

## **The political fallout of machine tool automation in the mid-20<sup>th</sup> century United States**

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Abstract: Since the late 1960s, Americans have been losing confidence in political and elite social institutions, and certain regional and demographic groups have turned away from the previously dominant Democratic party. Scholars have highlighted the role of cultural factors in explaining these shifts. We investigate the role of technological change, focusing on the automation of production in metal manufacturing – in particular, the diffusion of computer numerical control (CNC), which began in the 1970s. Workers who were more exposed to CNC technology reported less confidence in American institutions and weakened identification with the Democratic party. Exposure to the CNC shock at the commuting zone level reduced vote share for Democratic candidates in the South and decreased voter participation outside of the South.

## **I. Introduction**

The late 1960s and early 1970s marked the beginning of two profound shifts to the political landscape in the United States. First, Americans began to express lower levels of confidence in a wide range of institutions, including political institutions like Congress and the presidency as well as elite organizations like major companies, the press, medicine, and education (Twenge et al 2014). Second, many white Southerners and working-class white voters in other regions switched from the Democratic to the Republican party (Kuziemko and Washington, 2018; Kuziemko, Marx, Naidu, 2023).

Scholars have emphasized cultural accounts of these shifts in political attitudes and affiliation. These cultural forces include disaffection with the civil rights and feminist movements, conflict between those who fought in Vietnam and those who protested the war, and mistrust in government after misdeeds in Vietnam were uncovered and the war was lost (Pharr et al 2000; Maxwell and Shields 2019; Kuziemko, and Washington, 2018; Perlstein 2009). The 1974 resignation in disgrace of Richard Nixon from the Presidency following the Watergate break-in is a singular political event that also likely played a role in declining trust in government (Lipset and Schneider 1983).

We offer a complementary explanation for these social trends that focuses on the role of technological change. Specifically, between 1970 and 1990 an automation shock eliminated many production jobs in the key sector of metal manufacturing. A technology called computer numerical control (CNC) automated a significant part of the machining tasks needed for the creation of metal parts for manufactured goods. CNC uses motors, sensors, and computers to codify and automate the precise movements formerly performed by skilled workers. We focus on the CNC shock not because it is the only source of economic dislocation during this period but because it is one that we can identify clearly in the data.

In prior work, we investigated how the diffusion of CNC machine tools changed employment patterns both at the industry and local labor market levels (Boustan, Choi, and Clingingsmith 2022). We found that affected industries shed workers, particularly 1) on the production floor and 2) among workers with a high school degree or less. The negative effect of CNC automation was stronger in the non-unionized sector. These results are based on a new measure of exposure to CNC technology that combines baseline variation at the industry level in installed machine tools

by type – such as lathes, mechanical presses, grinding machines and so on – with differential shifts by tools from hand-based to computerized tools. Our 1958 baseline is well before the spread of CNC.

In this paper, we find that CNC automation was a factor in both the rising distrust in American social institutions and in the shift in partisan affiliation of workers in the affected industries. Starting with a sample of respondents to the General Social Survey (GSS) who work in one of the affected metal manufacturing industries, we show that workers who were more exposed to CNC automation report less confidence in American institutions as measured by a 12-institution index. The relationship is about twice as strong for workers in the South, where unionization rates were lower. A 10-percentage point change in CNC exposure, approximately the difference between the most and least exposed metal manufacturing industries in 1990, is associated with a 3-percentage point decline in confidence in the non-South and a 6-percentage point decline in the South (relative to a base of around 80% confidence in the 1970s). CNC exposure also changes the stated political preferences of affected workers, reducing their identification with the Democratic Party.

The diffusion of CNC technology influenced the broader labor market outside adopting industries, including through worker flows. We next examine the effect of the advent of CNC technology on voting behavior in local labor markets that were more- or less-exposed to CNC automation. We produce a local measure of exposure to CNC technology by weighting our industry-level CNC exposure measure by the initial industrial composition of the labor markets. Exposure to the CNC shock increases votes for both the Republican party and for third party candidates in the South, lowering the vote share for the Democratic party. Outside of the South, exposure to CNC technology decreases voter participation but does not affect the partisan mix of votes cast. These results complement our worker-level findings by implicitly capturing the effect of CNC on unemployment (rather than only considering workers still employed in affected industries) and by measuring changes in voting behavior, rather than stated political preference.

### ***Contributions to the literature***

Our paper contributes to both a contemporary literature assessing the relationship between recent economic shocks, social dislocation, and political change, as well as a longer historical literature identifying the winners and losers from automation through the 19<sup>th</sup> and 20<sup>th</sup> centuries.

One of Robert Margo's many seminal contributions to our understanding of American economic history – and an inspiration for our work in this volume – is his documentation and analysis of the impact of technical change on firms and workers in the 19<sup>th</sup> century. Since 1850, key technological innovations contributing to factory automation have included: the rise of steam power, the creation of interchangeable metal parts, the adoption of powered machine tools, factory electrification, and the development of the assembly line. Margo and various co-authors have shown that the use of powered machine tools displaced skilled artisanal workers with lower-skilled operatives, who each completed one of many tasks in the production of a final product. The resulting division of labor and capital intensity associated with this shift resulted in heightened labor productivity, but at the cost of job loss for a set of skilled artisans (Atack, Bateman and Margo 2004, 2008; Katz and Margo 2014; and Atack, Margo, and Rhode 2019, 2022, this volume).

The job dislocation associated with automation has engendered protest, social disaffection, and conflict since the beginning of the Industrial Revolution. Perhaps most famously, textile workers in 18<sup>th</sup> and 19<sup>th</sup> century England destroyed spinning and weaving equipment that reduced their bargaining power and threatened their livelihoods (Hobsbawm 1952). The introduction of threshing machines in Britain, which displaced agricultural labor, led to rioting and induced political change (Caprettini and Voth 2020; Aidt and Franck 2015). In the United States, automation was a factor in the frequent, widespread, and disruptive strikes in the US auto industry in the late 1940s (Clark 2018). At this time, automakers were deploying transfer machines, then the most advanced automation technology (Hounshell 2000). A compromise reached in 1950, the so-called “Treaty of Detroit,” held that unions would bargain over wages and working conditions while firms would determine the organization of production (Milkman 1997).

In recent years, scholars have documented the social and political consequences of job loss due to the most recent wave of automation following the diffusion of industrial robots, as well as due to shocks like the Great Recession and rising import competition from Japan and later from China. Workers facing job loss due to plant closures experience declining mental health and are more likely to commit crime (Kuhn, Lalive, Zweimüller 2009; Strully 2009; Amorim, Britto, Fonseca, Sampaio 2023; Rege et al. 2019; Britto, Pinotti, Sampaio 2022). Case and Deaton (2020) argue

that faltering economic opportunities for lower-skilled workers have been an important cause of rising rates of “deaths of despair,” including deaths from suicides or drug overdoses, although the strength of this relationship has been questioned (Ruhm 2018; Dow, Godøy, Lowenstein, Reich 2020). Employees who face dislocation with the spread of industrial robots or competition with China increasingly support right-wing parties, which tend to promote the distrust of social institutions (Frey et al 2018; Anelli et al 2021; Caselli et al 2021; Gallego and Kurer 2022; Autor, Dorn, Hanson, Majlesi 2020). Survey evidence documents that workers with higher expectations of automation-driven unemployment exhibit more populist views (Golin and Rauh 2023).<sup>1</sup>

We bridge these two strands of literature on the social dislocations of automation – the historical and the contemporary – by considering the diffusion of CNC machine tools in the 1970s and 1980s, a period that coincided with a weakening of trust in institutions.

Our work also contributes to a broader literature on the causes of decline in social trust and confidence in institutions in the latter part of the 20<sup>th</sup> century. Here, our paper is most closely related to studies that identify individual economic fortunes as a cause of declining trust in institutions (Brandt, et al. 2015; Mewes, et al. 2021; Kim, et al. 2022). Newton and Norris (2000) examined confidence in institutions across advanced countries and argued that government failures in both economic and foreign policy, rather than social-psychological or cultural factors, can explain declines in confidence. Others have argued that episodes such as the Vietnam War and the Watergate scandal contributed to broad declines in trust in government (Lipset and Schneider 1983, Pharr et al 2000; Schulman 2001).

## **II. Historical background**

### ***Erosion of confidence in institutions***

Trust in the federal government and other important institutions of American life has been in decline since the mid-1960s. Figure 1 documents this pattern with data from the National Election Study. In the late 1950s and early 1960s, nearly 75% of Americans trusted the government to do the right thing “just about always” or “most of the time” (Pew Research Center 2023). This trust

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<sup>1</sup> See Guriev and Papaioannou (2022) for a review of the political economy of populism.

was broadly shared by members of the Republican and Democratic parties. Trust declined precipitously from the mid-1960s to 1980, bottoming out around 20%. Despite rebounds in the early 1980s (the first Reagan administration) and mid-late 1990s (the Clinton administration), trust in the federal government never approached its earlier peak, and since 2007 has hovered around 25%.

Figure 2 presents broader patterns of confidence in a set of 12 major institutions using the data from the General Social Survey that we analyze in this paper. Since 1973, the GSS has asked respondents about confidence in major institutions, including economic organizations like major companies and organized labor; political institutions like the Executive Branch, Congress, the Supreme Court, and the military; and other social institutions like the press, television, organized religion, education, medicine and science. In the early 1970s, the average American had some or a great deal of confidence in 83% of these institutions (10 out of 12). Confidence fell gradually in the 1970s and 1980s, and then more rapidly. By 2014, confidence had fallen to 73% (8.75 out of 12). Figure A1 presents separate time trends for each of the 12 major institutions. By the end of the series, some institutions retained at least some confidence of close to 95% of respondents (science and the military), while other institutions commanded some/great confidence from only 55% of the sample (Congress, the press, and the executive branch).

Why did trust in government and major institutions decline from the mid-1960s onward? We divide this question into two parts. First, why did Americans once have such high confidence in government and other institutions circa 1950? Second, what forces lead to the decline in confidence?

Americans' high levels of confidence in government and major institutions reflects a confluence of events in the mid-20<sup>th</sup> century. In the late 1940s, the US was emerging from an exceptional period of transformation of the role of the federal government in American life. The New Deal and the Second World War expanded the role played by the federal government in ensuring individual welfare and in managing economic activity (Lindert 2004; Fishback 2017; Levy 2021). The United States won the war against Japan and contributed to the defeat of Germany. The postwar economy boomed (Field 2003; Gordon 2017). The combination of strong economic growth and government support for homeownership and collective bargaining ushered in a sustained era of middle-class

comfort and shared prosperity (Goldin and Margo 1992; Fetter 2013). Into the 1950s, there was a broad bipartisan liberal consensus in American politics that embraced the expanded role of the Federal government in American life. Through the early 1960s, the liberal consensus expanded to include support for full civil rights for black Americans, particularly focused on ending the Jim Crow laws that restricted black economic opportunity and political participation in the South (Perlstein 2009).

The initial fissures in this bipartisan liberal consensus came from the political right. An anti-government ideology began to take shape in the latter 1950s, focused on animosity toward the New Deal, fear of Communist infiltration of government, and the emerging Civil Rights reforms. Political entrepreneurs such as Clarence Manion forged partnerships between conservative southern Democrats and anti-New-Deal Republicans under the umbrella of resistance to the expansion of federal power. This movement coalesced around the Arizona senator Barry Goldwater, who ran an insurgent campaign for the Republican nomination in the 1964 presidential election. While he lost, the movement was energized by the substantial support he garnered both in the old South and the emergent Sunbelt.

The political left in the United States was also transformed by the consolidation of the Cold War in the 1950s. The discrediting of orthodox Marxism following the spread of reports of Soviet repression, both internally and in Eastern Europe, and the rise of a radical youth culture in the 1960s shifted the left toward domestic social issues (Gitlin 1996). Resistance to the Vietnam-era draft and support for new movements such as feminism, gay liberation, and environmentalism created a strong anti-establishment ethos on the left.

Against this backdrop of weakening consensus, trust in mainstream institutions collapsed in the late 1960s and early 1970s, following a set of specific events and a general weakening of economic conditions. The year 1968 was a turning point moment, marked by a “dreary catalogue of depressing events” that undermined national consensus further (Schulman 2001, p. xii). The Tet Offensive cast the grinding failure of the Vietnam War into sharp relief, although it took a further seven years for the United States to exit the conflict. Soviet forces invaded Czechoslovakia, crushing the hopes of the Prague Spring. American cities burned with race riots and both businesses and many white families left for the suburbs. A few years later in 1974, President Nixon

resigned after it was discovered he authorized and then covered up a break-in at the Democratic National Committee's headquarters. The Vietnam War officially came to an end in 1975 with the capture of Saigon by the North Vietnamese.

The national pall expanded through the late 1970s, accelerated by weak economic conditions. The OPEC oil embargo of 1973 ushered in a decade of energy crisis and, along with loose monetary policy in the early 1970s, sparked double-digit inflation. The New Majority coalition of working class and white ethnic voters that came together to elect Nixon was initially willing to back President Carter, but his policies were not able to break the hold of the stifling combination of high unemployment and high inflation. In July 1979, President Carter surprised the electorate by telling the truth: America was facing a crisis of confidence. "The erosion of our confidence in the future," President Carter warned, "is threatening to destroy the social and the political fabric of America" (Carter 1979). But telling the truth did not fix the problem.

Eventually, President Carter's nominee to the Federal Reserve, Paul Volcker, was able to halt the spiraling inflation, but not without a major recession that Time Magazine declared on its cover was "Gathering Gloom for Workers" (Alexander 1981). Ronald Reagan capitalized on the dour national mood by combining attacks on the Federal government with a sunny optimism about the private sector, memorably declaring in his 1981 inaugural address that "In this present crisis, government is not the solution to our problem, government is the problem" (Perlstein 2021).

### ***Political realignment***

Rising anti-establishment sentiment was particularly directed at the Democratic party, the establishment party which had held the House of Representatives in all but four years between 1932 and 1980. The shift away from the Democrats had a marked pattern, first by region and then by education group.

The allegiances of Southern voters turned against the Democratic party first. At mid-century, 80% of white voters in the "Solid South" identified as Democrats (Kuziemko and Washington, 2018; Figure 1). Using Gallup data, they show that this share fell continuously over the next sixty years, converging with the non-Southern average (40%) by 1985 and then dipping below the non-South to the low 20% by 2005. Kuziemko and Washington (2018) argue that, in the 1960s, and



particularly after Kennedy's Civil Rights speech in 1963, the southern shift away from the Democrats was driven by racial conservatism and opposition to Civil Rights. Figure 3, Panel A replicates this regional pattern using partisan self-identification in the GSS from 1972 onward. The broad patterns are similar, even if the levels differ in some years. We find that white respondents reduced their affiliation with the Democratic party in both the South and non-South between 1970 and 1990. After 1990, the Democratic share stabilized at around 45% in the non-South but continued to fall in the South, reaching the low 30% in the 2010s.

Voting patterns by education began to shift in the late 1970s and 1980s. Before 1975, less-educated and working-class voters were more likely to vote for the Democratic party. This relationship began weakening in the late 1970s as the Democratic party platform shifted away from direct support for labor toward redistribution through the tax system. By 2005, Kuziemko, Marx and Naidu (2023) show that the partisan divide by education had entirely flipped, with more-educated voters now more likely to vote for the Democratic party. We replicate this pattern in Figure 3, Panel B. We find a fall in Democratic affiliation between 1970 and 1990, both for respondents with a Bachelor's degree or higher and with a high school degree or less. In the mid-1990s, around 42% of both education groups identified as Democrats. Subsequently, more-educated respondents increasingly identified as Democrats, reaching a high of 55% in 2020, while respondents with high school or less fall to around 35%.

### ***CNC technology, job loss, and the transformation of attitudes***

This paper links the transformation of confidence and political affiliation to the diffusion of CNC technology. CNC automated machine tools that had relied on human operatives to select and perform the tool's physical movements, instead using computer programs and sensors to direct the machine. The first numerically controlled machine tool was invented in the United States in the early 1950s at the MIT Servomechanisms Lab, building on the advances in computing and servomechanisms that emerged during World War II, but CNC tools were not developed for wide commercial applications until the late 1960s. In our previous work tracing the effect of CNC technology on the labor market, we found that the diffusion of CNC-enabled tools led to the elimination of jobs on the factory floor, particularly affecting workers with a high school education or less.

The disruption of metal manufacturing jobs due to CNC automation may have accelerated the decline in institutional confidence for several reasons. First, job loss has long term negative effects on income in general, which can lead workers to believe that the economy doesn't work for them and that policy makers do not have their best interests at heart. Although we do not find overall declines in employment in more exposed local labor markets, many of the offsetting jobs that absorbed displaced workers were in less well-paying sectors. Second, other production workers may realize that employment is not secure in an environment of technical change. CNC diffusion began in an era when long careers with one firm were expected and when high school graduates believed it was possible to have a middle-class life from industrial labor.

Job loss and factory reorganization may produce resentment and dissatisfaction with the status quo. The shift of less educated voters toward the Republican party coincided with a shift in beliefs about which party would best maintain prosperity toward the Republicans. During the 1960s the Democrats held a strong edge on economic issues, but beginning in around 1974 the Republicans began gaining ground and held an edge for the 1980s and much of the 1990s (Gallup News Service 2023).

### **III. Data**

#### ***Political and social outcomes***

We consider the effect of computer numerical control technology on three measures of social and political change: confidence in major institutions, self-reported partisan affiliation and vote shares for the Republican party and for third parties.

*Confidence, political self-identification, and union membership:* The General Social Survey (henceforth "GSS") contains individual-level questions on attitudes and opinions. Most important for our purposes are questions about confidence in social institutions, partisan affiliation, and union membership.

The GSS elicited reports on levels of confidence in 12 major economic, political and social institutions using the following question: "I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of

confidence, only some confidence, or hardly any confidence at all in them?” The question is asked annually from 1972 to 1991 and biannually thereafter.

For each respondent, we create measures of confidence for each of the 12 major institutions and a composite measure of confidence in all twelve institutions. We consider two definitions of having confidence in an institution: either reporting at least “some confidence” in the institution or reporting “great confidence” in the institution. Following the National Opinion Research Center (NORC), our composite measure of individual confidence is a simple average of reported confidence across all 12 institutions.

We measure partisan affiliation using a question on political self-identification, which asks respondents to characterize themselves as Republican, Democrat, or Independent. We construct indicator variables for identification as a Democrat and for membership in a union.

Exposure to CNC technology is captured at the individual level based on an individual’s industry of employment and survey year. We further split the sample by region (South and non-South) using GSS information on region of residence because unionization levels varied by region and unionization mediated the effect of CNC exposure on worker outcomes. Our GSS sample includes only workers employed in one of the seven sub-industries of metal manufacturing classified in Boustan, Choi and Clingensmith (2022) as experiencing CNC-based automation in this period.

*Voting outcomes:* We supplement our results on individual-level partisan affiliation with local area results on votes cast by political party. We construct commuting-zone (CZ) level vote counts by party using the county-level voting data from ICPSR (1964-1996) and the MIT Election Lab (2000). We map these county-level outcomes to 1990 CZ geographies using the crosswalk by Eckert et al. (2020). For each election, we measure the share of votes cast for Republican candidates, the share of votes cast for third parties (neither Republicans nor Democrats), and the share of eligible voters who cast a vote in the election.<sup>2</sup>

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<sup>2</sup> We drop data from Alabama and Minnesota because of missing information for some political parties in some years. We also exclude 32 CZs (4.4% of observations) for which our population estimates at the CZ level diverge from the true population counts by more than 10%. In particular, we merge in county-level Census population counts to the voting data for the initial year in each decade (e.g., 1960 population counts for the 1964 election). We then crosswalk this county level file to the CZ level, collapse at the CZ level, and compare our population estimates with CZ-level population counts. We exclude the few cases in which these two population counts diverge by more than 10%.

We measure exposure to CNC technology at the CZ level by weighting exposure to the CNC shock at the industry level by initial employment by industry in the CZ from the 1970 Census. This CZ-level measure of exposure will capture all workers affected by CNC automation, regardless of their current employment status.

Given the idiosyncrasies of each presidential election cycle, we group three elections before CNC diffusion (1964, 1968 and 1972) and three elections after CNC had penetrated US manufacturing (1992, 1996 and 2000). In the first period, the largest third-party candidate was George Wallace, a conservative States' Rights anti-segregation candidate who garnered 13.5% of the vote in 1968, and in the second period the largest independent candidate was Ross Perot, an anti-free-trade business man who received 18.9% of ballots cast in 1992. We calculate the “long difference” for each voting outcome at the CZ level to measure political changes from the periods before and after intensive CNC diffusion.

### ***Exposure to CNC automation***

We adopt industry-by-year level measures of exposure to CNC technology that were developed by Boustan, Choi, and Clingingsmith (2022). This measure relies on two sources of variation: (a) the initial share of each machine tool in an industry's tool base in 1958, before the diffusion of CNC technology, and (b) the shift in the market for each tool type from hand-based tools to computerized tools.<sup>3</sup> Tool-level shifts to CNC technology are observed from trade data counting the number and value of tools exported by type and by CNC-status for the three major machine tool exporters (Japan, Germany, and Italy).<sup>4</sup>

Combining these two sources of variation, this measure of CNC exposure reflects the cumulative share of CNC tools in the global market by tool type, weighted by baseline tool use in a given industry. In particular, CNC exposure for industry  $j$  in year  $t$  can be calculated as:

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<sup>3</sup> Industry-level tool use in 1958 is from the 1958 *American Machinist Inventory of Metalworking Equipment* (AMIME). The AMIME records the value of tool inventories for metalworking subindustries.

<sup>4</sup> The export values of each machine tool by major exporter are collected from the *Economic Handbooks of Machine Tool Industry*, from 1971 to 2009.

$$Exposure\_CNC_{j,t} = \sum_k \left( \frac{VT_{k,j,1958}}{\sum_k VT_{k,j,1958}} Share\_CNC_{k,t} \right) \quad (1)$$

where  $\frac{VT_{k,j,1958}}{\sum_k VT_{k,j,1958}}$  is the value share of tool  $k$  among the tool inventory for industry  $j$  in 1958, and  $Share\_CNC_{k,t}$  is the cumulative share of CNC tools among machine tool  $k$ .

The measure is populated for seven (aggregated) sub-industries of metal manufacturing that were exposed in some way to CNC automation. All metal industries had very low exposure to CNC in the early 1970s. By 1990, industries like aircraft increased exposure to CNC tools dramatically, while industries like motor vehicles were less affected.

Industry-by-year variation in CNC exposure can then be assigned to commuting zones according to the baseline share of commuting-zone employment in each industry in 1970, prior to the CNC diffusion. CNC exposure in commuting zone  $m$  in year  $t$  is calculated as:

$$Exposure\_CNC_{m,t} = \sum_j \left( \frac{EMP_{m,j,1970}}{EMP_{m,1970}} Exposure\_CNC_{j,t} \right) \quad (2)$$

where  $\frac{EMP_{m,j,1970}}{EMP_{m,1970}}$  is the share of workers in commuting zone  $m$  employed in industry  $j$  in 1970.<sup>5</sup>

Here,  $Exposure\_CNC_{j,t}$  is defined as above at the industry-by-year level and is defined to be zero for any non-metal manufacturing industry.

#### IV. CNC exposure and trends in social outcomes

##### *Confidence in institutions and partisan self-identification*

We start by investigating whether workers in industries with growing exposure to CNC technology report lessened confidence in major institutions. In earlier work, we find that CNC exposure is associated with declines in employment, particularly for workers on the production floor and for

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<sup>5</sup> The baseline share of employment by industry and commuting zone is computed from 1970 Census.

workers in the non-union sector (Boustan, Choi, Clingingsmith 2022). This job loss and industrial change may weaken faith in various social institutions.

Our main individual-level outcomes  $y_{i,j,t}$  include average confidence in 12 major institutions and self-reported partisan affiliation. Our preferred specification regresses individual-level measure of confidence and affiliation on a measure of CNC exposure based on an individual’s industry of employment in year  $t$ , controlling for fixed effects for 3-digit industry ( $\alpha_j$ ) and 5-year bin ( $\gamma_t$ ):<sup>6</sup>

$$y_{i,j,t} = \alpha_j + \gamma_t + \beta Exposure\_CNC_{j,t} + X\Gamma + \varepsilon_{i,j,t} \quad (3)$$

Before turning to our regression analysis, Figure 4 depicts correlations between CNC exposure at the industry-year level and the average share of workers reporting “some or great” confidence according to the composite index. Panel (a) plots the raw correlation and Panel (b) controls for industry and year-bin fixed effects. In both cases, we find that workers in industries more exposed to CNC technology express lower confidence in major institutions. Even after controlling for industry and year-bin fixed effects in Panel (b), we continue to find a strong negative relationship between CNC exposure and confidence in institutions ( $\beta = -0.35$ ). Controlling for year-bin effects is important because CNC exposure is generally rising over time, while confidence was falling over this period, which could lead to a spurious relationship.

In Table 1, we estimate the effect of CNC exposure on workers’ average confidence in major institutions, partisan affiliation, and union membership. We present our preferred specification, which controls for industry fixed effects, year-bin fixed effects, and individual demographic controls.<sup>7</sup> We weight each person-year observation by the representative weight provided in the GSS. We report results for the full sample, as well as two regional subsamples (Non-South and South).

Exposure to CNC technology is associated with a decline in confidence in major institutions, defined either as having “some or great confidence” (column 1) or “great confidence” (column 2). The relationship between CNC exposure and confidence is stronger in the South than outside of

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<sup>6</sup> 5-year bins are defined as 1972-1976, 1977-1981, and so forth.

<sup>7</sup> Demographic controls include age, age squared, indicators for being female and for being nonwhite and indicators for educational attainment.

the South. A 10-percentage point increase in CNC exposure, approximately the difference between least and most exposed industries at the peak of our sample period, is associated with a 3.6-percentage point decline in some/great confidence nationwide and an even stronger decline in this measure in the South (6.1 percentage points).

Overall, the average confidence level fell by 10 percentage points over this time period (see Figure 2). To put the magnitude of the CNC shock into perspective, consider that 9% of the adult population (12.2% of the workforce) was employed in metal manufacturing in 1970. We thus multiply the coefficients by 0.09, suggesting that CNC automation itself can explain 0.32 percentage points of this national trend, or around 3% of the total decline in confidence. Explaining 3% of the total national decline due to an economic shock hitting one industry alone suggests that the overall effect of economic dislocation due to technical change and the resulting displacement could be far larger.

Alongside the declining confidence in mainstream institutions, we also find a shift away from self-identification with the Democratic party, which was the party in power for most of this period. Coefficients in Column 3 suggest that a 10-percentage point increase in CNC exposure is associated with a 11 to 13 percentage point decline in the likelihood that a respondent identifies as a Democrat in both regions. Identification with the Democratic party fell by around 20 points during this period (Figure 3). Multiplying the coefficients by 0.09 to account for the share of metal manufacturing in the workforce implies that the CNC shock can explain 1.1 percentage points (6%) of this decline.

Exposure to CNC automation appears to have a stronger effect on confidence in the South. To understand this regional pattern, Column 4 considers the effect of CNC exposure on union membership. In earlier work, we find that the effect of CNC technology on job loss was stronger in the non-union sector. Not only did the South have lower levels of unionization at baseline (15% versus 35% of the non-Southern workforce; see Figure A2, but we also find that exposure to CNC technology lowers union density further in the South. A 10-percentage point increase in exposure to CNC corresponds to a 15-percentage point decline in union affiliation in metal working in the South, or 3-percentage point decline in overall union affiliation (given that metal working

represented around 20% of the union workforce at the time), but has essentially no effect on union membership in the rest of the country.

Thus far, we have examined the combined effect of CNC exposure on confidence in all major institutions. However, we might expect that workers fearing displacement may blame economic institutions like major corporations or organized labor, or political institutions like Congress or the President, but may not lose confidence in other institutions like scientific establishment or organized religion.

Figure 5 plots the coefficient on CNC exposure for confidence in all 12 institutions separately using the broader definition of confidence (“some or great confidence”). We break the institutions into rough categories (economic, media, cultural, political), but we do not observe a clear relationship between the type of institution and the effect of CNC exposure. Instead, we identify a negative point estimate for 11 of 12 institutions (the military is the exception), with a statistically significant decline ( $p < 0.1$ ) in confidence in organized labor, the press, and Congress. Automation-based economic change appears to weaken confidence in mainstream institutions across the board. Figure A3 replicates this pattern for the narrow definition of confidence (“great confidence”). Again, we observe negative point estimates for most institutions.

### *Voting patterns*

We now turn to studying the effect of CNC exposure on voting behavior in presidential elections at the commuting zone level. Our main outcomes  $\Delta y_m$  are the changes in the share of Republican votes, the share of third-party votes (non-Republican, non-Democrat), and the share of eligible voter participation in commuting zone  $m$ . The changes are constructed as long differences between elections conducted before and after the widespread diffusion of CNC technology. Given the idiosyncrasies of individual elections, we group three elections to represent each time period, averaging vote shares and voter turnout for the elections of 1992, 1996, and 2000 (after CNC) relative to these values for the elections of 1964, 1968, and 1972 (before CNC).

In particular, we estimate the following long-difference regression relating changes in vote shares and voter turnout to changes in exposure to CNC at the commuting zone (CZ) level:



$$\Delta y_m = \alpha_d + \beta \Delta Exposure\_CNC_m + X'\Gamma + \varepsilon_m \quad (4)$$

We measure exposure to automation at the CZ level by weighting our CNC exposure measure for each industry and period (1970, 2000) by the initial share of industry employment in a given CZ, according to equation (2). Our preferred specification controls for Census division fixed effects ( $\alpha_d$ ), base-period (1970) labor market demographic characteristics, metal/non-metal employment shares, and 1-digit industry shares (in the vector  $X$ ). Outside of the South, CZs with high exposure (90<sup>th</sup> percentile) to CNC automation include Elmira, NY, a Rust Belt factory town once home to large plants for General Electric and Westinghouse, and low exposure (10<sup>th</sup> percentile) include Sioux Falls, SD, which was primarily engaged in food processing. In the South, low exposure CZs are often central places in agricultural areas (e.g., Monroe, LA) whereas high exposure CZs are manufacturing areas like Louisville, KY.

Our main regression analysis is presented in Table 2. Panels (a), (b), and (c) show results for the share of Republican votes, share third-party votes, and eligible voter participation, respectively. We report results for the full sample (columns 1-3), as well as for regional subsamples (Non-South and South, columns 4 and 5).

We start in Column 1 with a basic specification that includes Census division fixed effects and controls for baseline CZ-level demographic characteristics. Here, variation in CNC exposure across commuting zones is due both to variation in initial levels of manufacturing employment and to variation in exposure within manufacturing. In this case, we do not see a relationship between CNC exposure and political outcomes. Column 2 adds controls for the baseline shares of metal and non-metal employment and column 3 adds baseline shares of employment in other 1-digit industries (e.g., transportation, communication and utilities; wholesale and retail trade). Here, we rely on variation in exposure to CNC technology between sub-sectors of metal manufacturing, controlling for baseline industrial composition, and a relationship begins to emerge between CNC exposure and voting behavior. However, we do not see a statistically significant relationship with any outcomes in the pooled national sample.

A stronger relationship between CNC automation and political outcomes emerge at the regional level. Recall that the South was going through a partisan realignment away from the old “Solid South” of Southern Democrats. In the South, we find that exposure to automation is associated

with rising vote shares for the Republican party and for third party candidates. To interpret the magnitude of this effect, consider a one standard deviation (1.4 percentage point) increase in CNC exposure at the commuting zone level. This heightened exposure is associated with a 9.1-point increase in the share of Republican votes ( $= 6.5 \times 0.014$ ) and a 7.1-point increase in the share of third-party votes ( $= 5.1 \times 0.014$ ). Votes for the parties other than the Democrats rose from 20% to 75% of the Southern electorate since 1940 (55 points). Exposure to factory automation can explain 29% of the total ( $= 16.2/55$ ) if we consider votes for both Republican and third-party candidates. If, instead, we focus only on the Republican party, given that third-party popularity is episodic, automation can explain 16% of the total rise in non-Democratic voting.

One response to anger and concern about automation and job loss is shifting allegiance away from the dominant political party. Another potential response is declining to participate in elections altogether. In the Non-South, we find little effect on vote shares by party but instead see a strong relationship between CNC exposure and voter non-participation. In the Non-South, a one standard deviation increase in CNC exposure (2.8 percentage points) is associated with a 12.6-point decline in the share of eligible voters turning out for the election ( $= -4.5 \times 0.028$ ). A 12.6 point decline in voter turnout is around 2/3s the size of a typical gap in voter participation between presidential election and midterm election years (58% vs. 40% turnout, Desilver 2023).

Taken together, we find notable differences in the political response to automation by region. The CNC automation shock hit the South during an era of political realignment. The Republican party was newly ascendant and represented a viable alternative to voters angry about Civil Rights reforms, cultural change and economic dislocation. Outside of the South, the Republican party had yet to become a welcoming option for working-class voters. In these regions, voters in areas more exposed to CNC-based automation were more likely to disengage from the electoral process entirely.

## **V. Conclusion**

Americans both lost confidence in many central social institutions during the late 20<sup>th</sup> century and engaged in a related political realignment that saw many traditionally Democratic voting blocs

shift their allegiance to the Republican Party. Traditional accounts of these processes emphasize the role of social and political events, such as the civil rights movement, the Vietnam War, and the Watergate scandal. The 1970s and 1980s also saw major transformations in the working lives of Americans, including factory automation, deindustrialization, offshoring, trade shocks and the rising importance of computers in the workplace. In this paper we have studied one important aspect of factory automation, the diffusion of CNC machine tools, as driver of loss of confidence and realignment. We found that CNC diffusion is associated with reduced confidence in institutions for workers in affected industries, especially in the South where union membership was lower, and that it contributed to both partisan realignment and to voter disengagement. Although the diffusion of CNC alone – a shock to the metal-working industry – explains a small part of the transformation of American politics in this era, we view CNC as emblematic of a wider set of automation forces that collectively had a transformative effect on work and workers.

The last decade has seen a surge in populism linked to widespread skepticism of American institutions. With a few exceptions, both journalists and scholars are again more focused on cultural explanations, such as racial resentment and xenophobia animated by demographic change, and an increasing divergence in values between urban and rural voters, and less on economic factors. Our work emphasizes that economic transformation is an enduring cause of political dissatisfaction and should be higher on the agenda for those seeking to understand the current rise in populism.

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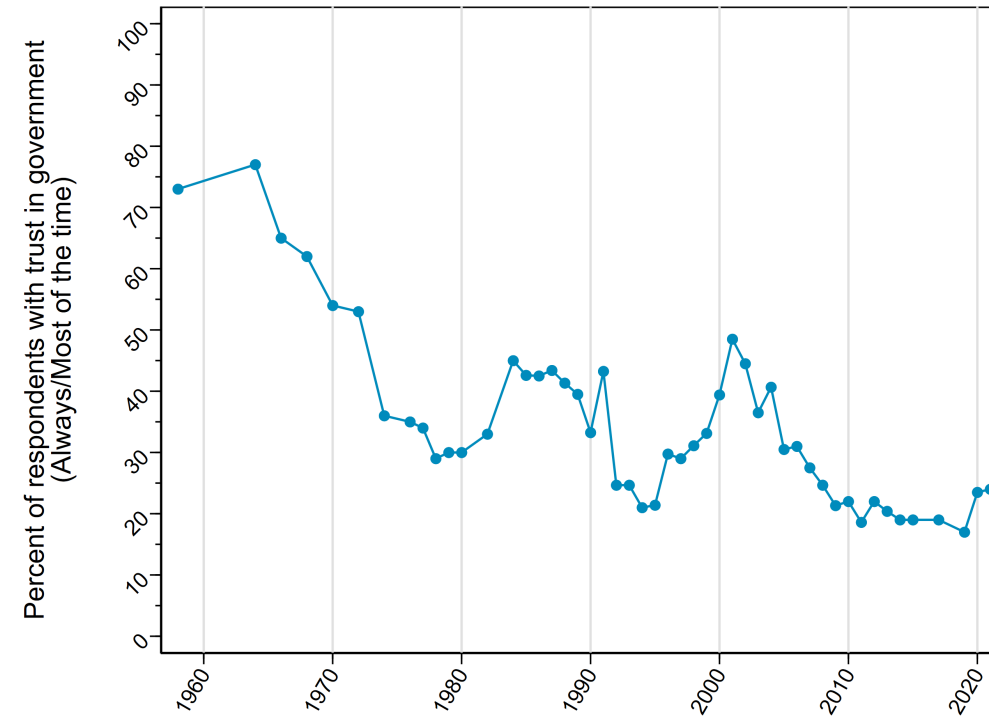
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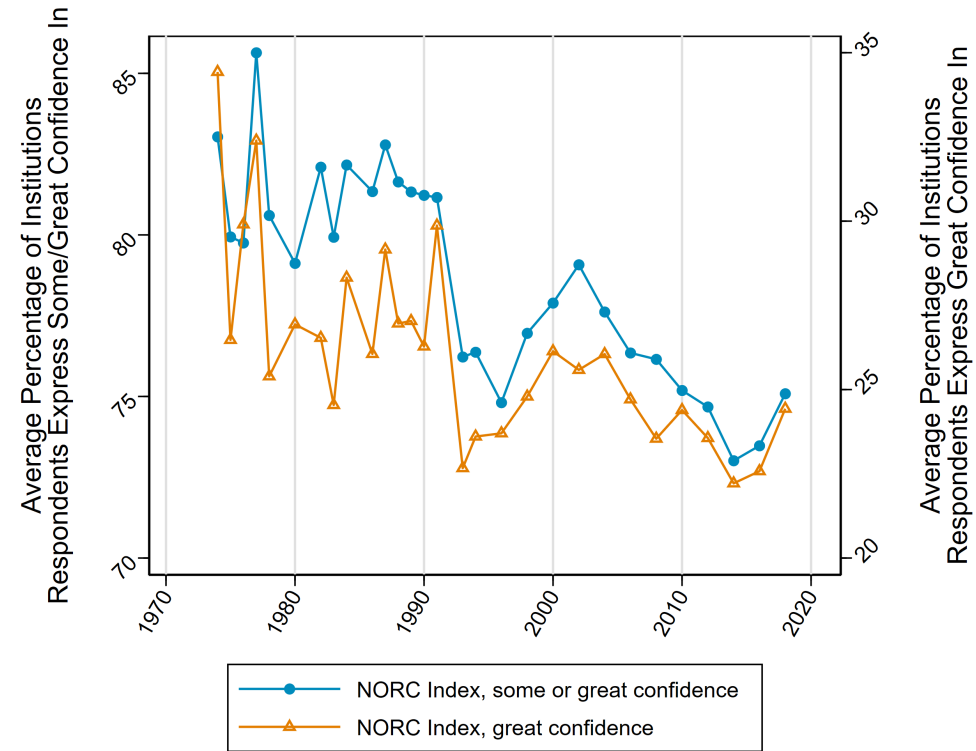
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Figure 1: Trust in Government over Time



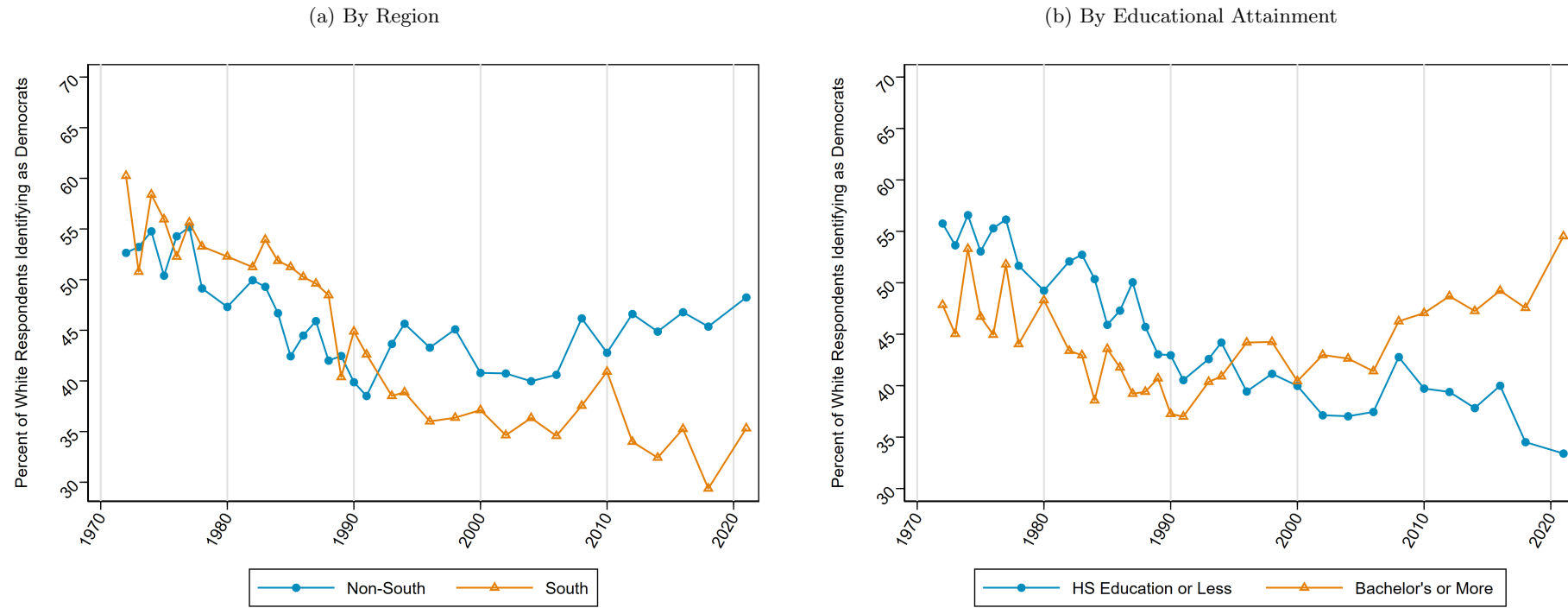
Notes: The figure shows percentage of respondents who have trust in government about always or most of the time. The data is from Pew Research, with original sources including the Pew Research Center, National Election Studies, Gallup, ABC/Washington Post, CBS/New York Times, and CNN Polls. Question wording is consistent over time.

Figure 2: Confidence in Institutions over Time



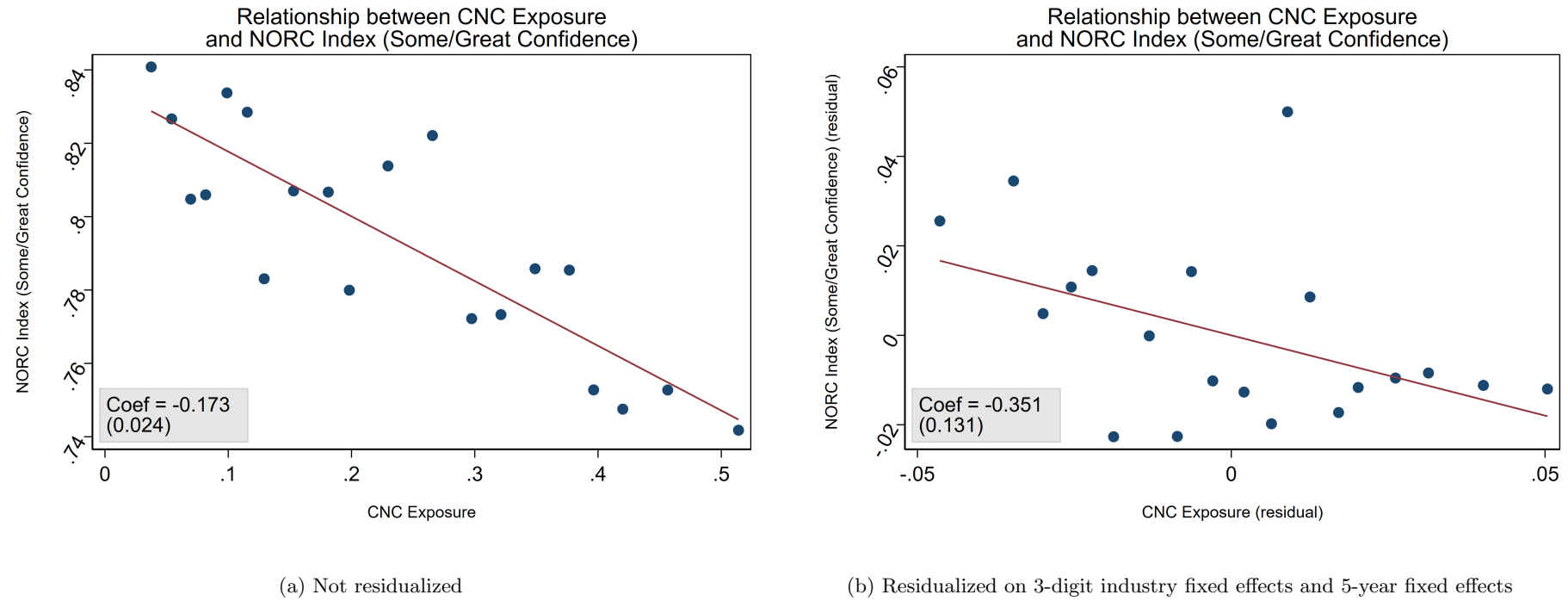
Notes: The figure plots the average percentage of institutions respondents express confidence in over time, using the NORC index from the General Social Survey (GSS). The NORC Index is constructed using 12 underlying measures of confidence in: major companies, labor, press, TV, religion, education, medicine, science, the Executive Branch, Congress, the Supreme Court, and the military. The some or great confidence series plots the mean percentage of institutions a respondent has some or great confidence in, in a given year. The great confidence series plots the same, but for a higher degree of confidence.

Figure 3: Partisan Identification by Region and Educational Attainment



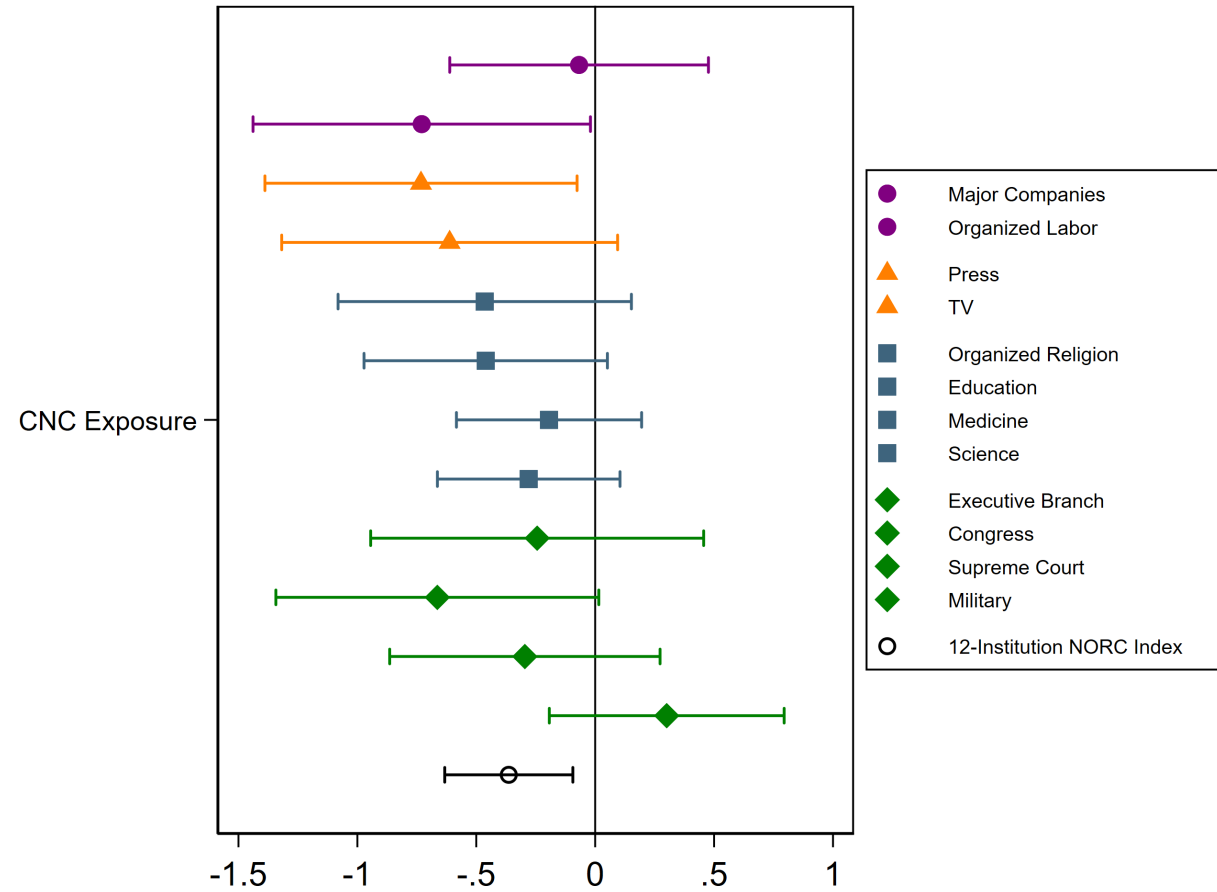
Notes: The figures show the partisan identification by region and educational attainment. The partisan identification is constructed from the General Social Survey (GSS). We use a sample of white respondents to compute the share of the respondents who identify as Democrats over time. We create the series by Southern states and Non-South states in panel (a), and by educational attainment in panel (b).

Figure 4: Confidence in Institutions and CNC Exposure



Notes: The figures show the residualized bincatters of CNC exposure measure and the NORC index described in Figure 2. CNC exposure measure is developed by Boustan, Choi, and Clingingsmith (2023). Panel (b) scatters the residualized NORC index which removes 5-year and 3-digit industry fixed effects against the CNC exposure measure.

Figure 5: Effect of CNC Exposure on Some or Great Confidence in Institutions



Notes: The figure plots the coefficients on CNC exposure, the effect of CNC exposure on confidence in each of the 12 social institutions. This figure shows results from the preferred specification, which includes 5 year fixed effects and 3-digit industry fixed effects. This specification includes demographic controls (age, age squared, nonwhite indicator, indicators for educational attainment, and sex). Observations are at the person level.

Table 1: The Effect of CNC Exposure on Confidence and Group Membership

|                    | 12-Institution NORC Index    |                         | Group Membership            |                         |
|--------------------|------------------------------|-------------------------|-----------------------------|-------------------------|
|                    | (1)<br>Some/Great Confidence | (2)<br>Great Confidence | (3)<br>Identify as Democrat | (4)<br>Union Membership |
| <i>Full Sample</i> | -0.363**<br>(0.137)          | -0.286<br>(0.174)       | -1.120***<br>(0.327)        | -0.519<br>(0.327)       |
| Observations       | 2986                         | 2986                    | 4083                        | 3230                    |
| <i>Non-South</i>   | -0.316*<br>(0.155)           | -0.071<br>(0.202)       | -1.135**<br>(0.375)         | -0.295<br>(0.372)       |
| Observations       | 2286                         | 2286                    | 3097                        | 2448                    |
| <i>South</i>       | -0.605**<br>(0.304)          | -0.908***<br>(0.334)    | -1.324*<br>(0.687)          | -1.494**<br>(0.687)     |
| Observations       | 700                          | 700                     | 986                         | 782                     |

Standard errors in parentheses. Number of observations follows.

\* p<.1, \*\* p<.05, \*\*\* p<.01

Notes: The specification includes 5 year fixed effects and 3-digit industry fixed effects and demographic controls (age, age squared, nonwhite indicator, indicators for educational attainment, and sex). Observations are at the person level. Columns (1) and (2) use the 12-Institution NORC Index as the outcome variables. In the General Social Survey (GSS), levels of confidence are “hardly any,” “only some,” or “a great deal.” In column (1), respondents who reply “only some” or “a great deal” are coded as having confidence in a given institution. In column (2), only respondents who reply “a great deal” receive the same classification. Columns (3) and (4) use identification as Democrats and union membership as the outcome variables.



Table 2: The Effect of CNC Exposure on Voting Outcomes

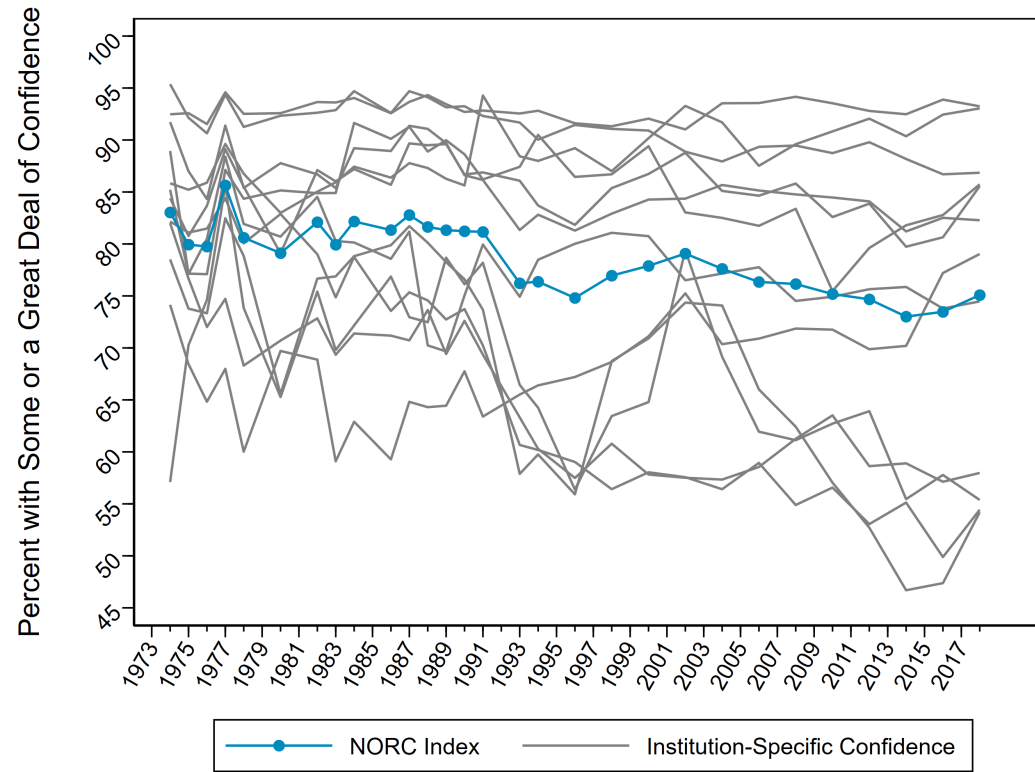
|   | Full Sample |         |         | Non-South | South   |
|---|-------------|---------|---------|-----------|---------|
|   | (1)         | (2)     | (3)     | (4)       | (5)     |
| <b>Panel (a): Share of Republican Votes</b>                   |             |         |         |           |         |
| Change in CNC Exposure  | -0.243      | 3.049   | 3.186   | 1.743     | 6.595   |
|   | (0.157)     | (2.124) | (2.004) | (2.358)   | (3.432) |
| Observations  | 683         | 683     | 683     | 408       | 275     |
| Mean 30-Year Change in Dependent Variable                     | -0.0369     | -0.0369 | -0.0369 | -0.0478   | -0.0207 |
| <b>Panel (b): Share of Non-Republican, Non-Democrat Votes</b> |             |         |         |           |         |
| Change in CNC Exposure  | 0.062       | 1.158   | 1.138   | -0.569    | 5.108** |
|   | (0.094)     | (1.040) | (1.051) | (0.668)   | (1.883) |
| Observations  | 615         | 615     | 615     | 371       | 244     |
| Mean 30-Year Change in Dependent Variable                     | 0.0564      | 0.0564  | 0.0564  | 0.0997    | -0.0096 |
| <b>Panel (c): Share of Eligible Voter Participation</b>       |             |         |         |           |         |
| Change in CNC Exposure  | 0.182       | -1.824  | -2.333  | -4.584**  | 2.953   |
|   | (0.182)     | (1.888) | (1.842) | (2.226)   | (3.142) |
| Observations  | 690         | 690     | 690     | 408       | 282     |
| Mean 30-Year Change in Dependent Variable                     | -0.0191     | -0.0191 | -0.0191 | -0.0508   | 0.0267  |
| <b>Controls</b>   |             |         |         |           |         |
| Census divisions  | X           | X       | X       | X         | X       |
| Demographics  | X           | X       | X       | X         | X       |
| Metal/non-metal employment shares                             |             | X       | X       | X         | X       |
| Industry shares   |             |         | X       | X         | X       |

Standard errors in parentheses.

\* p&lt;.1, \*\* p&lt;.05, \*\*\* p&lt;.01

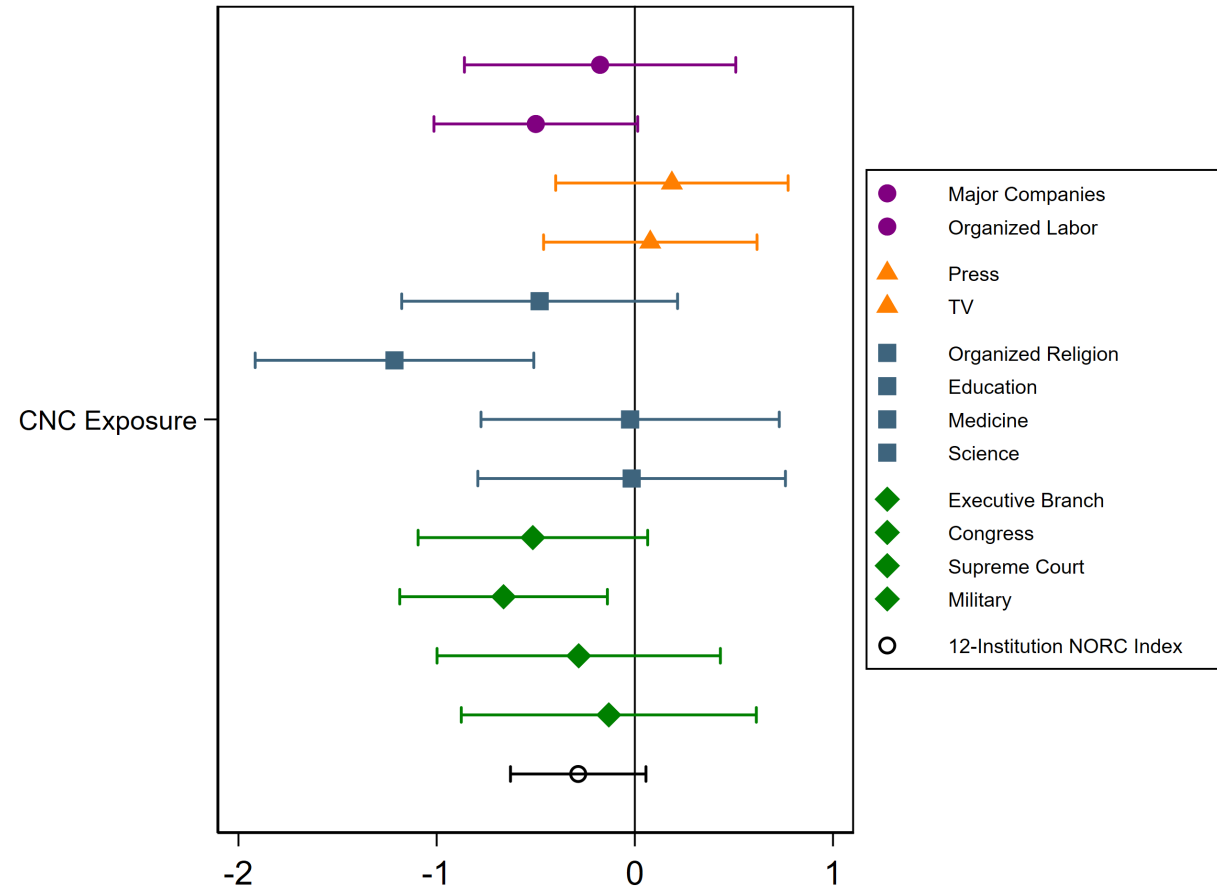
Notes: Analysis is at the commuting zone (CZ) level with collapsed county-level voting data from ICPSR 13 (1964-1988), Dave Leip's Atlas of U.S. Elections (1992, 1996) and the MIT Election Lab (2000). Outcomes are from Presidential elections in the United States and are calculated by taking the long difference of the average dependent variable share in 1992, 1996, and 2000 versus the average in 1964, 1968, and 1972, for a given CZ. Column (1) includes controls for Census Division and demographic controls (age, age squared, nonwhite indicator, indicators for educational attainment, and sex). Column (2) adds the CZ shares of metal and non-metal employment, while column (3) and those thereafter add controls for industry shares in other industries. All controls utilize 1970 data unless otherwise noted. Columns (4) and (5) keep the same set of controls as column (3), but cut the sample, keeping CZs in the non-south and south respectively. The final two table rows in each panel show the number of observations and the mean change in the dependent variable. Some CZs are missing voting data, which explains fewer than 722 CZs represented in the table. We exclude 32 commuting zones whose population estimates diverge from the census population counts by more than 10 percent.

Figure A1: Index of Confidence over Time



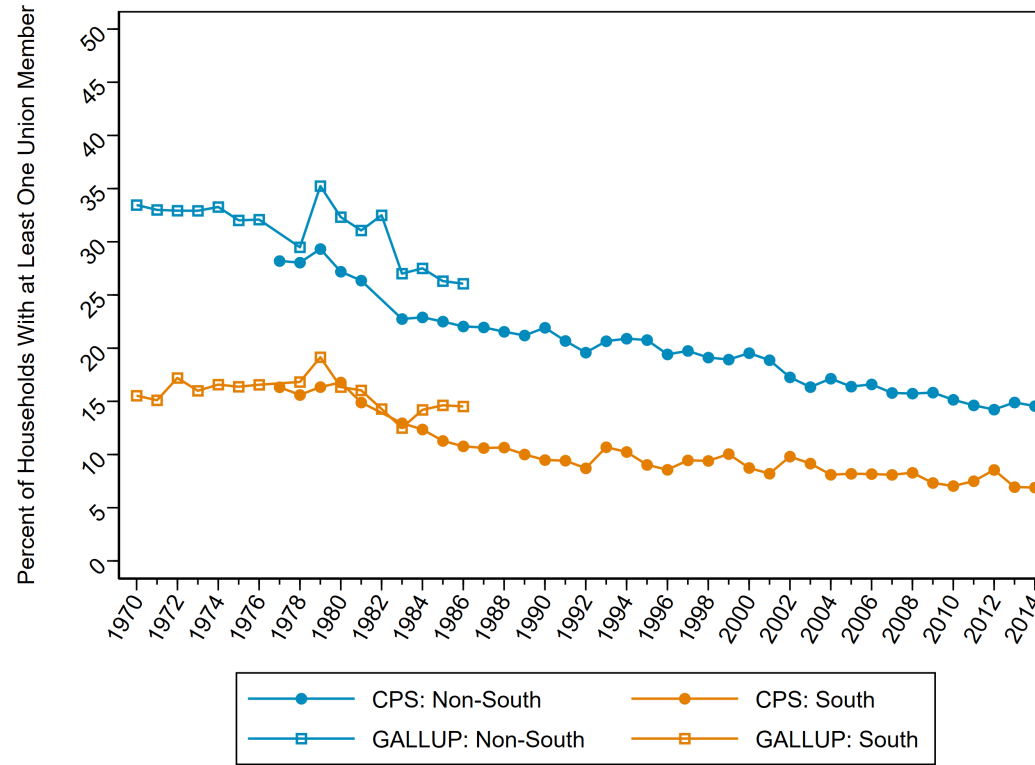
Notes: The figure plots the average percentage of institutions respondents express confidence in over time, using the NORC index from the General Social Survey (GSS). The NORC Index is constructed using 12 underlying measures of confidence in: major companies, labor, press, TV, religion, education, medicine, science, the Executive Branch, Congress, the Supreme Court, and the military. The faded lines represent confidence in these institution-specific measures.

Figure A2: Effect of CNC Exposure on Great Confidence in Institutions



Notes: The figure plots the coefficients on CNC exposure for confidence in each of the 12 social institutions. This figure shows results from the preferred specification, which includes 5 year fixed effects and 3-digit industry fixed effects and demographic controls (age, age squared, nonwhite indicator, indicators for educational attainment, and sex). Observations are at the person level.

Figure A3: Union Membership Over Time



Notes: This time series uses data from GALLUP (1970-1986) and the CPS (1977-2014).