Political Machinery: Automation Anxiety and the 2016 U.S. Presidential Election*

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Abstract

Was the 2016 U.S. Presidential Election a riot against machines by democratic means? Throughout history, technological breakthroughs have created new prospects of comfort and prosperity for mankind at large but it has equally left plenty to "vegetate in the backwaters of the stream of progress." During the days of the British Industrial Revolution a sizable share of the workforce was left worse off by almost any measure. The result was a series of riots against machines. In similar fashion, the Computer Revolution has caused many workers in middle-income routine jobs to shift into low-income jobs or non-employment. Against this background, we examine if groups in the labor market that have lost to technological change are more likely to opt for radical political change. Pitching automation against a host of alternative explanation—including workers exposure to globalization, immigration, manufacturing decline, etc.—we find robust evidence of a relationship between electoral districts exposure to automation and their share of voters supporting Donald Trump in the 2016 Presidential Election. Additional estimates suggest that the support was particularly high in areas characterized by low-educated males in routine jobs. These findings speak to the general perception that low-skilled male workers in routine jobs have been the prime victims of the Computer Revolution, leading them to rage against machines.

JEL: J23, J24, J31, N60, O14,

Keywords: industrial revolution, labor markets, technological change, political economy

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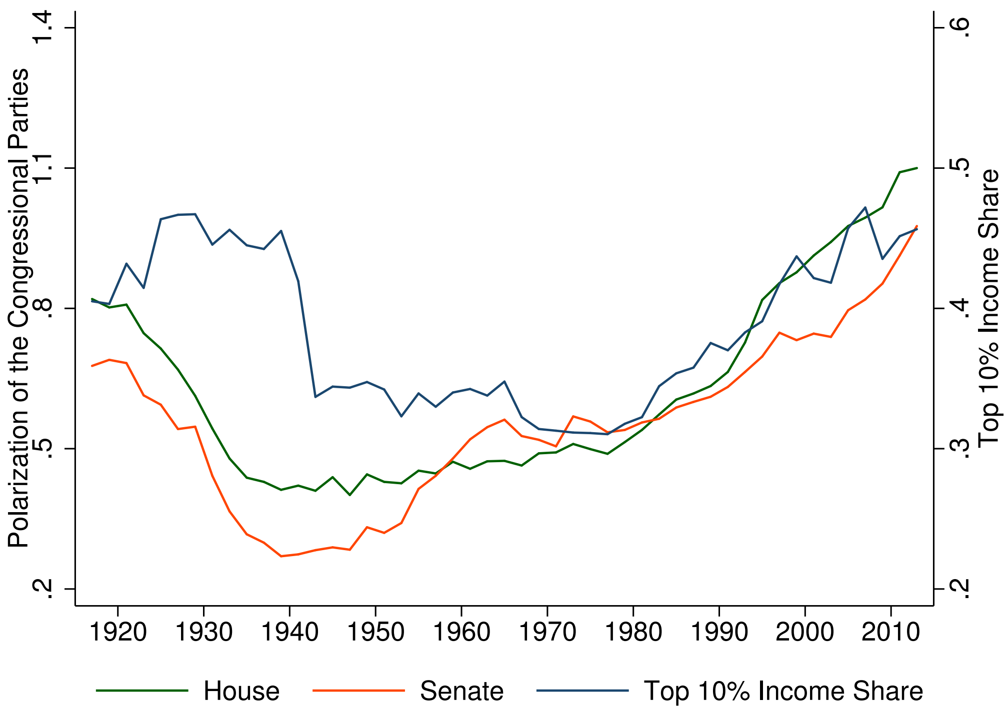
1 Introduction

Was the outcome of the 2016 U.S. Presidential Election shaped by a growing automation anxiety? According to a recent poll of unemployed American's between the ages of twenty-five and fifty-four, 37 percent stated automation as one of the prime reasons of their misfortunes (Hamel *et al.*, 2014). The causes of the populist backlash in America and Europe are far from conclusive, yet parallels have been drawn with the machinery riots of the British Industrial Revolution, when "Luddites" smashed power looms in fear of losing their jobs. A post-election article in *The Wall Street Journal* featuring the headline "Trump's focus on jobs, globalization and immigration tapped anxiety about technological change," speaks to the frequent belief that automation was the real cause of voters economic concerns. Despite such beliefs, empirical efforts to examine the extent to which automation anxiety determined the outcome of the U.S. Presidential Election have remained scant. What is clear is that the vote for Donald Trump was a vote against the status quo: according to the Exit Polls, 82 percent of voters believed that Trump would perform best in bringing about change, while the corresponding figure for Hillary Clinton was 14 percent.

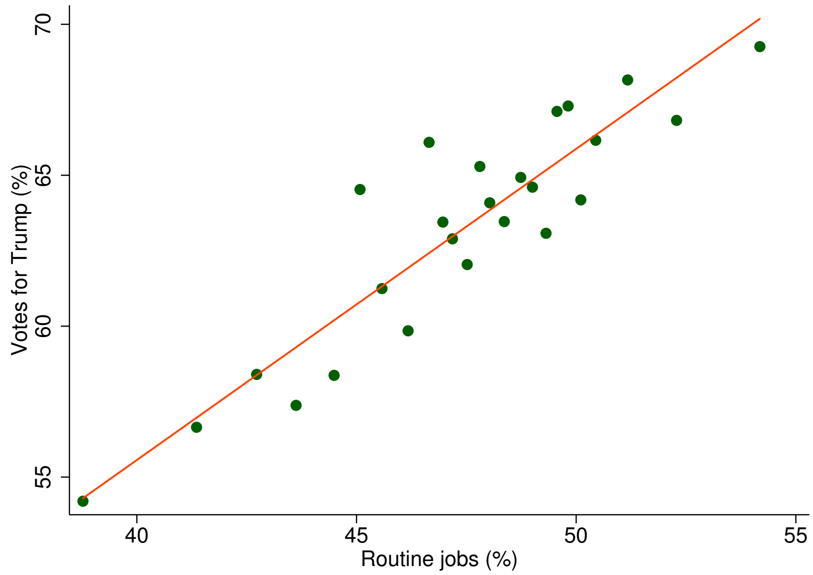
This paper examines the link between workers exposure to automation and voting patterns in the 2016 U.S. Presidential Election through the lens of economic history. Our analysis builds on two sets of observations. First, job automation is rarely a Pareto improvement: since the Computer Revolution of the 1980s, automation has left a sizable fraction of the workforce worse off. The sharp reduction in middle-income jobs in the U.S. economy cannot be explained without reference to the disappearance of "routine jobs"—i.e., occupations mainly consisting of tasks following well-defined procedures that can easily be automated (Autor *et al.*, 2003; Acemoglu and Autor, 2011). As traditional middle-income jobs have dried up, many workers have shifted into low-income service occupations (Autor and Dorn, 2013), while others have dropped out of the workforce altogether (Cortes *et al.*, 2016a). Meanwhile, the falling price of computing has increased the demand for skilled workers performing non-routine cognitive tasks, leading to an expansion of high-income jobs (Katz and Murphy, 1992; Acemoglu, 2002; Autor and Dorn, 2013). The title *Lousy and Lovely Jobs*, of work by Goos and Manning (2007), thus captures the labor market consequences of the Computer Revolution in America and elsewhere, where labor market polarization has created both winners and losers, as employment has shifted towards the top and bottom tails of the occupational wage distribution.

Second, the economics of automation cannot be separated from its politics. (As shown by Figure 1, economic and political polarization in America has gone hand in hand; and the link has seemingly grown stronger since the age of computers.) For ordinary workers, their skills constitute their capital; it is from their human capital that they derive their subsistence. Because automation is accompanied by creative destruction in employment, which often comes with social costs—including vanishing incomes, forced migration, skill obsolescence, and episodes of unemployment—it threatens not only the incomes of incumbent producers but also the power of incumbent political leaders (Acemoglu and Robinson, 2013). The reason is simple: if workers that have lost out to automation do not accept labor market



Notes: This figure shows the polarization of the U.S. House and Senate based on data on the distance between the parties on the first (liberal-conservative) dimension from Vote View (https://voteview.com) and the share of national income accruing to the top 10% obtained from the World Wealth & Income Database (http://wid.world/).

Figure 1: Income Inequality and the Polarization of the Congressional Parties.



Notes: This figure shows the positive relationship between the share that voted for Trump in the 2016 Presidential Election across 3,108 counties reported in the *Atlas of the U.S. Presidential Election* and the share of routine jobs in each county's corresponding local labor market. We sort all observations into 25 equally sized groups with each circle corresponding to the mean value in each group, while the line corresponds to a fitted OLS regression based on the underlying data.

Figure 2: Automation exposure and the support for Trump.

outcomes, they will resist the force of technology through non-market mechanisms, such as political activism (Mokyr, 1990, 1998; Mokyr *et al.*, 2015). The British Industrial Revolution provides a case in point. The downfall of the domestic system—which was gradually displaced by the mechanized factory—inflicted substantial social costs on workers, leading them to rage against the machines that pioneers of industry marveled about: the 1779 riots in Lancashire and the Luddite risings of 1811 to 1813, are only two of many attempts to bring the spread of machines to halt (Mantoux, 2013). Other options of restricting automation were limited to the workers who feared losing their jobs. Even with the Reform Acts of 1832 and 1867, property ownership remained a requirement for voting, meaning that most Britons were politically disenfranchised. Although the Industrial Revolution began with the arrival of the factory, it came to a close not just with the construction of the railroads but also with the publication of the *Communist Manifest*o—while the accelerating pace of technological progress paved the way to modernity, it also bred many political revolutionaries along the way.

Against this background, we ask the question: was the outcome of the 2016 U.S. Presidential Election shaped by a growing automation anxiety? Figure 2 provides a first glance of our key finding, documenting the positive relationship between the support for Trump and workers exposure to automation across U.S. counties. We show that this relationship holds also when controlling for a range of other economic factors such as educational levels, exposure to trade competition, and manufacturing employment, as well as differences in the age and ethnic composition of voters across electoral districts. Examining differences in votes cast in the 2012 and the 2016 elections as well as differences in exposure *within* states serves to show that similar patterns are also evident when factoring out historical divisions along party lines. Additional results that examine differences in the types of workers employed in routine jobs show that the support for Trump mainly accrued from areas with a large share of low-educated males. These findings lend support to the general perception that low-skilled men have been the prime victims of automation and are thus more likely to opt for radical political change.[1]

The remainder of this paper is structured as follows. We begin by discussing the political economy of automation, showing that economic history has not been a long tale of progress. Despite the technological wonders of the British Industrial Revolution, the first three generations did not experience its benefits. The absence of better paid jobs as the mechanized factory displaced the domestic system led workers to riot against the spread of machinery. In similar fashion, we show that a sizable share of the American workforce has been left worse off in economic terms as a result of the Computer Revolution. Lastly, examine the political implications of the Computer Revolution in terms of its impacts on the outcome of the U.S. 2016 Presidential Election.

2 The Political Economy of Automation

Why have economic models failed to incorporate the resistance to new technology? One reason is that standard neoclassical theory typically treats automation as a Pareto improvement: in the event that workers are displaced by machines, new and better paid jobs become available for everyone. The irrelevance of such models is evident from the historical record: technological change has always been accompanied by what the great economist Joseph Schumpeter famously termed "creative destruction". As new technologies displace old ones, they also render the skills of parts of the workforce obsolete. This dilemma is prominently featured in James Joyce colorful novel *Ulysses* (1922), in which Leopold Bloom takes note of the disruptive force of technology:

> "A pointsman's back straightened itself upright suddenly against a tramway standard by Mr. Bloom's window. Couldn't they invent something automatic so that the wheel itself much handier? Well but that fellow would lose his job then? Well but then another fellow would get a job making the new invention?"[2]

Bloom's observation goes to the heart of creative destruction: as automation makes the jobs of some workers redundant, it also creates new employment opportunities, but for a *different* breed of worker. The surge in child labor that accompanied the spread of the factory system during the early days of the British Industrial Revolution bears witness to this view: the machines of the first factories were made simple

[1] As documented by Cortes *et al.* (2016a), for example, advances in automation has caused especially low-skilled young and prime-aged men to leave routine occupations and shift into non-employment and low-income non-routine jobs.

[2] Cited in Akst (2013).

enough to be tended by children.[3] As many of the old artisan skills were made obsolete by advances in mechanization, adult male workers lost out: the share of children rapidly expanded and reached about half of the workforce employed in textiles during the 1830s (Tuttle, 1999). As noted by Andrew Ure (1835): "even in the present day [...] it is found to be nearly impossible to convert persons past the age of puberty, whether drawn from rural or handicraft occupations, into useful factory hands."[4] In similar fashion, since the beginnings of the age of computers, machines have replaced repetitive assembly workers, machine operatives, secretaries, paralegals and workers doing repetitive costumer service (Autor *et al.*, 2003). Meanwhile, entirely new tasks have emerged, creating demand for a different set of skills, like those of audio-visual specialists, software engineers, database administrators, and computer support specialists (Berger and Frey, 2016). Consequently, workers without a college education, who have seen their jobs being automated away, have shifted into low-income jobs or non-employment (Cortes *et al.*, 2016a).

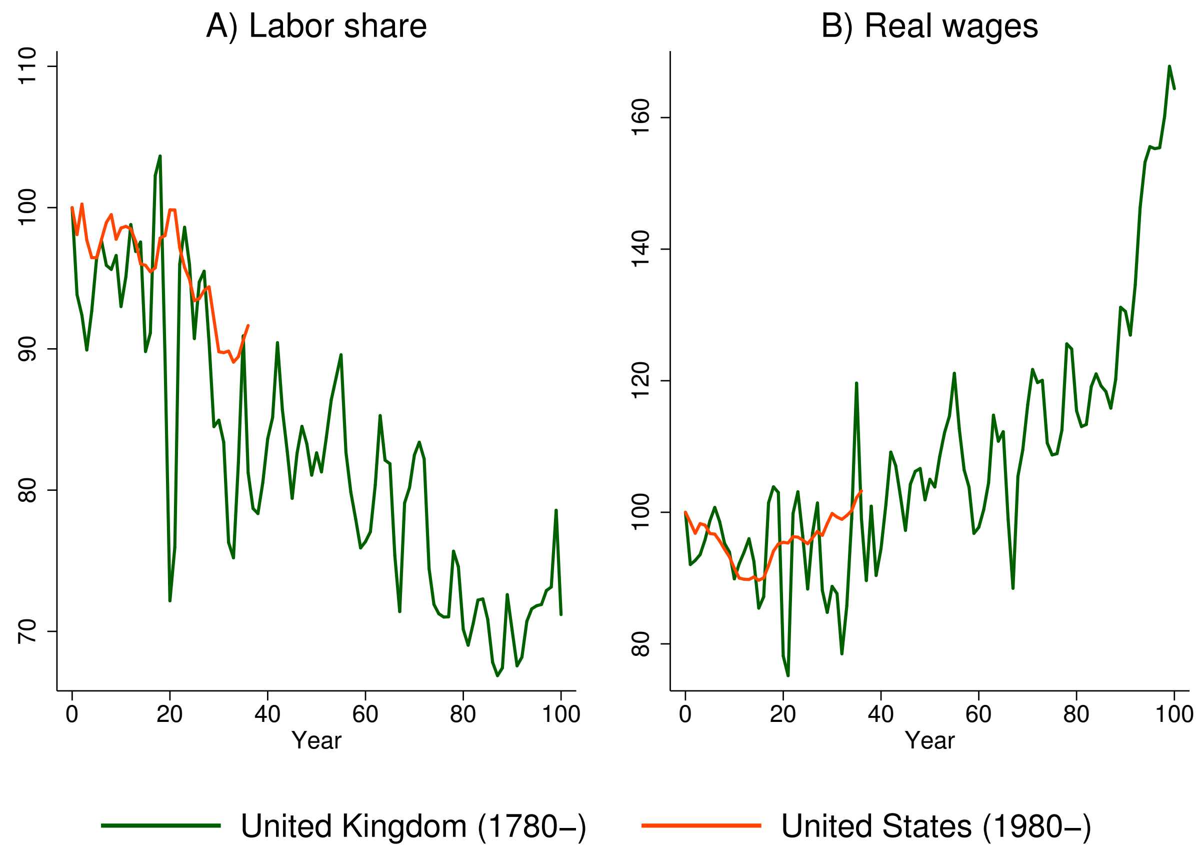
This process of creative destruction, upon which long-run growth ultimately rests, has *always* created both winners and losers in the labor market. Because creative destruction comes with social costs—as some workers see their incomes disappear, are forced to migrate, and may experience episodes of unemployment—it is not unlikely to lead to social unrest, in turn threatening the power of incumbent political leaders. Thus, because resistance to new technology takes place outside the market, the economics and politics of automation are intimately connected. As forcefully argued by Mokyr (1998):

> "Any change in technology leads almost inevitably to an improvement in the welfare of some and a deterioration in that of others. To be sure, it is possible to think of changes in production technology that are Pareto superior, but in practice such occurrences are extremely rare. Unless all individuals accept the verdict of the market outcome, the decision whether to adopt an innovation is likely to be resisted by losers through non-market mechanism and political activism."

Ultimately, however, the extent of resistance to automation depends on how its benefits are being shared. During the twentieth century, railroad telegraphers, telephone operators, and longshoremen, all lost their jobs to automation. Yet, the continued expansion of manufacturing and rising educational attainment in America allowed most workers to switch into better paid jobs: the share of national income accruing to the "middling sort" increased up until the 1970s (Lindert and Williamson, 2016; Gordon, 2016). This period, referred to by economists as the "great compression", witnessed rapid advances in automation that made the vast majority of workers better off, prompting President Kennedy to note that "a rising tide lifts all the boats." All the same, there is no assurance that workers who see their jobs disappear will find new and better paid employment opportunities. During times when a greater share of the workforce loses out to automation, it naturally follows that resistance to new technology will be more vehement. Figure 3 documents two such episodes: the British Industrial Revolution and the Computer Revolution in

[3] With the aid of machines, spinning was quickly learned and needed little strength: early spinning machines were simple and smaller in size, making them perfectly suitable to be tended by children.

[4] Cited in Mokyr (2009).



Notes: This figure shows the labor share of national income (panel A) and the trajectories of real wages (panel B) in the United Kingdom between 1780-1880 and in the United States between 1980-2015). U.S. real wages are calculated from BLS average weekly earnings of production and nonsupervisory employees deflated with a CPI index and labor share data based on the BLS labor share index. U.K. real wage and labor share data is taken from Allen (2009).

Figure 3: A tale of two industrial revolutions.

America. During the first six decades of the Industrial Revolution ordinary Englishmen did not see any of the benefits from automation: as output expanded, real wages stagnated, leading to a sharp decline in the share of national income accruing to labor. The trajectories of the American economy over the four decades following the Computer Revolution almost exactly mirror the first four decades of the Industrial Revolution in Britain.

2.1 The Rise of the Luddites: Evidence from the British Industrial Revolution

The British Industrial Revolution was the defining episode that made technology the chief engine of economic growth and eventually allowed mankind to escape the life that Thomas Hobbes described as "nasty, brutish, and short." *Eventually* was nonetheless a long time. Between 1780 and 1840—the *classic* period of the Industrial Revolution—the lives of ordinary workers got nastier, more brutish, and shorter.

The standard of living debate surrounding the Industrial Revolution will probably never settle for good, but the optimists have an increasingly difficult case to make as empirical evidence continues to accumulate.[5] Almost by any measure, material standards and living conditions for the common Englishman did not improve before 1840. Output expanded, yet the gains from growth did not trickle down to the vast majority of the population. The best estimates suggest that while output per worker increased by 46 percent over the classic period (Crafts and Harley, 1992), real wages rose by a mere 14 percent (Feinstein, 1998).[6] Meanwhile, working hours increased by 20 percent (Voth, 2000), suggesting that hourly wages even declined in real terms.[7] The main beneficiaries were industrialists who saw the profit share of income double (Allen, 2009). The view of Friedrich Engels (1845), that industrialists "grow rich on the misery of the mass of wage earners", was thus largely accurate for the period he observed: as wages declined and the profit share of national income doubled, the income share accruing to the top 5 percent in Britain almost doubled as well (Lindert, 2000).

Why did living standards during the days of the Industrial Revolution falter? As argued by Allen (2016), the issue of faltering standards of living was the result of the destruction of hand loom weaving and other manual trades. The displacement of the domestic system by the mechanized factory inflicted substantial pains on the workers that felt the force of the factory. The observation of Baines (1835), that handloom weavers were in "deplorable condition", cannot be explained without reference to the rise of power loom weaving. Comparing the wages of weavers to occupations left unaffected by technological change, Allen (2016) has shown that poverty accompanies progress as the incomes of hand loom weavers collapsed in response to the spread of the power loom. Not only did wage inequality grow rapidly; the earnings potential of weavers was reduced to barebones subsistence.

Where did workers who lost their jobs to the force of the factory end up? While we lack individual-level data to trace their fates, recent empirical evidence from Northamptonshire is illustrative (Shaw-Taylor and Jones, 2010). As factory mechanization in Britain left the local worsted cloth industry unable to compete, it flooded the agricultural labor market with former weavers for many decades. The workers that shifted into agricultural jobs were left significantly worse off: the wages of agricultural laborers in

[5]Economic historians have made many attempts at measuring long-run trends in real wages during this period. The first landmark study was that of Lindert and Williamson (1983), showing that real wages in Britain increased already after the Battle of Waterloo (1815). Their findings were always controversial, however, especially since they did not concur with findings about patterns of consumption and biological indicators of living standards. In fact, biological indicators suggest that overall material standards if anything declined: Floud *et al.* (1990) and Komlos (1998) show somewhat different temporal patterns, but both find that men in 1850 were shorter than they had been in 1760. This finding is consistent with data on per capital calorie consumption, which was lower in 1850 relative to 1800 (Allen, 2005). Beyond food consumption, the share of households with a surplus for non-essentials declined among low wage agricultural laborers and factory workers over the first half of the nineteenth century (Horrell, 1996). New real wage series reflect these trends: based on an updated cost of living index, Feinstein (1998) largely confirmed what we know from patterns of consumption and biological indicators, showing that real wages were stagnant before 1840. Recently, however, Clark (2005) has developed a new price index. Although Clark's (2005) estimates shows that real wages did not improve beyond their mid-eighteenth century level until the 1820s, they are more optimistic than those of Feinstein (1998). All the same, reconciling the differences in the two price indexes, Allen (2009) largely confirms Feinstein's (1998) picture of real wage trends up until 1860.

[6]The real wage index even fell from its base of 100 in 1780 to 84.9 in 1800, just before the outbreak of the Napoleonic Wars, and only increased slightly thereafter.

[7]Voth (2000) documents the increase in working hours for the period 1760 to 1830.

Britain were just around twice of barebones subsistence, and significantly lower than those of weavers before their incomes collapsed due to mechanization (Allen, 2016). The flood of ex-weavers could not possibly have been absorbed by the agricultural sector, suggesting that many were left unemployed since the industrial sector did not grow at a sufficient pace to replace the jobs lost in weaving (Shaw-Taylor and Jones, 2010). The benefits of the Industrial Revolution in Northamptonshire was only felt generations after weaving had collapsed, as was also the case in Britain in general.

From an economics point of view, the faltering standards of living during the classic period of the Industrial Revolution represent something of a dilemma: why would workers voluntarily agree to participate in the industrialization process if it reduced their utility? Yet, this is only a puzzle in the absence of coercion. Coercion was however far from absent. Clashes between workers and the British government over the adoption of machines were frequent. On May 10th in 1768, the first steam-powered sawmill in Limehouse was burned to the ground by sawyers claiming that it had deprived them of employment; in 1772, a factory using Cartwright's power loom in Manchester was similarly burnt down; and the riots of 1779 in Lancashire, where machines had diffused most rapidly, were no less severe than previous episodes.[8] Workers rioted against the increasingly mechanized factory, but efforts to bring the spread of machines to halt were unsuccessful as the British government took an increasingly stern view on any attempts to hinder industrial and technological development, which it deemed critical to Britain's competitive position in trade (Mokyr, 1990; Caprettini and Voth, 2017; Mantoux, 2013; Berg, 1982). During the Luddite risings of 1811 to 1813, rioters achieved nothing more than their predecessors, except forcing the British government to deploy an even larger army: the 12,000 troops sent to resolve the situation exceeded the size of the army which Wellington took into the Peninsula War against Napoleon in 1808. As argued by Mantoux (2013): "Whether their resistance was instinctive or considered, peaceful or violent, it obviously had no chance of success, as the whole trend of events was against it."

2.2 Men Without Work: The Victims of the Computer Revolution

Like in the early days of the Industrial Revolution, growth has failed to trickle down to ordinary Americans since the age of computers began in the early 1980s. Over the period 1979 to 2013, productivity growth was eight times faster than hourly compensation: as productivity grew by 64.9 percent, hourly compensation for 80 percent of the American workforce grew only by 8.2 percent, while the top 1 percent of earners saw cumulative gains in annual wages of 153.6 percent (Bivens *et al.*, 2014). Wages of the vast majority of Americans thus stagnated or even declined. With the exception of a brief period in the late 1990s, the wages of middle-income workers were either flat or in decline, while the wages of low-wage workers fell by 5 percent. The greatest reversal of fortunes has taken place since the turn of the 21st century: between 2000 and 2013, hourly wages fell for the bottom 30 percent and were flat for the next

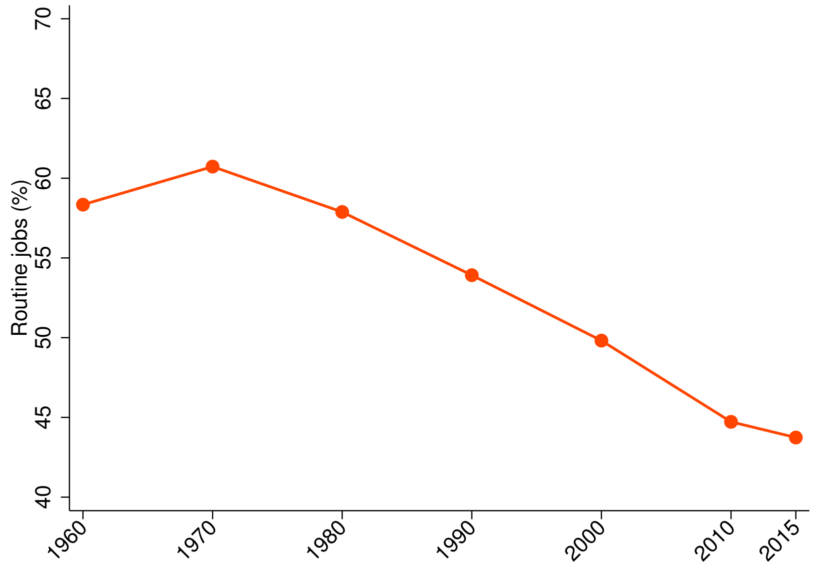
[8]Moreover, using newly-compiled data on the diffusion of threshing machines, Caprettini and Voth (2017) show that labor-saving technology was the key determinant of the probability of unrest during the "Captain Swing" riots of the 1830s. Where machines were adopted, the probability of riots was around 50 percent higher: machines themselves were the key cause of their concerns.

40 percent (Bivens *et al.*, 2014). Like during the classic years of the Industrial Revolution, most growth has accrued to owners of capital; the labor share of income in America fluctuated around 64 percent during the postwar period, but has trended downward since the 1980s, reaching its lowest postwar level after the Great Recession, and is now averaging 6 percentage points below the level that prevailed during the first four decades of the postwar period (see Figure 3). Thus, a large segment of the workforce have become detached from the engine of growth. According to estimates by Summers (2015), the income distribution of 1979 would leave today's top 1 percent with a $1 trillion less in annual income, while adding on average $11,000 a year for a family in the bottom 80 percent.

Although the causes of this detachment are still being debated, a growing body of work has identified automation as one of the prime forces driving the shifts in income shares along the occupational wage distribution (Autor *et al.*, 2003, 2006; Autor and Dorn, 2013; Graetz and Michaels, 2015; Michaels *et al.*, 2014; David, 2015), and from labor and owners of capital (Karabarbounis and Neiman, 2013), downplaying alternative—albeit complementary—explanations emphasizing the role of globalization, immigration, deunionization, and manufacturing decline. Across geographies and industries, the trillion-fold secular decline in the price of computing (Nordhaus, 2007), has caused a sharp reduction in the demand for routine jobs, such as those of machine operators, assembly workers, bookkeepers, paralegals, and secretaries (see Figure 4). In recent years, this process has speeded up: while the disappearance of per capita employment in routine occupations has been a key feature of the U.S. labor market since the 1980s, it has not been a gradual phenomenon. Most routine employment loss has happened during economic downturns and has more recently been accelerated by the Great Recession. Though employment in high- and low-skill occupations has rebounded since 2009, the recovery for middle-income routine employment has been jobless. Jobless recoveries were not observed in routine occupations prior to the age of computers, suggesting that joblessness has been driven by technology (Jaimovich and Siu, 2012).

Where have workers who lost their jobs to automation reallocated? An emerging literature suggests that advances in automation has caused workers to transition into either non-employment or non-routine manual jobs (Cortes *et al.*, 2016a). In tandem with routine jobs disappearing, Autor and Dorn (2013) document a structural shift in the labor market, with workers reallocating their labor supply to low-income service occupations. Arguably, this is because the manual tasks of service occupations are less susceptible to computerisation, as they require a higher degree of flexibility and physical adaptability (Acemoglu and Autor; Autor *et al.*; Goos and Manning; Goos *et al.*; Goos *et al.*). Deteriorating median wages are directly linked to such shifts: routine occupations (e.g., machine operators, secretaries and administrative assistants) tend to occupy the middle of the wage distribution, whereas manual non-routine occupations (e.g., janitors and building cleaners, personal and home care aides) cluster at the bottom (Autor and Dorn, 2013; Goos and Manning, 2007).

In particular, the decline in routine employment has been driven by a declining propensity for low-skilled prime-aged in routine physical occupations and the decline of prime-aged women with intermediate levels of education in routine cognitive occupations. As shown by Cortes *et al.* (2016a), these same groups account for a substantial fraction of both the increase in non-employment and employment in

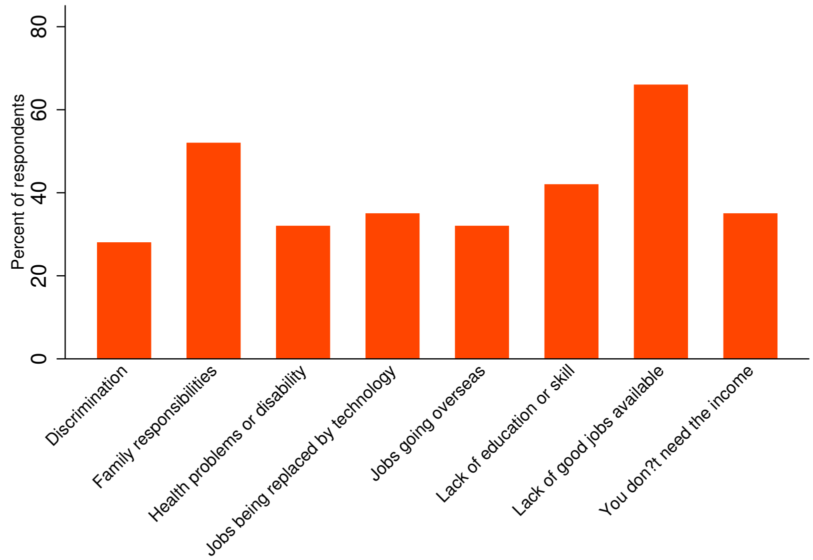


Notes: This figure shows the share of routine jobs in total US employment between 1960 and 2015 based on data drawn from the IPUMS and ACS samples. Routine jobs are defined as in Jaimovich and Siu (2012) and are described in more detail in the main text.

Figure 4: Routine jobs in the United States, 1960-2015.

low-wage, non-routine manual occupations observed during the same time period. More direct evidence of advances in automation leading to non-employment has recently been provided by Acemoglu and Restrepo (2017), documenting a robust negative effects of robots on employment and wages. Yet, while robots affected both men's and women's jobs, the effect on male employment was up to twice as big. Greenstone and Looney (2011) further calculate that the median earnings of prime-aged men have fallen by 28 percent in real terms over the past four decades, while for those without a high school diploma, the drop was 66 percent. According to Eberstadt (2016) timely book *Men Without Work*, 24 percent of men between twenty-five and fifty-four will be out of work by 2050 at current trend.

Moreover, the decoupling of average and median real wages can in part be explained by falling prices of computing, contributing the substantial employment growth in occupations involving cognitive tasks where skilled labor has a comparative advantage, as well as the persistent increase in returns to education (Katz and Murphy, 1992; Acemoglu, 2002; Autor and Dorn, 2013). While college educated men have fared much better relative to their low-skilled counterparts, by shifting into high-income cognitive occupations, improvements in labor market outcomes were not experienced equally by both genders. Despite the rapid growth in employment in high-income cognitive occupations, the probability that a college-educated male was employed in one of these jobs has fallen since the age of computers (Cortes *et al.*, 2016b). The relative prominence of college-educated women in such jobs can be explained by an increase in the demand for social skills in such occupations, where the psychology and neuroscience literatures that indicate that women have a comparative advantage. Thus, in short, the prime victims of the Computer Revolution have been low-skilled men in routine jobs; the winners has been college educated



Notes: Each bar corresponds to the percent of respondents that are unemployed but able to work who state that each factor is a major or minor reason why they are not working based on Hamel, Firth, and Brodie (2014).

Figure 5: Why are Americans out of work?

women.

2.3 The New Machinery Riots: Did the Computer Revolution Shape the Outcome of the 2016 U.S. Presidential Election?

Was the outcome of the 2016 U.S. Presidential Election driven by parts of the electorate more exposed to automation? Of course, Trump did not make any pledge to bring technological progress to halt during his election campaign. In fact, he barely mentioned technology at all. His pledge to bring back jobs in mining and manufacturing, which have long been automated away, bears with it an implicit promise to restrict automation although few voters will have noted this logic. All the same, it remains indisputable that Trump represented a challenge to the political status quo; fully 82 percent of voters believed that Trump was the candidate for change according to the Exit Polls.

Although many voters are unlikely to have recognized the true causes of their concerns, automation prominently features as one of the prime reasons American's identify behind their struggle to find work (see Figure 5). While identifying the workers that have lost out to automation is empirically challenging, it is evident from a series of studies that workers employed in routine occupations have been most exposed to automation (Autor *et al.*; Acemoglu and Autor; Autor and Dorn; Goos and Manning; Goos *et al.*; Goos *et al.*; Jaimovich and Siu). Building on the intuition that these workers are more likely to opt for radical change, we explore the relationship between the support for Trump and the share of routine jobs across electoral districts. Doing so, we take advantage of the variation in the exposure of the workforce to automation across locations. A growing body of work shows that U.S. cities have fared very differently from automation in the past: since the Computer Revolution of the 1980s, human capital abundant areas have created new jobs for software engineers, computer support specialists, data administrators and analysts, etc. (Lin, 2011; Berger and Frey, 2016, 2017), while locations with a greater share of routine employment have seen jobs being automated away (Autor and Dorn, 2013).

To examine the link between workers exposure to automation and the propensity of voters to opt for Trump, we match county-level data on the distribution of votes from the 2016 Presidential Election—using Dave Leip's Atlas of U.S. Presidential Elections—with their corresponding local labor market, as defined by Autor and Dorn (2013). This approach yields voting patterns for a total of 3,108 counties and the employment structure of the corresponding 722 local labor markets—which we refer to as "Commuting Zones (CZs)"—that cover the U.S. mainland. For each CZs, we draw on individual-level data from the 2015 American Community Survey (ACS) that provide a 1 percent sample of the U.S. population to identify the share of the labor force employed in routine jobs.[9] Routine jobs are defined following the approach in Jaimovich and Siu (2012), where jobs in Sales, Office/Administration staff, Production/Craft/Repair, Operators/Fabricators/Labours are classified as routine, which aligns with the occupational groups identified in Autor and Dorn (2013).[10] Throughout our analysis the central variable is the share of a CZs labor force that is employed in routine occupations in 2015, which we decompose into demographic subgroups in some specifications.

As shown in Figure 2, there is a positive relationship between the support for Trump in the 2016 election and the degree of specialization in routine work across the United States. Although this correlation is highly suggestive, we next proceed to analyze the persistence of this relationship when controlling for a variety of factors. Our specifications match the share of Republican two-party vote at the county-level to economic conditions in CZs:

$$V_{czs} = \alpha_s + \delta RJ_z + \gamma \mathbf{X}_z + e_{cs}, \tag{1}$$

where the outcome variable V_{cs} is Trump's share of the total votes in the 2016 election in county c, in CZ z, located in state s. The variable of interest is the share of employment of routine occupations RJ_z. X_z is a vector of CZ-level control variables including a variety of demographic and labor market characteristics based on information provided in the ACS samples. Additional estimates also include state fixed effects (α_s) to examine whether a link between support for Trump and the share employed in routine jobs also exist when factoring out traditional state-level divisions along party lines. All regressions are weighted by their total number of votes in the 2016 Presidential Election and standard errors are clustered at the CZ-level throughout.

Table 1 presents a variety of estimates based on equation (1). As shown in column 1, the share of routine employment alone has considerable explanatory power, accounting for more than a third of the

[9]To match the voting age restriction, we restrict our samples to workers aged between 18 and 64, excluding unpaid family workers and workers living in institutions.

[10]Jaimovich and Siu (2012)provide details comparing different definitions of routine occupations in their Appendix B.1 showing that their definition is identical to the occupation groups which are derived from Autor and Dorn (2013).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
% routine jobs	2.106***	1.495***	1.169***	0.576***	0.150**	0.554***	0.587***
	(0.127)	(0.222)	(0.172)	(0.146)	(0.061)	(0.157)	(0.154)
% low-educated in routine jobs						-0.106	-0.079
						(0.207)	(0.207)
% low-educated men in routine jobs							0.377***
							(0.130)
Labor market controls	No	Yes	Yes	Yes	Yes	Yes	Yes
Demographic controls	No	No	Yes	Yes	Yes	Yes	Yes
State FE	No	No	No	Yes	Yes	Yes	Yes
Observations	3,108	3,108	3,108	3,108	3,108	3,108	3,108
R-squared	0.366	0.414	0.513	0.567	0.642	0.567	0.568

Notes: This table presents OLS estimates of equation (1) in the main text. The outcome in all columns expect column 5 is the percentage share of votes for Trump in the 2016 Presidential Election. In column 5, the outcome is the difference between the percentage of votes for Trump and the percentage of votes cast for Mitt Romney in the 2012 Presidential Election. Additional controls are described in more detail in the main text. Statistical significance based on standard errors clustered at the CZ-level is denoted by: *** p<0.01, ** p<0.05, * p<0.10.

Table 1: Routine jobs and the support for Trump: OLS estimates.

variation in support for Trump. Moreover, an increase in a CZs share of routine jobs is associated with a considerable increase in the support for Trump: a 5 percentage point increase in the share of routine jobs (roughly one standard deviation) is associated with an increase in the share voting for Trump in 2016 by roughly 10 percentage points. Of course, this relationship may reflect the fact that the distribution of routine employment is likely correlated with a variety of factors that may drive the relationship documented in column 1: CZs that specialize in routine occupations, for example, also typically exhibit lower educational attainment, more manufacturing jobs, and are more likely to be rural.

To account for these potentially omitted variables, column 2 adds a set of labor market controls, including the share of the population with a college degree, the share that is unemployed, the manufacturing employment share, the exposure of the workforce to Chinese imports—as defined in Autor *et al.* (2013, 2014) and—as well as an indicator reflecting whether or not a CZ is located in a rural or urban area.[11] Because voting patterns are reported to have varied substantially along a variety of demographic dimensions, column 3 further adds controls for the share of a CZs population that is foreign born, as well as female, and the black and hispanic shares, respectively.[12] Although the estimated magnitude declines when adding these additional controls, a positive and highly statistically significant link between the share of routine jobs and support for Trump persists, which is also evident when factoring out state-

[11] Autor *et al.* (2016b) and Autor *et al.* (2016a) further document the impacts of import competition on political polarization in the United States as well as the 2016 Presidential Election.

[12] For brevity we do not report the estimates for these additional covariates, but note that they generally align with popular perceptions of the areas that supported Trump: the support was significantly lower in areas with a more educated population, that are urban, or where blacks or hispanics constituted a large share of the population.

level differences, thus only exploiting the variation in votes for Trump and specialization in routine work *within* states (column 4).

An additional concern is that our estimates reflect some omitted factor that is correlated with support for the Republican party. To alleviate such concerns, column 5 replaces the outcome variable with the difference in the percentage of votes accruing to Trump and the percentage of votes cast in favor of Mitt Romney in the 2012 U.S. Presidential Election. These estimates reveal that the growing support for the Republican party candidate between 2012 and 2016 was particularly evident in areas with high shares of routine employment.

We next proceed to examine how the support for Trump varied across subgroups employed in routine jobs. Column 6 adds a variable denoting the share of routine jobs that are low-skilled, revealing no relationship between the educational background of workers in routine jobs and their support for Trump. As discussed above, however, the main group that has been adversely affected by the onrushing wave of automation has been low-skilled *males*. Column 7 adds a variable corresponding to the percent of routine jobs held by low-skilled males, showing that the support for Trump was indeed considerably higher in areas characterized by a large share of the prime victims to automation, echoing the perception that dissatisfaction is largest among the groups hit hardest by the force of technology.

A remaining identification challenge is that the distribution of routine jobs across present-day America may be correlated with a variety of factors that stem from the dramatic decline in routine jobs since the 1980s, in areas that specialized in routine work *before* the days of the Computer Revolution (Autor and Dorn, 2013). To identify the component of present-day specialization in routine jobs that is determined prior to the era of rapid computerization, we exploit historical differences in routine employment across CZs to instrument for the share of jobs that are routine today. More specifically, we use the variation in the share employed in routine jobs in 1980, which largely precedes the recent era of automation, to instrument for the share of routine jobs in 2015.

Table 2 reports IV estimates using the variation in routine jobs across CZs driven by long-run differences in routine employment shares. Table 2 documents a strong first-stage correlation between routine employment in 1980 and the share of routine jobs in 2015, which reflects the persistence in occupational specialization across local labor markets. We can reject a 10 percent IV bias in all instances, since the Kleibergen-Paap F-statistics all exceed the conventional critical values, which reduces concerns that our estimates are affected by weak instrument problems. A comparison of the IV estimates with the above reported OLS estimates consistently show that IV estimates are larger in magnitude. As CZs specialized in routine *prior* to the Computer Revolution have seen the most rapid adoption of computer technologies and the most rapid decline in routine employment (Autor and Dorn, 2013), the larger IV estimates are consistent with an interpretation that an important source of the support for Trump accrued from voters with a high exposure to automation, both presently and historically.

	(1)	(2)	(3)	(4)
% routine jobs	2.037***	2.583***	1.565***	0.880***
	(0.159)	(0.602)	(0.458)	(0.309)
Labor market controls	No	Yes	Yes	Yes
Demographic controls	No	No	Yes	Yes
State FE	No	No	No	Yes
Kleibergen-Paap F-stat	75.1	26.6	19.8	68.8
Observations	3,108	3,108	3,108	3,108
R-squared	0.366	0.393	0.510	0.566

Notes: This table presents 2SLS estimates of equation (1) in the main text where outcome is the percentage share of votes for Trump in the 2016 Presidential Election. The first stage exploits the variation in routine jobs across CZs in 1980 as an instrument for the contemporary share of routine jobs. Statistical significance based on standard errors clustered at the CZ-level is denoted by: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table 2: Routine jobs and the support for Trump: IV estimates.

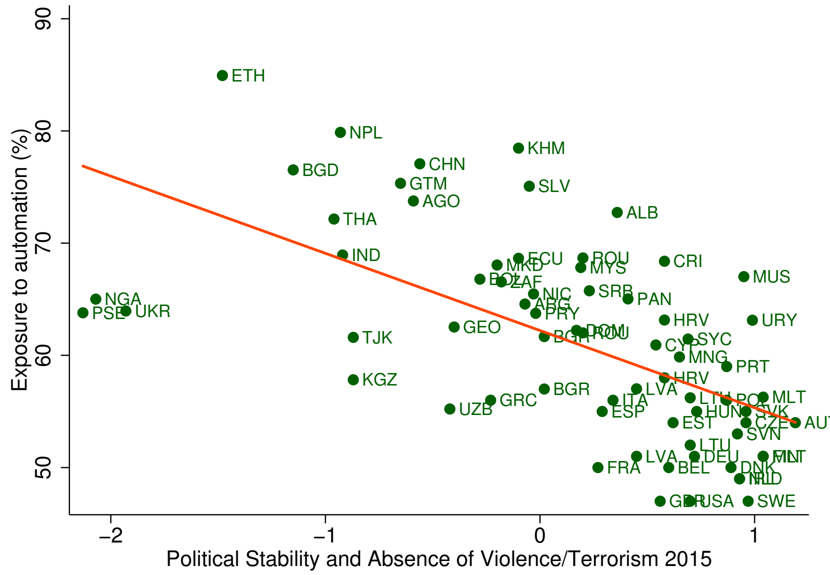
3 Concluding Remarks

The politics of automation has shaped our economic trajectories for millennia. Prior to the "great escape" brought by the Industrial Revolution, political leaders frequently banned any labor-saving technology in the fear of social unrest, providing one explanation for why economic growth was stagnant for most of human history (Acemoglu and Robinson, 2013; Mokyr, 1990). The British government was the first to consistently and vigorously take action against any attempts to hinder the spread of machines, offering "another explanation why Britain's Industrial Revolution was first" (Mokyr, 1992). The long-term benefits of the Industrial Revolution have been immense and indisputable: prior to 1750, per capita incomes in the world doubled every 6,000 years; thereafter, it has taken some 50 years for incomes to double (DeLong, 1998). Even the poorest British citizens today enjoy goods and services in an abundance that was unimaginable to their pre-industrial ancestors. But those benefits came at the expense of three generations of Englishmen (see Figure 3), of which many were made worse off by the force of technology (Shaw-Taylor and Jones, 2010; Allen, 2016; Baines, 1835; Allen, 2009).[13] To borrow David Landes (2003) phrase:

> "if mechanization opened new vistas of comfort and prosperity for all men, it also destroyed the livelihood of some and left others to vegetate in the backwaters of the stream of progress. [...] the victims of the Industrial Revolution numbered in the hundreds of thousands or even millions."

Could the British Industrial Revolution have happened if ordinary workers were also voters? Of course, there is no way of running the experiment, but many did their utmost to bring the spread of machines to halt by the means they had: besides the flood of petitions against machines that came into parliament,

[13] Thus, economic historians have long debated if the Industrial Revolution was worth it (see Williamson, 1982).



Notes: This figure shows the percentage of employment that is at "high risk" of automation over the next decades based on data from WDR (2016) and the World Bank's Political Stability and Absence of Violence/Terrorism index where higher values correspond to more stability.

Figure 6: Automation exposure and political stability around the world.

workers voted against machines with sticks and stones (Mantoux, 2013).[14] As an analogy, Wassily Leontief (1983) famously suggested that, "If horses could have joined the Democratic party and voted, what happened on farms might have been different."[15] Instead, the proliferation of automobiles, tractor and trucks caused the annihilation of the horse as a prime mover on farms and as a mean of moving goods and people around. While the Computer Revolution has not rendered the workforce redundant, a large share of American's have lost the race to technology, which is reflected in the reallocation of millions of workers from middle-income jobs to low-income occupations or non-employment as their jobs have been automated away (Autor and Dorn, 2013; Cortes *et al.*, 2016a). This paper has shown that the victims of the Computer Revolution have a higher propensity to opt for radical political change: electoral districts with a higher share of jobs exposed to automation were significantly more likely to support Trump. The 2016 U.S. Presidential Election can thus be described as a riot against machines by democratic means.

Looking forward, automation is likely to become a growing political challenge.[16] Recent developments in artificial intelligence and mobile robotics are widely regarded the beginnings of a "Second Machine Age"; computers are now able to perform even a wider range of non-routine tasks, such as medical diagnostics, translation work, and driving a car (Brynjolfsson and McAfee, 2014). As a result, Frey

[14]Most citizens lacked voting rights, for which property ownership remained a prerequisite; even with the Reform Acts of 1832 and 1867.

[15]Cited in Curtis (1983).

[16]As forcefully argued by Crafts (2015), "fears about long-term 'secular stagnation', based on the end of innovation as we have known it, seem overdone. The problem is much more likely to be the factor-saving bias of technological progress based on computerization of jobs than a drying-up of productivity growth."

and Osborne (2017) estimate that 47 percent of U.S. employment is at "high risk" of automation over the forthcoming decades, with a substantial share falling into *non-tradable* sectors of the economy, to which most workers have already reallocated: 98 percent of total U.S. employment growth between 1990 and 2008 accrued in sectors where jobs are unaffected by import competition (Spence and Hlatshwayo, 2012). While this shields many workers from the adverse impacts of trade (Acemoglu *et al.*, 2016), it does not constitute a safeguard against automation—indeed, as President Obama noted when leaving office: "The next wave of economic dislocations won't come from overseas. It will come from the relentless pace of automation that makes a lot of good, middle-class jobs obsolete."

The political challenges stemming from automation are by no means confined to the United States: in fact, low- and middle-income countries exhibit a higher relative exposure to emerging technologies. Using the Frey and Osborne (2017) methodology, the World Bank has estimated 77 percent of jobs in China are at "high risk" of automation, with similar shares being reported for India, South Africa, and Brazil (WDR, 2016). Worryingly, countries with a greater exposure to automation also typically rank lower in terms of political stability: Figure 6 shows a negative correlation between countries exposure to emerging technologies and their political stability index (the outliers being Nigeria, Ukraine, and the West Bank and Gaza). It stands to reason that leaders in politically unstable countries are particularly likely to view automation as a destabilizing factor, which they might seek to restrict.

Of course, over the very long-run automation has *always* been an engine of comfort and prosperity: after six decades of stagnant wage growth during the British Industrial Revolution, ordinary workers eventually became the prime beneficiaries of automation as they adapted and acquired new skills (Bessen, 2015; Galor and Moav, 2004). Between 1840 and 1900, real wages in Britain grew by 123 percent, considerably faster than output per worker (Allen, 2009) Could history repeat itself? Perhaps so; so far, the economic trajectories of the Computer Revolution closely resembles those of the British Industrial Revolution. But any future benefits from automation hinges upon its politics. To avoid further populist rebellion and a looming backlash against technology itself, governments must find ways of making the benefits from automation more widely shared.

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