The Determinants of Output Value in the U.S. Manufacturing Industry

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Introduction

- In 2018, total output from manufacturing in the U.S. was $2.335 trillion (NAM, 2020)
  - 11.39% of the total output in the economy comprised manufacturing
  - 12.8 million employees worked in the manufacturing industry
- In 2016, there were 249,982 manufacturing firms around the nation
  - The majority of firms were located in California, Texas, Ohio, Illinois, and Pennsylvania
- For the last 40 years, employment in the manufacturing industry has steeply declined
  - In 1980, there were almost 21 million people working in manufacturing
  - By 2000, employment dropped to 19 million
  - Now, only 12.8 million workers are employed in manufacturing
- Adjusting for inflation, output in 2017 was more than 80% above its level 30 years ago (BLS, 2018)

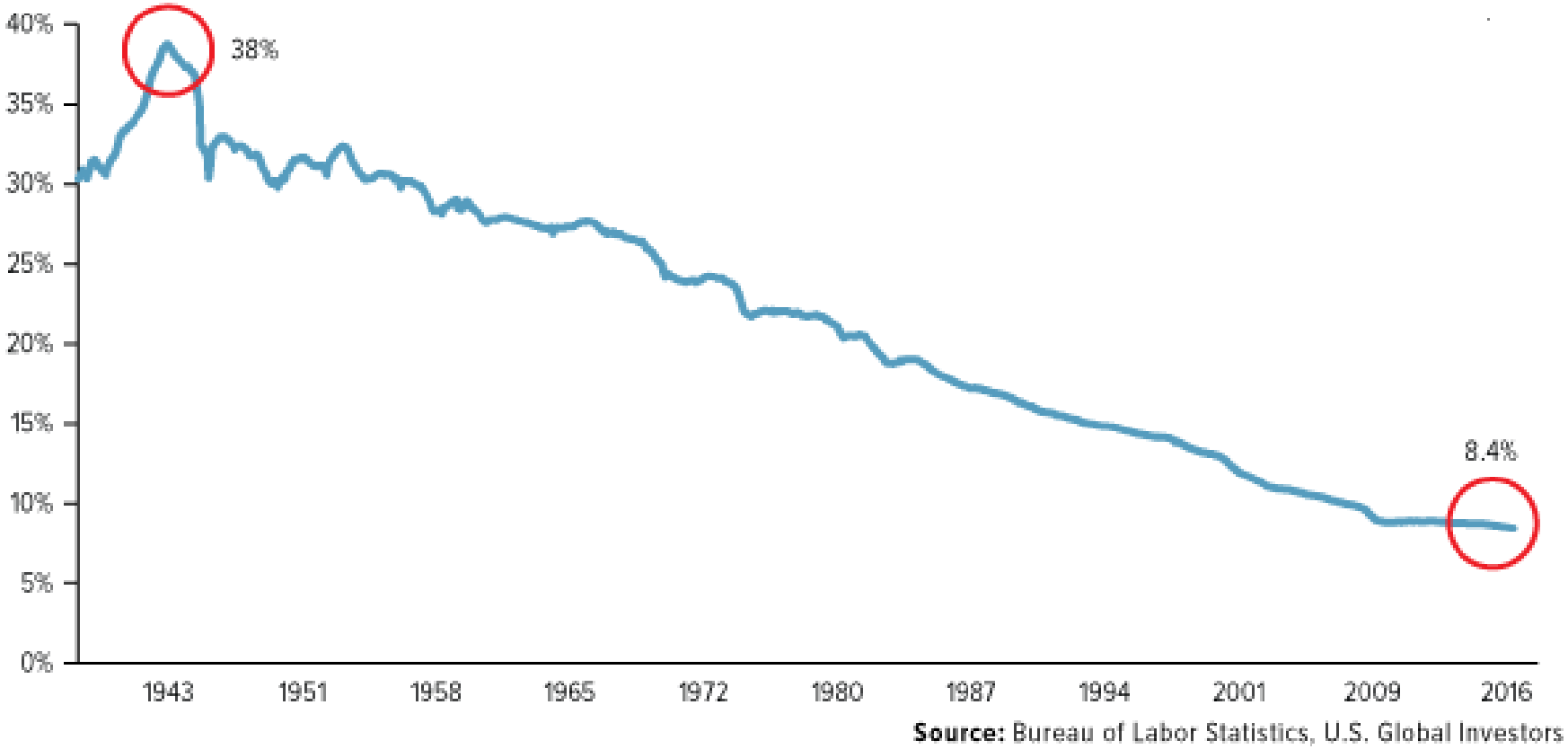
Research Question & Motivation

- How does the capital-labor mix influence manufacturing output value?
  - Employs a large, state-level dataset spanning 14 years

Background

- U.S. manufacturing employment is decreasing at an increasing rate (Fort et al., 2018)
  - Employment fell by 12% from 1979 to 2000
  - Employment dropped by another 25% from 2000 to 2012
  - More than twice as much as the drop in the two decades before
- Adjusting for inflation, output in 2017 was more than 80% above its level 30 years ago (BLS, 2018)
- Simultaneous increase in manufacturing output and decrease in manufacturing jobs (Fort et al., 2018)
  - Suggests that over the long term, American manufactures have become far more productive

Manufacturing Jobs as a Percent of Total U.S. Workforce



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Literature Review

- Manufacturing has diminished as economic activity has shifted more towards service-producing industries (Almon & Tang, 2011)
- From 1950 to 1998, average annual efficiency growth rates were 0.11% for labor, 0.22% for capital, 4.83% for energy, and 2.51% for materials (Bernstein et al., 2004)
  - The vast majority of manufacturing firms chose to prioritize improvements in energy and materials efficiency
- Significant relationship between employment and value added (Fort et al., 2018)
  - Depending on the state, industry, and year the relationship can be either positive or negative
- Increased industry growth, reflected by increased real value of shipments, is directly impacted by the number of jobs, wages, cost of materials, and total capital expenditures (Brown, 2018)

Data

- 2003-2018 Annual Survey of Manufacturers (ASM)
  - Covers all manufacturing establishments based in the United States with at least one paid employee
  - Dependent Variables:
    - Value of shipments
    - Value added production
  - Key Independent Variables:
    - Total Capital Expenditures
    - Labor Costs
    - Employment
  - Other Variables:
    - Cost of materials
- State population (Census)

Summary Statistics

Table 1. Summary Statistics

	Mean	SD	Min	Max
Dependent Variables				
Value of Shipments	121304.70	(132153.50)	5390.66	803007.60
Value-Added Production	53271.14	(55811.91)	1095.27	307716.00
Independent Variables				
Total Capital Expenditures	3546.69	(3831.15)	62.98	23592.22
Production Workers' Annual Wages	11957.69	(12879.99)	328.75	87849.34
Nonproduction Workers' Annual Wages	2076.66	(5174.60)	-699.79	48137.81
Number of Production Workers	166791.70	(162368.80)	5559.00	978081.00
Number of Nonproduction Workers	73685.81	(81892.18)	1566.00	616297.00
Cost of Materials	68363.92	(79489.17)	3670.75	541413.00
N	**744**			

Note: Monetary values are measured in millions of 2018 dollars and number of workers is measured in thousands

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OLS Results

Explanatory Variables	Value of Shipments	Value-Added Production
Total Capital Expenditures	1.485*** (0.272)	1.421*** (0.278)
Production Workers' Annual Wages	1.793*** (0.158)	1.890*** (0.162)
Nonproduction Workers' Annual Wages	1.743*** (0.158)	1.863*** (0.162)
Number of Production Workers	0.0425*** (0.009)	0.038*** (0.009)
Number of Nonproduction Workers	0.0441*** (0.017)	0.036** (0.017)
Cost of Materials	1.181*** (0.011)	0.187*** (0.011)
Constant	-143.746 (402.222)	-146.7187 (413.238)
N	744	744
Adjusted R^2	0.997	0.981

Notes: 1. Standard errors are shown in parentheses
2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.01$

FE Results

Explanatory Variables	FE (Year)	FE (Year & State)
Total Capital Expenditures	1.517*** (0.276)	0.632*** (0.186)
Production Workers' Annual Wages	1.585*** (0.185)	3.177*** (0.269)
Nonproduction Workers' Annual Wages	1.541*** (0.188)	3.061*** (0.270)
Number of Production Workers	0.0493*** (0.010)	-0.062*** (0.021)
Number of Nonproduction Workers	0.068*** (0.021)	-0.022 (0.015)
Cost of Materials	1.182*** (0.011)	1.126*** (0.012)
Constant	-2011.172* (1159.385)	-143.746 (402.222)
N	744	744
Adjusted R^2	0.997	0.999

Notes: 1. Standard errors are shown in parentheses
2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.01$

Conclusions

- Findings are consistent with recent studies
  - Negative relationship between employment and value of shipments / value-added production
- Given more detailed longitudinal subsector-level data
  - Greater range of years
  - Detailed information about industry's subsectors

Questions and Answers

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