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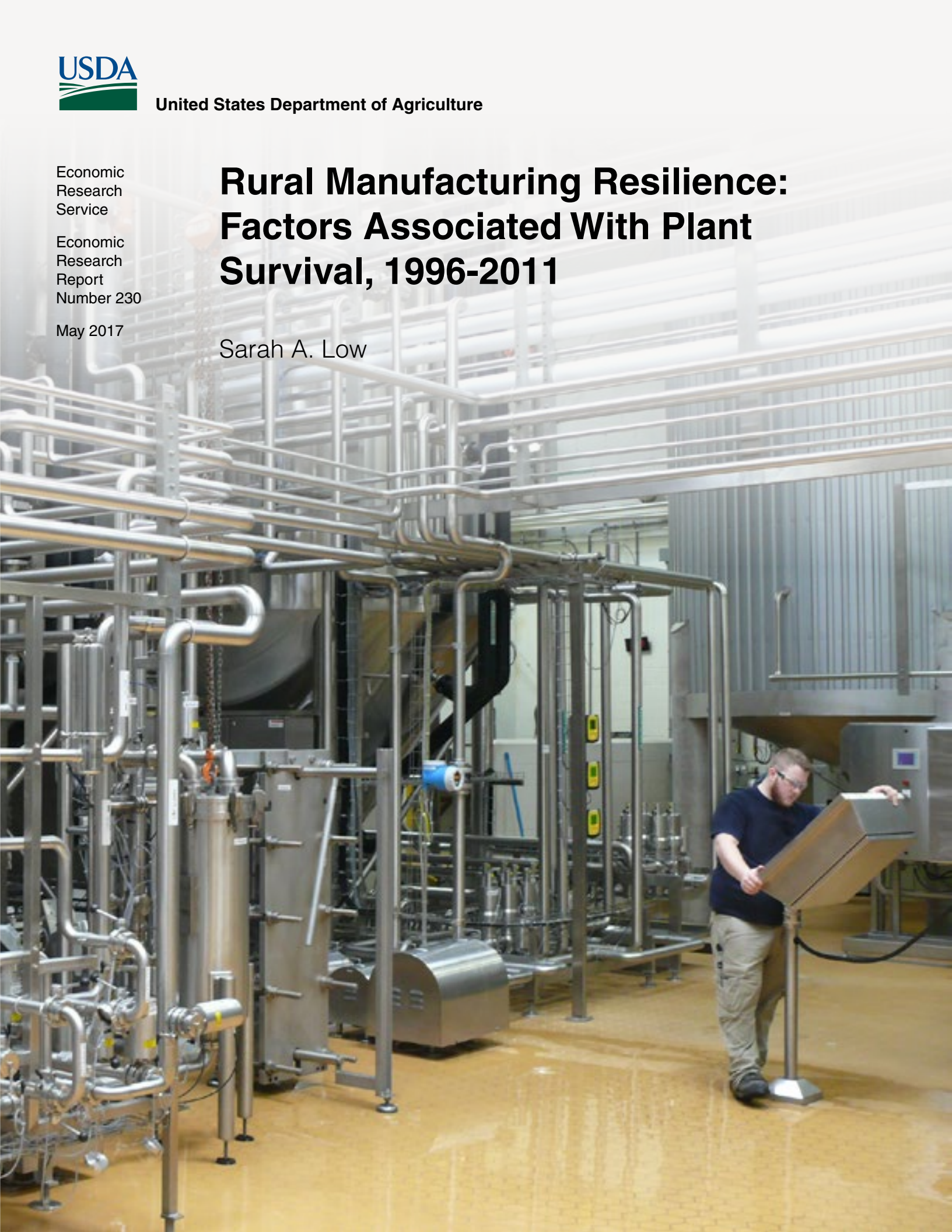
Rural Manufacturing Resilience: Factors Associated With Plant Survival, 1996-2011

Sarah A. Low



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Rural Manufacturing Resilience: Factors Associated With Plant Survival, 1996-2011

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Abstract

Manufacturing provides jobs and income that individuals, families, and communities in rural areas rely upon. In this study, rural manufacturing plant survival during a 15-year period (1996-2011), which includes two recessions and a longstanding decline in manufacturing employment, is examined. An indepth survey, the 1996 ERS Rural Manufacturing Survey, is linked to quarterly employment records so that the relationship between survival and plant- and community-level factors can be examined. Results suggest that smaller, independent manufacturing plants had higher survival rates than larger plants and multi-unit plants, such as branch plants. Results offer potential insights into rural economic development policy, like tradeoffs between retention incentives, financial capital access programs, or support for entrepreneurship development.

Keywords: Rural manufacturing, survival, survival analysis, loan guarantee, direct loan, survey data, administrative data, economic development, tax incentives.

Acknowledgments

The author thanks Nicholas Walsh and Kevin Patrick, USDA, Economic Research Service, for research assistance; colleagues David McGranahan, Tim Wojan, and Jason Brown for feedback; and reviewers—Anil Rupasingha, USDA, Economic Research Service; Ginger Allen, USDA, Rural Development; Eric Thompson, University of Nebraska-Lincoln; and Steven Deller, University of Madison-Wisconsin. The author acknowledges Jessica Helfand and Michael LoBue, Office of Employment and Unemployment Statistics, Bureau of Labor Statistics, for their assistance. Thanks also to Dale Simms for editorial assistance and Curtia Taylor (both USDA, ERS) for production and design assistance.

This project was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of BLS.

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Rural Manufacturing Resilience: Factors Associated with Plant Survival, 1996-2011

Sarah A. Low

What Is the Issue?

In the rural (nonmetropolitan) private sector in 2011, manufacturing provided 13 percent of jobs and 20 percent of personal earnings—almost twice the jobs and three times the earnings that production agriculture provided. Rural manufacturing employment was approximately equal to that of the rural retail trade and the rural health care/social assistance sectors in 2011. While the U.S. manufacturing industry has become more productive, it has exhibited a declining employment share for decades and is under strong competitive pressure. However, to the communities in which they are located, existing plants provide relatively well-paying jobs. A better understanding of the factors affecting rural manufacturers' survival may help businesses, communities, and policymakers retain, or even expand, manufacturing jobs in rural America.

What Did the Study Find?

Between 1996 and 2011, over half (55 percent) of a nationally representative sample of manufacturing plants survived (i.e., still had paid employees). Of those, independent plants were more likely to survive (59 percent) than multi-unit plants (50 percent), and rural plants were slightly more likely to survive than those in metropolitan counties (57 percent versus 53 percent).

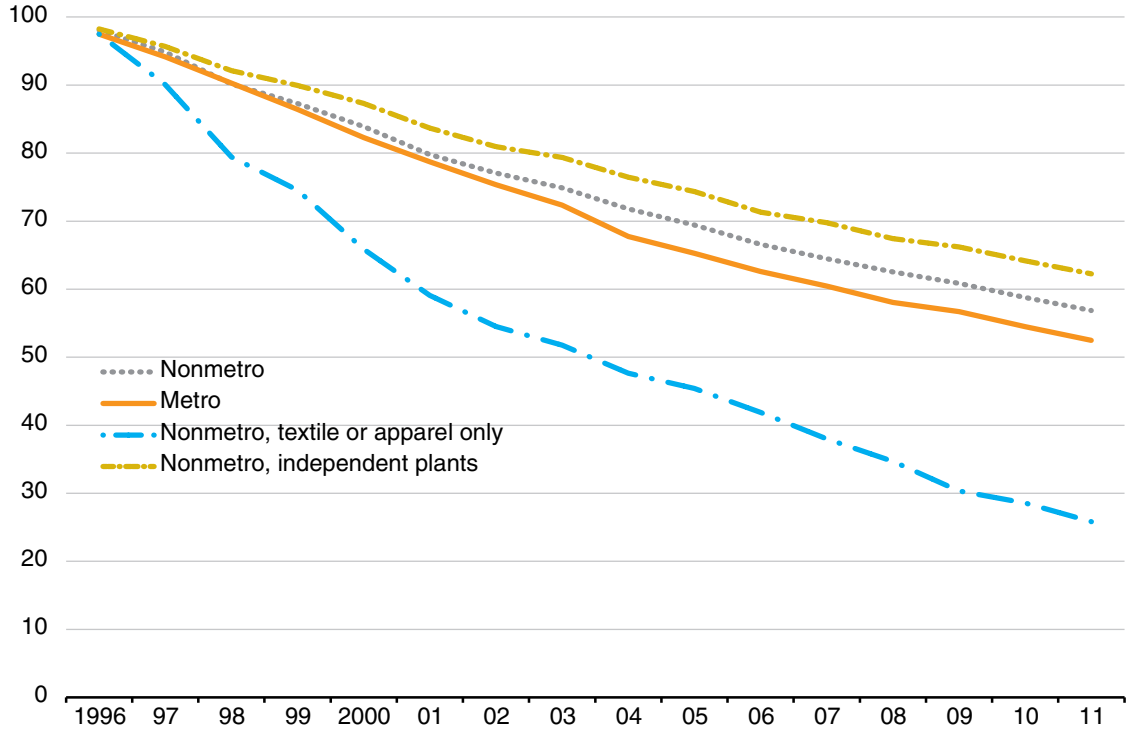
Higher rural dependence on manufacturing, coupled with higher survival rates for rural plants, suggests that survival of existing manufacturing plants is especially important to rural communities; 28.5 percent of rural counties had manufacturing-dependent economies (a quarter of earnings come from manufacturing) during much of the study period. In these communities, a plant closure will reduce local jobs and earnings directly, while the multiplier effect may further depress local demand and income.

Looking more specifically at rural plants, the analysis found that:

- Independent manufacturing plants were 35 percent more likely to survive than plants that were part of a multi-unit firm (i.e., branch plants or headquarters). This finding is counter-intuitive because States and regions have long tended to put more effort into recruiting or retaining branch plants than supporting locally based entrepreneurial, independent manufacturing plants.

Annual survival rates for manufacturing establishments, 1996-2011

Percent of plants surviving since study began



Source: USDA, Economic Research Service calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.

- Smaller, independent manufacturing plants were more likely to survive—an independent plant with 100 employees was 9 percent more likely to survive than an independent plant with 200 employees, all else being equal.
- Survival rates for independent manufacturing plants were highest in the Northeast and Midwest.
- Survival rates were significantly lower (25.8 percent) for rural textile mills and apparel product manufacturers (versus a 57-percent overall survival rate).
- Fifteen percent of independent plants and 13 percent of multi-unit plants indicated that obtaining sufficient capital was a major problem—these plants were significantly less likely to survive than plants indicating access to capital was a minor problem or not a problem.

How Was the Study Conducted?

Manufacturing plants surveyed in the ERS 1996 Rural Manufacturing Survey (RMS) were linked to unemployment insurance records collected quarterly for the Bureau of Labor Statistics. Linking the two data sets enabled studying plant survival over a 15-year period (1996-2011) that includes two recessions and declining employment in U.S. manufacturing. The RMS provides qualitative information on plants' characteristics, perceived access to financial capital, and involvement in economic development policies. Statistical analysis called survival analysis is used to assess the relative contribution of plant- and county-level factors on a plant's probability of survival.

Rural Manufacturing Resilience: Factors Associated With Plant Survival, 1996-2011

Introduction

Manufacturing provides jobs and income that individuals, families, and communities in rural areas rely upon. The survival of existing manufacturing plants is important to the communities these plants are located in. Communities affected by plant closure face wage depression, further job insecurity, and diminished economic multipliers; affected individuals may even suffer declines in mental and/or physical health (Rephann et al., 2005; Tomaney et al., 1999). This report examines plant survival over 1996-2011, a period that includes two recessions, to determine what characteristics may have led some plants to survive and not others.

The focus on manufacturing plants is in keeping with the outsized impact of their closure on rural communities and the popularity of public policy aimed at retaining them. The study period encompasses several waves of economic development theory and related policy practices: (1) industrial recruitment, especially with incentives; (2) retention and growth of existing businesses, especially with financial capital and technical assistance; and (3) strategies to develop industry clusters. Existing plants were often targeted for relocation or retention with incentives—e.g., tax breaks, land and/or utility incentives—offered by State or regional/local governments (Drabenstott, 2006). Existing plants also form the basis of nascent industry clusters, which were the target of policies like the Advanced Manufacturing Jobs and Innovation Accelerator Challenge, a Federal program designed to promote cluster development in urban and rural regions. (We cannot draw conclusions about the impacts of specific policies due to the nature of the variables available in the Rural Manufacturing Survey.)

This study of manufacturing survival is unique for several reasons. Unlike most survival studies that follow a cohort of startups throughout their earliest years, this study examines a representative sample of plants in rural America at one point in time (1996) and those plants' survival over the next 15 years. With this unique focus—survival—we cannot speak to the impact of specific factors on other important outcomes for manufacturing, such as startup of new plants, employment, or sales growth. Most previous research on manufacturing plant survival used very limited information on the plant itself beyond size, ownership structure, and industry characteristics (Bernard and Jensen, 2002; Doms et al., 1995), in part because these are usually the only variables for which data are available. This analysis is unique because it uses both survey data and U.S. Department of Labor, Bureau of Labor Statistics administrative records—the manufacturing survey provides indepth plant information and perceptions, while the linked establishment-level unemployment insurance records demonstrate whether a plant had paid employees (survived) each quarter for 15 years. Finally, this report is unique because it is national in scope but focused on rural America.[1]

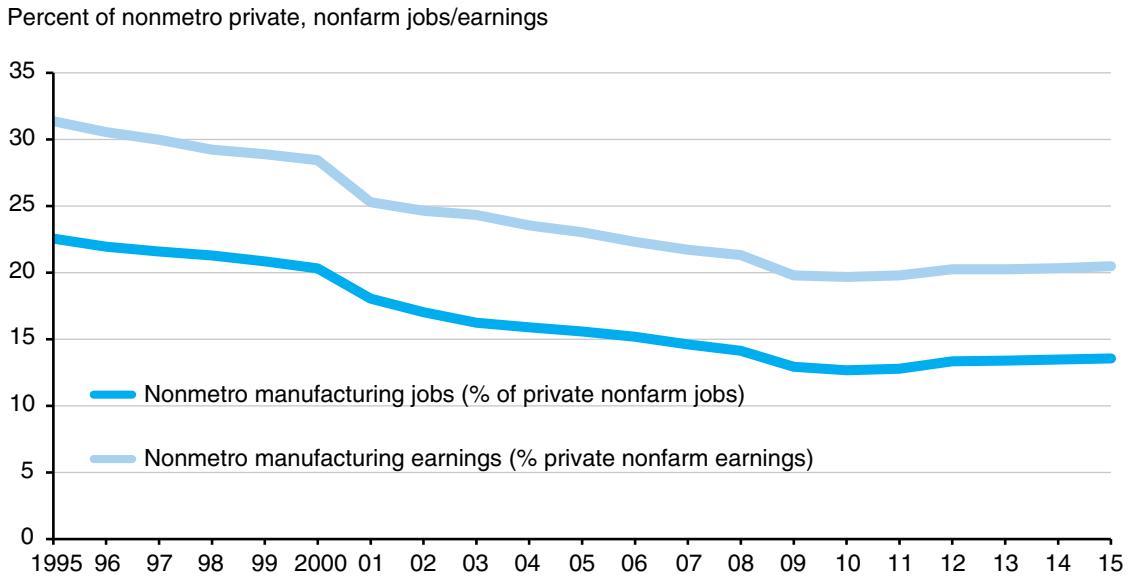
[1] Throughout this report, we may refer to nonmetropolitan (nonmetro) counties, as defined by the Office of Management and Budget (OMB), as "rural." We use the 1993 OMB definition of metropolitan and nonmetropolitan as it was the definition at the beginning of the study period. For discussion of these terms, see http://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/what-is-rural.aspx.

Why Study Rural Manufacturing Survival?

Manufacturing jobs and income are integral to the rural economy. Despite manufacturing's declining share of employment during the study period, it provided almost twice the jobs and three times the earnings of production agriculture in 2011 (Bureau of Economic Analysis, 2014), despite record high agricultural prices and earnings that year. To put the size of rural manufacturing employment in perspective, it was approximately equal to rural retail trade and rural health care/social assistance employment in 2011 (Bureau of Economic Analysis, 2014). In the years since, manufacturing employment has stabilized (fig. 1). Manufacturing and the relatively small mining sector had the highest rural median earnings among major industries in 2015, higher even than the median earnings for professional/scientific/technical services and finance/insurance (Kusmin, 2016).

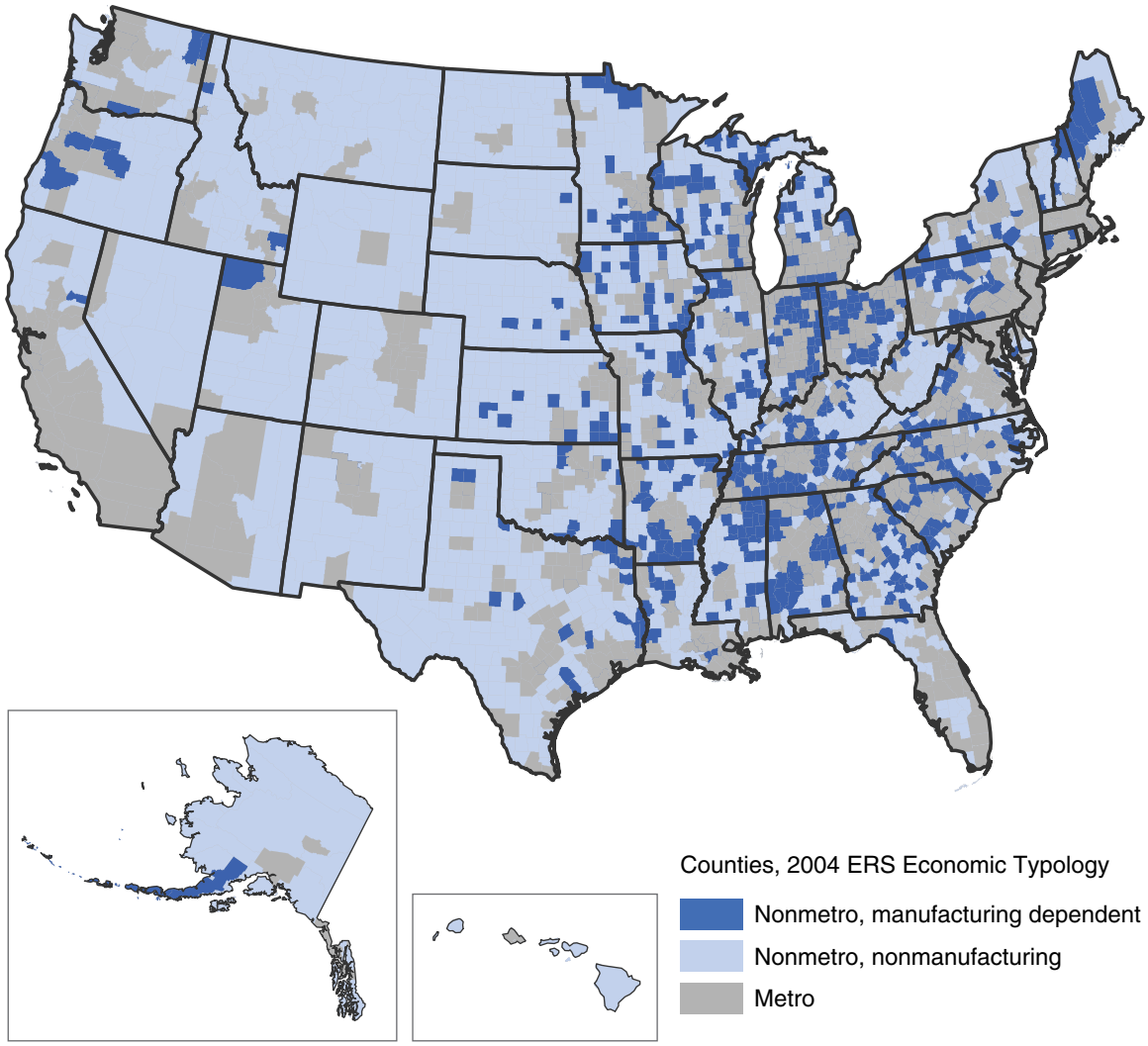
Manufacturing is important to a wide swath of rural America. Using the 2004 ERS Economic Typology (created with 2000 data, it is representative of most of the study period), ERS defined 585 rural counties (28.5 percent) as manufacturing dependent, with at least 25 percent of earnings coming from manufacturing (fig. 2). In many communities, a closing plant will reduce local employment, earnings, and the economic base—and negative multiplier effects further depress local demand and income (Tomaney et al., 1999). According to Tomaney and colleagues, individuals unemployed a year after a plant closed were likely to remain unemployed and tended to be older, less skilled, and/or unwilling to relocate. Plant closures can also affect the ability of local governments to raise revenue and support existing services, such as water and sewer services (Cowan, 2012). Thus, the survival of existing manufacturers is of particular importance to the communities in which those plants are located.

Figure 1
Manufacturing share of nonmetropolitan jobs and earnings, 1995-2015



Note: Pre-2001 data are based upon the Standard Industrial Classification system while data from 2001 onward are based on the North American Industrial Classification System.
Source: USDA, Economic Research Service analysis of Bureau of Economic Analysis, Regional Economic Information System data

Figure 2
Nonmetro manufacturing dependent counties



Note: Alaska and Hawaii are not geographically representative.
Source: USDA Economic Research Service county typologies.

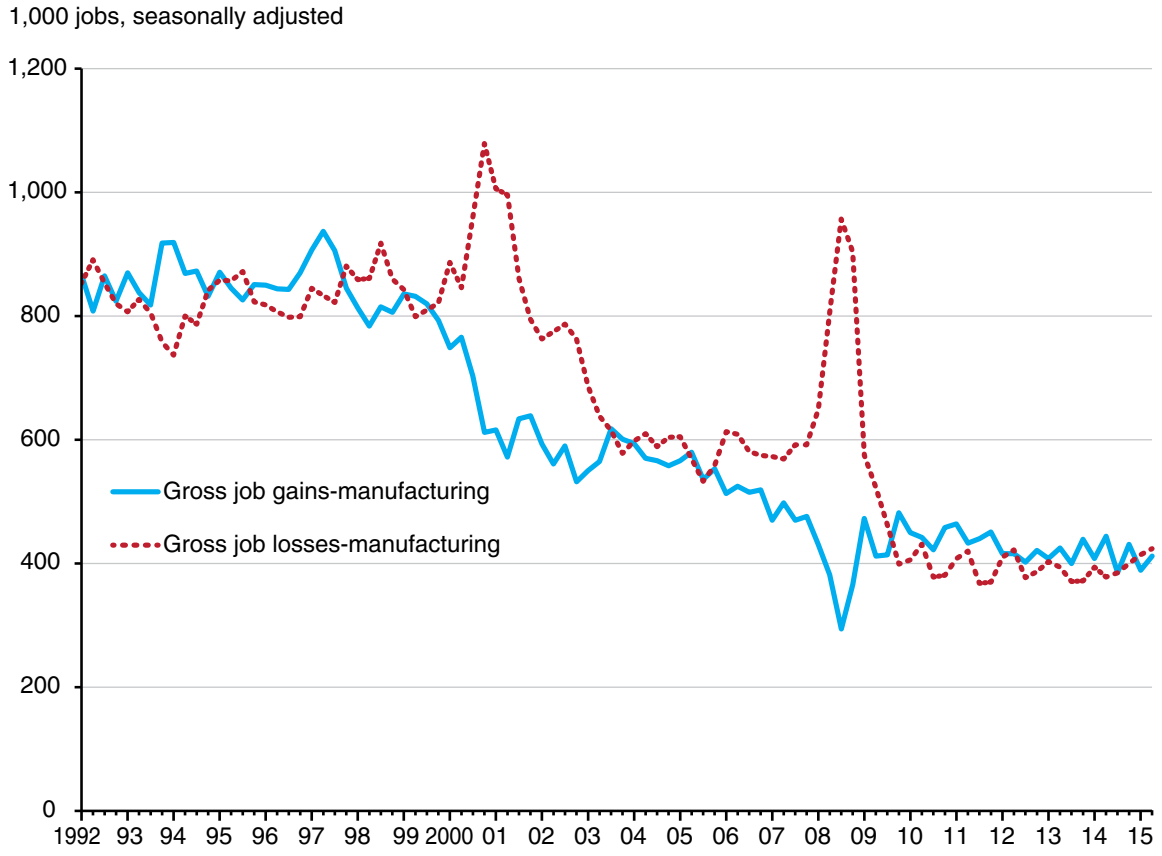
Policymakers have recognized the importance of manufacturing to America. Shortly after his inauguration, President Donald Trump launched the Manufacturing Jobs Initiative, which includes a group of business leaders that will provide advice on how best to promote manufacturing job growth. According to a Congressional Research Service report (Levinson, 2012), few new manufacturers are likely to create large numbers of jobs, implying that retention of existing manufacturers is key. The Obama administration policies targeted manufacturing as well. The 2014 Revitalize American Manufacturing and Innovation Act, for example, provided for setting up a network for manufacturing innovation, while the Investing in Manufacturing Communities Partnership rewarded best practices for coordinating and leveraging economic development funds.

How Did U.S. Manufacturing Fare During the Study Period?

The study period, 1996-2011, was one of general decline in manufacturing employment. Factory closings exceeded openings almost every quarter between 1998 and the end of the study period (Bureau of Labor Statistics, 2016). Beginning in 1999, gross job losses in manufacturing trended higher than gross job gains (fig. 3). Although real manufacturing gross domestic product (GDP) rose steadily throughout the study period, manufacturing value-added as a share of GDP has been declining since the mid-1950s, from over 25 percent to 12.0 percent in 2015 (Bureau of Economic Analysis, 2016).

Some rural manufacturing industries fared better than others in the past 15 years. Combined, the apparel, textile, and textile product manufacturing industries experienced the largest percentage decrease in employment from 2001 to 2015 (fig. 4); however, these three industries represented only 8.5 percent of rural manufacturing employment in 2001.[2] Food manufacturing is the biggest rural manufacturing industry, representing 14.7 percent of rural manufacturing employment in 2001; its decline in employment over 2001-15 was relatively small. The second-largest rural manufacturing industry is transportation equipment, which includes but is not limited to automobiles

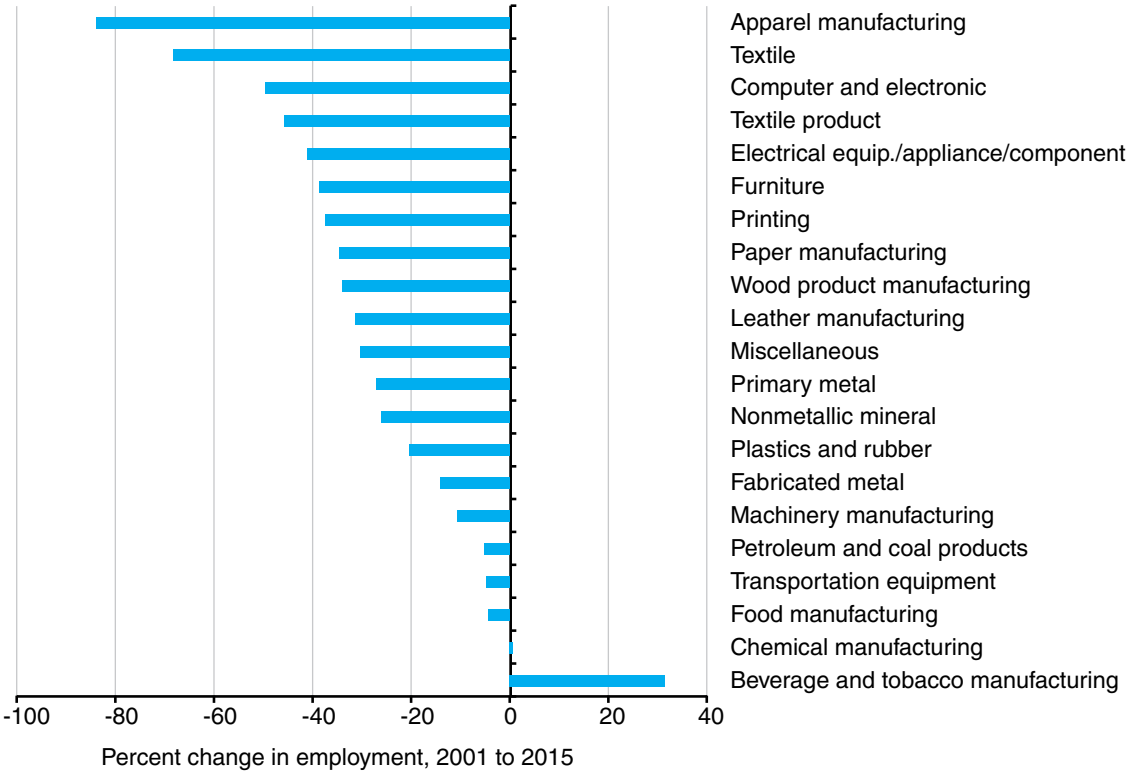
Figure 3
Total U.S. gross job gains and losses in manufacturing



Source: USDA, Economic Research Service analysis of Bureau of Labor Statistics, Business Employment Dynamics data.

[2] We use 2001 as a base year due to the Standard Industrial Classification (SIC) system being replaced by the North American Industrial Classification System (NAICS) in 2001.

Figure 4
Employment change in nonmetropolitan manufacturing industries, 2001-2015



Note: Due to the Standard Industrial Classification (SIC) system being replaced by the North American Industrial Classification System (NAICS) in 2001, we examine only change since 2001.
Source: USDA, Economic Research Service calculations using average annual Quarterly Census of Employment and Wages employment data, 2001 and 2015.

and auto parts, with 12.0 percent of rural manufacturing employment in 2001; employment in this industry declined by 8.7 percent over 2001-15. Employment in beverage and tobacco manufacturing grew, driven by beverage manufacturing. However, this industry accounted for only 0.6 percent of rural manufacturing employment in 2001.

The context for rural manufacturing changed considerably during the study period or shortly beforehand. For example, the Asian financial crisis occurred in 1997, and the United States' granting of Permanent Normal Trade Relations to China (2001) facilitated some manufacturing industries' investment in Chinese production facilities (Autor et al., 2013). The study period occurs just after implementation of the North American Free Trade Agreement, to which some attribute job losses in labor-intensive industries such as textiles (Minchin, 2009). The decline in U.S. manufacturing employment during 1996-2011 was also driven by labor-saving technological change (Krugman and Lawrence, 1993; Sachs et al., 1994). In a decomposition study, Tregenna (2009) found that the decline in manufacturing employment was associated more with falling labor intensity than with general decline in the manufacturing sector.

Finally, the study period includes two recessions, one in 2001 and another in 2007-09, the so-called "Great Recession." The 2001 recession was especially rough on manufacturing industries—it coincided with a steeper decline in manufacturing jobs than during the Great Recession (Pierce and Schott, 2012).

Economic Development/Industrial Policy Context, 1996-2011

According to Deller (2014), economic development theory is marked by three eras since the Great Depression (1929-39), with practices from all eras influencing the study period.[3] The first wave of economic development focused on ***recruiting large industrial firms*** with tax breaks and incentives that made land, labor, and utilities inexpensive. This "smokestack chasing" started after the Great Depression, peaked between the 1950s and 1980s, and is still widely pursued (Deller, 2014). Firm recruitment policies have long dominated U.S. economic development practice despite being criticized by researchers (Feser, 1998). Porter (1996) noted that while regions bidding against each other for a plant is indeed a zero-sum game, other firm recruitment incentives (e.g., streamlined regulations, specialized worker training, and infrastructure building) can attract investment. Recruitment is popular because it leads to immediate, tangible results whereas encouraging entrepreneurship and innovation or otherwise improving existing firms is slower to show results (Eisinger, 1995).

The second wave of economic development policy emphasized the ***retention and growth of existing businesses*** and promotion of entrepreneurship. This wave was most prevalent from the early 1980s to the early 1990s (Drabenstott, 2006) and featured increased access to financial capital through government-guaranteed loans and technical assistance (Bradshaw and Blakely, 1999; Deller, 2014).

The third wave of economic development emphasizes increasing industrial competitiveness, with partnerships and a focus on regional cluster policy and distinct regional assets, such as natural amenities or human capital (Drabenstott, 2006; Deller, 2014). Strategies include public-private partnerships to facilitate regional collaboration among once competing communities. Clusters are geographical concentrations of specialized activity that make skilled labor more readily available and ancillary businesses more integrated (Martin and Sunley, 2003). Cluster policy, popularized by Michael Porter in the early 1990s, is designed to improve productivity and encourage innovation via firm proximity (Feser, 1998).

Financial Capital and Economic Development

Among other things, this report examines the relationship between manufacturing plant survival and survey respondents' perceptions about access to financial capital and other first- and second-wave economic development policies.[4] The focus on financial capital is partly because the Rural Manufacturing Survey included unique questions on the topic and partly because inadequate financing can hurt firms' chances of survival. Blanchflower and Evans (2004) found that credit-constrained firms were more likely to use credit cards; this type of high-cost financing likely hinders expansion or investment in innovation, ultimately making firms less likely to survive (Conroy et al., 2017). Data on firms' finances are sensitive and scarce, but prior studies find a positive relationship between access to financial capital and a firm's survival. A study using the Federal Reserve's 2003

[3] This study cannot estimate the impact on plant survival of economic development policies, partly because the Rural Manufacturing Survey does not contain good indicators of policies; information in this section is intended to provide context for interpreting results later.

[4] In a companion study, Low and Brown (2016) examined the relationship between plant survival and the third wave of economic development policy—industry clusters/competition. Low and Brown found increased levels of competition from establishments in the plant's industry and county led to a lower probability of survival for both independent and multi-unit plants, but impacts were minor. Although economic theory suggests benefits to operating in a cluster, these areas are highly competitive, featuring higher rents and wages. Stephan (2011) suggests only the best performing firms can survive in competitive environments. Other empirical studies find decreased survival in highly competitive local environments (e.g., Huiban, 2011), despite the popularity of policies promoting clusters (Feser, 1998).

Survey of Small Business Finances found that credit access and credit constraints were the most important factors for predicting small firm survival in 2004-08 (Mach and Wolken, 2012).

Access to financial capital may be especially problematic for rural firms. Rupasingha (2013) showed that small business loan volume per capita was considerably lower in rural areas than in metro areas throughout this analysis' study period. Conroy and colleagues (2017) found a positive relationship between small business lending and entrepreneurship that was stronger in rural counties than in urban counties. Cole and Wolken (1995) posit that rural businesses are particularly disadvantaged due to informational asymmetry in financial capital markets—information on businesses is imperfect and costly to obtain, especially in remote areas.[5] Although technology has increased the availability and timeliness of so-called "hard" information (e.g., credit payments) about rural borrowers, the rich "soft" information obtained via close contact with borrowers remains more elusive in rural areas (Petersen and Rajan, 2002).

Market failure in commercial credit is the justification for second-wave economic development strategies revolving around increased access to financial capital, especially for rural or smaller businesses for which information on creditworthiness is most expensive to supply and obtain.[6] Government direct lending was once a popular policy tool, but since the late 1970s, governments have reduced direct lending in favor of loan guarantees that encourage private-sector lending (see box, "Examples of Loan Guarantee Programs").[7] As a result, guaranteed loans dominated Federal lending activities by the late 1990s (USDA Economic Research Service, 1997). For example, the USDA Business and Industry Direct Loan Program was discontinued in 2001, but the USDA Business and Industry Guaranteed Loan Program is still thriving.

What Factors Are Related to Plant Survival?

Manufacturing plant survival is largely contingent on plant characteristics, but local conditions and policy may also be associated with greater resilience in the face of economic stress. If a region were to promote manufacturing as a viable economic development strategy, better understanding of what types of plants are most resilient and how local and regional context can affect the survival of rural manufacturers could help communities and policymakers retain, and possibly even expand, manufacturing jobs in rural America. This report does not focus on all policies related to manufacturing during 1996-2011, only those we have survey data on.[8]

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[5] The two main types of information problems in financial markets are adverse selection and moral hazard (Besley, 1994). Adverse selection exists when a lender does not know something about the riskiness of a borrower; for example, the plant has management troubles or is unable to obtain other forms of credit. Under adverse selection, credit is rationed. Moral hazard occurs when a lender is unable to observe a borrower's actions after the loan is made, as when management irresponsibly spends the borrowed capital. Moral hazard may result in higher interest rates, reducing the incentive for borrowers to repay (Besley, 1994).

[6] If government lending programs do reduce rationing in the market for loans to these businesses, then there should be a positive relationship between measures of government programs and economic performance. Indeed, the Small Business Administration's loan guarantee programs have been associated with regional employment growth (Craig, Jackson III, and Thomson, 2007, 2008).

[7] Stiglitz and Weiss (1980) and Stiglitz (1993) provide the rationale for government intervention in business lending. Stiglitz and Weiss (1981) present a formal model that shows how credit market imperfections (i.e., informational asymmetries) can result in credit rationing and market failure. In their model, private lending institutions allocate funds inefficiently as a result of information asymmetries that systematically disadvantage informationally opaque businesses, like rural businesses, startups, or small businesses. These applicants are harder to obtain information about compared to a larger or public company, or a company in a dense metro area that lenders can easily observe.

[8] Trade, for example, is controlled for with industry fixed effects and is not a focus of the report.

Examples of Loan Guarantee Programs

Typically, Government agencies guaranteeing loans work with banks to reduce the risk in offering loans to firms denied credit under typical underwriting standards (the USDA Business and Industry Guaranteed Loan Program is an exception). Banks usually charge full market rates for guaranteed loans—the loan is rarely subsidized (Bradshaw, 2002).

USDA Business and Industry Guaranteed Loan Program

The USDA Rural Development Business and Industry Guaranteed Loan Program (B&I program) aims to improve and finance business, industry, and employment in rural communities by guaranteeing loans for rural businesses, allowing private lenders to extend more credit than they would typically be able to. There is little literature evaluating the effectiveness of the B&I program; Johnson (2009) found that the B&I program is related to employment growth in rural counties but not necessarily income growth.[1]

Unlike some loan guarantee programs (discussed below), the USDA program is used for loans that would pass credit-risk underwriting standards, absent the guarantee (Comptroller of the Currency, 2012). Banks may desire a B&I program loan guarantee because the federally guaranteed portion of these loans does not count toward a bank's legal lending limit, which is especially attractive to community banks with lower legal lending limits. The majority of lenders active in the USDA B&I program are small community lenders that use the program because the guaranteed portion does not count toward their legal lending limit (Comptroller of the Currency, 2012).

In the 5 years before the study period began, relatively few USDA B&I loan guarantees were made to manufacturing establishments (24-48 per year), so it is unlikely that the USDA B&I loan guarantee program data are driving results in this study. Approximately one-quarter of USDA B&I loan guarantees were made to manufacturing plants during 1990-1995, but recipients represent only 0.25 percent of manufacturers.

Other Loan Guarantee Programs

The Small Business Administration's (SBA) General Small Business Loan 7(a) loan guarantee program is SBA's most common loan program. It provides a loan guarantee for businesses that cannot get loans through conventional channels without a government guarantee. The borrower remains obligated for the full amount due and the guarantee is for the lender—the government will reimburse the lender for loss (according to the guarantee) in the event of payment default. As with the USDA B&I Guaranteed Loan program, the SBA guaranteed loan programs are generally associated with regional employment growth (Cortes, 2010; Craig et al., 2007, 2008) but not income growth (Cortes, 2010).

Many State or regional loan guarantee programs were operating just before this report's study period began. The California State Loan Guarantee Program, for example, served selected small firms that could nearly, but not quite, obtain a bank loan (Bradshaw, 2002). The program's goal is to expand employment and economic activity in California, especially in disadvantaged areas, by expanding access to credit. Bradshaw found that employment increased in firms participating in the program compared to similar surviving firms during 1991-95.

[1] Johnson used propensity score matching and ordinary least squares regression models for her analysis.

Data

Data for this analysis are principally from the nationally representative Rural Manufacturing Survey (RMS), which was conducted for ERS in 1996. The sampling frame included all manufacturing establishments with at least 10 employees (excluding newspaper publishing).[9] The RMS contains detailed information on plant characteristics. The survey also contained subjective information on perceived challenges such as access to financial institutions and on the relative importance of State and local tax incentives to a plant.

This report also uses administrative employment records from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW).[10] QCEW employment data are available from almost every U.S. employer and count filled jobs, including full-time and part-time, temporary and permanent. Excluded are self-employed workers and workers in certain industries, not including manufacturing. The QCEW is compiled from State unemployment insurance records.

Linking the RMS to administrative data on plant employment allows the tracking of establishment survival each quarter for 15 years, from third-quarter 1996 until third-quarter 2011. Plants are defined as having exited (failed) when they drop out of the QCEW, meaning they ceased having any paid employees and were designated as an exit by State labor market agents. If plants move within the State, the State agent determines if it is the same plant (not an exit) or not (considered an exit). Plants moving outside the State are always labeled as an exit. Plants cannot re-enter the QCEW after exiting. Plants that close via merger or acquisition are not considered an exit by BLS.

[9] Nonmetropolitan plants, nonmetro plants in Western States, and large plants were oversampled to ensure adequate sample representation of these types of plants. Plant size strata and sample weights were used to ensure that the survey represented all U.S. manufacturing establishments with 10 or more employees. For more information about the Rural Manufacturing Survey, strata, and survey sample weights, see Gale et al. (1999).

[10] For more information on the Quarterly Census of Employment and Wages, see http://www.bls.gov/cew/cewfaq.htm#Q01

Results

Plant Survival Rates

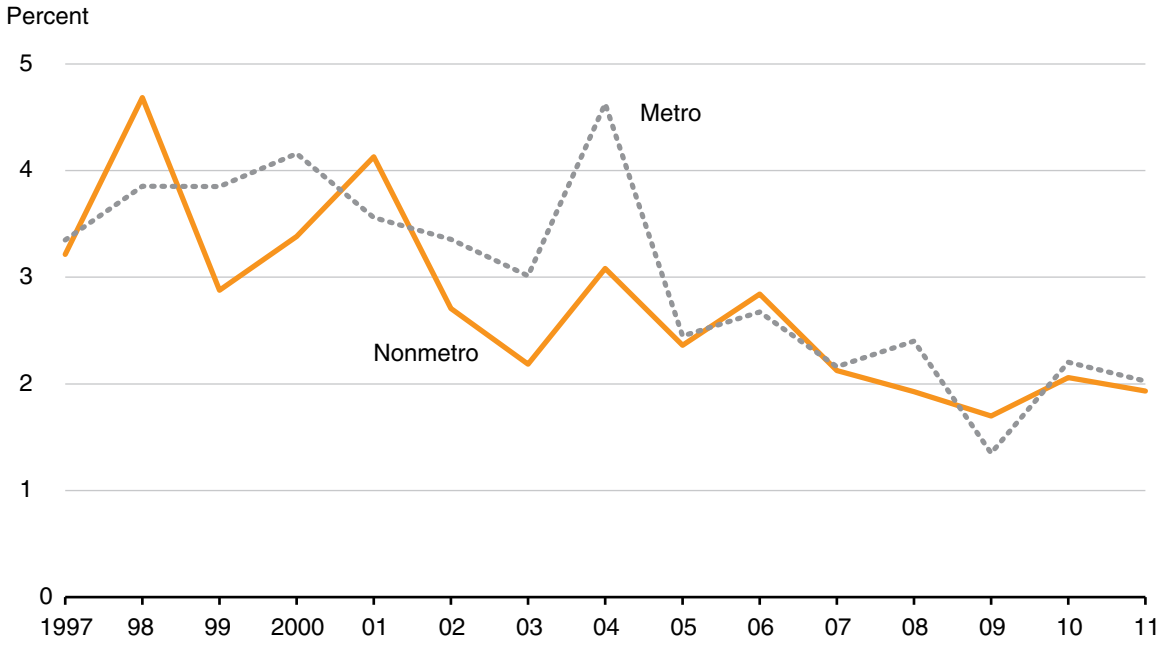
Over half (55 percent) of manufacturing plants in the RMS in 1996 survived during the 15-year study period. Shutdown rates varied over time, ranging from 1.5 percent to 4.5 percent annually (fig. 5). The annual rate of plant failure trends downward after 2001; this is expected because the plants most likely to fail did fail early in the study period, leaving the plants most likely to survive in the study longer.

Survival Rates Vary With Plant Characteristics

Survival rates varied notably by plant ownership structure (independent versus part of a multi-unit firm) and whether or not a plant was in a rural (nonmetropolitan) county (fig. 6). Independent plants—single-unit manufacturing plants or firms with only one physical location—had a 59-percent survival rate over 1996-2011 while multi-unit plants had a 50-percent survival rate. The average survival rate for plants in rural counties was 57 percent, versus 52.5 percent for plants in metropolitan counties. The average survival rate for independent plants located in rural counties was 62 percent while the average rate was 50 percent for multi-unit plants located in rural counties.[11]

Figure 5

Annual hazard (shutdown) rates for nonmetro and metro manufacturing plants, 1997-2011

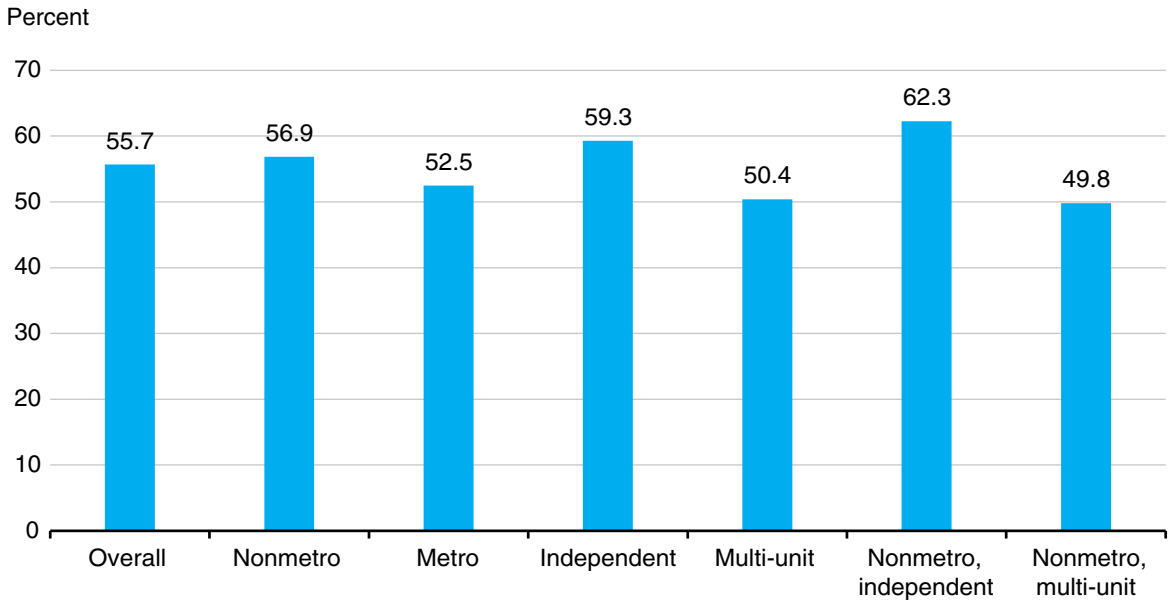


Note: Hazard/shutdown rate defined here as percent of plants that failed between Q4 in a particular year (t) and Q4 the subsequent year (t+1), conditional on plants having survived to Q4 of year t.

Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.

[11] The results in this section are cumulative survival rates, meaning the percentage of establishments surviving from the beginning of the study period to the end, 1996-2011.

Figure 6
Survival rates by plant characteristics, 1996-2011



Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from U.S. Dept. of Labor, Bureau of Labor Statistics.

While survival rates did vary some by industry, they were only statistically significantly lower than the all-manufacturing average ($p<0.1$) for textile mills and apparel product manufacturers (fig. 7). In rural America, textile and apparel manufacturing plants had a 25.8-percent survival rate during 1996-2011.

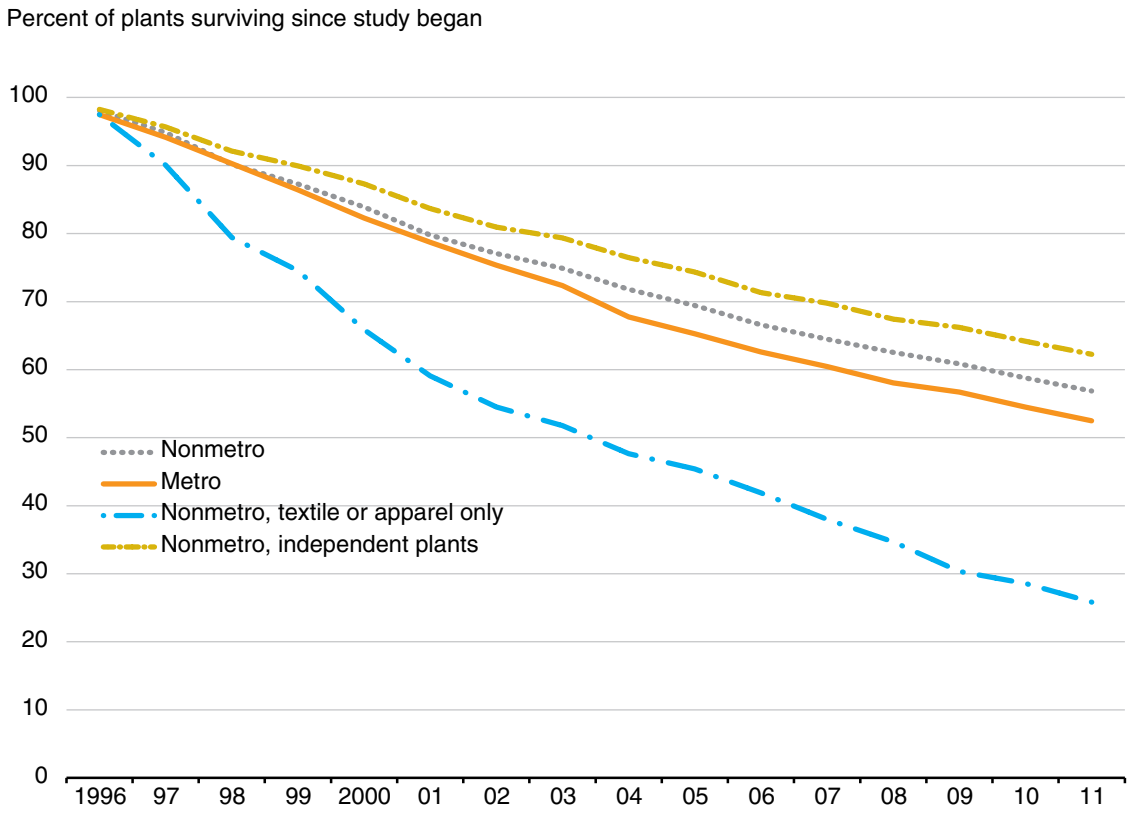
Simple Multivariate Survival Analysis

To help disentangle the effect of, say, plant industry and ownership structure on survival, analysis that controls for the statistical effects of these and other characteristics is used. This multivariate analysis is known as survival analysis. The variable of interest is the quarterly time interval between the 1996 survey and a plant's exit (meaning the plant was no longer employing workers), if that occurred. The overall goal is to determine what factors (variables) are most influential in explaining the length of plant survival.

Prior research on establishment survival suggests controlling for the statistical effects of ownership structure, employment (size), industry, and region, at a minimum (Audretsch and Mahmood, 1994, 1995; Dunne et al., 1988; Jarmin, 1999).[12] In this section, a simple survival analysis using these variables plus a nonmetropolitan/metropolitan variable is used to discuss results of the nonmetropolitan/metropolitan and the independent/multi-unit variables (which are not included in the main multivariate analysis). For more technical information on the survival analysis and the full set of results, see the Appendix.

[12] Establishment age is also commonly used in studies of startup survival and is predictive for younger establishments. Startups represent only around 3 percent of the sample and, when included in alternative specifications, a startup dummy variable was statistically insignificant. See the Appendix for more detail.

Figure 7
Annual survival rates for manufacturing establishments, 1996-2011



Source: USDA, Economic Research Service calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.

First, the entire sample—that is, both nonmetropolitan and metropolitan plants, so survival between the two can be compared—is used. The statistical effects of plant ownership structure (independent or multi-unit), plant size (the log of average full-time and part-time employment in 1995 as reported in the RMS), industry (2-digit Standard Industrial Classification categories as in the RMS), and Census region are controlled for. Plants in metro counties were 23 percent less likely to survive than plants in nonmetro counties, and independent plants were 27 percent more likely to survive than multi-unit plants (table 1 and appendix table 3).[13]

Looking at independent plants and multi-unit plants separately demonstrates that most of the metro-rural difference is driven by independent plants. A subsample of independent plants only (with the same statistical control variables) shows that metropolitan, independent plants are 35 percent less likely to survive than rural, independent plants (table 1 and appendix table 4).

When looking at only multi-unit plants, with the same statistical controls, there is no statistically significant difference between metro and rural hazard rates (table 1, appendix table 5). Thus, as the survival rates suggested, there are substantive differences between rural independent and multi-unit plant survival rates.

[13] Unlike nonmetro/metro and independent/multi-unit, all other variables are included in the subsequent analysis, the full multivariate analysis; we discuss those results in the subsequent section and table 2.

Table 1

Simple survival results, metro and nonmetro plants, independent and multi-unit plants

Sample	Conditional result	Than
All plants	Independent plants are 27% more likely to survive	Multi-unit plants
All plants	Plants in rural counties are 23% more likely to survive	Plants in metro counties
Independent plants	Independent plants in rural counties are 35% more likely to survive	Independent plants in metro counties
Multi-unit plants	Statistically insignificant difference in probability of survival between rural and metro plants	--

Note: The analysis these results are drawn from includes plants in both metro and nonmetro counties. These are excerpted results—the full models are presented in appendix table 3 (all plants), appendix table 4 (all independent plants), and appendix table 5 (all multi-unit plants).
Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the Bureau of Labor Statistics.

Table 2

Plant characteristics and effect on survival

Variable of interest	Effect on rural, independent plant survival	Effect on rural multi-unit plant survival	Than
Size—A plant with 100 employees	9% more likely to survive	Statistically insignificant effect	A plant with 200 employees
Region—West	34% more likely to survive	Statistically insignificant effect	In the south
Region—Midwest	36% more likely to survive	21% more likely to survive	In the south
Region—Northeast	41% more likely to survive	Statistically insignificant effect	In the south
Industry-textile mill	125% less likely to survive	61% less likely to survive	Than food & kindred product manufacturing
Industry-apparel	191% less likely to survive	176% less likely to survive	Than food & kindred product manufacturing

Note: These results are excerpted from full models presented in appendix table 1 (nonmetro, independent plants), and appendix table 2 (nonmetro, multi-unit plants).
Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.

Among independent plants, rural plants' tendency to survive longer than branch plants or headquarters may be surprising due to commonly perceived rural disadvantages (Buss and Lin, 1990). Recent research, however, finds a rural survival advantage (see Huiban (2011) for manufacturing and Christie and Sjoquist (2012) for most industries). Yu and colleagues (2011) found that between 1992 and 2004, metro firms were 18 percent more likely to fail than rural firms in Iowa and 58 percent more likely to fail in Kansas.

Why might independent plants in rural areas be less likely to fail than those in metro areas? For one, there is less competition in rural areas, increasing the likelihood of plant survival. Industry clusters are based on the premise that the synergy of similar firms will elevate competitiveness and spur growth of all proximate firms (Feser, 1998). However, as clusters grow, individual firms become highly competitive; rents are pushed higher and competition for workers increases, leading to higher labor costs (Huiban, 2011; Stephan, 2011). Consequently, only the highest performing firms can survive. Indeed, Low and Brown (2016) find that both rural and urban manufacturing plants are less likely to survive when located in a highly competitive environment.

Another hypothesis is that independent, rural plants have fewer alternatives (to exiting), compared to multi-unit plants or plants in a more urban area. Yu and colleagues (2011) posit that rural plant survival may be higher because the salvage value for rural plants is lower than for urban plants—if a plant were to fail, its resale value might be lower due to thinner demand in a rural market. As a result, the plant stays in business longer than it would in a market with greater demand for the plant's capital stock and higher salvage values. Plants may avoid or delay failing due to high exit costs, or low salvage value, even if the price received for output is considerably lower than the average variable cost of production (Dixit, 1989). Exit cost could be influenced by ownership structure because a multi-unit plant can redeploy its assets at another location, an option unavailable to independent plants (see box, "Interpreting the Results").

Results of the Full Multivariate Survival Analysis

As our focus is mainly on survival of rural manufacturing plants, the multivariate analysis exclusively uses rural plants.[14] In this section, we use the same statistical technique—survival analysis—but include more variables than simple plant and geography variables. Because rich survey data are available, we examine additional plant characteristics and owner perceptions and their bearing on survival.

This full analysis includes variables measuring average production worker pay (from the RMS), the log of county population, the log of average plant employment, and industry (based on the two-digit standard industrial classification (SIC))—the latter two of which were also used in the simple model. Metropolitan/nonmetropolian and independent/multi-unit variables are not included because we now look exclusively at rural, independent plants and rural, multi-unit plants, separately.[15] A suite of subjective questions on State and local tax rates and breaks, access to customers, and financial capital is also included in the full analysis. These subjective variables are discussed in detail in the subsequent results; the survey questions they are drawn from are available in appendix figure 1. Appendix table 6 contains variable means.

[14] The companion study, Low and Brown (2016), examines both urban and rural plant survival.

[15] Statistical tests showed that rural independent plants and rural multi-unit plants should not be pooled for survival analysis as the results for these two groups are significantly different.

Interpreting the Results

The statistical analysis used in this report generates what are known as hazard ratios, which are related to the probability that a plant will exit, calculated for a one-unit change in the variable of interest. Hazard ratios are presented in appendix tables 1-5. To ease interpretation, results discussed in the text (i.e., tables 1-3) are converted from hazard ratios into a percent increase (or decrease) in the probability of survival with a higher value for the variable of interest.

For example, take the result that independent plants are 27 percent more likely to survive than multi-unit plants. This percent probability of survival increase is generated from a hazard ratio of 0.73 (i.e., 1 - 0.73 = 0.27). The hazard ratio 0.73 is the ratio of the hazard rate for independent plants (where independent plants equal 1 and multi-unit plants equal 0) to the overall hazard rate. The hazard ratio or percent probability of survival increase (decrease) does not convey anything about how quickly a plant exits, only that the odds of survival are higher (lower) given a certain covariate. The statistical model assumes that the hazard ratio is constant over time.

Plant Characteristics and Survival

Most studies of manufacturing plant survival focus on plant-level characteristics. Plant characteristics are strongly related to their survival, more so than policy-related factors, simply due to plant heterogeneity.

Result: Among rural, independent plants, smaller plants are more likely to survive.

Smaller independent plants were more likely to survive than larger independent plants in rural America. Results suggest that a rural independent plant with 100 employees was 9 percent more likely to survive than a rural independent plant with 200 employees, all else being equal (table 2, appendix table 1). Why smaller independent plants were more likely to survive is not clear. It may be that their relative nimbleness made them more resilient during economic downturns than large plants. Smaller plants may have been more likely to continue operations when marginal costs exceeded marginal revenues in the short run, perhaps for idiosyncratic reasons such as the owner knowing how much a community depends on the plant for jobs. That smaller, independent plants were more likely to survive is interesting in a policy context as research suggests that small, locally owned businesses are positively associated with local economic performance (Rupasingha, 2016).

Result: Independent plant survival rates differ by region.

Independent plants in the Northeast, West, and Midwest census regions were 35-41 percent more likely to survive than those in the South (table 2).[16] Multi-unit plant survival rates did not vary as much regionally, though multi-unit plants in the Midwest were 21 percent more likely to survive than in the South. At the beginning of the study period (1996), manufacturing in the South was becoming more efficient, flexible, and modern, with fewer attempts to attract large branch plants (Rosenfeld, 1992).

[16] Census regions are defined here: http://www.census.gov/econ/census/help/geography/regions_and_divisions.html

Result: Plant survival rates vary by industry.

The textile mills and apparel products industries were especially hard hit during the study period. Textile and apparel manufacturing were the only industries with statistically different hazard ratios in both the independent and multi-unit groups' survival analysis, when compared to the reference industry, Food and Kindred Products (table 2, appendix tables 1-2).

Result: Survival is more predictable for rural independent plants than for rural multi-unit plants.

The survival of multi-unit plants was more difficult to predict with the information available than was independent plant survival; there were more statistically significant factors for independent plants than for multi-unit plants (table 1, table 2). Multi-unit plant survival is likely more difficult to predict due to factors not observed in the survey—decisions are likely determined at headquarters and are based upon the entire firm's operations rather than the characteristics of the local plant or community (Low and Brown, 2016).

Economic Development-Related Perceptions and Plant Survival

Three waves of economic development policies affected many manufacturing firms during the study period of 1996-2011. Here, we examine the relationship between plant survival and subjective survey questions on perceptions related to some first- and second-wave economic development strategies.[17]

Government programs to increase access to financial capital (a second-wave strategy) were especially popular during the study period because of perceptions that such access is more difficult in rural areas. Among RMS respondents, 26 percent of rural, independent plants and 18 percent of rural, multi-unit plants reported that access to financial institutions was a major or minor problem.

Result: Perceived problems obtaining capital is associated with decreased plant survival.

According to the Rural Manufacturing Survey, 15 percent of rural, independent plants and 13 percent of rural, multi-unit plants indicated that obtaining sufficient capital was a major problem when trying to implement improvements. Compared to plants indicating that obtaining sufficient capital was not a major problem (i.e., a minor problem or not a problem), independent plants indicating that it was a major problem were 91 percent less likely to survive and multi-unit plants were 31 percent less likely to survive (table 3). Of note, this finding is about a *perception*; there is nothing causal about it. A plant already having financial trouble at the time of the 1996 RMS would be unattractive to potential lenders and at a higher risk of failure. This finding only suggests that more research is needed on whether access to financial capital affects plant survival in rural America.

Result: Perceived importance of government loan guarantees may be associated with multi-unit plant survival.

The RMS asked whether participation in government direct loan and (separately) guaranteed loan programs was very important to the plant (see appendix figure 1 for the survey questions). The ques-

[17] Low and Brown (2016) examined the relationship between a particular third-wave strategy, clustering, and plant survival; being in a highly competitive industry cluster was associated with decreased survival rates.

Table 3
Policy-relevant characteristics and plant survival

Variable of interest	Effect on rural independent plant survival	Effect on rural multi-unit plant survival	Than
Obtaining capital a major problem	91% more likely to fail	31% more likely to fail	Plants indicating that obtaining sufficient capital is a minor problem, not a problem, or "don't know"
State/local tax rates a major problem	Statistically insignificant effect	Statistically insignificant effect	Plants indicating that state/local tax rates are a minor problem, not a problem, or "don't know"
State/local tax breaks important	Statistically insignificant effect	Statistically insignificant effect	Plants indicating that state/local tax breaks are somewhat important, not important, or not used
Government direct loans important	Statistically insignificant effect	Statistically insignificant effect	Plants indicating that government direct loans are somewhat important, not important, or not used
Government guaranteed loans important	74% more likely to fail	45% less likely to fail	Plants indicating that government guaranteed loans are somewhat important, not important, or not used

Note: These results are excerpted from full models presented in appendix table 1 (nonmetro, independent plants), and appendix table 2 (nonmetro, multi-unit plants).

Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.

tions cannot be used to assess the effectiveness of these programs, but can suggest the relationship between plant survival and government direct/guaranteed loans. The RMS did not inquire as to which government direct or guaranteed loan programs a plant participated in. These programs were very popular just before the study period began—according to Stiglitz (1993), a quarter of all loans in the 1980s had either a government guarantee or were a government direct loan.

Independent plants were 74 percent *less* likely to survive if they indicated government guaranteed loan programs were very important, compared to those indicating they were somewhat important or not important/not used (table 3). Results for multi-unit plants are weaker statistically, but suggest multi-unit plants were 45 percent *more* likely to survive if they indicated government guaranteed programs were very important (table 3). Six percent of independent plants reported that government guaranteed loans were very important, and only 4 percent of multi-unit plants did the same. Thus, the above results are based upon a relatively small sample of plants.[18] At least half of known government guaranteed loan recipients did not find the program to be "very important." Eight percent of independent plants reported the government guaranteed loans were only "somewhat" important (versus 6 percent at "very"), and 7 percent (versus 4 percent) of multi-unit plants reported they were only "somewhat" important.[19]

Why guaranteed loan program results differed between independent and multi-unit plants is uncertain. Independent plants that indicated access to loan guarantee programs was very important may

[18] These results have relatively high standard errors.

[19] Regression results were statistically weaker when "very" and "somewhat" important were combined, compared to the results for "very" important alone.

have already been experiencing difficulties and vulnerable to shutdown pressures (adverse selection) or may have used the government guarantee to take on riskier projects (moral hazard). It is possible that multi-unit plants receiving guaranteed loans were more likely to participate in a loan guarantee program not because they failed to meet conventional underwriting standards but because they were obtaining a large loan and the sheer size of the loan required a guarantee for the lender to meet regulatory lending limitations (Comptroller of the Currency, 2012).

It could be that independent plants were more likely to participate in loan guarantee programs because they could not otherwise obtain a commercial loan (and thus were more likely to exit). For example, the California State Loan Guarantee Program requires that participating businesses *not* meet conventional underwriting standards (Bradshaw, 2002), while the USDA Business and Industry Guaranteed Loan Program requires that participating businesses *do* meet conventional underwriting standards (Comptroller of the Currency, 2012). If independent plants were more likely to participate in the former type of loan program and multi-unit plants were more likely to participate in the latter, this could explain the results observed. Unfortunately, we do not know which programs the surveyed plants participated in.

The RMS also asked about the perceived importance of government direct loan programs. Slightly more plants perceived direct loan programs to be "very" important (7.5 percent of independent plants and 4.6 percent of multi-unit plants) than perceived guaranteed loans to be very important (5.9 percent and 3.6 percent). Direct loan programs are generally designed to provide capital to establishments that cannot obtain funding through traditional lenders. Thus, establishments benefiting from government direct loans are more likely to recognize the importance of the program—it was likely the only capital available to them. The relationship between government direct loans and establishment survival is not found to be statistically significant (table 3), implying (1) there is truly no effect, (2) there is an effect but it is small and masked by statistical problems, or (3) there is an effect but it is not measurable because of issues like adverse selection and moral hazard.

Result: State and local tax incentives seem not to matter in plant survival.

State and local tax incentives (breaks)—a first-wave economic development practice—were perceived to be very important over the prior 3 years by 18 percent of independent plants and 23 percent of multi-unit plants. More incentive recipients (36 percent of multi-unit plants and 23 percent of independent plants) deemed the tax breaks to be somewhat important than very important. Moreover, only 25 percent of independent plants and 18 percent of multi-unit plants indicated that State and local tax rates were a major problem for their establishment's ability to compete.

Neither the tax rate nor tax break perceptions were statistically significantly in relation to plant survival (table 3). As with the nonresult on government direct loans, this could imply that tax incentives truly have no effect or that there is an effect but it is small and/or masked by statistical problems.

Conclusions

Higher dependence on manufacturing jobs and income coupled with higher rural manufacturing survival rates suggests that the survival of manufacturing plants is integral to the rural communities in which they are located.

Independent manufacturing plants may be especially important to rural jobs and income; many independent manufacturing plants are second- or third-generation family businesses with deep ties to the local community. Smaller, independent manufacturing plants are more likely to be locally owned, and such businesses are positively associated with income growth and lower poverty rates (Rupasingha, 2016). This analysis indicates that smaller, independent manufacturing plants in rural areas were more likely to survive the economic shocks to the manufacturing sector during 1996-2011 than were larger plants; also, independent plants were more likely to survive than were multi-unit plants. Multi-unit plant survival was found to be more idiosyncratic in nature, with decisions likely made at headquarters and based on the entire firm's standing across multiple sites.

Results suggest that access to financial capital may be related to survival rates for rural manufacturing plants, but more research is necessary to understand the relationship between particular forms of financial capital or programs promoting capital access—traditional private-sector avenues or government programs—and plant survival.

Combined, these results offer potential insights into economic development policy. Local and regional economic development practitioners and policymakers may make tradeoffs between incentives used to attract and/or retain branch plants and supporting local manufacturing entrepreneurs with technical assistance or access to financial capital. The results suggest that local retention policies and incentives may be less effective if targeted toward multi-unit plants than toward independent plants in rural areas, for example.

A few caveats of this study are worth noting. Unobserved factors such as the manager's personality and abilities, the specific goals of the owner, and local efforts to retain manufacturing plants likely also affect plant survival. Only factors observable in the RMS survey and administrative data could be examined, however. Further, only plant characteristics observed at the time of the survey were studied; changes in these characteristics made after the survey was conducted are not observed. Although trade is considered by some to be important to plant closures during the study period (Pierce and Schott, 2012), this report does not focus on trade impacts (though differential impacts of trade on particular manufacturing industries such as textiles and apparel are reflected in the differences estimated across industries).

More research would be helpful to explore why multi-unit and independent rural manufacturing plants had different results for the survey question on whether government loan guarantees were used and deemed very important by the plant. Information on the specific government loan guarantee programs used by rural manufacturing plants and the requirements of those programs would be needed to better understand the impacts of such loan guarantees. More research also might explain the lack of relationship between the perceived importance of tax incentives and survival, since most survey respondents considered these incentives either very or somewhat important to business operations. Such research could investigate the actual impacts of State or local tax policies rather than the impacts of their perceived importance.

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Appendix: Data, Methods, and Results

Data: Technical Details

The nationally representative Rural Manufacturing Survey (RMS) was conducted for USDA's Economic Research Service in 1996. The sampling frame was purchased from a private vendor and included all establishments in Standard Industrial Classification (SIC) division D (Manufacturing), excluding newspaper publishing. The sample universe was plants with at least 10 employees. Nonmetropolitan plants, western plants, and larger plants were over sampled. Sampling weights were based upon survey strata (region of the country, plant employment, and metropolitan/nonmetropolitan location). Plant-size strata were used to ensure that the survey represented all U.S. manufacturing establishments with 10 or more employees. For more information about the survey and survey weights, see Gale et al. (1999). The reader should know that the survey responses are solely what was reported by the survey respondent, generally plant owners or managers. There exists evidence that, due to respondent bias, business surveys must be conducted, reported, and interpreted with care (Barkley and McNamara, 1994).

Survey responses were linked to the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW), a longitudinal, establishment-level administrative record of employment and wages reported by employers (for more information, see box, "Linking Administrative and Survey Data"). RMS respondents in Massachusetts, Michigan, New York, Mississippi, New Hampshire, and Wyoming are excluded from this study due to State statute. Match rates varied from 100 percent to 82 percent in different States. The impact of the omitted plants is unknown. However, when comparing summary statistics between the entire RMS population and

Linking Administrative and Survey Data

Forty-four States plus the District of Columbia agreed to participate in this study by permitting access to their State Quarterly Census of Employment and Wages data; Massachusetts, Michigan, New York, Mississippi, New Hampshire, and Wyoming did not. Consequently, RMS respondents in these 6 States are excluded from this study, bringing the sample to 3,540 respondents before linking.

The RMS establishments were linked to the QCEW based principally upon establishment name and address (using fuzzy matching with much human input). Where ambiguity existed, industry and employment were also used to link records. The match rate was exceptionally high (88 percent) for this sort of activity, especially using data from the mid-1990s. State match rates were between 82 percent and 100 percent, principally because some States had better quality data and addresses.

Despite losing respondents from six States and additional respondents in the matching process, the sample used in this analysis looks very similar to the full sample of RMS respondents. The linked sample and whole RMS sample did not have a statistically different share of metropolitan/nonmetro plants, durable/nondurable plants, ownership structure (independent plants or those part of a multi-unit firm), or average employment.

the QCEW-linked population, no statistically significant difference between these populations was found in terms of proportions in metro/nonmetro areas, in durable/nondurable subsectors, being independent/multi-unit plants, or in the average employment level.

Dependent Variable

Exits occur when a plant drops out of the QCEW, meaning they ceased having any paid employees and were designated as an exit by State labor market information agents. Plants cannot re-enter the QCEW after failing. Positive closures (i.e., mergers and acquisitions) are not considered an exit by BLS if the establishment's location remains within the State. If a plant relocates outside the State, it is considered an exit.

Explanatory Variables

The log of the average number of employees on payroll in 1995, as reported on the RMS, is used as the measure of plant size; this number includes full-time, part-time, and temporary workers. This variable is a continuous variable.

We control for the cost of labor, which we expect to be higher in areas with more competition for labor and in plants with higher educational requirements, with the average hourly wage for production workers in 1995, from the RMS.[20]

The log of population in the county is a continuous variable capturing the size and congestion of the county; this variable is measured using the 1990 decennial census. Census region dummy variables (Northeast, Midwest, South, and West) are based upon the plant's physical location. 2-digit SIC code dummy variables, with Food & Kindred Product Manufacturing as the omitted industry, are used as control variables in the analysis. Three-digit SIC codes were also tested, but the results were very similar and the computational expense much higher. These subsector fixed-effects also control for subsector-specific disturbances that occurred during the study period, including, for example, the effects of the United States granting permanent normal trade relations to China.

We did not have data on the age of the plant, but the RMS did contain a dummy variable for whether a plant was a startup (i.e., less than 5 years old at the time of the RMS), and this variable was statistically insignificant in exploratory analysis. Few plants in the sample were startups (approximately 3 percent); thus, including this startup dummy variable had little influence in the regression and was excluded from the analysis.

Subjective explanatory variables on State and local taxes, access to customers, and financial capital are drawn from questions on the RMS and are reproduced in appendix figure 1. See the body of the text for descriptive statistics and more information on these variables.

Plant ownership structure is classified as either independent (a firm with only one physical location; i.e., a single-unit plant) or multi-unit (to include both branch plants and headquarters); this variable is from the RMS. The dummy variable for metropolitan counties is defined using 1990 census

[20] Production worker pay is our proxy for human capital. The survey included the percent of production workers with no high school diploma, which is correlated with production worker pay. Results were unchanged when substituting production worker pay with the percent production workers with no high school diploma (the coefficient on this was also statistically insignificant).

Appendix figure 1

Subjective survey questions

One purpose of this survey is to assess which types of government or government-sponsored programs are the most helpful to businesses. For each program, please tell us how important that program has been for your business's operations in the last three years.

	VERY IMPORTANT	SOMEWHAT IMPORTANT	NOT IMPORTANT OR NOT USED
Direct loans from a government agency	1	2	3
Government insurance or guarantee for loans	1	2	3
Revolving loan funds run by a nonprofit organization	1	2	3
Tax breaks by state or local government	1	2	3

LOCATIONAL BARRIERS TO COMPETITIVENESS

Q60. The following is a list of factors related to your establishment's location. For each one please tell us whether this is A MAJOR PROBLEM, A MINOR PROBLEM, or NOT A PROBLEM for your establishment's ability to compete.

	MAJOR PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Access to major customers	1	2	3
Access to financial institutions	1	2	3
State and local tax rates	1	2	3

Q22. Next is a list of problems organizations may face when they try to implement NEW TECHNOLOGIES or MANAGEMENT PRACTICES. For each one please tell us whether this has been A MAJOR PROBLEM, MINOR PROBLEM, or NOT A PROBLEM for your establishment.

	MAJOR PROBLEM	MINOR PROBLEM	NOT A PROBLEM/ NOT APPLICABLE	DON'T KNOW
Availability of adequate technical assistance	1	2	3	4
Adequacy of worker skills	1	2	3	4
Employee turnover	1	2	3	4
Obtaining sufficient capital	1	2	3	4

Source: 1996 USDA, Economic Research Service Rural Manufacturing Survey mail-out instrument.

data.[21] These variables are not included in the full analysis as that analysis was split by rural, independent and rural, multi-unit, but they are used in the simple analysis.

Survival Analysis: Technical Details

In estimating establishment survival, the approach of Audretsch and Mahmood (1994, 1995) and Agarwal and Audretsch (2001), known as hazard or duration analysis, is followed, as opposed to a binary choice model or nonparametric methods (Forsyth, 2005).

The Cox proportional hazard model is preferred over parametric hazard models because it does not require us to make distributional assumptions about hazard rates. Unlike failure rates for new establishments, which generally follow a theoretically appealing distribution because startups face the highest hazard early in their lifetime, respondents were at a variety of ages when first observed in the 1996 survey. Thus, their hazard function does not follow any known distributional form. Additionally, the Cox model corrects for problems of censored data, both left-censoring (i.e., plants excluded from the survey frame because they failed before the sample was drawn), and right-censoring (i.e., plants surviving when observation ended in 2011).

The basic Cox proportional hazard model can be expressed as:

$$h(t) = h_0(t) \cdot \exp(x'\beta + z'\delta) \quad (1)$$

where $h(t)$ is the conditional hazard rate for an establishment and $h_0(t)$ is the unspecified baseline hazard function. The hazard function estimates the conditional probability that an establishment will exit in the next time interval (quarter, in this case), conditional upon the firm having survived to time t. Establishment-specific explanatory variables are in vector x, while vector z contains various measures of local context. The conditional probability that the jth firm exits at time t given that a single establishment exited in t is given as the ratio of the hazards:

$$Pr_j = \frac{\exp(x'\beta + z'\delta)}{\sum_{j \in R} \exp(x'\beta + z'\delta)} \quad (2)$$

where $j \in R$ denotes those establishments that are at risk only at time t. The baseline hazard rate $h_0(t)$ is assumed to be the same for all establishments and is not assumed to have any particular shape. One advantage of this model is that the baseline hazard cancels out from the expression in (2). The intuition is that in the absence of all information about the baseline hazard, only the order of the duration provides information (Kiefer, 1988). Thus, the Cox proportional hazard model captures the effects of explanatory variables on the estimated probabilities that establishments fail within a given time interval, rather than the time it takes for each establishment to fail, typical of standard hazard models (Audretsch and Mahmood, 1994; Kiefer, 1988).

Since plants' survival is observed quarterly, the existence of tied failure times (i.e., multiple plants failing in one quarter) requires special treatment. We utilize the approximation proposed by Breslow (1975), which is widely used to incorporate the case of ties and works best when the number of failures in the risk group is small relative to the risk group size, as in our case.

[21] A map showing which counties were defined as metropolitan and nonmetropolitan in 1993, using 1990 census data, is available at https://wayback.archive-it.org/5923/20110914000642/http://www.ers.usda.gov/Briefing/Rurality/RuralUrbCon/priordescription.htm

The partial likelihood function derived from Cox (1972, 1975) is calculated by multiplying the probabilities together for each of the k events of exit,

$$PL(\beta, x, \delta, z) = \prod_{j \in R}^{k} (\exp(x'\beta + z'\delta) \Big/ \sum \exp(x'\beta + z'\delta)) \quad (3)$$

Equation (3) incorporates the covariates at each successive point in time to calculate the risk of exit confronting the ith establishment at time t. The coefficients of the model are estimated by maximizing the partial likelihood function.

The estimated coefficients indicate the relationship between explanatory variables and the hazard function. The hazard ratio is the exponentiated coefficient and is a convenient way to interpret results—it is the ratio of the hazard rate for a one-unit change in the corresponding covariate to the overall hazard rate. A negative coefficient thus leads to a hazard ratio less than one, implying a decrease in the hazard rate and that the probability of survival increases with a higher value of the variable (Agarwal and Audretsch, 2001).

Since survey data were used in this analysis, adjusted standard error estimates that accommodate the survey design are reported. Sampling weights were based upon survey strata (region of the country, size of the plant, metropolitan/nonmetropolitan location).

We examined the appropriateness of the proportional hazard assumption, an assumption necessary for using this empirical model, with a standard test of whether the model was adequately parameterized and well specified (Cleves et al., 2008). We find no evidence that the specifications violate the proportional hazards assumption when we test for a nonzero slope in a regression of the scaled Schoenfeld residuals on functions of time. Two graphical methods also suggest the models are well specified, corroborating the Schoenfeld residual test results.

As robustness checks, the simple model was estimated with parametric models (exponential, Weibull, Gompertz). The coefficients had the same signs as they do in the Cox proportional hazards model. Simple probit estimations, controlling only for industry and employment, were also estimated as a robustness check. Most results were the same in sign and significance. Exceptions include: For independent plants, government direct loans being deemed very important was associated with a statistically significant ($p<0.1$) increase in survival; for multi-unit plants, the coefficient on government guaranteed loans was insignificant and the coefficient on tax breaks being very important was statistically significant and associated with a small decrease in survival.

Appendix table 1

Full set of survival analysis results, nonmetro independent plants

Single-unit, nonmetro	Hazard ratio	Standard error	Significance
Log employment (size)	1.15	0.067	**
Production worker pay	1.00	0.025	
Log county population	1.03	0.082	
State/local tax rates are a major problem	1.00	0.001	
State/local tax breaks are very important	0.89	0.134	
Access to major customers a major problem	1.25	0.278	
Obtaining sufficient capital a major problem	1.91	0.281	***
Government direct loans very important	0.71	0.193	
Government guaranteed loans very important	1.74	0.413	**
Northeast	0.59	0.130	**
West	0.66	0.122	**
Midwest	0.64	0.092	***
Textile mill products	2.25	0.771	**
Apparel and other textile products	2.91	0.954	***
Lumber and wood products	1.44	0.387	
Furniture and fixtures	1.55	0.584	
Paper and allied products	1.06	0.701	
Printing and publishing	1.84	0.646	*
Chemical and allied products	2.54	0.928	**
Petroleum and coal products	0.87	0.697	
Rubber and misc. plastic products	1.72	0.542	*
Leather and leather products	3.48	2.643	
Stone, clay, and glass products	1.08	0.404	
Primary metal industries	0.94	0.353	
Fabricated metal industries	0.76	0.239	
Industrial machinery and equipment	1.41	0.377	
Electronic and other electric equipment	0.73	0.284	
Transportation equipment	1.81	0.574	*
Instruments & related products	0.69	0.580	
Miscellaneous manufacturing industries	2.26	0.755	**
N	967		
Population (weighted)	70,292		
F test (30, 937)	3.81 (P<0.001)		

Significance: *** p<0.001, ** p<0.05, * p<0.1.

Appendix table 2

Full set of survival analysis results, nonmetro multi-unit plants

Multi-unit, nonmetro survival	Hazard ratio	Standard error	Significance
Log employment (size)	0.98	0.049	
Production worker pay	1.03	0.023	
Log county population	0.90	0.070	
State/local tax rates are a major problem	1.00	0.002	
State/local tax breaks are very important	1.01	0.132	
Access to major customers a major problem	1.05	0.229	
Obtaining sufficient capital a major problem	1.31	0.192	*
Government direct loans very important	0.77	0.282	
Government guaranteed loans very important	0.55	0.208	*
Northeast	0.90	0.206	
West	0.75	0.154	
Midwest	0.79	0.094	**
Textile mill products	1.61	0.417	*
Apparel and other textile products	2.76	0.619	***
Lumber and wood products	1.52	0.311	**
Furniture and fixtures	1.80	0.490	**
Paper and allied products	0.88	0.276	
Printing and publishing	0.64	0.253	
Chemical and allied products	0.59	0.205	
Petroleum and coal products	1.12	0.709	
Rubber and miscellaneous plastic products	1.05	0.272	
Leather and leather products	0.97	0.686	
Stone, clay, and glass products	0.62	0.162	
Primary metal industries	1.12	0.313	
Fabricated metal industries	0.72	0.194	
Industrial machinery & equipment	0.99	0.245	
Electronic and other electric equipment	1.42	0.372	
Transportation equipment	1.63	0.426	*
Instruments and related products	0.82	0.382	
Miscellaneous manufacturing industries	1.46	0.615	
N	1,075		
Population (weighted)	51,749		
F test (30, 1,045)	3.12 (p<0.001)		

Significance: *** p<0.001, ** p<0.05, * p<0.1.

Appendix table 3

All plants

All plants	Hazard ratio	Standard error	Significance
Independent/single-unit	0.73	0.053	***
Log employment	1.04	0.030	
Northeast	0.69	0.085	***
West	0.81	0.076	**
Midwest	0.76	0.059	***
Metropolitan	1.23	0.100	**
Industry fixed effects	Yes		
N	3037		
Population (weighted)	185,487		
F test (24, 3013)	8.32 (p<0.001)		

Significance: *** p<0.001, ** p<0.05, * p<0.1.

Appendix table 4

All independent plants

Independent plants, all	Hazard ratio	Standard error	Significance
Log employment	1.11	0.048	***
Northeast	0.63	0.104	***
West	0.73	0.094	**
Midwest	0.66	0.078	***
Metropolitan	1.35	0.150	***
Industry fixed effects	Yes		
N	1489		
Population (weighted)	110,332		
F test (23, 1466)	3.72		

Significance: *** p<0.001, ** p<0.05, * p<0.1.

Appendix table 5

All multi-unit plants

Multi-unit, all	Hazard ratio	Standard error
Log employment	0.99	0.037
Northeast	0.82	0.152
West	0.91	0.120
Midwest	0.88	0.088
Metropolitan	1.09	0.130
Industry fixed effects	Yes	
N	1548	
Population (Weighted)	75,155	
F (24, 3013)	5	

Significance: *** p<0.001, ** p<0.05, * p<0.1.

Appendix table 6

Variable means for nonmetro independent and multi-unit samples

	Independent, nonmetro		Multi-unit, nonmetro	
	Mean	Std. error	Mean	Std. error
Log(employment)	3.49	0.004	4.45	0.004
Hourly pay	8.80	0.010	9.23	0.010
Log(county population)	10.40	0.005	10.32	0.004
State and local tax rates—share major problem	0.25	0.002	0.18	0.001
State and local tax breaks—share very important	0.18	0.002	0.23	0.002
Access to customers—share major problem	0.06	0.001	0.07	0.001
Obtaining capital—share major problem	0.15	0.001	0.13	0.001
Direct loans—share very important	0.08	0.001	0.05	0.001
Guaranteed loans—share very important	0.06	0.001	0.04	0.001
Northeast—share	0.12	0.001	0.08	0.001
West—share	0.13	0.001	0.08	0.001
Midwest—share	0.36	0.002	0.42	0.002
South—share	0.39	0.002	0.43	0.002
Textiles and apparel—share	0.07	0.001	0.10	0.001

Source: USDA, Economic Research Service (ERS) calculations using the 1996 ERS Rural Manufacturing Survey and establishment-level Quarterly Census of Employment and Wages from the U.S. Dept. of Labor, Bureau of Labor Statistics.