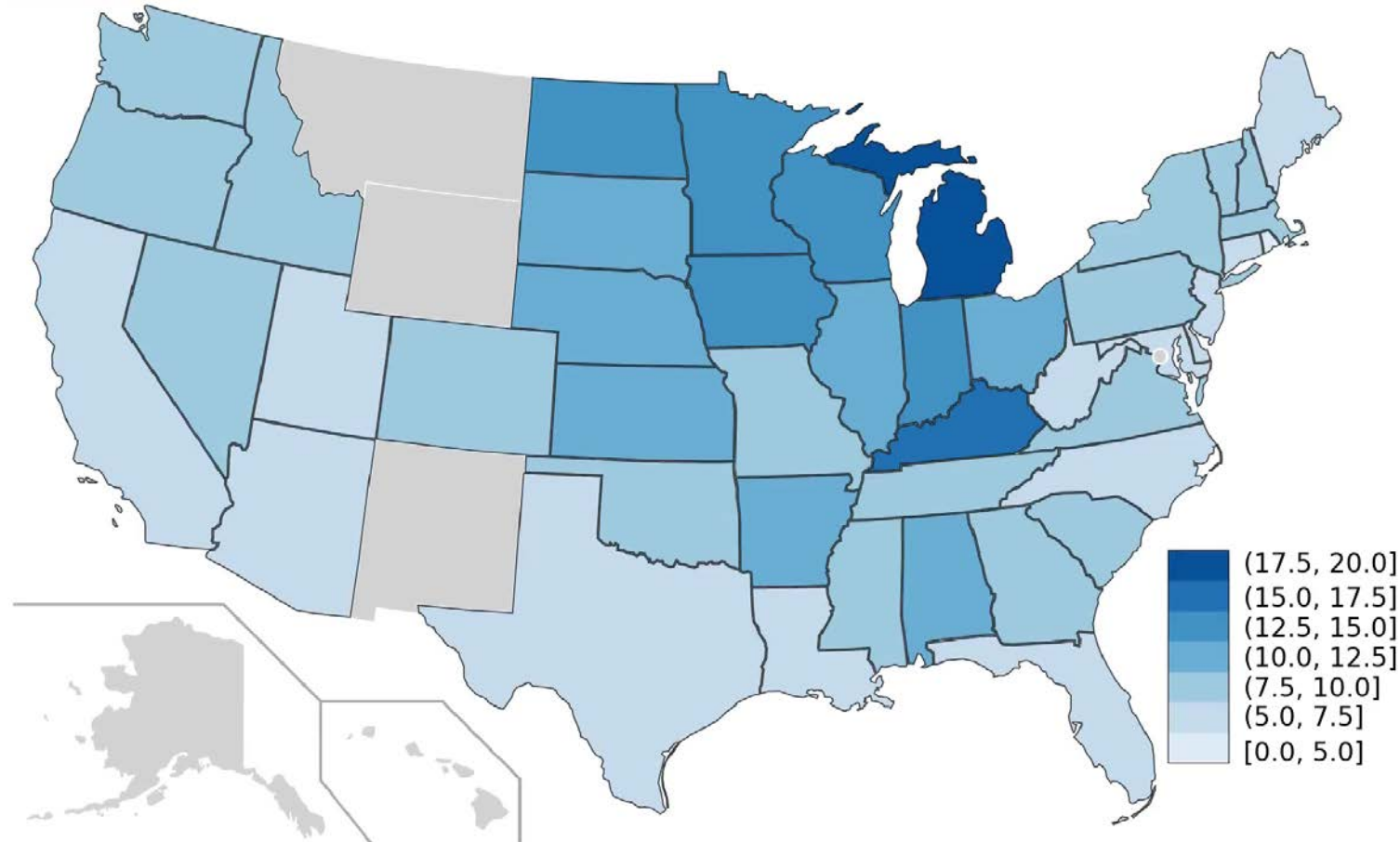
Note: Not imputed for delinquents or missing data.  
Own Calculations. Preliminary.  
Source: Annual Survey of Manufactures.

## Share of Workers Exposed to Robots 2018 ASM

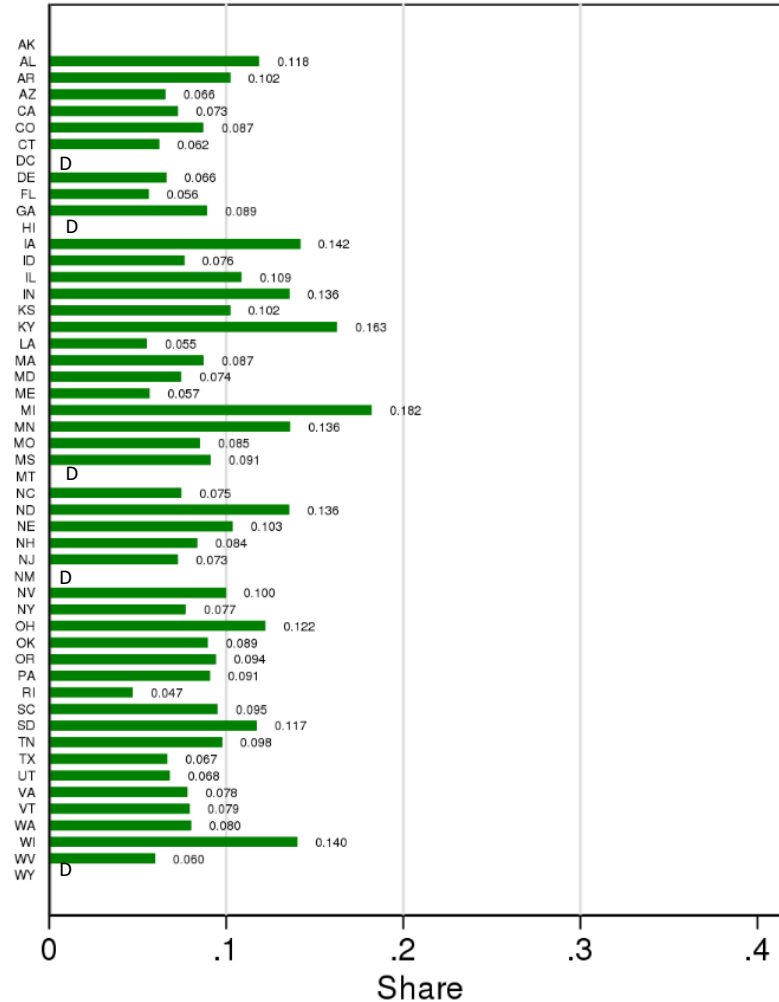


Note: Not imputed for delinquents or missing data.  
Own Calculations. Preliminary.  
Source: Annual Survey of Manufactures.

# Percent of Plants Using Robots: by State

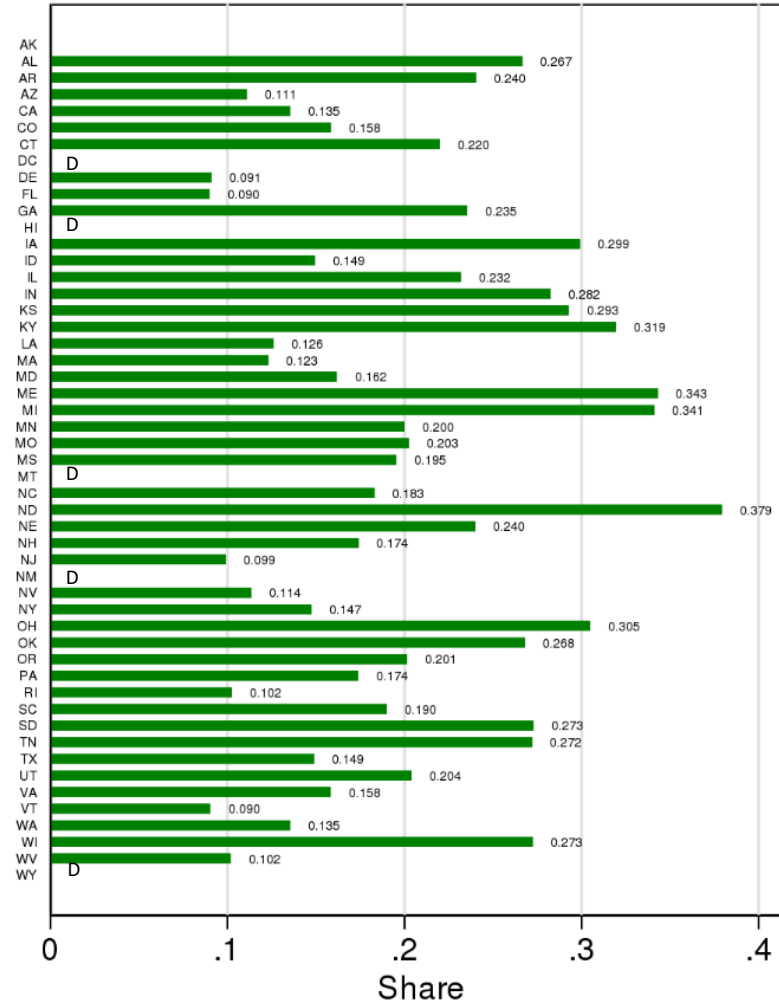


### Share of Plants Using Robots 2018 ASM



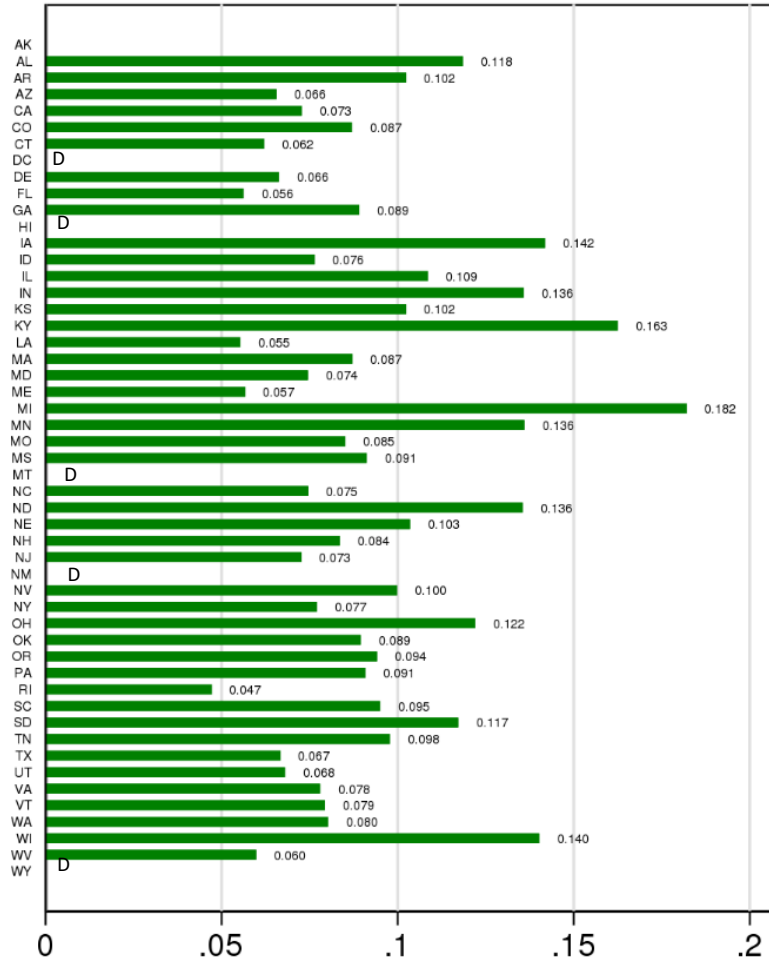
Note: Not imputed for delinquents or missing data.  
Own Calculations. Preliminary.  
Source: Annual Survey of Manufactures.  
D = Suppressed States.

### Share of Workers Exposed to Robots 2018 ASM



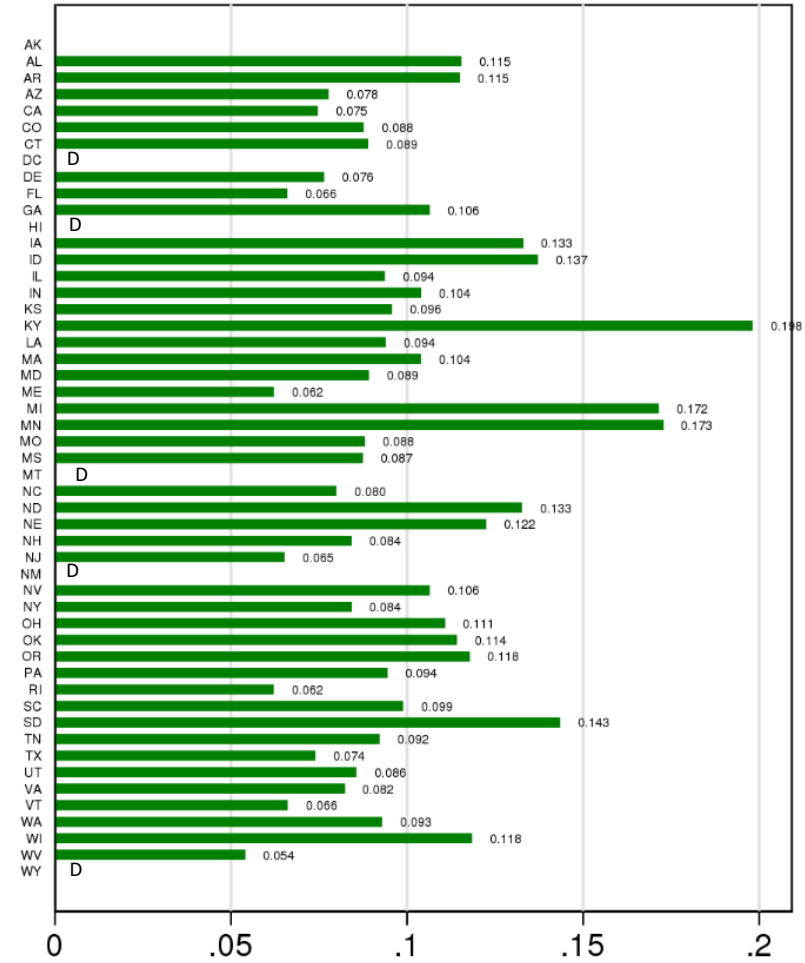
Note: Not imputed for delinquents or missing data.  
Own Calculations. Preliminary.  
Source: Annual Survey of Manufactures.  
D = Suppressed States.

### Share of Plants Using Robots 2018 ASM



Note: Not imputed for delinquents or missing data.  
 Own Calculations. Preliminary.  
 Source: Annual Survey of Manufactures.  
 D = Suppressed States.

### Share of Plants Using Robots 2018 ASM, Controlling for Industry



Note: Not imputed for delinquents or missing data.  
 Own Calculations. Preliminary.  
 Source: Annual Survey of Manufactures.  
 D = Suppressed States.



*Results are preliminary.  
 Differences not tested for statistical significance.*

# Next Steps and Release Plans

- 2018 Experimental Data product by 02/2021
  - ASM web page
  - Tech Stats <https://www.census.gov/techstats>
- Finalize data review
- Develop imputation methods
- Count of robots
- Create confidence intervals for Robotics estimates
- Continue data collection and review for 2019 ASM

# Discussion Questions

- Beyond robots
  - other automation technologies
  - skill complements: apprenticeships/credentials
- Collecting counts from producers:
  - RIA approach
  - Potential collaboration
- Survey of Manufacturing Technologies/ICT Survey
  - Discontinued in 1993 (DOD funded) and 2013 respectively
  - Value in reviving? Funding collaboration?
- Beyond manufacturing
  - ACES - Next set of slides!!
  - Other?

# Questions/Comments

## Thank you!

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