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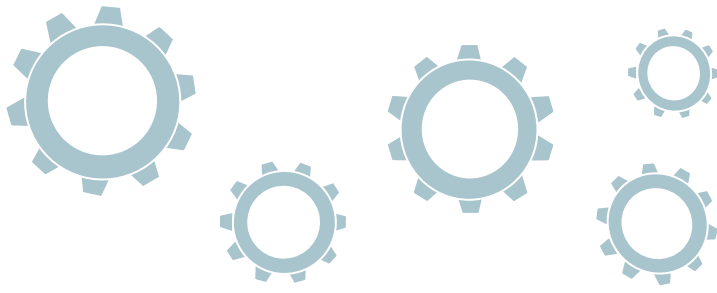
This study highlights divergence in regional economic performance and the impact on households and communities, which necessitates an urgent call to research and policy analysis.

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Introduction

Social and political unease surrounding the wide differences in regional economic performance has troubled Americans for more than a generation. While geographic variation in economic growth is not new, it appears more pronounced today than in the recent past. Over the past decade, several important studies have addressed this issue, implicating trade, automation, and the forces of urban agglomeration.

Writing in *Foreign Affairs* in 2006, Alan Blinder laid out a case that offshoring of job tasks could well be part of a new industrial revolution. Autor (2011) outlined an argument that labor market polarization was occurring, moving workers from the middle into low-skill or high-skill occupations. Describing workplace changes resulting from ‘the new machine age’ Brynjolfsson and McAfee (2014) focused on the economic growth resulting from artificial intelligence and other recent innovations. In a highly influential book, Moretti (2012) explained urbanization effects on labor markets, and their effect on the ‘new geography of jobs’ in the United States. It is worth noting that these concerns are not new. Writing in 1815, and again in 1823, David Ricardo provided the basic outline of both the benefits and costs of trade and technological unemployment.

Our interest in these issues reflects a growing concern that the geographic and education level concentration of labor market shocks have the potential to be far worse in the immediate future than in past decades. Indeed, a study examining the past three recessions (1991, 2001, and 2007-2009) reported that half of all new business formation occurred in 125, 64, and 20 counties respectively (EIG, 2016). To put that more plainly, half the net establishment growth in the United States since the last recession occurred in just 0.64 percent of the more than 3,100 US counties.

The differences in geographic volatility are best framed by examples. Over the past two recessions (2001 and 2007-2009), the unemployment rate in Montgomery County, Maryland peaked at 3.8 and 6.0 percent respectively. Comparatively, Elkhart County, Indiana experienced an unemployment rate of 10.1 and 20.0 percent during the same business cycles. Montgomery County is in the Washington, D.C. metropolitan area and is heavily dependent on government employment, whereas Elkhart, Indiana is a manufacturing intensive county, with roughly 45 percent of wages directly tied to the production of goods.

It is not only regions, but also workers who are experiencing this divergence. Real weekly wages for the average worker have increased by two percent since the immediate aftermath of the 2001 recession, and less than 4.0 percent since 1979. But even this slow growth is not shared equally. High-income workers have seen significant wage gains, while low-income workers are experiencing declines.

Job opportunities are also bifurcated by educational attainment. Since 1992, the United States has seen an increase of more than 35 million jobs for workers with some post-secondary education. However, over the same time, there were 2 million fewer employed workers with only a high school diploma and 5 million fewer jobs for those without a high school degree. Accompanying this was a decline in the labor force participation rate of high school graduates from 63 percent to 57 percent. Though some of these changes reflect a higher share of adults participating in post-secondary education, it is clear that employment options for those with education beyond high school are growing, while jobs for those workers who have not attended college are declining.

One critical element of this trend for both regions and individual workers is declining employment in manufacturing. Historically viewed as a pathway to the middle class, jobs in manufacturing have been declining since the late 1970s and have seen a roughly 30 percent drop since the turn of the 21st Century. The contrast between manufacturing production and employment, however, is stark. Since 2000, manufacturing production in the US has risen more than 10 percent in inflation-adjusted terms, while manufacturing employment has declined by almost 5.5 million jobs. Though automation and trade alone do not account for many of the changes that occurred across regions of the United States, the fortunes of manufacturing have special resonance for several reasons. First, manufacturing tends to be highly geographically concentrated, with job losses focused by location and industry. Second, manufacturing jobs have been a source of middle-class wages throughout the middle part of the 20th Century. The loss of these employment options interacts with the observed bifurcation of jobs noted by Autor (2011).

The geographic interaction of these factors is well described by Moretti (2012), who offers an accessible and compelling portrait of agglomeration related changes and the ensuing impact on population and employment change. Agglomeration forces occur in more densely populated places, with thick labor markets and an

abundance of highly educated workers. This trend offers a clear explanation for the observed population dynamics of the past two decades. All net US population growth has occurred in large urban places. Moretti's work primarily focuses on urban places, but the impact of these trends in counties that are not part of large metropolitan areas is also clear. After all, migration related population growth in urban places necessarily comes at the expense of rural communities.

The problems these trends generate are not confined to commercial economic activity. Chetty, Hendren, and Katz (2016) provided causal explanations for inequality of opportunity at the commuter zone county level, focusing on a broad suite of effects that limit intergenerational income mobility. Chetty's work is part of a much broader effort to identify spatial dimensions to inequality of opportunity. This work offers a clear analog to that of Moretti, and serves as part of the basis for the discussion that follows. What is clear from both of these works, along with the observed data presented above, is that a bifurcation of economic experience is underway, across geography and education.⁽¹⁾

One need not accept the causative interpretations of any of these studies to acknowledge that the issues they explore are worthy of much fuller understanding and illumination. Thus, with this white paper, we intend to highlight divergence in regional economic

performance and the impact on households and communities. We hope to guide researchers and policymakers towards a better appreciation of the complexities of interregional economic difference, including how they may be related to income inequality at the household level. To accomplish this, we provide maps and preliminary analysis of two important characteristics of regional economies: the degree to which counties in the US are exposed to automation-related job losses and the offshoring of employment.

What follows is a series of relatively simple data presentations and preliminary analysis of these issues. The proximal goal is to combine existing research initiatives in a comparable and intuitively useful way to guide future research on these matters. This is a work of synthesis, which argues that the divergence of labor market opportunities for people and places necessitate an urgent call to research and policy analysis. To begin, we offer a brief discussion of automation, trade, and regional economic vulnerability.

1. Likewise, Murray (2013) outlines the significant changes in household composition and the distribution of income over the past 50 years. This work chronicles the increasing bifurcation of household income, educational and marital experience. Together with Piketty's (2014) treatment of inequality, these works offer a concerning portrait of the growing divergence of economic experiences in the United States, although both authors offer markedly different explanations for divergence.

Automation, Trade, and Regional Economies

A number of studies have sought to identify the relative effect of automation and trade on manufacturing job losses in recent decades. Acemoglu, Dorn, Hansen, and Price (2014) estimated employment losses in the United States due to imports from 1999-2013 in the 2.0 million to 2.4 million range. The direct manufacturing estimates resulting from this would appear to be in the 1.0 million to 1.3 million range. This would account for between 10 and 20 percent of total manufacturing job losses since the peak of manufacturing employment in the late 1970s. Other contemporary studies report similar findings. Hicks and Devaraj (2015) reported roughly 88 percent of job losses in manufacturing from 2000 to 2010 were due to productivity changes, not to import substitution.

Housemann, Kurz, Langerman, and Mandel (2011) argue that statistical measurement of the value of intermediate goods is biased towards import substitutes. Thus, the official statistical data overstates worker productivity growth in the United States and understates import substitution. Autor, Dorn, and Hanson (2016) report exposure to Chinese trade in commuter zones is responsible for 26 to 55 percent of job losses associated with manufacturing employment decline in the 1999-2013 period.

Pierce and Schott (2016) provide a very detailed account of job losses associated with extending Permanent Normal Trading Relations (PNTR) to China in 2001. They link the significant declines

in manufacturing employment to import substitution, reporting a contribution of roughly 1.3 percent of the percent of employment declines during the 2000-2007 period (combined job creation and destruction changes). This accounts for perhaps half of total manufacturing employment losses over this time.

All of these studies conclude that both productivity gains and trade have played a role in the loss of manufacturing jobs over the past generation. Importantly, none of these studies argue that there are net losses to trade, simply that understanding the distribution of job losses offers a better understanding of the distribution of benefits and costs across occupations and geography.

The implications of these studies are useful in understanding and preparing for the future. Employment declines since the 1990s have been concentrated within a few industries, occupations and worker educational attainment levels. Indeed, these forces are also associated with political changes, which potentially impact trade and technology policy. According to the related analysis of voting patterns at the congressional district level, these job losses have led to a significant polarization of voting patterns (Autor, Dorn, Hanson, and Majlesi, 2016). Restating their conclusions simply—with broad job losses, red districts get redder, and blue districts get bluer. Any observer of the 2016 presidential primaries will appreciate their study.

Still, the manufacturing job losses described here account for trade job losses of between 1.0 and 2.0 percent of all US jobs, with

total job losses in manufacturing alone accounting for less than 3.7 percent of current employment. This occurred during a period of growing employment, tighter labor markets and an unemployment rate near consensus levels of full employment by 2017. Importantly, the apparently high levels of political tension and social discord resulting from these forces have occurred within the context of modest employment growth, not declines. However, there is ample evidence that automation will continue to replace specific human tasks, and trade will continue to reflect regional

comparative advantage. Thus, the distribution of job losses may continue to polarize both regions and households through very different economic outcomes.

Thus, evidence regarding which occupations may be most impacted offers important insight into regional economic conditions, which may materialize in the coming decades. To understand this better, we examine the potential for automation and trade-related employment changes in the coming years. To do this, we use data from two existing studies Frey and Osborne (2017) and Blinder (2009).

Data and Methodology

The Frey and Osborne (2017) study estimated the probability of automation related employment losses at the occupation level for the United States. By examining the specific tasks through the recent Bureau of Labor Statistics O*Net job function data, they were able to assign a probability of automation to each occupation. The Frey and Osborne approach has been supplemented by additional analysis, which largely corroborates the range of automation effects reported (Bowles, 2014; McKinsey, 2017), and has been replicated in other geographies (Frey, Osborne, and Holmes, 2016). Arntz, Gregory, and Zierhan (2016) report a much smaller share of automatable jobs (fewer than 10 percent) focusing on heterogeneity within occupations as an explanation for the different estimates. The estimates of automation probability should be viewed in the context of time, rather than occupation. Ultimately parts of all occupations can be automated; thus, the risk reported here is relative, not absolute.

The Blinder study examined all US occupations similarly and assigned an ordinal level of offshorability of each job according to the description of the O*Net functions of the job.⁽²⁾ Other studies (Smith and Rivkin, 2008; Blinder and Krueger, 2013) support the Blinder findings. As with automation probabilities, it is best to view these as relative, rather than absolute risks of job losses.

The Frey and Osborne and the Blinder studies both offer useful insights into the automation and offshorability of jobs. However, adapting these estimates regionally requires some simplifying assumptions and calculations. The US Bureau of Labor Statistics does not report occupations at the county level, but some states do provide estimates. The American Community Survey (ACS) does offer broad occupation categories at the county level, they are: management, business, science and arts; service; sales and office; construction, extraction and maintenance; and production, transportation, and material moving.

Using the ACS categories permits us to aggregate the probability of automation to the county level, by occupation of the residence of workers. This allows us to collapse both the Blinder and the Frey and Osborne studies into a single county level of exposure to

either trade or automation. We also converted Blinder's rank of the offshorability of occupations to an index from 1 to 100 so as to offer some comparability with the automation probabilities at the county level.

We first evaluate the occupation-level employment risk by multiplying the probability of relative risk of automation and offshorability for occupations and their respective national employment.

$$\text{Occupation Employment Risk}_{oi} = P_{oi} \times N_o$$

...where subscripts *i* is automation or offshorability; *o* is each occupation. The probability of automation risk, *P*, from Frey and Osborne, (2017) or offshorability risk from Blinder (2009); *N* national employment for each occupation from The Bureau of Labor Statistics (2014). We then compute the expected value of this Occupation Employment Risk weighted by national employment and aggregated to the five broad ACS occupation categories for automation and offshorability risk.

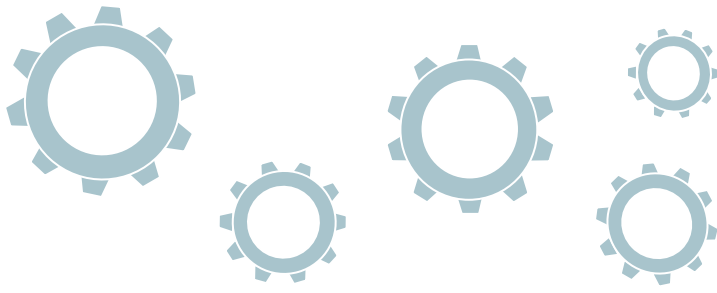
$$\text{ACS Employment Risk}_{ACSi} = [(\sum_{oi} P_{oi} \times N_o) / (\sum_{oi} N_o)]_{ACS}$$

...where subscript *ACS* represents each of the five broad occupation categories of the American Community Survey; and *i* is automation or offshorability. We then multiply this weighted share of employment risk of automation and offshorability across each of the five broad ACS occupation categories for all US counties.

$$\text{County Employment Risk}_{ci} = \text{ACS Employment Risk}_{ACSi} \times N_c$$

...where subscripts *c* is the county; and *i* is automation or offshorability.

2. See the descriptions of jobs at www.oNETonline.org.



Findings

A far smaller share of jobs can be offshored than can be automated, so the range of potential offshored jobs is smaller, but this raises another data concern. As a workplace is automated, it is unlikely that all occupations will be eliminated. Rather, some jobs will be created, some will be destroyed, and others will be unaffected. For example, the automation of an assembly plant might result in the loss of much of the workforce in assembly occupations, but it might also result in an increase in the number of workers associated with operating and maintaining the assembly equipment. Management occupations may be mostly unaffected.

In contrast, a plant that closes due to offshoring of production will lose all of the occupations within the factory, even if individual occupations are not readily offshorable. This is a particularly relevant problem because the county-level ACS data aggregates occupations. So, we cannot differentiate the management of a factory from the management of a hospital, though each faces very different offshoring risks.⁽³⁾

Finally, automation and offshorability risk from these two studies are estimated across the margin of tasks. Other factors, such as, relative price changes of finished goods and the relative costs of capital and labor, play a very important role in the decision to offshore or automate a firm. So, these figures should be viewed as a relative risk of job losses due to automation or offshorability. While we are certain that automation will occur, and certain that centuries of specialization of labor and trade liberalization will continue over the long run, we are highly uncertain of the pace of these events. Still, the existing research allows us to craft maps that highlight the potential employment risks due to automation and offshorability of jobs. These are presented in *Figures 1 and 2*, and represent relative risk of employment changes due to the offshorability of jobs and the automation of tasks. In both maps, the darker colored regions exhibit a higher relative risk of offshorable job losses or automation.

As is apparent from these graphics, there is a great degree of regional variation in the risk of job losses due to offshoring and automation. There are clear clusters of high risk in the industrialized Midwest and in several urban places across the country. We include maps for each major census region of the US in a separate Appendix document.

Figure 1. US Relative Offshorability Risk to Employment

Source: Blinder, 2009 and authors' calculations

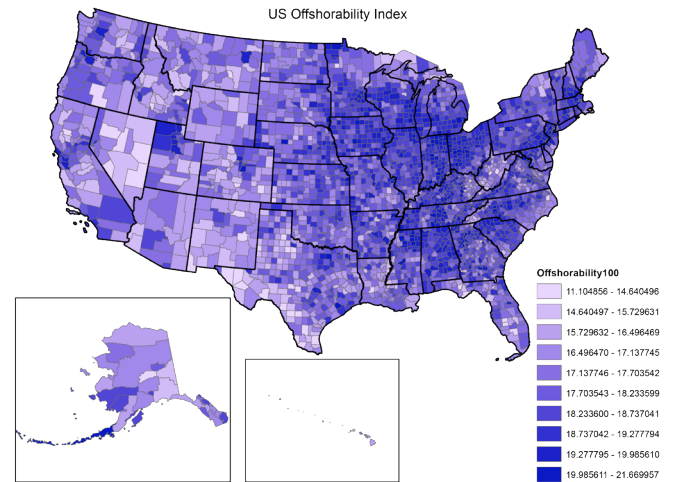
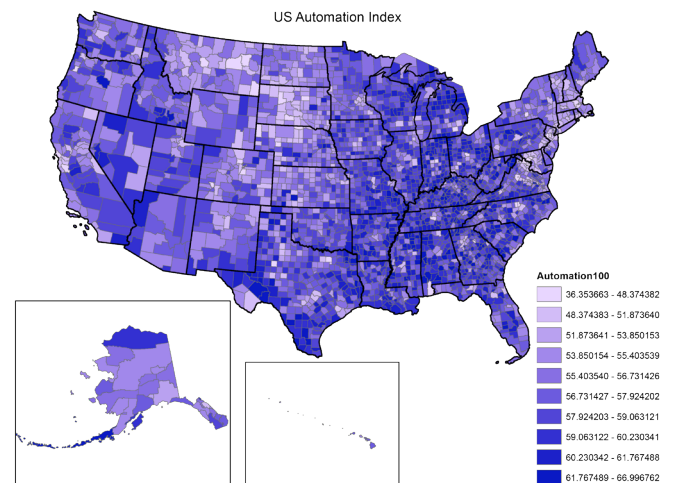


Figure 2. US Relative Automation Risk to Employment

Source: Frey and Osborne, 2017 and authors' calculations



- There is an abundant literature on labor shocks due to automation and the role of education (Schultz, 1975). This literature argues that education tends to mitigate labor market shocks. Further, Autor (2014; 2015) argues that the degree of labor market complementarities of technology shocks are often ignored, while the labor substitution effects are overstated. Better understanding the speed and differential effects of automation related labor market shocks will emerge later as one of our research recommendations.

To better illustrate the occupations we describe, we show the 10 most and least offshorable jobs and automatable occupations. These data provide some insight into the level of detail of occupations along with the wage and probability of automation. *See Tables 1 and 2.*

These data imply a degree of concentration of both automation and offshorability risk, but interpreting them individually demands some caution. The automation-related jobs offer an easy interpretation. Again, the relative risk measure is essentially a weighted measure of total employment risk. So, a score of 0.67 means that two-thirds of jobs are at 100 percent risk of automation, and the remaining third at zero percent risk, or that the average job is at a 67 percent risk of automation loss. For offshorability, the number represents a weighted share of jobs that could be offshored. For example, in the first alphabetic county (Aleutians East Borough), roughly 31 percent of jobs are first on the ranking of offshorability – or, conversely, all the jobs rank in the 32nd percentile of the Blinder (2009) offshorability measure. *See Table 3 on page 7.*



Table 1A. Ten Most Offshorable Occupations

Source: Blinder, 2009

Occupation	# of Employees (1,000s)	Annual Wage
15-1131 Computer programmers	328.6	\$29,460
43-9021 Data entry keyers	216.8	\$79,530
17-3012 Electrical and electronics drafters	30.1	\$59,520
17-3013 Mechanical drafters	65.7	\$53,520
15-1111 Computer and information research scientists	25.6	\$80,110
15-2011 Actuaries	24.6	\$97,070
15-2021 Mathematicians	3.5	\$111,110
15-2041 Statisticians	30.0	\$110,620
15-2099 Mathematical science occupations, all other	1.8	\$66,210
27-4032 Film and video editors	33.5	\$23,530

Table 2A. Ten Most Automatable Occupations

Source: Frey and Osborne, 2017

Occupation	# of Employees (1,000s)	Annual Wage
43-9021 Data entry keyers	216.8	\$29,460
15-2099 Mathematical science occupations, all other	1.8	\$66,210
41-9041 Telemarketers	237.9	\$23,530
13-2053 Insurance underwriters	103.4	\$65,040
15-2091 Mathematical technicians	1.2	\$46,600
51-6051 Sewers, hand	12.0	\$23,640
13-2082 Tax preparers	90.4	\$36,450
51-9151 Photographic process workers and processing machine operators	28.8	\$26,590
25-4031 Library technicians	101.8	\$32,310
49-9064 Watch repairers	2.7	\$34,750

Table 1B. Ten Least* Offshorable Occupations

*Note: We provide only a representative list of the least offshorable jobs because 518 of the 819 occupations included are not directly offshorable.

Occupation	# of Employees (1,000s)	Annual Wage
29-1125 Recreational therapists	18.6	\$45,890
11-9161 Emergency management directors	10.5	\$67,330
49-1011 First-line supervisors of mechanics, installers, and repairers	447.1	\$63,010
21-1023 Mental health and substance abuse social workers	117.8	\$42,170
29-1181 Audiologists	13.2	\$74,890
21-1022 Healthcare social workers	160.1	\$52,380
29-1122 Occupational therapists	114.6	\$80,150
29-2091 Orthotrists and prosthetists	8.3	\$64,430
29-2099 Health technologists and technicians, all other	102.2	\$41,260
29-1022 Oral and maxillofacial surgeons	6.8	\$233,900

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29-1122 Occupational therapists	114.6	\$80,150
29-2091 Orthotrists and prosthetists	8.3	\$64,430
29-2099 Health technologists and technicians, all other	102.2	\$41,260
29-2092 Hearing aid specialists	5.9	\$49,600

Table 3A. 25 Highest Risk Offshorability Counties

Source: Blinder, 2009

Rank	County	Offshorability Risk
1	Aleutians East Borough, Alaska	0.31
2	Pontotoc County, Mississippi	0.31
3	Tippah County, Mississippi	0.30
4	Roseau County, Minnesota	0.30
5	LaGrange County, Indiana	0.30
6	Los Alamos County, New Mexico	0.30
7	Clinton County, Indiana	0.30
8	DeKalb County, Tennessee	0.30
9	Chickasaw County, Mississippi	0.30
10	Kosciusko County, Indiana	0.30
11	Aleutians West Census Area, Alaska	0.30
12	Whitfield County, Georgia	0.30
13	Falls Church City, Virginia	0.30
14	Williamson County, Tennessee	0.30
15	Jackson County, Kentucky	0.30
16	Moore County, Tennessee	0.30
17	Elkhart County, Indiana	0.30
18	Blackford County, Indiana	0.30
19	Williams County, Ohio	0.30
20	Hamilton County, Indiana	0.30
21	Arlington County, Virginia	0.30
22	Elk County, Pennsylvania	0.30
23	DeKalb County, Indiana	0.30
24	Howard County, Maryland	0.30
25	Dallas County, Iowa	0.30

These rankings will no doubt offer pause to many communities. Indeed, the authors work in a state that can claim four of the top 25 counties in the automation category, and seven of the top 25 counties in the offshorable category. We wish to reiterate that these are not predictions of job losses, but rather representations of the relative risk to automation and trade-related job losses that may occur in the coming years across the nation.

What this analysis does provide are maps of vulnerable places where people live and work. It is these places where job disruptions are most likely. These maps do not tell us when these job disruptions will occur, nor does it speak to the net benefit of trade or technology-related productivity growth, but it is undoubtedly positive over the long run.

The issue lies in the distributional effects, which are likely to be significant. Moreover, these maps do not speak to the potential response by entrepreneurs and households who might find significant opportunity resulting from technology and trade-related

“We wish to reiterate that these are not predictions of job losses, but rather representations of the relative risk to automation and trade-related job losses that may occur in the coming years.”

Table 3B. 25 Highest Risk Automation Counties

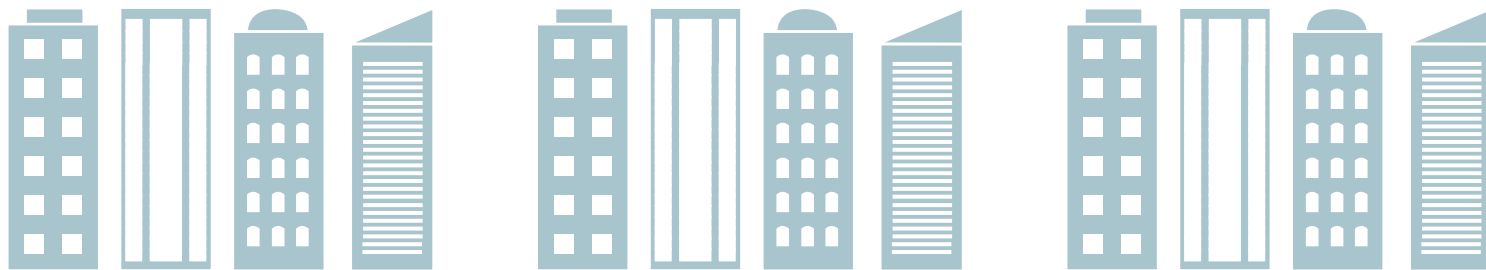
Source: Frey and Osborne, 2017

Rank	County	Automation Risk
1	Aleutians East Borough, Alaska	0.67
2	Quitman County, Georgia	0.67
3	Aleutians West Census Area, Alaska	0.65
4	Buena Vista City, Virginia	0.65
5	Chickasaw County, Mississippi	0.65
6	Allendale County, South Carolina	0.65
7	Tyrrell County, North Carolina	0.65
8	Coosa County, Alabama	0.64
9	LaGrange County, Indiana	0.64
10	Murray County, Georgia	0.64
11	Covington City, Virginia	0.64
12	Dillon County, South Carolina	0.64
13	Switzerland County, Indiana	0.64
14	Blackford County, Indiana	0.64
15	Whitfield County, Georgia	0.64
16	Conecuh County, Alabama	0.64
17	Benton County, Mississippi	0.63
18	Treutlen County, Georgia	0.63
19	Greene County, Alabama	0.63
20	Meigs County, Tennessee	0.63
21	Pickens County, Alabama	0.63
22	Galax City, Virginia	0.63
23	Perry County, Indiana	0.63
24	Atkinson County, Georgia	0.63
25	Estill County, Kentucky	0.63

changes. However, from these maps we can offer additional analyses pointing towards much that is unknown about the potential distributional impacts should automation or offshoring job losses continue at their recent pace or accelerate in years to come.⁽⁴⁾

That leads us to explore some of the individual and regional dimensions associated with risk of automation and offshoring, as well as the social and economic consequences, the viability of current policy measures at the state and local level, and implications for public policy development and future research.

4. Economists measure the net gains to trade as the increased output minus the cost of production. Trade increases production through specialization and reduces costs through comparative advantage. We are unaware of any empirical study reporting negative welfare effects of trade. At the same time, there are large distributional effects, with winners in losers across industries, regions, occupations, and educational attainment. We explore that issue here.



Questions About Vulnerable People and Places

The role of trade and automation in labor market outcomes, household composition, and regional economic performance remains a fruitful area of research. This is particularly true for work designed to inform forward-looking policy development at the state and regional level, where policy development lags. To focus this issue, we outline a preliminary examination of changes in labor markets, households, and regional economies resulting from productivity and trade shocks. This leads to several general observations outlined below. We follow with recommendations for future research and policy considerations.

Labor market responses to trade and productivity shocks have been unequal at the regional level. Differential exposure to automation and trade clearly play a part in this, but worker differences also matter, as do broader labor market conditions. Job losses in rural places and during periods of cyclical unemployment exacerbate labor market outcomes in term of both wages and re-employment.

One important study that measured employment and wage gains across the business cycle found that geographic differences played a significant role in re-employment for individual workers even when controlling for initial levels of human capital (Yagan, 2016). This study suggests a significant and long-term divergence between labor markets as a consequence of recent shocks, and reports similar long-term impacts of other recent studies of trade shocks on regions (Autor, Dorn, and Hanson, 2016).

These studies examine trade and cyclical adjustment patterns of individuals and local labor markets. However, we need a better understanding of automation-related shocks to employment. Individual differences in labor market outcomes may also be linked to initial levels of human capital and the likely returns to retraining. Workers who benefit from retraining investments or who are located in larger labor markets may be less likely to experience labor force displacement due to automation (Shultz, 1975). Understanding the duration and magnitude of these shocks as well as policy-related effects on labor market outcomes are needed to develop policy options.

The urgency of this is difficult to overstate. As difficult as labor market adjustments of the past generation may have been, it is likely that the vulnerability of labor markets to differential automation shocks may be much larger than previous experience with trade. To illustrate this, we offer two simple graphics. *Figure 3A* correlates

Figure 3A. Educational Attainment and Offshoring Risk

Source: Blinder (2009), author's calculations

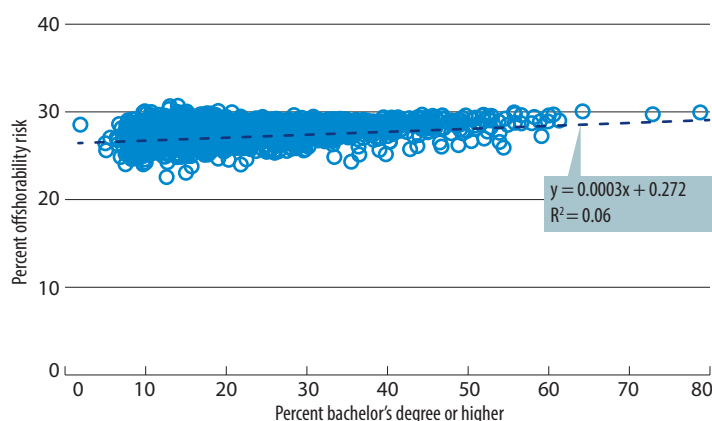
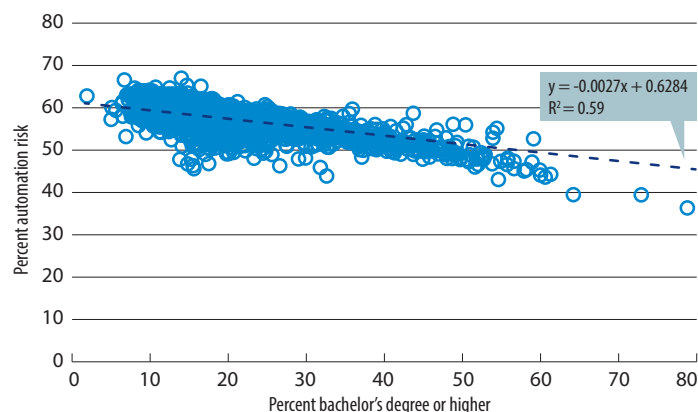


Figure 3B. Educational Attainment and Automation Risk

Source: Frey and Osborne (2017), author's calculations



trade exposure at the county level with educational attainment, while *Figure 3B* illustrates automation risk and educational attainment at the county level.⁵

As these graphics illustrate, lower levels of local educational attainment expose a county to greater relative risk of automation-related job losses than trade-related losses. Even considering that the data

5. Blinder (2009) and Frey and Osborne (2017) noted these correlations in their original works. Blinder noted that offshoring risk was uncorrelated with wages, while Frey and Osborne noted that automation risk was highly correlated with wage rates.

from trade adjustments may include many occupations that have already been subject to significant offshoring, the simple correlation between educational attainment and offshoring risk is modest relative to the automation risk. This suggests that the speed of the automation-related employment changes could be far more disruptive than those accompanying offshoring.

Regional heterogeneity in job loss risk due to trade and automation is also complex. As suggested in *Figure 4*, trade or offshorability job risk is more evenly distributed across the rural-urban continuum (using the USDA RUCC scale). In contrast, the risk of job loss due to automation is lower in highly urbanized and very rural places than it is in more suburban or urban fringe counties.⁽⁶⁾

Again, the implication here is that regional variation in potential job losses accrues across several margins. Industrial structure, educational attainment and the degree of rurality all affect the potential employment risk of increased automation and trade-related job losses. Moreover, the degree to which automation-related job losses are concentrated may significantly influence factors, such as local income inequality and intergenerational mobility (Chetty, Hendren, Kline, and Saez, 2014).

These changes may also play a role in agglomeration economies as employment shocks tend to have a disproportionate impact on non-urban areas. One result of this may be the reinforcing of multiple equilibria in economic development, as poor places grow more slowly while more populous and better-educated regions grow more quickly. One way to examine this is to evaluate the degree to which broader labor markets are subject to automation or offshoring job risk.

Autor, Hanson, and Dorn (2016) examine local labor market exposure to import substitution related job losses. They focused on commuter zone (CZ) exposure to imports and report trade exposure impacts across labor markets and fiscal impacts, of which the trade adjustment assistance (TAA) is small in comparison to other transfer payment effects ranging from federal disability and retirement to medical costs.⁽⁷⁾ These authors stress the distributional effects of trade, not its net effect, which is a point we reiterate often in this paper.

To extend this question of import substitution more broadly, and to inform a forward-looking policy, we offer two related analyses among labor markets. Here we compare the risk of automation and offshoring in counties with or to the average exposure to each in their neighboring counties.⁽⁸⁾ The notion behind this is that labor markets for individual counties will typically comprise the county itself and adjacent counties. This matters because a low correlation between adjacent counties would suggest lower vulnerability to the risk of automation or offshoring because counties with higher risk might be surrounded by counties of lower risk, and vice versa. A higher, positive correlation between the two suggests that risks to automation or offshorability are clustered, and that broader labor market regions share similar risks. See *Figure 5 on page 10*.

Figure 4A. Offshorability Risk and Urbanization

Source: Blinder (2009), USDA (2013), author's calculations

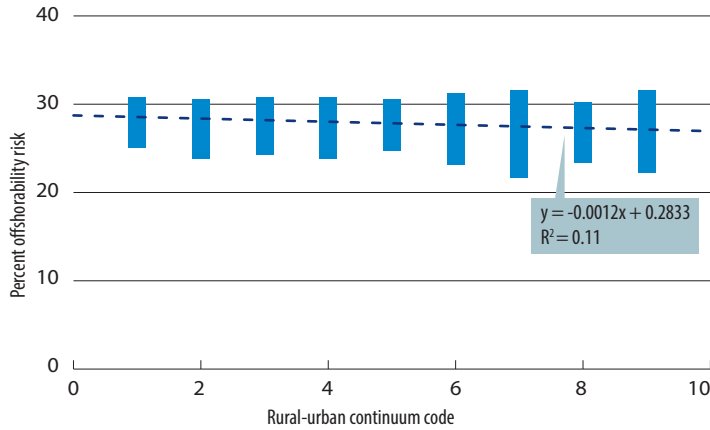
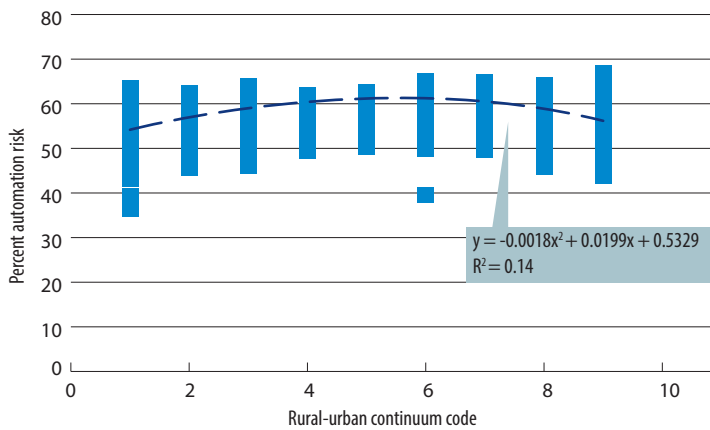


Figure 4B. Automation Risk and Urbanization

Source: Frey and Osborne (2017), USDA (2013), author's calculations



6. The USDA Rural Urban Continuum Code measures the degree of urbanization of a county based on population and metropolitan status.

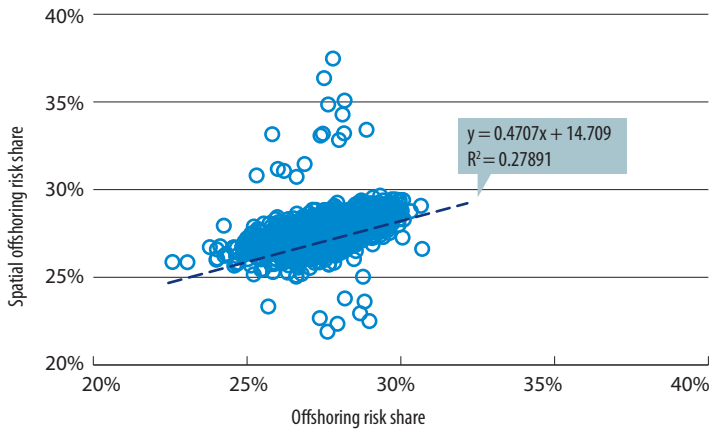
- 1 = Counties in metro areas of ≥ 1 million population.
 - 2 = Counties in metro areas of 250,000 to 1 million population.
 - 3 = Counties in metro areas of fewer than 250,000 population.
 - 4 = Urban population of ≥ 20,000, adjacent to a metro area.
 - 5 = Urban population of ≥ 20,000, NOT adjacent to a metro area.
 - 6 = Urban population of 2,500 to 19,999, adjacent to a metro area.
 - 7 = Urban population of 2,500 to 19,999, NOT adjacent to a metro area.
 - 8 = Completely rural or < 2,500 urban population, adjacent to a metro area.
 - 9 = Completely rural or < 2,500 urban population, NOT adjacent to a metro area.
- See <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/documentation>.

7. Autor, Hanson, and Dorn (2016) report that a \$1,000 increase in Chinese trade exposure leads to \$0.65 in unemployment and trade adjustment assistance (TAA) benefits, \$8.40 in Social Security disability, \$10.00 in Social Security retirement, \$15.04 in other income assistance, and \$18.27 in health benefits. So, unemployment and direct TAA benefits comprise just 6.3% of government costs to employment losses due to trade exposure.

8. This is formally the population weighted mean of the automation or offshorability measure in adjacent counties. This was calculated through the use of a first order contiguity matrix, \tilde{W} , such that the adjacent county is \tilde{W}_y , gives the value of each in county y . We note again here that the ACS data link worker occupations to the county of residence, not to the county of employment.

Figure 5A. Offshoring Risk in Own County and Average of Adjacent Counties

Source: Blinder (2009), author's calculations



As is apparent in *Figure 5*, the risk of job losses related to automation or offshoring is highly correlated. Counties with low risk are adjacent to other low-risk counties, and high-risk counties are adjacent to other high-risk counties. This clustering of risk imposes concerns beyond purely economic considerations. The fiscal consequences of clustered risk are also significant, as few states have adopted fiscal instruments designed for vastly different regional outcomes. This calls for a much deeper exploration of the ‘new federalism’ and the role that state and local governments may play across several margins of automation and offshorable job losses.⁽⁹⁾

In addition to fiscal and labor market outcomes, job loss due to automation and offshoring will also have household impacts that will vary by education, skills, and occupation. To exemplify this, we offer *Figure 6*, which aggregates occupational median earnings with deciles of relative risks of offshorability and automation. Occupations face roughly equal trade-related risk across income deciles.⁽¹⁰⁾ However, low levels of automation risk are associated with much higher wages. Indeed, occupations in the lowest automation risk decile averages more than \$80,000 in annual salary, while occupations in the highest decile of automation risk have incomes less than \$40,000 per year.

In addition to earnings-related clustering of job losses due to automation, there is a very apparent clustering of intergenerational income mobility and risk of automated job losses. Using Chetty, et al.’s 2014 analysis of absolute income mobility between generations, we plot the simple correlation to automation-related job risk. We observe a correlation between automation risk and lower income mobility at the county level in the United States.

The optimistic result of this correlation is that employment polarization from automation-related shocks may be less than past observations. However, the troubling aspect of this is that employment losses may be concentrated within the most vulnerable households, which might be more geographically concentrated. See *Figure 7*.

Figure 5B. Automation Risk in Own County and Average of Adjacent Counties

Source: Frey and Osborne (2017), author's calculations

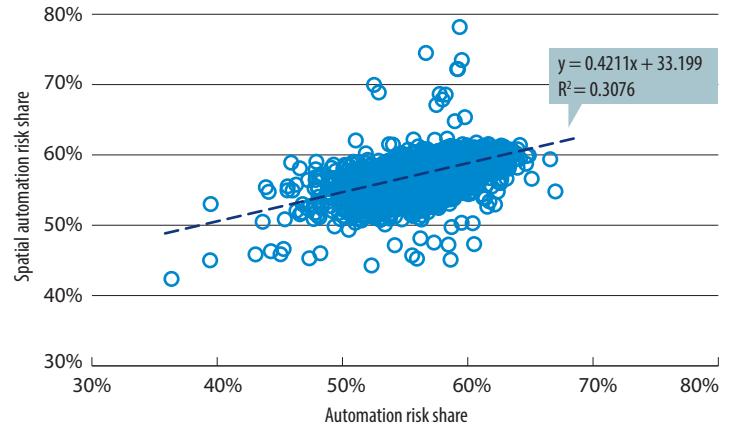


Figure 6. Automation and Offshoring Risk by Income Decile

Source: Bureau of Labor Statistics, authors' calculations from Blinder (2009) and Frey and Osborne (2017)

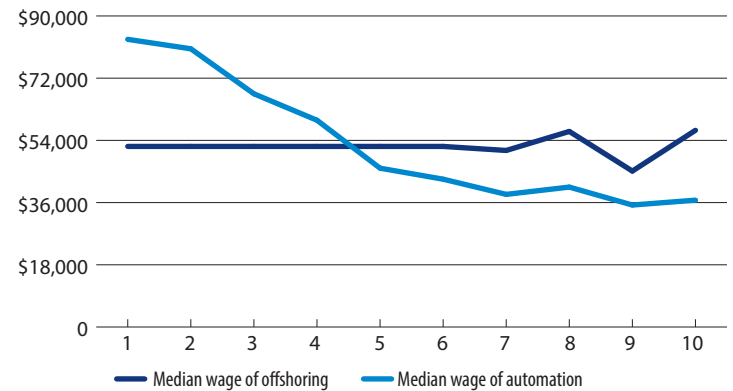
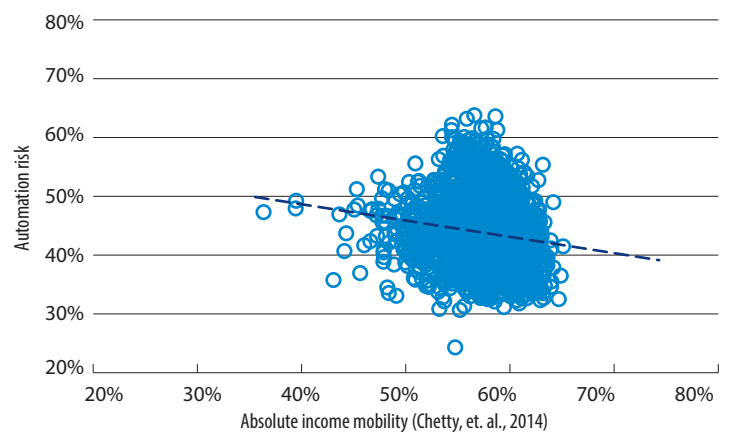


Figure 7. Automation Risk and Intergenerational Income Mobility

Source: Chetty, et. al. (2014), Frey and Osborne (2017), authors' calculations



9. New federalism refers to centralization of tax collections, but decentralization of expenditures through the use of intergovernmental direct transfers (block grants). See Weingast (2009) for an example on incentives.

10. The ninth decile of offshorability occupational median earnings was slightly lower than eighth and tenth decile because the ninth decile mostly includes “production, transportation, and material moving” occupations and very few “management, professional, and related” occupations.

Potential implications for workers and households also emerge from these preliminary correlations. Workers facing the highest risk of automation-related job losses tend to be nearby other workers facing similar risks. Moreover, a higher risk of automation tends to correlate with a lower intergenerational income mobility. The disparity between the highest and lowest wage jobs and place-based intergenerational mobility in automation-related job loss has potential impacts beyond the individual worker and beyond purely commercial economic considerations.

As social scientists have long asserted, employment is more than an economic indicator. An individual's occupation and related characteristics, such as prestige and wages, are also integral to that individual's identity formation and social location. The consequence is that job displacement or involuntary job loss due to non-performance-based reasons, such as automation or offshoring, not only has direct impacts on the economic wellbeing of people, families, and communities, but also indirectly impacts health and mortality, childhood wellbeing, educational attainment, community integration and upward mobility. It is in the interaction of economic and non-economic impacts that households and communities will be faced with the greatest challenges if vulnerability to job displacement becomes actual job loss.

Of course, job displacement does have important economic implications that go beyond the period of displacement. Not only do displaced workers tend to experience longer periods of unemployment than do workers who were laid off for other reasons, but they also experience substantial loss of income over their lifetimes (Faber, 2005). The cumulative lifetime loss of income for displaced workers is estimated at around 20 percent, and income impacts can be observed for 20 years post-displacement (Brand and von Wachter, 2013). Moreover, job instability remains elevated for these workers for at least a decade after the original displacement event (Brand, 2014). When displaced workers do find work, they are more likely to work part-time, seasonally, or as contract workers, and the jobs gained are likely to be of lower quality in terms of authority, autonomy, and benefits as compared to their pre-displaced employment and to their non-displaced counterparts (Brand, 2006).

On a very basic level, this long-term job instability and depression of wages has a direct impact on economic wellbeing. Unemployment is associated with higher rates of poverty, lower rates of homeownership, and greater use of government assistance. The impacts of displacement go beyond economics, however. Health, family stability, educational outcomes, and social integration are also impacted at the individual, family, and community levels.

The impact of job displacement on health is seen in the short- and long-term for both mental and physical health. Displacement is associated with higher rates of depression and anxiety, which can be as high as 30 percent greater than for nondisplaced workers, and lower levels of positive psychological assets, such as self-esteem, satisfaction with life, and social supports (Burgard, Brand, and House,



“ Families who experience job loss must often move for new jobs, which in and of itself creates family stress, school disruptions, and social network disintegration. ”

2007). Workers who have experienced displacement have higher rates of mortality for at least 20 years after the original job loss (Sullivan and von Wachter, 2009; von Wachter, 2010). They see an increase in hospitalizations, use more medical services and disability benefits, and have more disability, cardiovascular disease, medical conditions, self-destructive behaviors, and suicide (Burgard, Brand, and House, 2007). Many displaced workers also lose their health coverage, making medical care more expensive and less accessible at the very time their medical needs are increasing.

Economic shocks also have the potential to increase family tension and disruption, resulting in an increased risk for divorce and family conflict. The effect of divorce and conflict on children's wellbeing is well documented, and finds that, all else equal, children from these households have worse outcomes than children from intact households and households with little family conflict (Amato and Keith, 1991). Even without divorce or conflict, family stability can still suffer due to displacement. Families who experience job loss must often move for new jobs, which in and of itself creates family stress, school disruptions, and social network disintegration. This exacerbates the rural population declines that accompany the growth of cities described by Moretti (2012). Moreover, economic instability makes it more difficult for already disadvantaged families to provide basic necessities, like education fees, transportation, food, and safe housing (Kalil and Ziol-Guest, 2008).

Unsurprisingly, the impacts of job displacement have a longer-term impact on the educational outcomes for the children of displaced parents. Children in homes that have experienced job displacement are more likely to have to repeat a grade, drop out of school, and get suspended or expelled than are kids in homes without job displacement (Johnson, Kalil and Dunifon, 2012). These kids also have lower educational attainment and earn less as adults than do kids from homes that do not experience job

displacement (Kalil and Wightman, 2011; Page, Stevens, and Lindo, 2009). Downward mobility of parents due to job displacement may also negatively impact how children value education and work in their lives.

Negative educational outcomes are not limited to kids from homes with job displacement. Researchers have also found indirect effects on peers and teachers in communities with high levels of displacement (Ananat, Gassman-Pines, and Gibson-Davis, 2011). Because individuals and families experience job displacement within a larger societal context, communities themselves are impacted by displacement. Displaced workers are less likely to participate in social organizations, like churches, youth groups, charitable organizations and informal social events with family, friends, and neighbors (Brand and Burgard, 2008). Adults' and children's social networks are impacted, and the social withdrawal that often accompanies job displacement impacts the broader community.

The findings of direct and indirect impacts of displacement are not homogenous across populations. The negative long-term impacts of displacement have been found to be worse for

low-skilled, less-educated workers, who are likely to work in more vulnerable jobs, as indicated in previous figures. Highly educated and skilled workers in high-wage positions, on the other hand, are not only less vulnerable to displacement, but are more likely to experience "skills transfer" when they are displaced (Faber, 2005). Alternatively, the negative indirect impacts of displacement may create less disruption in low-income households with existing job instability because of the coping strategies previously developed in the face of economic insecurity, whereas professional and white-collar workers may experience more psychological distress due to the untested nature of new-found economic insecurity (Brand, 2014). Households with one income earner, single-mother households, and minority households would also be expected to experience these vulnerabilities differently.

These observations about concentrated regional and worker risks of dislocation through trade and automation motivate a brief discussion of federal, state, and local policies designed to mitigate unequal effects of labor market shocks. We discuss these in turn.



Examining Federal, State, and Local Policy

Federal-Level Policy Responses

The United States maintains a suite of policy interventions designed to assist households and regions affected by trade and automation. The suite of policies aimed at individual workers and households includes Trade Adjustment Assistance (TAA), Unemployment Insurance, Supplemental Assistance for Needy Families (SNAP), Temporary Assistance for Needy Families (TANF), and Medicaid. Despite the seeming flexibility of TAA, the best evidence suggests it plays a modest role in overall worker assistance in the wake of trade-related job displacement (Autor, Dorn and Hanson, 2016; Baicker and Rehavi, 2004).

There is also increasing evidence that workers may use other benefits, such as Social Security retirement and disability insurance

as a substitute for other assistance programs (Duggan, 2003; David and Duggan, 2006; Kreuger and Meyer, 2002). These programs are supplemented by a variety of state and local programs, ranging from the federally funded, locally managed training assistance programs, like the Workforce Investment Act, to local organizations providing food, clothing, and housing assistance.

The suite of efforts designed to help households weather the disruption of job loss and to sustain labor supply are focused at people, not regions. Very little regionalization of public or transition assistance is currently available for regions facing structural adjustment. What is available is largely limited in scope and size, such as enterprise zones (see Ham, Swenson, Imrohoroglu and Song, 2011; Neumark and Kolko, 2010). State and local governments, instead, focus on industrial policy at the local level.

Existing Industrial Policy at the State and Local Level

Policy attention to job losses is not new. State and local governments have long sought to attract businesses and address regional economic divergence through a variety of public policies. These include tax abatements and incentives, large infrastructure development efforts, changes to labor market policies (i.e. Right-to-Work) and regulatory policy designed to attract economic activity to a state or region.

A broad debate over the usefulness of these policies has engaged scholars for more than two decades. There is an emerging consensus that the scale and focus of many policies at the state and local level have rendered disappointing results. Still, in 2017 most local economic development efforts remained focused narrowly on attracting and retaining businesses in their region. These policies are more apparent outside large urban places, suggesting a more immediate research concern for smaller urban centers and rural communities. These efforts concentrate on ‘footloose’ firms that can locate their production or headquarters without worry about local demand for their goods or services.

Even in places where alternative strategies have begun to influence local economic development efforts, resources are allocated to activities that focus on attracting new businesses to the community. The most recent survey by the International City/County Management Association (ICMA) reported a mean municipal expenditure on economic development of \$1.3 million per year with traditional business attraction services comprising most of the expenditures.

Notable contributions to this line of research include Gabe and Kraybill (2002), who evaluate the impact of tax incentives on firms in Ohio from 1993 through 1995. Employing data on recipients and non-recipients, the authors report the firms that did not receive the incentives outperformed the recipient firms in their growth expectations. In a review of the impact of Michigan’s Economic Growth Authority (MEGA) incentives on county employment growth in manufacturing, wholesale, and construction, Hicks and LaFaive (2011) found no discernible effect on employment in these sectors. Both studies influenced subsequent changes to incentives in these states.

These studies cast doubt on both the ability of communities to effectively manage business location decisions through the narrow application of development incentives and the benefit of capturing firm relocation on local economies.

A broader analysis of the suite of local economic development incentives reported a very small impact on overall outcomes of these efforts (Reese, 2013). Findings from Fisher and Peters (1998) reported that no more than one in 10 dollars spent on development have any effect. Hicks (2016) offered a supply-side view of economic development efforts. He argued that most research has focused on evaluating the demand side elements of

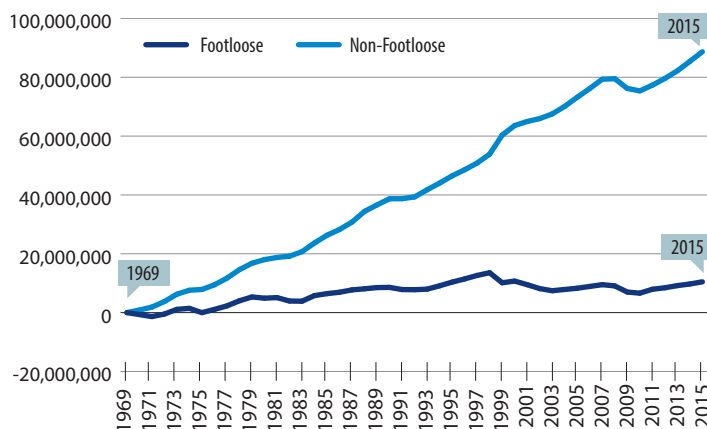
firm relocation, while the availability of ‘footloose’ jobs has shrunk dramatically over the past several decades. In *Figure 8* (updated here through 2015), Hicks calculates the total net employment growth from 1969 in the United States, across two types of industries: footloose and non-footloose. Footloose jobs are those that export their good or service outside a region and that can make location choices about where to produce. In this calculation, all manufacturing and warehousing/wholesaling jobs, non-site specific business services (like the motion picture industry), and all non-local financial services are footloose. The remaining jobs are in industries that are dependent upon local consumption.

This measure is imperfect, since it does not count the small share of corporate headquarters positions, which could conceivably locate anywhere. Still, the marked growth in non-footloose jobs versus the nearly static growth of footloose jobs offers a very distinct visualization of the local economic development problem; they are chasing job growth that largely does not exist. Indeed, all the net growth in footloose jobs was in financial services, while nearly all the local and state incentives focus on manufacturing firms.

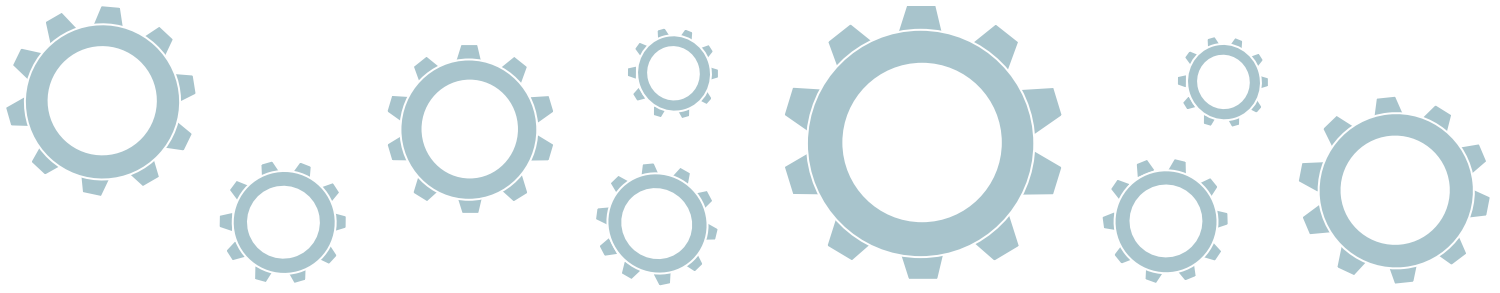
Despite significant research on the impact of federal, state and local policy, the potential for historically large labor market shocks argue for an update to much of the existing literature. This leads us to consider a number of implications for research and policy analysis.

Figure 8. Cumulative Growth in Footloose and Non-Footloose Jobs in the US (1969-2015)

Source: BEA and authors' calculations



“Despite significant research on the impact of federal, state and local policy, the potential for historically large labor market shocks argue for an update to much of the existing literature.”



The Implications of Automation and Offshoring in the 21st Century

In the preceding pages, we have combined existing research on the likelihood of job automation along with the risk of job offshorability and applied these analyses to counties in the United States. Acknowledging that the past two decades have been ones of enormous economic and social anxiety associated with this phenomenon, we argue that the potential for an even more disruptive period lies in the future. Importantly, the extreme political and social discontent of the past few years accompanied net job growth, and a reasonably mild trade and automation disruption of less than five percent of total employment. The evidence outlined above suggests a much higher share of jobs are susceptible to automation and offshorability in the future than in the recent past.

We cannot know the pace or depth of automation and offshoring, but it is clear that large swathes of the American economy are likely to face these changes. Moreover, the risk, especially of job automation, is concentrated across labor markets, income, and educational attainment levels. Thus, the net impacts are likely to differ substantially from the distributional impacts of labor market changes due to automation and offshoring.

In light of the varied impacts of job displacement, there are a number of areas requiring research. This work should seek to determine both the relationship between displacement and impacts and the appropriate policy response to mitigate negative impacts to individuals, families, and communities.

Improved measurements of automation and offshorability risks is obviously an important area of research. Frey and Osborne (2017) and Blinder (2009) have set a high bar, but retrospective examinations of risk may better inform projections about the speed and magnitude of employment changes as well as adjustment costs. In particular, it is important to understand the impact of industrial structure on the role automation plays as either a substitute or complement to labor. Automation that complements labor should increase employment, while automation that is a substitute for labor will reduce employment. Any effective policy intervention will have to understand this nuanced effect of automation.

There is limited research that investigates the correlation between displacement and broader community effects. Given the

importance of community on long-term economic outcomes, family formation and disruption, and intergenerational mobility, this relationship deserves more attention (see Chetty, Hendren and Katz, 2016; Kalil and Wightman, 2011; Page, Stevens and Lindo, 2009). This is an especially urgent problem outside large urban areas, where less research attention has been focused in recent years.

What characterizes individual, family and community resilience to economic shocks, like job displacement, can also be a productive area of research. The Great Recession has provided an important test-case for the efficacy of expanding some government benefits, like unemployment insurance and skills retraining programs. Evaluating the costs and benefits of support services to individuals, families, and communities now may allow for the adoption of these institutions prior to large labor market shocks in the future. Additionally, understanding how families cope with economic shocks, make ends meet in the face of economic insecurity and do or do not return to pre-displacement socioeconomic positions will give researchers and policy makers better information about how to support continued upward mobility in an era of widespread economic vulnerability.

Individual, household and community healthcare outcomes resulting from widespread employment shocks should also be a fruitful path of research. This research should evaluate both supply and demand issues related to healthcare, focusing on the context of recent and ongoing federal policy changes. This, too, is an especially urgent problem for rural areas where limited healthcare providers may exacerbate access issues for households.

The interactions between automation and offshoring risk matter also to the distribution of wage and employment gains at the occupation and regional level. So, too, do labor market conditions unrelated to trade and automation. For example, we recommend a better understanding of the role of agglomerations, particularly labor market thickness, in buffering the effects of automation and offshoring. The implication for rural places, and the degree to which rural places are connected to urban labor markets, is important for understanding the distributional effects of job losses.

Intergenerational effects are important, both for individual households and for regions. The persistence of shocks relative to the magnitude of policy responses will continue to be a fruitful area of research.

Infrastructure differentials between regions and the impact on the fiscal structure, re-employability, and population change will be important in offering insights into appropriate policy responses. In particular, the role of broadband and other telecommunications infrastructure, roads, and transportation services in community

sustainability in the wake of employment shocks should figure into the policy discussion. In this context, the role of transportation infrastructure in defining labor market size, especially for rural and micropolitan places will be important for evaluating spending priorities.

The role of public finance in mitigating economic shocks related to trade and automation should also be considered as a key component to any regional strategy. Likewise, a better understanding of the efficacy of regional industrial policy is important moving forward.

Summary

In this study, we synthesize research that increasingly points to the risks of large labor market shocks due to automation and trade. We do not wish to be alarmist. Both trade and automation related economic growth are hallmarks of a vibrant economy. But, as we note above, the social and political unease that accompanies large shocks, with varying distributional inequities felt by workers in different occupations and with differing skill levels, is real. That workers live in places with high concentrations of similar workers suggests labor market shocks may be increasingly concentrated across geographies. Together, these factors risk increasing political polarization and divergent regional economic outcomes. This warrants effort to better understand the geographic and labor market risks, especially as they involve differential levels of educational attainment and occupational and geographic concentration.

Our goal, then, is to highlight the relative risk that shocks from automation and trade play on the unequal labor market outcomes across workers and places. We also outline the impact of these labor market shocks across different margins—wage, employment, fiscal stability, and social and health concerns.

We also appreciate the significant ongoing research on these phenomena as well as a lengthy history of analysis on the policy role of federal, state and local governments. The public concern over these issues has occurred at a time of rising employment, no doubt partly due to labor complementarities of recent technological change (see Autor, 2014). However, more rapid or geographically concentrated labor market shocks may not accompany equally robust labor markets. If the social and political discomfort of the past decade and a half occurred during one of the largest labor market expansions in history, less robust economic conditions offer a much more disquieting forecast.

“ We do not wish to be alarmist. Both trade and automation related economic growth are hallmarks of a vibrant economy. However, the social and political unease that accompanies large shocks, with varying distributional inequities felt by workers in different occupations and with differing skill levels, is real. ”



Credits

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