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Employment Spillover Effects of Rural Inpatient Healthcare Facilities

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Abstract

This report estimates the share of wage/salary employment in inpatient healthcare facilities—hospitals, nursing homes, and other residential care facilities—versus other industries in rural counties during 2001-15, and the spillover effects of additional inpatient facility employment, in rural counties. On average, we find no clear spillover effect of inpatient facility employment on employment in other sectors, i.e., the employment multiplier is approximately 1. The multiplier is larger in rural micropolitan counties (1.24 total jobs) than in the most rural (noncore) counties (0.89 total jobs), but neither of these estimates is significantly different from 1, implying the absence of spillovers.

Keywords: inpatient healthcare employment multiplier, rural community development, rural healthcare, employment, inpatient healthcare facilities

Acknowledgments

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This research was conducted with restricted access to U.S. Bureau of Labor Statistics data. The views expressed here do not necessarily reflect the views of the BLS.

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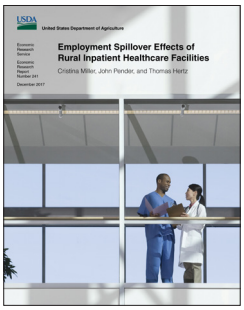


Employment Spillover Effects of Rural Inpatient Healthcare Facilities

Cristina Miller, John Pender, and Thomas Hertz

What Is The Issue?

Rural inpatient healthcare facilities—general medical/surgical hospitals, psychiatric and substance abuse hospitals, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities—provide local jobs and safeguard the health of local residents, improving the economic well-being of local communities. The healthcare industry is growing faster than any other U.S. industry and is projected to add the most jobs of any industry by 2024. However, little is known about the broader economic impacts of this growth in rural areas.

This report estimates the impact of rural healthcare facility jobs (excluding individuals who are self-employed) on total rural (nonmetropolitan) county jobs—and is measured in per capita terms. This report documents changes since 2001 in healthcare and other rural industrial jobs and how employment multiplier impacts differ between rural counties with a core urban area population of 10,000-49,999 (micropolitan) and the most rural counties with a core urban area population of less than 10,000 (rural noncore).

What Did the Study Find?

Inpatient healthcare facilities are large employers in rural communities. In 2001, inpatient healthcare facilities provided over 1.1 million wage and salary jobs in rural communities, or 7.6 percent of total rural wage and salary jobs. At its peak in 2011, inpatient healthcare employment represented over 1.25 million wage and salary jobs, or 8.5 percent of rural wage and salary employment.

Nationwide, employment in the healthcare sector rose before, during, and after the Great Recession, accounting for 39 percent of net private-sector jobs created since 2007. In contrast, rural healthcare employment grew by 9 percent between 2001 and 2011, then declined by 2 percent between 2011 and 2015.

From 2001 to 2015, inpatient healthcare facilities experienced modest employment gains in rural counties, despite the effects of the Great Recession. Micropolitan counties experienced 10-percent growth in inpatient healthcare employment while employment in this sector grew 3 percent in rural noncore counties.

In both micropolitan and rural noncore counties, the majority of inpatient healthcare facility jobs are in general medical/surgical hospitals (52.5 percent for micropolitan counties and 46.4

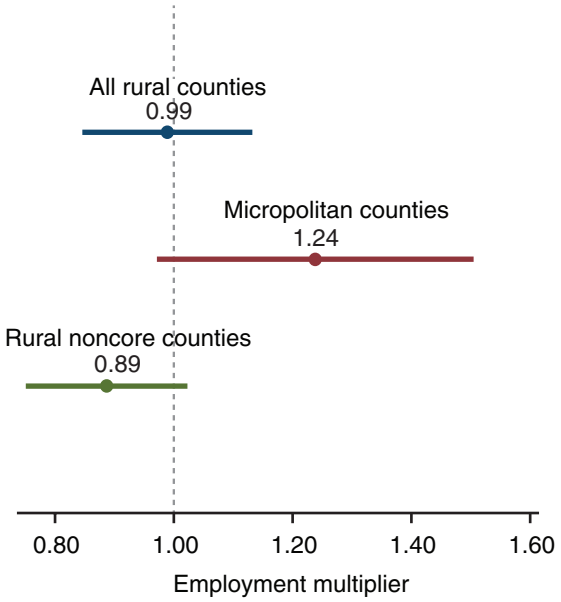
percent for noncore counties) or nursing care facilities (25.0 percent and 34.5 percent, respectively).

For rural counties as a whole, our point estimates of multiplier impacts imply that inpatient healthcare facility employment did not generate additional employment in the local economy beyond the people directly employed in the facilities. This could occur if any additional positive employment effects were offset by displacement or competition effects (jobs potentially lost in other industries as workers opt for healthcare facility employment).

In rural areas, on average, 0.99 job was created per inpatient healthcare facility job. We estimate a larger inpatient healthcare facility employment multiplier for more populated and more economically integrated micropolitan counties than for rural noncore counties. In micropolitan counties, on average, there was a larger effect of 1.24 jobs per inpatient healthcare facility job compared to 0.89 job in noncore counties. However, these multiplier estimates are subject to margins of error, as shown in the figure to the right.

Summary figure

Inpatient healthcare employment multipliers



Notes: This chart is a graphical representation of results included in Tables 2 and 3. The points represent the inpatient healthcare multipliers for all rural counties, micropolitan counties, and rural noncore counties. The lines represent the 90-percent confidence intervals of the respective multipliers. The multiplier is the total number of jobs in the county in all industries that result from the addition of one inpatient healthcare job. A multiplier equal to 1 implies that there is only a direct impact of that healthcare job. A multiplier greater than one implies that the inpatient healthcare job generated additional jobs in the county in other industries. A multiplier less than one implies that additional healthcare employment displaces jobs in other industries in the county. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area. Micropolitan counties contain a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000.
Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages data, 2001-15.

How Was the Study Conducted?

This report uses data from the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW), which tabulates employment and wage information on workers covered by State unemployment insurance or Federal workers covered by Unemployment Compensation for Federal Employees. Some employed persons are excluded from the QCEW data, such as members of the Armed Forces, the self-employed, proprietors, some agricultural workers employed on smaller operations, domestic workers, unpaid family workers, and railroad workers. This report also uses data from the Decennial Census (2000) and Intercensal Population Estimates by county.

The descriptive analysis focused on 1,817 rural counties (from the lower 48 States) for which wage and salary employment data were disclosed in the QCEW. Regression analysis was used to estimate the impact of inpatient healthcare facility jobs per capita as well as jobs in selected tradable sectors (agriculture, manufacturing, mining, and Federal and State governments) on total rural county jobs per capita. Employment in tradable sectors is assumed to be exogenous or independent of local demand. The regression analysis includes 1,752 rural counties that had inpatient healthcare facility sector jobs in at least 1 year during the study period (2001-15) with complete data on all relevant variables in all 15 years.

Employment Spillover Effects of Rural Inpatient Healthcare Facilities

Introduction

Inpatient healthcare facilities—general medical/surgical hospitals, psychiatric and substance abuse hospitals, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities—are a nexus for health and wellness services in many rural communities and may help to improve the health of rural residents, provide local jobs, and promote economic well-being in rural communities. Healthcare facilities demand high- and low-skilled labor, as well as goods and services from the local community. As an amenity, a rural healthcare facility may help attract or retain firms, retirement communities, and residents.

The U.S. Bureau of Labor Statistics (BLS), using Current Employment Statistics (CES) data, recently reported that "the healthcare industry is experiencing the fastest employment growth of all U.S. industries and is projected to add the most jobs between 2014 and 2024 (Henderson, 2015). Between 2001 and 2015, private-sector healthcare employment rose by 38 percent (adding 4.2 million jobs) versus 10 percent for total private employment. Employment in the healthcare sector rose before, during, and after the Great Recession, accounting for 39 percent (2.5 million additional jobs) of net private-sector jobs created since 2007. Much of the growth in the healthcare sector was concentrated in the ambulatory service sector (outpatient care centers, medical offices, home healthcare, and other ambulatory services), which grew by 59 percent between 2001 and 2015, and led by the home healthcare services subsector with job growth of 113 percent in that span.

Growth in inpatient healthcare facilities employment was slower than in the ambulatory service sector. Private hospital employment grew by 24 percent between 2001 and 2015, as did employment in nursing homes and other private residential care facilities. Moreover, these national numbers are dominated by trends in urban (metropolitan) areas; job growth in rural hospitals was much slower. Rural healthcare employment grew by just 9 percent (adding 105,000 jobs) between 2001 and 2011 (fig. 1), then declined by 2 percent (dropping 22,400) between 2011 and 2015 (the last year for which we have geographically disaggregated employment data from the BLS Quarterly Census of Employment and Wages (QCEW)).

Between 2001 and 2015, the most remote (rural noncore) counties experienced slower growth in inpatient healthcare employment (3 percent—adding 15,000 jobs) than in micropolitan counties (10 percent—adding 68,000 jobs) (figure 2).[1] The slow growth in healthcare employment reflects the struggle of many rural communities to attract and retain physicians and other healthcare professionals. Over 85 percent of rural counties were classified as having a shortage of primary care health professionals in 2005 (Doescher et al., 2009). Additionally, between January 2010 and December 2016, 78 rural hospitals (about 4 percent of the 1,855 rural hospitals (American Hospital Association, 2016)) closed (UNC Sheps Center, 2017). Hospital closures can have a rippling effect in the local community. Holmes and colleagues (2006) found that when the sole hospital in a rural community

[1]Micropolitan counties contain a core urban area population of 10,000 to 49,999. Rural noncore counties contain a core urban area population of less than 10,000.

closes, per capita income in the county decreases by 4 percent and unemployment increases by 1.6 percentage points.

A number of Government policies and programs have been designed to support rural healthcare systems in recognition of their importance. These include the Critical Access Hospital[2] program, the National Health Service Corps,[3] and several loan and grant programs provided by USDA, the Department of Housing and Urban Development, the Small Business Administration, and others.

Despite the priority assigned to rural health by Federal policymakers, relatively little is known about the economic impacts of healthcare employment on rural communities. Understanding the local multiplier impacts of healthcare can help policymakers better target efforts to promote employment growth in rural areas. Accordingly, we estimate the multiplier effect of inpatient healthcare facility wage/salary jobs on total county wage/salary jobs in rural communities using employment data for a balanced panel of all rural counties. Several single- or multi-county input-output (IO) model-based studies have estimated rural county hospital employment multipliers, but this is the first study to use an econometric approach to ascertain the multiplier effects of rural healthcare employment.[4]

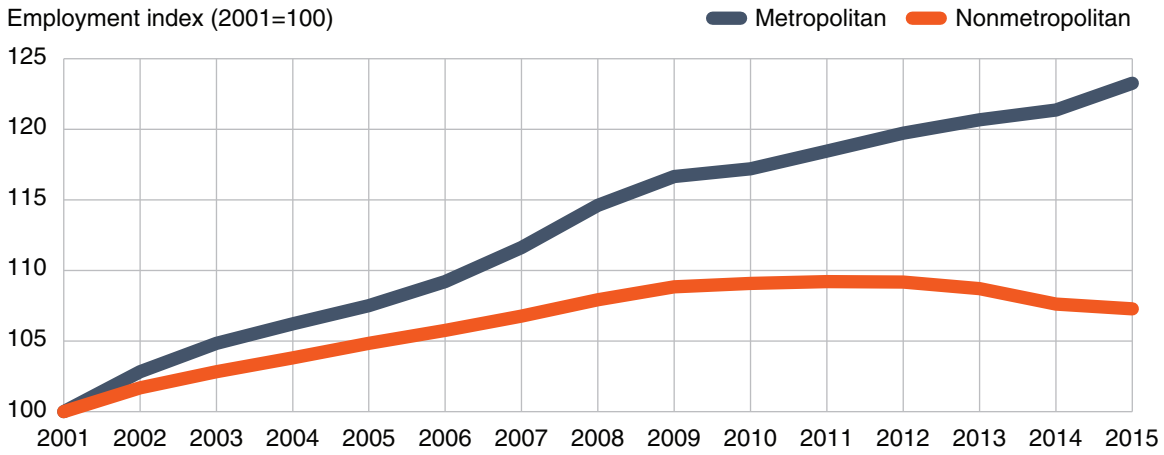
[2]Established in 1997 in the Balanced Budget Act, the Critical Access Hospital (CAH) classification enabled small rural hospitals (those with 25 beds or fewer) to receive cost-based reimbursement for Medicare services. As of February 2017, there were 1,339 CAHs.

[3]The National Health Service Corps (NHSC) offers student loan repayment to licensed healthcare professionals for a 2-year commitment to practice in a rural community.

[4]IO models are commonly used to estimate, in advance, the expected employment effects of rural development efforts. These estimates may not be valid if the assumptions underlying the models are not met, or if the data and input-output relations used by the models are national in scope and do not apply to the locations and specific industries being studied (Loveridge, 2004). Among the assumptions used by IO models are (i) all firms operate at constant returns to scale and use inputs in fixed proportions, (ii) local prices of production inputs (including labor) are not affected by local changes in input use, and (iii) input supply constraints do not affect local production in any firm (Brown et al., 2012). Econometric estimation of employment multipliers can test the validity of IO model multiplier estimates.

Figure 1

Growth in urban and rural inpatient healthcare facility employment, 2001-15

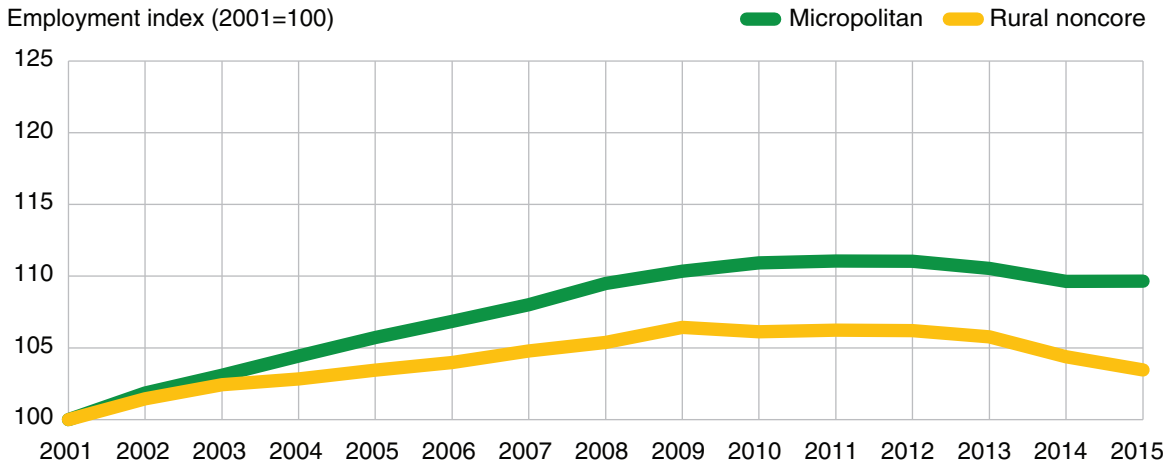


Note: Chart reflects 1,752 of 2,024 rural counties in the lower 48 States for which there were inpatient healthcare facility jobs in at least 1 year and no suppressed or missing data in the QCEW data (see figure 4 for more information on counties with no inpatient healthcare facility jobs, data suppression, and missing data in some years in the data set). The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.

Source:USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statstics Quarterly Census of Employment and Wages data, 2001-15.

Figure 2

Growth in rural (micropolitan and noncore) inpatient healthcare facility employment, 2001-15



Note: Chart reflects 1,752 of 2,024 rural counties in the lower 48 States for which there were inpatient healthcare facility jobs in at least 1 year and no suppressed or missing data (see figure 4 for more information on counties with no inpatient healthcare facility jobs, data suppression, and missing data in some years). The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area. The U.S. Office of Management and Budget (2003) defines micropolitan counties as containing a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000.

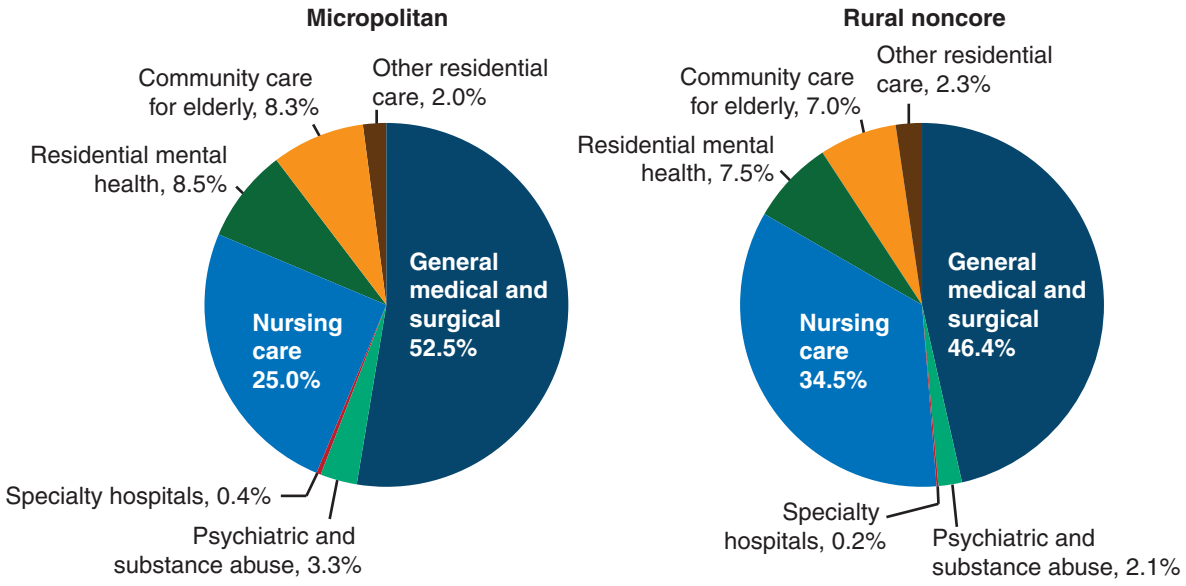
Source: Economic Research Service calculations using the BLS Quarterly Census of Employment and Wages data, 2001-15.

Employment in Rural Inpatient Healthcare Facilities

Rural inpatient healthcare facilities include general medical/surgical hospitals, psychiatric and substance abuse hospitals, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities (see box, "Types of Inpatient Healthcare Facilities"). The share of wage/salary jobs in each of these facilities varies between micropolitan counties, which are rural counties with a core urban area population of 10,000-49,999, and rural noncore counties, which are counties with a core urban area population of less than 10,000.

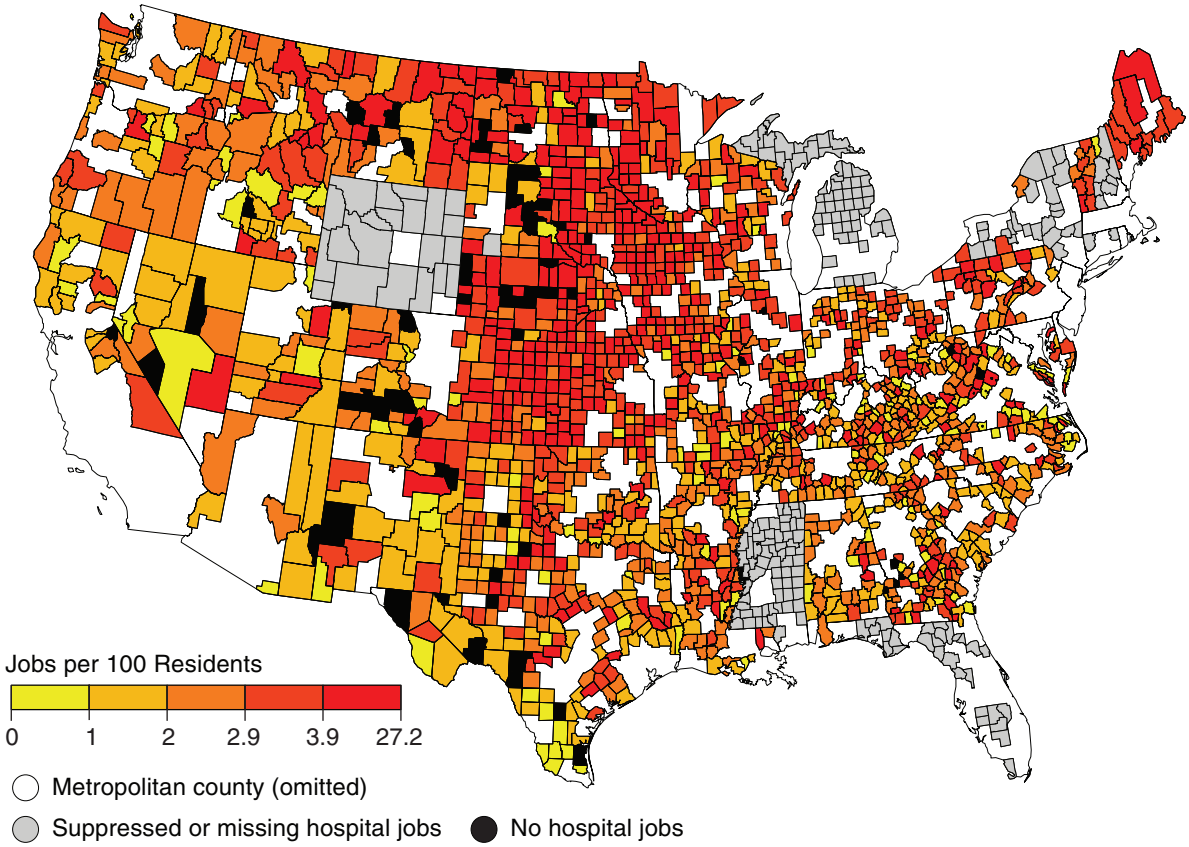
In both types of counties, general medical/surgical hospitals account for the largest proportion of healthcare employment—comprising 52.5 percent in micropolitan counties and 46.4 percent in rural noncore counties (figure 3). Nursing care facilities are the second largest category, employing 25.0 percent of inpatient healthcare employment in micropolitan counties and 34.5 percent in rural noncore counties. The third and fourth largest employers are residential mental health facilities and community care facilities for the elderly. The fact that, in rural noncore counties, general medical and surgical hospitals employ a smaller share of inpatient healthcare workers and nursing care facilities a larger share may reflect the siting of more advanced inpatient healthcare services in more urban settings.

Figure 3
Share of jobs by inpatient healthcare facilities in micropolitan and rural noncore counties (2001-2015)



Note: The average number of inpatient healthcare facility jobs in micropolitan counties is 1,335, with a standard deviation of 1,031. The average number of inpatient healthcare facility jobs in rural counties is 386, with a standard deviation of 366. This pie chart reflects only 1,752 of 2,024 total rural counties in the lower 48 States for which there were inpatient healthcare facility jobs in at least 1 year and no suppressed or missing data in the Quarterly Census of Employment and Wages data (see figure 4 for more information on counties with no inpatient healthcare facility jobs, data suppression, and missing data). The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area. The U.S. Office of Management and Budget (2003) defines micropolitan counties as containing a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000.
Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages data, 2001-2015.

Figure 4
Average inpatient healthcare facility jobs per 100 rural county residents, 2001-15



Note: The white areas of the map where there are no county borders are metropolitan counties and are excluded from this analysis. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.
Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data and U.S. Census Bureau Intercensal Population Estimates, 2001-15.

The average number of rural inpatient healthcare facility jobs per 100 county residents varies widely by region (figure 4). Rural counties with the most inpatient healthcare facility jobs per resident were concentrated in the Upper Midwest and northern Great Plains during 2001-15. Regions with fewer inpatient healthcare jobs per resident include much of the West, the southern Great Plains, and the South.

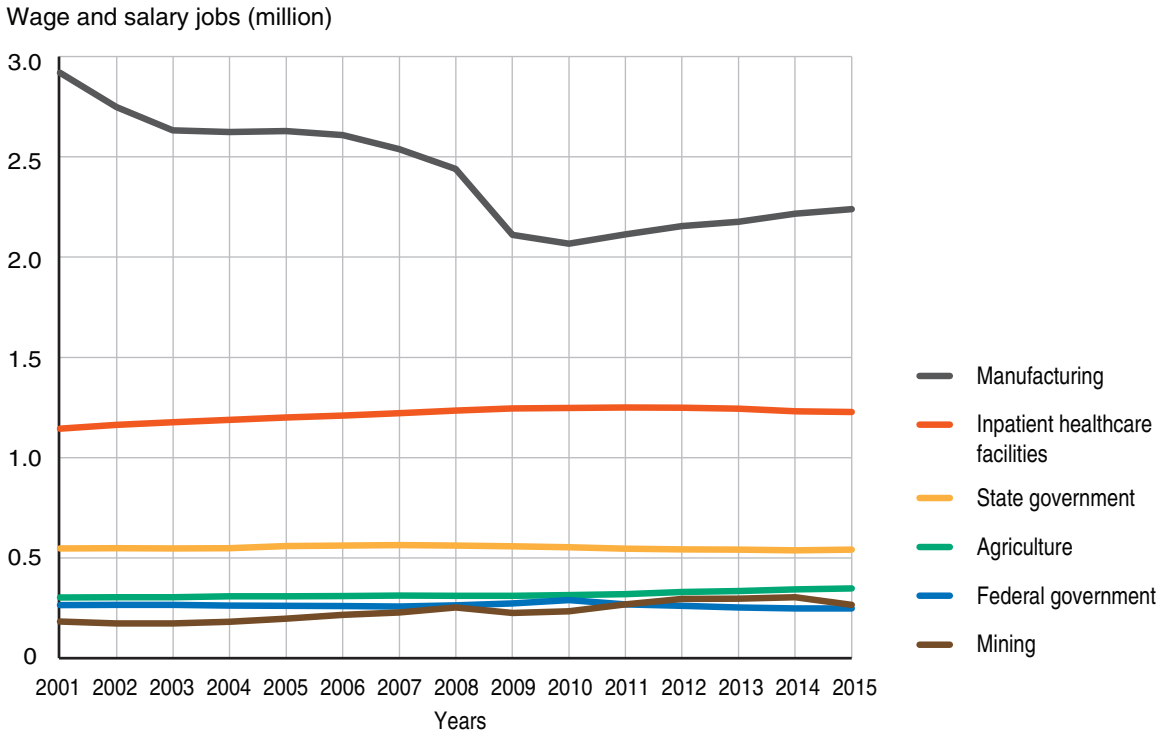
As noted earlier, inpatient healthcare job growth in rural areas lagged growth in urban areas but still exceeded growth rates in several tradable sectors[5] that are often characterized as essential to rural economies—agriculture, manufacturing, mining, and Federal/State governments. In particular, while rural manufacturing shed almost a half-million jobs between 2007 and 2010, rural inpatient healthcare jobs rose by 26,000 (figure 5). In 2001, inpatient healthcare facilities accounted for 7.6 percent of wage and salary employment in rural counties; this share rose to 8.5 percent in 2011 and

[5]In tradable sectors, employment is largely exogenous, or not dependent on local demand. See Appendix B for further explanation.

then declined to 8.1 percent in 2015. By contrast, manufacturing's share of rural employment was 19.4 percent in 2001, dropping to 14.7 percent by 2015.[6]

From 2001 to 2015, mining and agriculture provided slightly more jobs per 100 residents in rural noncore counties (0.7 and 1) than in micropolitan counties (0.5 and 0.6), while manufacturing provided more jobs per resident in micropolitan counties (6.2 versus 5.1 in rural noncore counties). The inpatient healthcare facility and government sectors provided similar numbers of jobs per 100 county residents in micropolitan and rural noncore counties (table 1).

Figure 5
Rural employment in inpatient healthcare facilities and selected tradable sectors (2001-15)



Note: This chart uses data for 1,817 of 2,024 rural counties in the lower 48 States. Counties with missing data on jobs in these sectors or counties with data suppression are excluded. The Quarterly Census of Employment and Wages data reflect only wage and salary jobs and exclude self-employed jobs. Inpatient healthcare jobs refer to jobs in general medical and surgical, psychiatric and substance abuse, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The agriculture sector includes farming, forestry, fishing, and hunting. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.
Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001-15.

[6]Figure 5 and table 1 include only the tradable sectors—manufacturing, mining, agriculture, and Federal/State Government—that are the focus of the multiplier analysis in this report. Service sectors (other than health care) are excluded from the figure.

Table 1

Jobs per 100 county residents by sector in all rural, micropolitan, and rural noncore counties, 2001-15 average

Sector	All rural counties	Micropolitan counties	Rural noncore counties
Manufacturing	5.7 (4.5)	6.2 (4.3)	5.1 (4.5)
Inpatient healthcare facility	2.9 (1.5)	3.1 (1.5)	2.6 (1.5)
State government	1.3 (1.9)	1.5 (2.2)	1.0 (1.2)
Federal Government	0.6 (1.1)	0.6 (1.0)	0.6 (1.3)
Agriculture	0.7 (1.3)	0.6 (1.1)	1.0 (1.5)
Mining	0.5 (1.7)	0.5 (1.6)	0.7 (1.7)
Service	23.8 (8.0)	25.9 (7.5)	20.9 (7.7)
Total jobs*	**35.7 (10.1)**	**38.3 (9.5)**	**31.9 (9.7)**

Note: This table uses 1,817 of 2,024 total rural counties in the lower 48 States. Standard deviations are shown in parentheses. Total Jobs* indicates the total the total number of wage and salary jobs per 100 residents is lower than the more commonly reported rural employment-to-population ratio (which varied between 54 and 59 percent over this period) for three reasons: (1) self-employment is excluded; (2) the QCEW does not fully cover all industries; and (3) we divide by total county population rather than just the county's adult population. The Quarterly Census of Employment and Wages (QCEW) data reflect only wage and salary jobs and exclude self-employed jobs. Inpatient healthcare facility jobs refer to jobs in general medical and surgical, psychiatric and substance abuse, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The U.S. Office of Management and Budget (2003) defines nonmetropolitan (rural) counties as containing an urban area of less than 50,000 residents and having less than 25 percent of its labor force commuting to metropolitan areas. Micropolitan counties contain a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000. Counties with missing data on jobs in these sectors or data suppression are excluded.

Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

Types of Inpatient Healthcare Facilities

General medical and surgical hospitals provide diagnostic and medical treatment to inpatients and outpatients with a wide variety of medical conditions.

Psychiatric and substance abuse hospitals specialize in diagnostic, medical treatment, and monitoring services for inpatients and outpatients who suffer from mental illness or substance abuse disorders.

Specialty hospitals provide diagnostic and medical treatment to inpatients with a specific type of disease or medical condition. These inpatient facilities provide long-term care for the chronically ill and rehabilitation/restoration services to the physically challenged or disabled.

Nursing care facilities provide residential care combined with either nursing, supervisory, or other types of care to the residents.

Residential mental health facilities provide residential care, counseling services, mental rehabilitation, and support services for patients with mental health and substance abuse illnesses.

Community care facilities for the elderly include establishments that are primarily engaged in providing residential and personal care services for the elderly and persons unable to fully care

for themselves or who do not desire to live independently. This care includes room and board, supervision, and assistance in daily living and housekeeping.

Other residential care facilities include establishments primarily engaged in providing residential care with supervision and personal care services, including: boot camp or disciplinary camp (except for correctional) for delinquent youth, group homes for hearing- or visually impaired children, and group foster homes.

Source: U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (2001-15) industry codes: North American Industry Classification System (NAICS) 622, 623.

Data Sources

This analysis uses employment data from the U.S. Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) for 2001 to 2015, and population and other demographic data from the 2000 Decennial Census (Census 2000) and Intercensal Population Estimates (2001-2015).

Quarterly Census of Employment and Wages. The QCEW provides estimates of county employment by industry, with considerable industry detail by six-digit North American Industry Classification System (NAICS) codes.[7] The inpatient healthcare facility variable in this report refers to an aggregation of subsectors under the NAICS code for healthcare and social assistance (NAICS codes 622 and 623). These include general medical/surgical hospitals, psychiatric and substance abuse hospitals, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities.

When disaggregated to the detailed county-industry level, the public-use QCEW employment data contain many missing values, reflecting the suppression of results for county-industry cells that are either too small or too driven by the results for a small number of employers, threatening employers' anonymity. The QCEW data used in this report are drawn from a restricted-access version of the QCEW data provided by BLS to ERS under an interagency agreement that includes suppressed values for most States. Some States still contain suppressed data: after excluding counties with data suppression during any of our study years, our dataset includes 1,817 of the 2,024 rural counties.[8] In the econometric analysis used to estimate employment

[7]QCEW counts wage and salary workers who are covered by State unemployment insurance or Federal workers covered by Unemployment Compensation for Federal Employees. Some employed persons are excluded from the QCEW data, such as members of the Armed Forces, the self-employed, proprietors, domestic workers, unpaid family workers, hired farmworkers on smaller farms in some States, and railroad workers covered by the railroad unemployment insurance system.

[8]Eight States did not permit the BLS to release their unsuppressed county data to ERS in some or all study years. As such, about 1 percent of total county employment at the 4-digit NAICS level of detail remains suppressed. The affected States—and the average shares of total employment across all 4-digit NAICS industries that remain suppressed in those States in particular years—are as follows: Connecticut, 14 percent, 2003-05; Florida, 13 percent, 2009-15; Massachusetts, 9 percent, 2001-15; Michigan, 19 percent, 2001-05; Mississippi, 41 percent, 2009-15; New Hampshire, 21 percent, 2003-15; New York, 15 percent, 2001-05; and Wyoming, 35 percent, 2001-15. However, suppression rates vary by industry, and the precise share of rural inpatient healthcare facility employment that is suppressed in these States cannot readily be estimated.

multiplier impacts, we also excluded counties that did not have an inpatient healthcare facility during any year of the study period (2001-15), resulting in a balanced panel of 1,752 counties.

2003 Urban Influence Codes. This report uses the U.S. Office of Management and Budget (OMB) definitions from May 2003. A metropolitan (urban) county contains a core urban area population of 50,000 or more. A nonmetropolitan (rural) county has an urban area of less than 50,000 residents and less than 25 percent of its labor force commuting to metropolitan areas. A micropolitan area contains a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000. We use the 2003 USDA Economic Research Service Urban Influence Code files, which use these definitions, to label our counties as rural, micropolitan, and rural noncore.

Decennial Census and Intercensal Population Estimates. This report draws on the Decennial Census (2000) and the Intercensal Population Estimate files (2001-2015) for data on population counts, births, and deaths for rural counties. The base year—2000 population by county—is used, and births are added and deaths subtracted to arrive at a "natural population" estimate for each rural county in each subsequent year. The natural population estimate is used to normalize the jobs estimates to reflect differences in populations across the counties.[9] We also use data from the 2000 Population Census and Intercensal Population Estimates to estimate shares of the population in each county by age, race, and gender, which were used in a robustness check reported in Appendix D.

[9]For technical reasons, normalized variables—jobs per capita—are better measures than total jobs for estimating multiplier impacts. Natural population is used rather than actual population (which is affected by net migration as well as natural population change) to address concerns about endogeneity of net migration, which could bias the results (see Appendix B for an explanation). However, estimation results are robust to using total jobs rather than jobs per capita, to using actual or natural population, and to deleting population as an explanatory variable (see Appendix D for results of robustness checks).

Links Between Rural Healthcare and Local Employment

Rural healthcare provision may affect total rural employment via multiple pathways, both direct and indirect. For example, healthcare employment may affect employment in the broader rural economy by increasing demand for the goods and services of other industries (standard input-output links), but there may also be offsetting displacement or competition effects on other local employers. Healthcare employment may also affect local employment by improving the health and increasing the productivity of workers (health impacts on human capital), attracting people and firms to the community (amenity impacts), or by bringing income to the community via medical payments by government programs and private insurance companies (revenue impacts). Although we do not attempt to estimate all of the impacts occurring via these different pathways, the existence of multiple pathways may result in estimates that differ from those found in the existing literature.

Local Input-Output Links

Input-output (IO) links occur due to the direct, indirect, and induced demand caused by inpatient healthcare facilities for other local goods and services.[10] Direct impacts of inpatient healthcare jobs on total wage/salary jobs in a county are represented by the level of employment within the healthcare facility itself. Indirect impacts result from the facility's purchases of goods and services from local suppliers, which generate jobs in those industries. An inpatient healthcare facility, for example, can increase the number of medically oriented (and nonmedically oriented) firms in the local economy.

According to Cordes (1999), hospitals have large effects on two industry sectors: retail/wholesale and services. Healthcare facilities are robust consumers of retail and wholesale goods, as well as business and personal services (Brooks and Whitacre, 2011). The American Hospital Association (AHA, 2008) found that hospitals alone had a $138-billion impact on retail and wholesale trade in 2006. Inpatient facilities can also have a positive impact on financial institutions through greater deposits at local community banks.

Induced impacts on local employment and local government revenue occur when healthcare facility employees (and their households) spend money nearby. For example, a physician relocating to work in a healthcare facility is likely to demand housing and other local goods and services, including education for his or her children. Furthermore, if household incomes in the region grow due to a surge in healthcare facility employment, this may increase tax revenues of the local government, which can induce additional impacts on the local economy as those revenues are spent.

Many studies[11] have used IO models to estimate the multiplier impacts of different types of healthcare facilities in rural areas, in most cases estimating both employment and income multipliers (McDermott et al., 1991; Doeksen et al., 1998a/b; Cordes et al., 1999; Stensland et al., 2002, Doeksen and Schott, 2003; Lusby et al., 2005; St. Clair et al., 2015; Willis and Bishop, 2015).

[10]Direct demand links in a region due to growth in an industry refer to the changes in sales, income, or employment in that industry and region. Indirect demand links refer to the changes in sales, income, or employment within other industries in that region that supply goods and services to the industry considered. Induced demand links refer to changes in sales, income, or employment that result from increased household and government income within the region due to the direct and indirect links.

[11]See Appendix A for a summary of related research.

The employment multipliers (total number of jobs stimulated per healthcare job) estimated in these studies range from 1.1 to 1.7. All of these studies focused on impacts in the local or regional economy, whereas the American Hospital Association (2011) estimated an employment multiplier in the national (both urban and rural counties) economy of 2.8.[12] This study differs from IO studies by analyzing observed data using statistical techniques rather than predicting employment effects using economic models.

Displacement and Competition Effects

With an increase in healthcare facility jobs, there is the potential for offsetting impacts on local employment due to displacement and competition effects. As a result of their assumptions, IO models always predict multipliers of economic activity that are greater than 1, discounting displacement effects that may occur when employment expands in one industry due to constraints on the supply of production inputs—including labor—in other industries or to the rising costs of these inputs (Brown et al., 2012). For example, when an inpatient healthcare facility hires new workers, it may attract them from other healthcare facilities or from other local industries. If the supply of such displaced workers is not constrained, if their skills and abilities are readily replaceable, and if the wages necessary to attract replacements are not higher than the wages paid to the displaced workers, there may be no displacement impacts on other local employers. But if these conditions are not met, attracting new employees to an inpatient healthcare facility may result in reduced local employment by other employers. In this case, the multiplier impact of increased inpatient healthcare facility employment could be less than 1; that is, the total increase in local employment could be less than the increase in inpatient healthcare employment.

The local employment multiplier may also be less than 1 if the expansion in inpatient healthcare facility activity competes with services provided by other types of healthcare providers. For example, an inpatient facility may begin to provide clinical services that previously were provided by local clinics or individual doctors' offices, potentially depriving them of that revenue stream and reducing the number of people that they employ.

Healthcare Effects on Human Capital

Healthcare services in a rural community may improve the overall health, quality of life, and longevity of the local residents. Bloom and colleagues (2004) argue that healthier workers are more productive, with fewer absences from work due to illness.

As individuals become healthier, they tend to live longer. One study found that improving a population's life expectancy by 1 year results in a 4-percent increase in labor output (Bloom et al., 2004). Increases in a population's life expectancy may have spillover effects in the local economy (Murphy and Topel, 2005). For instance, individuals with longer life expectancies invest more in their education, which improves their wages and facilitates more investments in health (Oster et al., 2013a).

A healthy person with a longer life expectancy may also be more willing to make other investments—such as in housing or retirement savings—that yield longer term returns (Oster et al., 2013b). The spillovers in the local economy from improved wages could include increases in

[12]Since national multipliers from IO models are always larger than local multipliers (because the spillover effects recirculate more in a larger economy), the AHA results are not comparable to estimates of local economic multipliers.

consumption, investment and savings, spurring demand for local goods and services (Grossman, 1972 and 2000).

Local Amenity Effects

An amenity is a characteristic of a location that increases the value of living or working there. In her seminal work on intercity quality-of life-differentials, Roback (1982) defined amenities to include both consumptive and productive amenities, where consumptive amenities are those characteristics of a location that appeal to consumers (e.g., clean air, comfortable climate, beautiful scenery) and productive amenities are those that appeal to producers by reducing costs of production (e.g., access to productive resources, infrastructure).

Healthcare services can act as a ***consumptive*** amenity by improving an individual's health and quality of life (McDermott et al., 1991; Deller et al., 2001) and by attracting to an area individuals who have a heightened demand for health services, such as young families and retirees. Healthcare services may also be a ***productive*** amenity for rural firms intent on providing nearby and adequate access to healthcare for their employees in order to boost productivity. The ability of firms to attract workers, especially skilled ones, and the costs of doing so may depend on the availability of health services (among other services) in a location.

According to Doeksen and colleagues (1997), the quality of the local inpatient healthcare facility is also under scrutiny in the firm's location decision. Facility costs and quality may affect the healthcare costs of the firm, so a firm wants healthcare facilities that have reasonable rates and are of high quality. According to Love and Crompton (1999), the "quality of employees' lives has a direct impact on an employer's bottom line through absenteeism, loyalty, turnover, productivity and healthcare costs."

Attracting people and businesses to a rural community causes both the local population and level of economic activity to grow. An increase in the population and number of businesses causes an increase in the demand for local goods and services, which may increase local employment and wages. The amenity value of healthcare services can also increase local property values (Miller, 2012).

Outside Revenue Effects

Healthcare employment also generates flows of external dollars into the community through third-party payers for local medical services. For example, Medicaid, Medicare, and subsidized private health insurance can bring additional revenues to rural areas from Federal and State governments, as well as from insurance companies (Holmes, 2006). In addition, nonlocal patients and their visitors may spend money on local goods and services, such as hotels, gifts, and food (McDermott et al., 1991). On the other hand, money may flow out of rural communities due to healthcare "outshopping" (Adams and Wright, 1991) wherein locals travel elsewhere to seek medical treatment and spend their money in another community.

Multiplier Effects From Rural Healthcare Employment

Conceptual Approach

We use a modified export-base framework to estimate the multiplier effects of inpatient healthcare facility employment and employment in tradable sectors.[13] We implement this approach by treating manufacturing, agriculture, mining, and State/Federal government as tradable sectors. Export-base theory rests on the premise that growth in tradable sectors drives growth in nontradable sectors of the local economy[14] (North, 1955; Richardson, 1972; Hewings, 1977). When a new job in a tradable sector is created, the local economy experiences an increase in demand for local goods and services due to indirect and induced labor demand and income effects, thus generating additional jobs in nontradable sectors. The assumption of a small open economy[15] implies that the growth in local demand has little impact on production in tradable sectors. Thus, the multiplier effect in export-base theory results from the responses of nontradable sectors to increases in employment or income in tradable sectors.

The export-base notion that exports are the only or main drivers of regional growth has been subject to considerable debate in the literature (Kilkenny and Partridge. 2009; Romanoff, 1974; Smith, 1984; Parr, 1999; Olfert and Stabler, 1999). Tiebout (1956), arguing for the importance of local conditions and nonbasic activity, maintained that "there is no reason to assume that exports are the sole or even the most important autonomous variable determining regional income." Clearly, employment growth in a region can result from developments in both nontradable and tradable sectors, such as productivity improvements, an increase in factor supplies, or local demand growth not tied to the tradable sector. Indeed, there is no *external* trade for the world economy as a whole, so growth in the global economy cannot depend on export demand. However, export demand is likely to be a more important source of employment growth the smaller the size of the region considered and the lower the transaction costs of trading with other regions (Tiebout, 1956).

In actuality, not all industries can be readily divided into tradable and nontradable sectors, and even the best taxonomy will not apply across all scales and locations. Although rural inpatient healthcare facilities depend mainly on demand from patients in their vicinity, they do bring revenue to rural communities from outside sources (such as revenue from patients admitted from outside the region, health insurance payments, and Government programs such as Medicare and Medicaid). In this sense, they act as sources of "export-base" revenue for the community. Still, the demand for rural inpatient healthcare services—and hence the level of employment—arises mainly from within the counties served. As such, rural healthcare facilities act in some ways as providers of "nontradable" services (Turner and Mallory, 1991; Doeksen et al., 1998).

So, local demand largely determines inpatient healthcare facility employment. However, a new or expanding healthcare facility can generate multiplier impacts on other parts of the local economy regardless of whether inpatient healthcare facilities provide tradable services. An econometric problem arises in attempting to identify the multiplier impacts of inpatient healthcare facility

[13]Appendix B demonstrates how the empirical model is derived from export-base theory.

[14]In this report, the term "local economy" refers to the county economy.

[15]A small open economy is one that is small enough, compared to trading partners, that its economic policies and activities do not alter local prices or interest rates.

employment. Unlike employment in tradable sectors such as manufacturing, mining, or most agricultural production (e.g., for national and export commodity markets), which can be reasonably assumed to be unaffected by local demand conditions in small open county economies, healthcare facility employment may be affected by local demand conditions. This leads to potential "endogeneity bias," which we address using instrumental variables (IV) approaches in Appendix C. We conclude that we are unable to reject the results of simpler ordinary least squares (OLS) estimation, which is our preferred model.[16]

Multiplier Estimates for All Rural Counties

Table 2 shows the estimated multiplier impact of employment in inpatient healthcare facilities and other sectors on total employment in rural counties, using an OLS model with county and year fixed effects, as explained in Appendix B. Rural counties contain an urban area population of less than 50,000 and less than 25 percent of its labor force commuting to metropolitan areas. The coefficient of rural inpatient healthcare facility employment—0.99—indicates that, on average, each additional inpatient healthcare facility job increases total employment by approximately 1 job, implying that it has no net spillover effect on total county employment. This estimate has a standard error of 0.09, implying a 95-percent confidence interval of 0.82 to 1.16.

An employment multiplier of 0.99 is smaller than most estimates of rural healthcare multipliers in the input-output (IO) model literature, which generally range between 1.1 and 1.7 (see Appendix A). The smaller estimated impact using an econometric approach may be due to the displacement/competition effects of healthcare facility employment, which may offset the positive input-output (and other hypothesized) linkages, as from increased spending by newly hired healthcare workers. Such offsets are not captured in IO modeling.

The estimated inpatient healthcare facility employment multiplier is similar to the estimated multipliers for employment in manufacturing (1.05), agriculture (1.17), and State government (1.06) but smaller than the multipliers for mining (2.17) and Federal Government (1.87).[17] This may be due to higher wages in mining and Federal jobs, which could result in bigger employment multipliers, since each such job generates more earnings that can be spent in the local economy.[18] These larger multipliers could also occur if mining and Federal workers have a higher propensity to spend their earnings in the county where they work, or if those industries buy more local inputs than do inpatient healthcare facilities.

[16]We also present the results of several alternative specifications of the ordinary least squares (OLS) fixed-effects models in Appendixes D and E (including models accounting for spatial dependence). The results of all models are qualitatively similar to those presented here, indicating that our results are statistically robust.

[17]The estimated multiplier for Federal jobs has a large standard error and is not statistically distinguishable from a value of 1.0 with 95-percent confidence. Federal jobs include employees of USDA/Forest Service and U.S. Department of the Interior/Bureau of Land Management offices, National Park Service parks, Federal prisons, Federal educational institutions, and military bases.

[18]The average annual rural county wages/salaries per employee, by industry sector, over 2001-15 were: mining ($63,916), Federal ($52,652), manufacturing ($39,467), State ($38,545), inpatient healthcare facility ($31,769), and agriculture ($27,093).

Table 2
Estimated impact of an additional inpatient healthcare facility job on total rural county employment, 2001-15

Variable	Estimated employment multipliers
Inpatient healthcare facility jobs per capita	0.99*** (0.09)
Manufacturing jobs per capita	1.05*** (0.03)
Agriculture jobs per capita	1.17*** (0.07)
Mining jobs per capita	2.17*** (0.21)
Federal Government jobs per capita	1.87** (0.91)
State government jobs per capita	1.06*** (0.07)
County fixed effects	Yes
Year fixed effects	Yes
Natural population	Yes
Number of counties	1,752
Number of observations	26,280
R^2	0.60

Note: This table shows Ordinary least squares (OLS) regression results with county and year fixed effects and an additional control variable, natural population. The dependent variable is total county wage/salary employment per capita. Clustered standard errors are in parentheses. ***, **, * = statistical significance at $p < 0.01$, $p < 0.05$, $p < 0.10$, respectively. Inpatient healthcare facility jobs refer to jobs in general medical and surgical, psychiatric and substance abuse, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for elderly, and other residential care facilities. The U.S. Office of Management and Budget (2003) defines nonmetropolitan (rural) counties as containing an urban area of less than 50,000 residents and having less than 25 percent of its labor force commuting to metropolitan areas.
Source: USDA, Economic Research Service calculations using the Quarterly Census of Employment and Wages data, 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

Multiplier Estimates for Micropolitan and Rural Noncore Counties

The estimated inpatient healthcare facility employment multiplier is larger, on average, for micropolitan counties (1.24 total jobs per healthcare job) than for rural noncore counties (0.89 total jobs; table 3).[19] This difference is to be expected. Employment spillovers to other sectors are more likely to be contained within a more populous and economically integrated micropolitan county since more of the intermediate goods and services can be sourced from within that county. The estimated multipliers for healthcare facility employment (1.24/0.89) are similar to the estimated multipliers

[19]This difference between the micropolitan and rural noncore inpatient healthcare facility employment multipliers is weakly statistically significant, with $p = 0.095$. The 95-percent confidence intervals for both estimates include 1.

for employment in manufacturing (1.08/1.04) and State government (0.97/1.08), and slightly smaller than the multiplier for jobs in agriculture (1.16/1.17).[20]

Almost all of the coefficients in table 3 (except for Federal jobs in rural noncore counties) are statistically significantly different from zero at the 1-percent level of significance, instilling confidence that the true values of these multipliers are not equal to zero. However, neither of the healthcare multipliers is statistically distinguishable from a value of 1.0 with 95-percent confidence. As such, we cannot state with confidence that inpatient healthcare facility employment generates any additional net employment in the local economy beyond the people directly employed in the healthcare facility.

Table 3
Estimated impact of an additional inpatient healthcare facility job on total county employment, micropolitan versus rural noncore counties, 2001-15

Variable	Micropolitan counties	Rural noncore counties
Inpatient healthcare facility jobs per capita	1.24***	0.89***
	(0.16)	(0.08)
Manufacturing jobs per capita	1.08***	1.04***
	(0.04)	(0.03)
Agriculture jobs per capita	1.16***	1.17***
	(0.06)	(0.09)
Mining jobs per capita	2.22***	2.14***
	(0.09)	(0.35)
Federal Government jobs per capita	2.00***	1.86*
	(0.40)	(1.09)
State government jobs per capita	0.97***	1.08***
	(0.16)	(0.09)
County fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Natural population	Yes	Yes
Number of counties	569	1,183
Number of observations	8,535	17,745
R^2	0.76	0.52

Note: This table shows micropolitan and rural noncore county Ordinary Least Squares (OLS) regression results that included county and year fixed effects and an additional control variable, natural population. The dependent variable is total county wage/salary employment per capita. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. Inpatient healthcare facility jobs refer to jobs in general medical and surgical, psychiatric and substance abuse, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for elderly, and other residential care facilities. Micropolitan counties contain a core urban area population of 10,000-49,999. Rural noncore counties contain a core urban area population of less than 10,000.
Source: USDA, Economic Research Service calculations using the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001- 15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

[20]The differences between the multiplier estimates for inpatient healthcare facility employment and for either manufacturing or State government employment are not statistically significant at a 10-percent significance level in any of the regressions reported in tables 2 and 3. The difference between the inpatient healthcare facility employment multiplier and the agricultural employment multiplier is statistically significant at the 2-percent level in the regression for rural noncore counties, but is not statistically significant at even the 10-percent level in the other two regressions.

Results Under Alternative Specifications

In Appendix C, we consider a number of instrumental variables (IV) approaches to account for the possibility that inpatient healthcare facility employment might be endogenously determined. In particular, the causal connection between healthcare facility employment and total employment may run in both directions, in which case our regression estimates could be biased. None of the IV approaches that we pursued yielded results that were statistically preferred to the OLS results that we report.

In Appendix D, we perform a series of robustness checks, including testing for lagged effects of inpatient healthcare facility employment, adding additional State- and region-by-year indicator variables, altering the treatment of our population control, adding additional demographic controls, and estimating the equation in first differences with fixed effects to account for county-specific trends as well as county-specific average levels of employment. The results are similar to our rural multiplier estimate of 0.99 for inpatient healthcare facilities, ranging between 0.91 and 1.03.

Finally, in Appendix E, we consider the possibility that inpatient healthcare facility employment in one county might have multiplier effects on total employment in a neighboring county, or vice versa. While significant spatial spillovers were detected in metropolitan counties, they were not evident in rural areas.

Conclusions

This report documents employment trends in rural inpatient healthcare facilities from 2001 to 2015, and estimates the impact of these employment changes on total county employment. The majority of rural healthcare facility jobs—in both micropolitan (rural counties containing a core urban area population 10,000-49,999) and rural noncore (rural counties containing a core urban area population of less than 10,000) counties—are in general medical/surgical hospitals and nursing care facilities. Hospital employment accounted for 52.5 percent of average total healthcare facility jobs during 2001-15 in micropolitan counties and 46.4 percent in noncore counties. Nursing care facilities—the second-largest employer among healthcare facility types in rural areas—accounted for a larger share of healthcare employment in noncore counties (34.5 percent) than in micropolitan counties (25.0 percent).

From 2001 to 2015, employment in rural inpatient healthcare facilities and in the agriculture and mining sectors was stable or grew modestly despite the effects of the Great Recession. Inpatient healthcare, agriculture, and mining jobs in the 1,817 rural counties included in this study exhibited small gains during the Great Recession (2008-09) as well as during the whole study period (2001-15).

Using regression analysis, we find that rural inpatient healthcare facility jobs have a positive impact on total county jobs, although we cannot state unequivocally that rural healthcare facility employment generates ***additional*** net employment in the local economy beyond those directly employed in the facility. On average, our estimated rural employment multiplier of 0.99 job per healthcare facility job is smaller than the range of local multiplier estimates found in the literature using input-output models (1.1 to 1.7 jobs), although the 95-percent confidence bounds on our estimate (0.82 to 1.16) overlap with this range of estimates. Our estimate is not statistically distinguishable from a value of 1.0, implying that the net impact of inpatient healthcare facility employment on total employment in rural counties is almost entirely due to the direct employment effect. If there are positive indirect or induced employment effects, these are offset by displacement or competition effects (jobs potentially lost in other industries as workers opt for healthcare facility employment).

Consistent with economic theory and with other studies of local employment multipliers (Moretti. 2010; Siegfried et al., 2007), we estimate a larger inpatient healthcare facility employment multiplier for more populated and more economically integrated micropolitan counties than for rural noncore counties. In micropolitan counties, on average, the estimated multiplier is 1.24 total jobs per inpatient healthcare facility job, versus 0.89 job in rural noncore counties—although these estimates are not statistically distinguishable from a value of 1.0 at the 95-percent confidence interval, implying that the net impact of inpatient healthcare facility employment on total employment in micropolitan and rural noncore counties is almost entirely due to the direct employment effect. In micropolitan counties, local demand (for additional goods/services) generated by growth in inpatient healthcare facility employment appears to be met by increased activity in the local nontradable[21] sector. In noncore counties, the local nontradable sector is likely smaller and less developed, and hence less responsive to small changes in demand for nontradable goods and services.

Our estimated employment multipliers for inpatient healthcare facilities are similar to multipliers for manufacturing and State government jobs, but smaller than multipliers for mining and Federal

[21]"Tradable sectors" are sectors in which employment is independent of local demand.

Government jobs. The estimated employment multipliers for agricultural jobs are slightly higher than for healthcare facility jobs, although the difference is statistically significant only in rural noncore counties. Agriculture may have more interindustry links to other sectors in rural economies than does the inpatient healthcare sector.

Overall, these results suggest that growth in inpatient healthcare facility employment contributes to total employment growth in rural economies. However, job growth in healthcare facilities, unlike in some other sectors, does not appear to have strong multiplier effects on total county employment. Previous research, based on IO rather than econometric models, appears to have overstated these employment multipliers. Nonetheless, inpatient healthcare facilities are important assets for rural communities, not only for the employment they provide but also for the essential services they deliver.

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Appendix A: Findings From Prior Healthcare Multiplier Research

In our review of previous research that estimated inpatient healthcare facility employment or income multipliers,[22] we found many studies have examined the economic impacts of inpatient healthcare facilities on local communities. Almost all were studies of small areas focused on one type of inpatient healthcare facility—general medical/surgical hospitals. Most concentrated on one or a few counties within the same State, while some looked at several counties in a handful of States. Almost all used input-output (IO) models. Appendix table 1 provides a detailed summary of the studies reviewed.

IO models are popular in estimating the multiplier impacts of many types of inpatient healthcare facilities in rural areas (McDermott et al., 1991; Doeksen et al., 1998; Cordes et al., 1999; Stensland et al., 2002; Doeksen and Schott, 2003; Lusby et al., 2005; Doeksen et al., 2008; St. Clair et al., 2015; Willis and Bishop, 2015). The employment multipliers (total number of jobs stimulated per healthcare job) found in these studies ranged from 1.1 to 1.7. All of these studies focused on impacts on the local or regional economy and examined a small number of counties. One impact study by the American Hospital Association (AHA, 2011) estimated multipliers in the national economy from hospital employment and income, finding a larger employment multiplier of 2.8. The AHA results are not comparable to estimates of local employment multipliers, however, because the spillovers recirculate to a greater extent in a larger economy.

Ona and Davis (2011) used quasi-experimental methods combined with IO modeling to investigate the economic impacts of Critical Access Hospitals (CAHs) on Kentucky's rural counties. Their quasi-experimental analysis found that CAHs had a statistically significant positive impact on the annual payroll growth rate in the health and social assistance sector, but statistically insignificant impacts on other indicators of growth in employment and earnings.[23] Using IO modeling, the estimated employment multiplier ranged from 1.23 to 1.64, and the income multiplier ranged from 1.12 to 1.48.

Relatively few studies examine the links between the provision of healthcare and local community development using an econometric approach. The most notable such study found mixed evidence on the economic impacts of hospital closures on local economies (Holmes et al., 2006). That study's small sample size and the potential endogeneity of hospital closures may have biased the results.[24] In addition, the study did not estimate multiplier impacts of inpatient healthcare facility employment. To the best of our knowledge, this report is the first study to econometrically estimate multiplier impacts of inpatient healthcare facilities.

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[22]An employment multiplier measures how many jobs in a region result from an increase in the number of jobs in a particular activity or industry, while an income or sales multiplier measures how much additional income or sales is due to an increase in income or sales in a particular activity or industry. Both types of multipliers measure impacts across industries from a change in a particular activity or industry.

[23]Ona and Davis (2011) did not estimate employment or income multipliers using quasi-experimental methods; those methods were used to estimate differences in the growth rates of jobs, annual payroll, and earnings between counties with CAHs and similar counties without CAHs.

[24]For example, changing economic conditions in the community may drive inpatient healthcare facility closures; as a result, the estimated impact of an inpatient healthcare facility closure may be picking up the effects of changing community conditions in addition to the effect of hospital closures.

Appendix table 1

Literature review of inpatient healthcare facility employment and income multipliers

Authors	Year	Methodology	Study Description	Results
McDermott et al.	1991	IO	Utah 4 rural hospitals Economic impact of hospitals	Employment multiplier (used) = 1.4 Income multiplier range = [1.62, 2.12]
Doeksen et al.	1998	IO	Perry, OK, hospital (1 hospital, 65 employees) 9 Oklahoma counties Economic impact of hospitals	Perry: Noncore employment multiplier = 1.46 Perry: Noncore Income multiplier = 1.43 9 counties: Employment multiplier range = [1.30, 1.81] 9 counties: Income multiplier range = [1.45, 1.87]
Cordes et al.	1999	IO	Nebraska hospitals 11 rural hospital; type 2, avg 52 beds, 3 hosp; type 3, avg 83 beds, 2 hosp; type 4, avg beds 231, 2 hosp] Economic impact of hospitals	Rural employment multiplier range [1.12, 1.49] Income multiplier range [1.11, 1.35]
Stensland et al.	2002	IO	Appalachia 10 rural hospitals (1 micropolitan and 9 rural noncore counties) Economic impact of hospitals	Micro employment multiplier = 1.49 Noncore employment multiplier range = [1.29, 1.63]
Doeksen and Schott	2003	IO	Atoka, OK, hospital Economic impact of hospitals	Noncore employment multiplier = 1.70 Noncore income multiplier = 1.47
Lusby, Leatherman, and Bishop	2005	I-O	Republic County, KS Economic impact of healthcare services	Noncore nursing/residential employment multiplier = 1.32 Noncore hospital employment multiplier = 1.58
Holmes et al.	2006	Regression	Hospital closures (1990-2000) Economic impact of hospital closures	Closure decreases per capita income by 4 percent, increases unemployment 1.6 percentage points
Doeksen, St. Clair, and Hartman	2008	IO	Grimes County, TX Economic impact of healthcare services	Noncore employment multiplier = 1.2
Ona and Davis	2011	Quasi-Experimental	Rural Kentucky, Critical Access Hospitals (CAH) Economic impact of CAHs	Employment multiplier range = [1.23, 1.64] Income multiplier range = [1.12, 1.48]
American Hospital Association	2011	IO	National economic impact of hospitals	National employment multiplier = 2.8 National income multiplier = 2.4
Doeksen et al.	2012	IO	73 CAHs in 21 States, Economic impact of CAHs	Employment multiplier = 1.38 Income multiplier = 1.24
St. Clair, Doeksen, and Eilrich	2014	IO	Economic Impact of Rural Nursing Homes	Employment multiplier = 1.6
Willis and Bishop	2015	IO	50 studies of Kansas counties Economic impact of hospitals	Micro county employment multiplier range = [1.10, 1.71] Noncore county employment multiplier range= [1.09, 1.56]

Notes: IO = Input-Output methodology.

Appendix B: Estimation Model

Derivation of Estimation Equation Using Export-Base Theory

We consider a small, open economy with a tradable (export) sector and a nontradable (service) sector. Assume, initially, that labor and all other inputs are elastically supplied, so changes in local demand for labor and other inputs do not change costs. Given these assumptions, outputs and input use in the ***tradable*** sector are determined by exogenous prices, meaning the market outside the local economy.[25] Hence, employment in the tradable sector is exogenous, since labor demand in this sector is determined by exogenous prices (the productivity of firms, as affected by their technology, is also assumed to be exogenous), and labor is supplied elastically at a fixed wage. Wages and input prices in the ***nontradable*** sector are also exogenously determined by assumption, but the size of this sector and the employment in it are determined by local demand for nontradable goods and services. Initially, we treat inpatient healthcare facilities as part of the tradable sector, and then address the potential nontradability and endogeneity of inpatient healthcare facility employment using an instrumental variables approach.

Let total employment per capita in the local economy *i* in year *t* be TE_{it}, employment per capita in the tradable sector be E^T_{it}, and employment per capita in the nontradable sector be E^N_{it}. We modify the traditional model to include employment per capita in the inpatient healthcare facility sector, which may act as a tradable or non-tradable sector, denoted by E^H_{it}. Employment per capita in the nontradable sector is determined by the supply and demand for labor in this sector, which depends on fixed locational factors such as proximity and access to population centers, infrastructure, natural resources, and amenities (all reflected in county-level fixed effects (a^N_i); macroeconomic factors (reflected in annual fixed effects a^N_t); employment per capita in the tradable sector (E^T_{it}) and the inpatient healthcare facility sector (E^H_{it}); local population (P_{it})[26]; and idiosyncratic factors (u^N_{it}). Assuming that E^N_{it} depends (approximately) linearly on these factors, we have:

$$(1) \qquad E^N_{it} = a^N_i + a^N_t + b^N E^T_{it} + c^N E^H_{it} + d^N P_{it} + u^N_{it}$$

Total local employment per capita (TE_{it}) is determined by the identity:

$$(2) \qquad TE_{it} = E^T_{it} + E^H_{it} + E^N_{it}$$

Substituting Equation (1) into Equation (2) gives the following:

$$(3) \qquad TE_{it} = a^N_i + a^N_t + (1+b^N) E^T_{it} + (1+c^N) E^H_{it} + d^N P_{it} + u^N_{it}$$

The parameters $(1+b^N)$ and $(1+c^N)$ in equation (3) are the local employment multipliers for employment in tradable sectors and inpatient healthcare facility employment, respectively.

In equation (3), both local inpatient healthcare facility employment (E^H_{it}) and population (P_{it}) may be endogenous (i.e., they may be affected by the factors determining total employment and thus

[25]In this report, the term "local economy" refers to the county economy.

[26]The local population level affects both the supply of and demand for labor in the nontradable sector (since local population affects demand for nontradable goods and services). Under restrictive assumptions, such as constant returns to scale in all firms, these effects may cancel out, such that local population level has no effect on nontradable employment per capita. We allow for a more general specification by including local population level as an explanatory variable in equation (1).

correlated with u^N_{it}). We use an instrumental variables approach to address both of these potentially endogenous variables. We tried several alternative candidates for instrumental variables to predict inpatient healthcare facility employment; the results of these estimations are discussed in Appendix C. For population, we assume that the main endogeneity issue, in the near term, arises from endogeneity of migration to or from rural counties. That is, people may migrate to or from rural counties as a result of changing economic conditions that lead to changes in population and in employment. To address this issue, we assume that the total population of a county is predicted by the "natural population" of the county (NP_{it}), defined as total county population in a base year (2000 in our data) adjusted by births minus deaths in each year:

$$(4) \qquad NP_{i,2000} = P_{i,2000};\ NP_{i,t} = NP_{i,t-1} + B_{i,t} - D_{i,t} \text{ for } t > 2000,$$

where $B_{i,t}$ and $D_{i,t}$ are births and deaths in county i in year t. Assuming that births and deaths are not much affected by factors affecting employment in the current year, we treat natural population as an exogenous instrumental variable that predicts local population, along with the other variables in equation (3):

$$(5) \qquad P_{it} = a^P_i + a^P_t + b^P E^T_{it} + c^P E^H_{it} + d^P NP_{it} + u^P_{it}.$$

Substituting equation (5) for P_{it} into equation (3), we obtain:

$$(6) \qquad TE_{it} = a^N_i + a^N_t + d^N(a^P_i + a^P_t) + (1+b^N+d^N b^P) E^T_{it} + (1+c^N+ d^N c^P) E^H_{it} + d^N d^P NP_{it} + u^N_{it} + d^N u^P_{it}.$$

We estimate equation (6) as a reduced form without seeking to identify all of the structural parameters:

$$(7) \qquad TE_{it} = a^R_i + a^R_t + (1+b^R) E^T_{it} + (1+c^R) E^H_{it} + d^R NP_{it} + u^R_{it}.$$

Equation (7) is very similar to equation (3), except that the multipliers $(1+b^R)$ and $(1+c^R)$ are not the same as in equation (3). The estimated multipliers in equation (7) differ from those in equation (3) by the factors $d^N b^P$ and $d^N c^P$, which account for the potential effect of tradable sector employment and inpatient healthcare facility employment on nontradable employment, via the effect of employment in these sectors on local population (b^P and c^P) multiplied by the effect of local population on nontradable sector employment (d^N). We assume that these population-related effects are due to changes in net migration to rural counties resulting from changes in tradable and inpatient healthcare facility employment (since we are assuming natural population is exogenous).[27]

Estimation Equation With Fixed Effects

We estimate equation (7) using an ordinary least squares (OLS) model with county and year fixed effects.[28] The key assumptions of the model are that (1) total employment per capita is affected

[27]If natural population were not assumed to be exogenous, we would exclude NP_{it} from equations (5), (6), and (7). In Appendix D, we report results of a model that excludes NP_{it}. The results are not substantially changed.

[28]We also estimate equation (7) using several instrumental variables (IV) estimation models to address the potential endogeneity of inpatient healthcare facility employment. The results of the IV models are discussed in Appendix C. In addition, we estimate several alternative specifications of the OLS fixed-effects model and a spatial lag model to check robustness of our results. The results of those models are reported in Appendixes D and E. Our qualitative conclusions are robust to these alternative model specifications.

linearly by the independent variables in the model, and (2) the unobservable factors affecting total employment per capita can be decomposed into components that vary over time but not across counties (year fixed effects), components that vary across counties but that are time-invariant (county fixed effects), and an idiosyncratic component that varies over time and across counties and is not correlated with the independent variables in the model.[29] The county fixed-effects model can account for the effects on total county per capita employment of any factors that are constant within counties over the timeframe of the study and that have an additive impact (e.g., natural amenities, access to urban areas, and major infrastructure). The year fixed effects will account for macroeconomic factors (such as a recession) that affect per capita employment similarly across all counties but differ by year.

The complete fixed-effects model is defined in equation (8). The subscript i represents county and t represents year. The year fixed effects are represented by γ_t and the county fixed effects by Φ_i. TCJ_{it} is total county jobs per capita, $hosp_{it}$ is inpatient healthcare facility jobs per capita, mfg_{it} is manufacturing jobs per capita, ag_{it} is agricultural jobs per capita, $mine_{it}$ is mining jobs per capita, fed_{it} is Federal Government jobs per capita, $state_{it}$ is State government jobs per capita, NP_{it} is the natural population as defined above, and u_{ct} is the idiosyncratic error term:

$$(8)\ TCJ_{it} = \beta_1 hosp_{it} + \beta_2 mfg_{it} + \beta_3 ag_{it} + \beta_4 mine_{it} + \beta_5 fed_{it} + \beta_6 state_{it} + \beta_7 NP_{it} + \gamma_t + \Phi_i + u_{it}\ .$$

The county fixed effects (Φ_i) are removed from the estimation by subtracting county-level means (averaging over all years) for all variables from their actual values (Wooldridge, 2009, p. 482). The year fixed effects (γ_t) are estimated by including dummy variables for each year.

Variables in the Estimation

In the estimation model, the outcome variable—total county jobs per capita—is as defined above. The explanatory variable of interest is inpatient healthcare facility jobs per capita (see Box 1 for more details). The control variables include natural population and jobs per capita in manufacturing, agriculture, mining, Federal Government, and State government. Excluded from the Federal and State government employment control variables are Federal and State inpatient healthcare facility employment; these are included in the inpatient healthcare facility employment variable.

As is common in county-level analysis, all variables in the model are expressed in per capita terms, which are calculated by dividing each employment variable by the natural population as defined above.[30]

[29]Technically, the fixed-effects model requires that the idiosyncratic error in every time period be uncorrelated with the independent variables in every time period; this assumption is called strict exogeneity of the independent variables (Wooldridge, 2009). This assumption could be violated if future values of the independent variables are affected by the current error term, even if the current value of the error term is uncorrelated with the current value of the independent variables. For example, if future inpatient healthcare facility employment is affected by current total employment, strict exogeneity would not hold. In this case, the model would be biased because the within-county mean values of the independent variables, which are subtracted from current values in the fixed-effects model, include future values that may be correlated with the current error term. However, as pointed out by Wooldridge (2009, p. 488), the bias resulting from a failure of strict exogeneity in a fixed-effects model, if concurrent exogeneity holds (i.e., current values of the independent variables are not correlated with current values of the error term), falls towards zero at the rate 1/T, where T is the number of time periods (15 in our estimations).

[30]We divided by the natural population rather than the estimated county population in each year to reduce the potential for endogeneity bias of the explanatory variables, which could result from endogenous changes in population. In addition, measurement error in estimates of county population could induce a positive correlation between estimates of total per capita employment and estimates of employment per capita by industry. However, our results were very similar when we used U.S. Census Bureau estimates of annual county population rather than natural population to estimate per capita employment.

Appendix C: Instrumental Variables Estimation Results

To address the possible endogeneity of inpatient healthcare facility employment, we attempted several instrumental variables (IV) approaches, including use of:

1. The total number of inpatient healthcare facility establishments in a county as an instrument for inpatient healthcare facility employment;
2. An instrumental variable for inpatient healthcare facility employment based on the approach of Moretti (2010), which uses a weighted average of initial county employment in each inpatient healthcare facility subsector in 2001, multiplied by the national rural employment in each inpatient healthcare facility subsector in a given year, divided by the national rural employment in each inpatient healthcare facility subsector in 2001;
3. Several alternative versions of the Moretti instrument, following the approaches of Faggio (2014) and Van Dijk (2015);
4. Instrumental variables based on heteroscedasticity of the error term, using the method of Lewbel (2012); and
5. Dynamic panel generalized methods of moments (GMM) models, using the approach of Arellano and Bond (1991).

The instrumental variables resulting from approaches (2), (3), and (4) failed to pass tests of relevance and weak identification; hence, the results of those analyses may be seriously biased (Stock and Yogo, 2005) and we do not report those results. In addition, the instruments generated by the Lewbel method (4) failed to pass the overidentification test, indicating invalidity of some of those instruments. Weak instruments tests are not available for the Arellano and Bond estimator (5), but the dynamic panel GMM models all have large standard errors on the estimated coefficients (suggesting that weak instruments is a problem for those models), and all failed the overidentification test.

Given the problems evident with the other methods, we report here only the results using the total number of inpatient healthcare establishments in a county as an instrument for inpatient healthcare facility employment. This model passes the instrument relevance test and the underidentification test at the 1-percent level or lower in all cases, and the weak instrument test at the Stock-Yogo 10-percent maximum IV size threshold in two of the three regressions (for all rural counties and for noncore counties). Even though the instrument passes the weak instrument test, the estimated coefficient of inpatient healthcare facility employment has a much larger variance in all three models than in the OLS fixed-effects models. Therefore, this model is not very informative about the value of the inpatient healthcare facility multiplier. Nevertheless, we report the results for this model for comparative purposes (first-stage results in Appendix table 2 and second-stage results in Appendix table 3).

The multipliers estimated using IV regressions in Appendix table 3 are similar to those shown in tables 2 and 3 for sectors other than inpatient healthcare facilities. The magnitudes of the multiplier estimates for inpatient healthcare facility employment are smaller, but the standard errors of these estimates are much larger than in tables 2 and 3. Hence, none of these inpatient healthcare facility employment multiplier estimates are statistically significantly different from 0 or from 1. An endogeneity test of the inpatient healthcare facility employment variable fails to reject exogeneity at a 0.30 level or higher in all regressions. This suggests that the OLS fixed-effects model should be preferred as the more efficient model, since the IV results do not reject the validity of the OLS model.

Appendix table 2

First-stage results of instrumental variables (IV) regression models with county and year fixed effects

Dependent variable: Inpatient healthcare facility jobs per capita
Instrumental variable: Total county inpatient healthcare establishments per capita

	Model (IV1a)	Model (IV2a)	Model (IV3a)
Variable	All rural counties	Micropolitan counties	Rural noncore counties
Manufacturing jobs/capita	0.005 (0.005)	0.02** (0.008)	0.0002 (0.007)
Agriculture jobs/capita	-0.01 (0.02)	-0.03 (0.04)	-0.002 (0.02)
Mining jobs/capita	-0.01** (0.005)	-0.02*** (0.004)	-0.004 (0.008)
Federal Government jobs/capita	-0.0001 (0.04)	-0.06 (0.06)	0.02 (0.05)
State government jobs/capita	0.03 (0.03)	0.05 (0.06)	0.02 (0.03)
Total county inpatient healthcare establishments per capita (IV)	9.48*** (1.42)	8.25*** (2.21)	9.66*** (1.65)
County fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Natural population	Yes	Yes	Yes
Observations	26,280	8,535	17,745
R-squared	0.07	0.06	0.08
Number of counties	1,752	569	1,183

Notes: This table shows the first stage results of the IV regression models with county and year fixed effects. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p<0.05$, and $p<0.10$, respectively. Inpatient health- care facility jobs refer to jobs in general medical/surgical hospitals, psychiatric and substance abuse facilities, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area. Micropolitan counties contain a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000.

Source: USDA, Economic Research Service analysis using U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data from 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

Appendix table 3

Second-stage results of instrumental variable (IV) regression models with county and year fixed effects

Dependent variable: Total wage and salary jobs per capita in the county
Instrumental variable: Total county inpatient healthcare establishments per capita

	Model (IV1b)	Model (IV2b)	Model (IV3b)
Variable	All rural counties	Micropolitan counties	Rural noncore counties
Inpatient healthcare facility jobs/capita	0.64 (0.42)	0.90 (0.62)	0.57 (0.48)
Manufacturing jobs/capita	1.06*** (0.03)	1.08*** (0.04)	1.04*** (0.03)
Agriculture jobs/capita	1.17*** (0.07)	1.14*** (0.07)	1.18*** (0.09)
Mining jobs/capita	2.16*** (0.21)	2.21*** (0.09)	2.14*** (0.35)
Federal Govt. jobs/capita	1.87** (0.91)	1.99*** (0.39)	1.87* (1.10)
State govt. jobs/capita	1.07*** (0.08)	0.99*** (0.16)	1.09*** (0.10)
County fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Natural population	Yes	Yes	Yes
Observations	26,280	8,535	17,745
R-squared	0.59	0.76	0.52
Number of counties	1,752	569	1,184
Kleibergen-Paap underidentification test p-value	0	0	0
Weak identification test Kleibergen-Paap Wald rk F statistic	44.36	13.92	34.39
Stock-Yogo critical value for 10% maximum IV size	16.38	16.38	16.38
Endogeneity test (p-value)	0.3891	0.5593	0.4886

Notes: This table shows the second stage results of the IV regression models with county and year fixed effects. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p<0.05$, and $p<0.10$, respectively. Inpatient health- care facility jobs refer to jobs in general medical/surgical hospitals, psychiatric and substance abuse facilities, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area. Micropolitan counties contain a core urban area population of more than 10,000 but less than 50,000. Rural noncore counties contain a core urban area population of less than 10,000.

Source: USDA, Economic Research Service analysis using U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data from 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

Appendix D: Robustness Checks

Robustness checks test some issues that could affect our results.[31] First, we test whether changes in inpatient healthcare facility wage and salary jobs have either a contemporaneous effect or a lagged effect on total wage and salary jobs by including a 1-year lag of inpatient healthcare facility jobs per capita (Model R1) and 1-year lags of all independent variables in per capita terms (Model R2). The results show that the impact is contemporaneous, as the coefficients of the lags in both models are small and statistically insignificant. Next, we exclude natural population from Model (R3) to check on possible effects of non-exogeneity of natural population. Excluding natural population does not affect the magnitude of the inpatient healthcare facility multiplier.

To address potential impacts of time-varying unobservables, we use additional controls (State-by-year and region-by-year) in Models (R4) and (R5). Model (R4) includes State-by-year fixed effects and Model (R5) includes region-by-year fixed effects (using the nine census divisions as regions). The results indicate that including State-by-year or region-by-year fixed effects does not affect the magnitude of the inpatient healthcare facility multiplier.

In Model (R6), we add additional age, race, and gender control variables that account for county demographic changes that can influence labor supply and labor demand within a county. Adding these controls did not change the inpatient healthcare facility multiplier. Model (R7) addresses potential measurement error in the yearly county employment data by collapsing the data set into 2-year averages. This does not alter the model's results.

An alternative approach to removing the county fixed effects is to estimate equation (4) in first differences (see Model R8). If the assumptions of the fixed-effects model hold, the first difference model should produce similar (though not identical) coefficient estimates. However, if the assumption of strict exogeneity of the independent variables does not hold (see footnote 29), both the fixed-effects and first-difference estimators will be biased, though the fixed-effects estimator likely will be substantially less biased (Wooldridge, 2009, p. 488). The first-difference estimator may yield more efficient estimates if the u_{ct} terms are very strongly serially correlated. Hence, we also estimated the model in first differences as a check on the robustness of our conclusions.

As a test of the robustness of the results to unobserved heterogeneity, we estimated the first-difference model with county fixed effects (see Model R8). This model controls not only for differences across counties in the mean level of total employment per capita, but also for differences across counties in linear trends of total employment per capita. The estimated inpatient healthcare facility employment multiplier for all rural counties using this model (0.91) is similar to, though smaller than, the multiplier in the fixed-effects model. All of the models produced results similar to table 1, with all indicating that the inpatient healthcare facility employment multiplier is not statistically significantly different from 1.

[31] In addition to the robustness checks in the tables, we tried clustering by commuting zones and by State, but the standard errors remained the same size. In addition, we tried Driscoll-Kraay standard errors to account for spatial correlation and it made the standard errors a bit smaller, but not enough to make the results of the rural, micropolitan, and rural noncore fixed-effect regression results statistically significantly different from 1. We did not include these results in the tables; results available upon request.

Appendix table 4

Ordinary least squares (OLS) with fixed-effects robustness checks, all rural counties

Dependent variable: Total wage/salary employment per capita

Variable	Model (R1)	Model (R2)	Model (R3)	Model (R4)	Model (R5)	Model (R6)	Model (R7) (2-year averages)
Inpatient healthcare facility jobs/capita	0.93*** (0.09)	0.92*** (0.09)	0.99*** (0.09)	1.03*** (0.08)	0.99*** (0.09)	0.98*** (0.08)	0.99*** (0.09)
Manufacturing jobs/ capita	1.07*** (0.03)	1.06*** (0.03)	1.06*** (0.03)	1.03*** (0.02)	1.05*** (0.02)	1.01*** (0.02)	1.06*** (0.02)
Agriculture jobs/capita	1.19*** (0.07)	1.08*** (0.04)	1.17** (0.07)	1.12*** (0.06)	1.17*** (0.07)	1.10*** (0.06)	1.18*** (0.07)
Mining jobs/capita	2.19*** (0.21)	1.75*** (0.15)	2.17*** (0.21)	2.11*** (0.19)	2.15*** (0.21)	2.04*** (0.17)	2.23*** (0.22)
Federal Govt. jobs/ capita	1.96* (1.00)	0.97*** (0.37)	1.86** (0.90)	2.17** (1.02)	1.90** (0.93)	2.12** (0.95)	1.85** (0.88)
State govt. jobs/capita	1.05*** (0.08)	1.14*** (0.08)	1.06*** (0.08)	1.03*** (0.08)	1.05*** (0.08)	1.01*** (0.07)	1.09*** (0.09)
Lag inpatient health-care facility jobs/capita	0.05 (0.06)	0.06 (0.06)					
Lag of other independent variables		Yes					
County fixed effects	Yes	Yes	Yes			Yes	Yes
Year fixed effects	Yes	Yes	Yes			Yes	Yes
Natural population	Yes	Yes		Yes	Yes	Yes	Yes
Demographics						Yes	
Region x year fixed effects					Yes		
State x Year fixed effects				Yes			
Observations	24,528	24,528	26,280	26,280	26,280	26,280	14,016
R-squared	0.60	0.60	0.60	0.63	0.60	0.61	0.61
Number of counties	1,752	1,752	1,752	1,752	1,752	1,752	1,752

Notes: Model (R1) includes a lag of inpatient healthcare facility jobs per capita. Model (R2) includes a lag of all explanatory variables. Model (R3) excludes the natural population control variable. Model (R4) includes State-by-year fixed effects. Model (R5) includes region-by-year fixed effects. Model (R6) includes additional control variables: demographic variables (age, race, and sex). Model (R7) uses a collapsed data set of 2-year averages for the dependent and independent variables. All models employ Ordinary Least Squares (OLS) with fixed effects and include all rural counties. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. The constant term is omitted from the table. Inpatient healthcare facility jobs refer to jobs in general medical/surgical hospitals, psychiatric and substance abuse facilities, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The results for models using micropolitan or rural noncore counties are available upon request. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.

Source: USDA, Economic Research Service analysis using U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001-15; U.S. Census Bureau, Intercensal Population Estimates 2000-2015; Census County Population by Characteristics datasets, 2001-15.

Appendix table 5

First difference with fixed-effects robustness check, all rural counties

Dependent variable: Change in total wage and salary jobs per capita

Change in…	Model (R8)
Inpatient healthcare facility jobs/capita	0.91***
	(0.05)
Manufacturing jobs/capita	1.01***
	(0.02)
Agriculture jobs/capita	1.01***
	(0.02)
Mining jobs/capita	1.53***
	(0.13)
Federal Govt. jobs/capita	1.27***
	(0.29)
State govt. jobs/capita	0.97***
	(0.04)
County fixed effects	Yes
Year fixed effects	Yes
Natural population	Yes
Observations	24,538
R-squared	0.41
Number of counties	1,752

Notes: Model (R8) is a first-difference model with county and year fixed effects and includes the natural population control. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. Inpatient healthcare facility jobs refer to jobs in general medical/surgical hospitals, psychiatric and substance abuse facilities, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.

Source: USDA, Economic Research Service analysis using U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15.

Appendix E: Spatial Lag Model

Spatial spillovers in employment (i.e., where employment in one county affects total employment in neighboring counties and vice versa) are a valid concern in county-level employment analysis. As a robustness check, we test for spatial spillovers in our data. LeSage (2014) states that there are two models that are predominantly used to address local spillovers, the spatial lag of the independent variables—called spatial lag of X (SLX) model—or the spatial Durbin error model (SDEM), which includes both spatially correlated error terms and spatial lags of the independent variables.

The first step is to run the LaGrange Multiplier (LM) test for spatial lags and spatial errors, using data for both urban and rural counties, since they may be neighbors. Our LM results indicated we should include spatial lags of the independent variables and a spatial error term, meaning we should run a SDEM model. Unfortunately, the full spatial panel data model for all 3,000 counties over 15 years is prohibitively large, and was not estimable. Fortunately, LeSage (2014) notes that if the objective is to answer the question "Do we have spatial spillovers?", then the SLX model is sufficient. LeSage notes that the parameter estimates should be identical under SLX or SDEM, the only difference between the models being that the SDEM may be more efficient. Thus, the SLX model is adequate for our purposes; following Gibbons and Overman (2012) and LeSage (2014), we use the spatial panel lag of X model and include spatial lags of all explanatory variables to test for spatial spillovers.

We show the regression results for the full OLS model with fixed effects and the full SLX model in Appendix table 6. Model (S1) is the full, balanced panel OLS model with fixed effects including both urban and rural counties; model (S2) is the full, balanced panel SLX model. We include only the spatial lag of inpatient healthcare facility employment in Appendix table 6 to save space (full results can be provided upon request).

We found that the spatial lag of urban inpatient healthcare facility employment was statistically significant, but the spatial lag of rural inpatient healthcare facility employment was not, nor were the spatial lags of the other explanatory variables. The multipliers estimated by both models are very similar, both for urban and rural counties. The rural inpatient healthcare facility employment multiplier estimated by the SLX model (0.99) is the same as that estimated by the OLS fixed-effects model. We conclude that the OLS-with-fixed-effects model is the preferred model for our rural county analysis.

Appendix table 6

Ordinary least squares (OLS) fixed-effects models with and without spatial lags of independent variables, all rural and urban counties

Dependent variable: Total wage and salary jobs per capita

Variable	Model (S1)	Model (S2)
Urban*Inpatient healthcare facility jobs/capita	1.40***	1.39***
	(0.17)	(0.17)
Rural* Inpatient healthcare facility jobs/capita	0.99***	0.99***
	(0.09)	(0.09)
Urban * Manufacturing jobs/capita	1.30***	1.30***
	(0.06)	(0.06)
Rural* Manufacturing jobs/capita	1.05***	1.05***
	(0.03)	(0.03)
Urban * Agriculture jobs/capita	1.00***	0.99***
	(0.15)	(0.14)
Rural* Agriculture jobs/capita	1.17***	1.17***
	(0.07)	(0.07)
Urban *Mining jobs/capita	1.42***	1.43***
	(0.18)	(0.18)
Rural*Mining jobs/capita	2.17***	2.17***
	(0.21)	(0.21)
Urban *Federal Govt. jobs/capita	1.43***	1.42***
	(0.10)	(0.10)
Rural* Federal Govt. jobs/capita	1.87*	1.90*
	(0.94)	(0.94)
Urban *State govt. jobs/capita	1.26***	1.26***
	(0.29)	(0.29)
Rural*State govt. jobs/capita	1.06***	1.04***
	(0.08)	(0.08)
W*Urban *Inpatient healthcare facility jobs/capita		0.68***
		(0.21)
W*Rural* inpatient healthcare facility jobs/capita		-0.16
		(0.22)

Appendix table 6

Ordinary least squares (OLS) fixed-effects models with and without spatial lags of independent variables, all rural and urban counties - *continued*

Dependent variable: Total wage and salary jobs per capita

Variable	Model (S1)	Model (S2)
W*Urban *Other independent variables		Yes
W*Rural*Other independent variables		Yes
County fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Natural population (urban and rural)	Yes	Yes
W*Natural population (urban and rural)		Yes
Observations	37,813	37,813
R-squared	0.50	0.50
Number of counties	2,703	2,703

Notes: Model (S1) is the OLS model with fixed effects, including both urban and rural dummies interacted with the independent variables (denoted by *). Model (S2) is the Spatial Lag of X model, which is an OLS model with fixed effects, including urban and rural dummies interacted with the independent variables and spatial lags of all of the independent variables (both urban and rural; denoted by W*). All models include county and year fixed effects as well as control for natural population. The independent variables and dependent variable in these models are in per capita terms. Clustered standard errors are in parentheses. ***, **, and * = statistical significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. The constant term is omitted from the table. Only the spatial lags of inpatient healthcare facility jobs are explicitly shown in the table. Inpatient healthcare facility jobs refer to jobs in general medical/surgical hospitals, psychiatric and substance abuse clinics, specialty hospitals, nursing care facilities, residential mental health facilities, community care facilities for the elderly, and other residential care facilities. The U.S. Office of Management and Budget (OMB, 2003) defines nonmetropolitan (rural) counties as counties containing core urban area populations of fewer than 50,000 residents and less than 25 percent of the labor force in a nonmetropolitan county commuting to core counties in an adjacent metropolitan area.

Source: USDA, Economic Research Service analysis using U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages data, 2001-15 and U.S. Census Bureau, Intercensal Population Estimates, 2000-15..