Population Aging, Local Economic Growth, and the Urban-Rural Divide*

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Abstract

This paper examines how population aging affects local economic growth across the urban-rural divide. Using U.S. county data spanning 2000–2020, we instrument changes in the share of adults aged 60 and older using historical age distributions and national cohort population changes. We find that a 10 percent increase in the older-adult share reduces real GDP per capita by approximately 2.7 percent in non-metro counties, while effects in metro counties are statistically insignificant. Population-weighted estimates reveal particularly large negative effects in non-metro counties that are not adjacent to metro areas. Among these counties, negative effects are concentrated in those with low or moderate commuting openness, while estimates for the most open counties are smaller and insignificant. Industry-specific estimates are positive in metro counties but negative in non-adjacent counties for finance and real estate, retail trade, and manufacturing, even as education and health services exhibit positive growth responses to aging. These findings suggest that regional economic integration may shape how local economies adjust to population aging.

Keywords: Population aging, Economic Growth, Regional, Urban, Rural, Sectoral, Openness, Commuting
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1 Introduction

Economists and demographers have long debated whether aging is a drag on growth or an opportunity to reconfigure economic structures. On one hand, a rising share of older adults may slow economic growth by reducing the size of the labor force, weakening productivity, and shifting spending away from investment and innovation (Maestas et al., 2023; Eggertsson et al., 2019; Cutler et al., 1990). On the other hand, aging could boost macroeconomic growth through mechanisms such as capital deepening, automation, longer working lives, and the expansion of age-aligned industries like healthcare and professional services (Daniele et al., 2019; Acemoglu and Restrepo, 2017; Feyrer, 2007; Du et al., 2026; Acemoglu et al., 2026; Cravino et al., 2022).

Macroeconomic studies have provided important insights into the national implications of population aging. Understanding its local consequences, however, requires considering the economic environments in which aging occurs. Local economies differ in their industrial composition, fiscal capacity, and connections to surrounding markets. These differences may shape both the pressures generated by aging and the opportunities for adjustment. National estimates may therefore conceal substantial variation in the economic consequences of aging across places.

The economic geography literature provides a framework for understanding this spatial variation by emphasizing how places are connected through goods and labor markets (Monte et al., 2018a; Allen and Arkolakis, 2014). Such connections may shape the consequences of aging through two channels. First, commuting gives employers access to workers beyond the resident population, potentially moderating the labor supply pressures associated with aging. Second, aging shifts consumption toward services (Cravino et al., 2022), but the resulting demand may support production outside the county where older residents live. Counties serving as regional centers may, therefore, capture demand from surrounding aging communities. These channels may be particularly relevant to the urban-rural divide: urban centers and counties connected to them may have greater access to outside workers and capture service demand from surrounding communities. More isolated rural counties, by contrast, may face tighter constraints on replacing retiring workers while some of the demand generated by their older residents supports production elsewhere.

In this paper, we estimate the impact of population aging on local economic growth across the urban-rural divide. We examine two related dimensions of spatial heterogeneity: proximity to metro areas and commuting openness, defined as the share of workers employed in a county who reside outside of it. Our outcome of interest is the change in log real GDP per capita over 2001–2010 and 2010–2019, while our key explanatory variable is the change in the

log share of adults aged 60 and older over the corresponding Census periods, 2000–2010 and 2010–2020. However, estimating this relationship using ordinary least squares (OLS) raises important endogeneity concerns. In particular, the timing and magnitude of population aging may be influenced by a county's economic conditions—for example, stronger economies might retain or attract older residents, while economically struggling areas may experience out-migration or mortality that skews the age structure. Additionally, local policy changes or unobserved shocks that affect both demographic change and economic growth could bias OLS estimates.

To address these challenges, our identification strategy follows a growing literature that uses lagged demographic variables as instruments for current population structure, including studies of aging at national and regional levels (e.g., Maestas et al., 2023; Daniele et al., 2019; Böhm and Siegel, 2021; Zhang et al., 2015). We implement an instrumental variables (IV) strategy that is conceptually similar to a shift-share design while also controlling for several different types of unobserved heterogeneity. Specifically, we instrument for the decadal change in the older adult share using county age distributions from 10, 20, and 30 years prior, combined with *national* cohort population changes. Historical age structure provides variation in predicted aging that is plausibly exogenous to contemporaneous local economic shocks, conditional on our controls and fixed effects. Using multiple lag lengths allows us to assess the sensitivity of our estimates to the historical demographic information used to construct the instruments.

We combine this IV strategy with a long-difference specification, state-by-decade fixed effects, Rural-Urban Continuum Codes (RUCC) indicators, and baseline county characteristics to account for potential confounding factors. Taking differences in log GDP per capita eliminates time-invariant county components of the outcome, while state-by-decade fixed effects absorb state-specific economic shocks and growth patterns that may be correlated with population aging. We additionally control for demographic and employment characteristics measured near the beginning of each study period.

The identifying assumption is that, conditional on these controls, historical age structure affects current economic growth only through its impact on recent population aging, and not through independent channels. This assumption becomes more plausible when using longer lags and richer controls for unobserved heterogeneity, as these reduce the likelihood that historical demographic composition is correlated with current unobserved economic shocks. To further assess this assumption, we conduct placebo tests analogous to pre-trend tests in a difference-in-differences framework. Specifically, we examine whether predicted aging for a future period is associated with economic growth in a prior decade. The placebo test provides reassuring evidence that the instrument is not proxying for persistent local economic

conditions, as predicted future aging does not explain pre-period economic growth in our preferred unweighted specifications.

Across all specifications, the instruments are strong and yield broadly consistent results, increasing confidence in the validity of our approach. Importantly, our strategy isolates variation in aging driven by long-run demographic momentum—such as cohort aging and mortality—rather than short-term migration flows or local economic sorting. In this sense, our estimates capture the impact of underlying demographic change on economic performance, rather than changes in age structure driven by selective in- or out-migration. This distinction is particularly relevant for policymakers, as it highlights the structural economic implications of aging populations rather than more transient, mobility-driven shifts.

Our results reveal substantial geographic heterogeneity in the economic effects of population aging. In our preferred unweighted IV specifications, a 10 percent increase in the share of adults aged 60 and older reduces real GDP per capita by approximately 2.7 percent in non-metro counties, while the estimated effect in metro counties is close to zero and statistically insignificant. These findings are consistent across instruments constructed using 10-, 20-, and 30-year lagged age distributions and remain robust to population weighting. Within non-metro counties, the unweighted estimates are consistently negative for both adjacent and non-adjacent counties, with generally larger negative point estimates in non-adjacent counties. However, the distinction becomes more pronounced when weighting by population. Using the 10-year lag instrument, a 10 percent increase in the older-adult share is associated with an estimated decline in GDP per capita of approximately 1.5 percent in adjacent non-metro counties, compared with 4.6 percent in non-adjacent counties. These results suggest that the economic consequences of aging differ not only between metro and non-metro areas but also with proximity to larger regional economies.

We further investigate the role of regional labor-market integration using commuting openness, measured as the share of workers employed in a county who reside outside it. Among non-adjacent non-metro counties, the estimated effects of aging are consistently negative and statistically significant in the lowest and middle terciles of commuting openness, across all instrument lags and both weighted and unweighted specifications. In contrast, counties in the highest tercile exhibit smaller and statistically insignificant effects. The relationship between commuting openness and aging effects is less consistent among adjacent non-metro counties. These findings suggest that even geographically isolated counties may differ substantially in their vulnerability to aging depending on their connections to surrounding labor markets. Greater access to workers from outside the county may provide one avenue for adjusting to demographic change, although our estimates do not identify a causal effect of commuting openness itself.

Our industry-specific results reveal additional geographic differences in how local economies respond to aging. In finance and real estate, retail trade, and manufacturing, the estimated effects are positive in metro counties but negative in non-adjacent counties, although not all individual coefficients are statistically significant. These patterns are consistent with the possibility that metro counties are better positioned to accommodate changes in demand and production associated with aging, while more isolated counties may be less able to capture the resulting economic activity. At the same time, education and health services exhibit significant positive effects in non-adjacent counties, suggesting that some industries may expand even where aging reduces aggregate economic growth. Other sectors, particularly construction, exhibit substantial negative effects across county types.

Finally, our principal findings are robust to alternative treatments of extreme growth observations, the inclusion of additional demographic controls, and the use of 2020 rather than 2019 GDP. Aggregating counties into commuting zones also produces negative effects of aging, with particularly large estimates in smaller labor markets. Together, these results indicate that the local economic consequences of population aging depend importantly on geographic context and are consistent with regional economic integration shaping opportunities for adjustment.

This paper contributes to and extends several strands of literature. First, we contribute to research on the broader economic consequences of population aging by identifying heterogeneity in its effects on local GDP per capita. Several pertinent studies examine subnational geographies. Maestas et al. (2023) use predetermined variation in aging across U.S. states to estimate its effects on economic growth, employment, and productivity. Bode et al. (2023) study aging and productivity growth in German counties, while Nicolini and Roig (2024) investigate aging and growth across European regions. We build on this literature by examining metropolitan proximity and commuting openness as two related but distinct dimensions of heterogeneity within the United States. Our finding that aggregate losses are concentrated in smaller and more isolated economies shows how an average growth effect can mask substantial differences across the urban-rural divide. Our industry-specific estimates further show that geographic differences extend beyond aggregate growth, with population aging associated with contrasting sectoral responses across metro and non-metro economies.

Our paper further contributes to the literature on local economic development by examining how population aging interacts with the connections between rural and urban economies. A central insight from this literature is that rural development depends on access to workers, markets, and economic opportunities beyond the local community (Irwin et al., 2010; Partridge and Rickman, 2008). We extend this perspective to demographic change by examining whether the growth effects of aging differ across metro counties, adjacent non-metro

counties, and more geographically isolated non-metro counties. Our results suggest that understanding rural vulnerability to aging requires considering both demographic change within a county and its connections to the broader regional economy.

Finally, our analysis connects population aging to research on commuting and local labor market adjustment. Renkow (2003) demonstrates the importance of intercounty commuting in accommodating local employment growth in North Carolina, while Monte et al. (2018a) provide theory and evidence that local employment responses to labor demand shocks vary with commuting openness. We examine whether this dimension of labor market integration also differentiates local responses to population aging, which can affect both labor supply and the composition of demand. By measuring the share of a county's workers who reside elsewhere, we distinguish the aging of the resident population from employers' reliance on that population for labor. The smaller estimated growth losses in more open counties are consistent with access to outside workers moderating the local consequences of aging. More broadly, this connects with research on regional resilience and the role of labor mobility and economic integration in shaping responses to adverse conditions (Martin, 2012; Diodato and Weterings, 2015; Feng et al., 2023). Spatial connections can also transmit and amplify shocks, as emphasized by Adao et al. (2019). Our work contributes to this strand of literature by documenting how these connections differentiate local growth responses to population aging, a persistent demographic transition.

2 Data

Our analysis combines several sources of county-level data to examine the relationship between population aging and local economic growth across the United States. We construct two observations per county corresponding to the 2000–2010 and 2010–2020 Census periods. The data include measures of economic performance, demographic change, baseline county characteristics, and geographic integration.

Our primary economic outcome is growth in real GDP per capita, constructed using county-level GDP estimates from the Bureau of Economic Analysis (BEA; U.S. Bureau of Economic Analysis (2023)). Because county GDP estimates begin in 2001, we calculate the change in log real GDP per capita from 2001 to 2010 and from 2010 to 2019. Both intervals span nine years, and the measures represent cumulative rather than annualized growth. We use 2019 rather than 2020 as the endpoint of the second period to avoid the economic disruptions associated with the COVID-19 pandemic and to maintain a consistent nine-year interval. Results using 2020 GDP are included as a robustness check.

We also use BEA county GDP-by-industry estimates to investigate heterogeneity in the

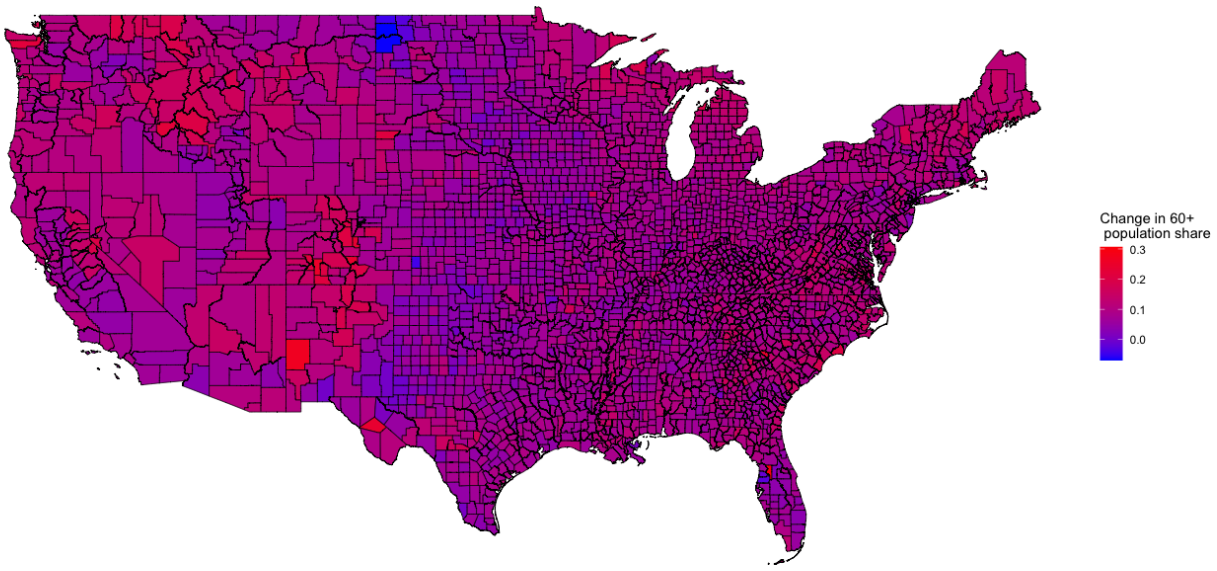
economic effects of aging across sectors. Industry-level GDP data are frequently suppressed to protect confidential business information, particularly in smaller and more rural counties, limiting the scope of this analysis. We therefore select the nine industries with the lowest shares of missing GDP observations among non-metro counties and additionally include agriculture because of its particular importance to rural economies. This yields ten industries: finance and real estate, government, manufacturing, education and health services, retail trade, construction, arts and hospitality, utilities, mining, and agriculture. For each industry, we construct growth in real GDP per capita over the same periods used in our aggregate analysis. Although these industries do not provide an exhaustive decomposition of aggregate economic activity, they allow us to examine sector-specific responses to population aging. We interpret these results cautiously, as remaining data suppression may affect the representativeness of counties included in each industry analysis.

Demographic data, including age-specific population counts, are obtained from the decennial U.S. Census through IPUMS (Schroeder et al., 2025). Our primary measure of population aging is the change in the natural log of the share of adults aged 60 and older, where the adult population is defined as individuals aged 20 and older. We calculate this change from 2000 to 2010 and from 2010 to 2020. Thus, demographic changes are measured over Census decades, while the corresponding GDP growth measures cover 2001–2010 and 2010–2019. We also use historical county age distributions to construct the predicted aging measures for our instrumental variables strategy. Figure 1 illustrates the substantial geographic variation in population aging between 2000 and 2020.

Our regressions include several baseline county characteristics that may be correlated with both demographic change and economic growth. These include the log of county population, the share of residents aged 25 and older with a bachelor's degree or higher, and the foreign-born share of the total population. Education and foreign-born measures are obtained from the Census Bureau's 2000 Census Summary File 3 and the 2006–2010 American Community Survey (ACS) five-year estimates. We also control for the shares of total county employment in farming and private nonfarm activities, calculated using BEA employment data. Population and demographic controls are measured in 2000 and 2010, while employment characteristics are measured in 2001 and 2010, corresponding to the beginning of each study period.

To examine geographic heterogeneity, we classify counties using the U.S. Department of Agriculture's Rural-Urban Continuum Codes (RUCC). We use the 2003 classification for the 2000-2010 period and the 2013 classification for 2010-2020, ensuring that county type reflects conditions near the beginning of each period. Counties with codes 1–3 are classified as metro, while codes 4–9 identify non-metro counties. We further distinguish non-metro

Figure 1: Change in the Share of 60 + Population: 2000 - 2020



Notes: The data are the change in population over 60 divided by the adult population defined as aged 20+ between 2000 and 2020.

counties adjacent to metro areas (codes 4, 6, and 8) from those that are non-adjacent (codes 5, 7, and 9).[1] These categories distinguish geographic proximity to metro labor markets while also accounting for differences in the size of local urban populations. Table 1 provides the definitions of the nine RUCC categories.

We measure commuting openness as the share of workers employed in a county who reside outside that county. This measure comes from county-to-county commuting flows in the 2006–2010 ACS, using the processed data provided by Monte et al. (2018a,b). The measure captures the extent to which local employers rely on workers from outside the county and provides a complementary indicator of regional labor-market integration. Because the commuting measure is observed for a single period, we treat it as a fixed county characteristic when examining heterogeneity in the effects of aging. We also conduct a robustness analysis at the commuting-zone level, aggregating county-level economic and demographic measures

[1] Adjacency is defined as physically adjoined to one or more metro areas and at least 2 percent of employed labor force commuting to central metro counties.

Table 1: Rural-Urban Continuum Codes (RUCC) Definitions

Code	Description
Metro counties:	
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Metro-adjacent non-metro counties:	
4	Urban population of 20,000 or more, adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
8	Urban population of fewer than 2,500, adjacent to a metro area
Non-adjacent non-metro counties:	
5	Urban population of 20,000 or more, not adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
9	Urban population of fewer than 2,500, not adjacent to a metro area

Source: USDA, Economic Research Service using data from the Office of Management and Budget and U.S. Department of Commerce, Bureau of the Census.

to broader geographic areas that provide an alternate approximation of local labor markets.

Finally, to limit the influence of extreme changes in economic output, particularly among very small counties, our baseline specifications exclude observations in the top and bottom 1 percent of the distribution of changes in log real GDP per capita. We apply the same trimming procedure separately to each industry's growth measure in the sectoral analysis. As robustness checks, we examine alternative treatments of outliers, including trimming observations in the top and bottom 3 percent and winsorizing the outcome at the 3rd and 97th or 5th and 95th percentiles. These alternative specifications allow us to assess whether our findings are sensitive to the treatment of extreme growth observations.

3 Empirical Strategy

3.1 Model Specification

We estimate the impact of demographic aging on local economic growth using a panel of U.S. counties observed at approximately decadal intervals from 2000 to 2020. Our primary explanatory variable is the change in the log of the share of adults aged 60 and older:

$$\text{Aging}_{cst} = \ln\left(\frac{\text{Old}_{cs,t}}{\text{Adults}_{cs,t}}\right) - \ln\left(\frac{\text{Old}_{cs,t-10}}{\text{Adults}_{cs,t-10}}\right) \tag{1}$$

where $\text{Old}_{cs,t}$ denotes the population aged 60 and older in county c, state s, at time t, and $\text{Adults}_{cs,t}$ denotes the population aged 20 and older.

The baseline estimating equation is:

$$\text{Growth}_{cst} = \beta \text{Aging}_{cst} + X'_{cst}\gamma + \delta_{st} + \varepsilon_{cst}, \tag{2}$$

where Growth_{cst} is the change in log real GDP per capita over the corresponding economic growth period. The vector X_{cst} contains predetermined county characteristics measured near the beginning of each period, including log population, the share of adults aged 25 and older with a bachelor's degree or higher, the foreign-born population share, the shares of employment in farming and private nonfarm activities, and RUCC indicators. The term δ_{st} represents state-by-period fixed effects. Standard errors are clustered at the state level.

Because the outcome is expressed as a long difference, time-invariant county components of log GDP per capita are eliminated from the estimating equation. State-by-period fixed effects additionally account for state-specific economic shocks and growth patterns that may be correlated with demographic change. Baseline demographic and employment controls help address differences in initial county characteristics that may independently predict subsequent economic growth.

3.2 Instrumental Variables

Estimating Equation (2) using ordinary least squares (OLS) raises important endogeneity concerns. In particular, changes in the age structure of a county may themselves be influenced by local economic conditions. For example, selective migration may affect both economic growth and the age composition of a county.[2] Unobserved local economic shocks may also simultaneously influence population aging and economic performance.

To address endogeneity in the relationship between local aging and growth, we adopt an instrumental variables (IV) strategy that predicts population aging using historical county age distributions and national cohort population changes. This approach is conceptually similar to a shift-share design: local age cohorts from earlier periods (the "shares") are combined with national cohort population changes (the "shifters") to construct predicted population aging (Borusyak et al., 2025). Because historical cohort sizes are predetermined relative to subsequent local economic shocks, the instrument exploits variation in aging arising from demographic momentum rather than contemporaneous migration responses to local economic conditions. Identification requires that, conditional on baseline county character-

[2]For example, Chen and Rosenthal (2008) document that aging individuals tend to locate in places with attractive consumer amenities.

istics and fixed effects, historical age structure does not affect subsequent economic growth through channels other than the resulting change in population aging.

For each Census period ending in year t and lag length $x \in \{10, 20, 30\}$, we use population data from time $t - x$ to predict the number of older and adult residents at the beginning and end of the period.[3] Historical county age cohorts are advanced using corresponding changes in national cohort populations. Specifically, for $h \in \{0, 10\}$, we predict the number of residents aged 60 and older and the total adult population at time $t - h$ as follows:

$$\widehat{\text{Old}}^{(x)}_{cs,t-h} = \sum_{j \geq 60-x+h} \text{Pop}_{jcs,t-x} \left(\frac{\text{Pop}_{j+x-h,t-h}}{\text{Pop}_{j,t-x}} \right), \tag{3}$$

$$\widehat{\text{Adults}}^{(x)}_{cs,t-h} = \sum_{j \geq 20-x+h} \text{Pop}_{jcs,t-x} \left(\frac{\text{Pop}_{j+x-h,t-h}}{\text{Pop}_{j,t-x}} \right). \tag{4}$$

In these expressions, $\text{Pop}_{jcs,t-x}$ is the number of residents in county c, state s, aged j in year $t - x$, while the ratio in parentheses represents the national population change for the corresponding birth cohort between $t - x$ and $t - h$. By applying the same national cohort ratios across counties, we project demographic change using historical local age structure rather than subsequent local changes in migration and mortality.

This approach relies on the idea that subsequent changes in local age structure are partly driven by demographic momentum—the aging of existing cohorts—rather than exclusively by local economic shocks that selectively attract or repel individuals of particular ages. Applying *national* cohort population changes removes the direct influence of county-specific demographic changes occurring after the historical baseline.

To construct the predicted aging measure, we calculate the change in the log of the predicted older adult share:

$$\text{PredAging}^{(x)}_{cst} = \ln \left(\frac{\widehat{\text{Old}}^{(x)}_{cs,t}}{\widehat{\text{Adults}}^{(x)}_{cs,t}} \right) - \ln \left(\frac{\widehat{\text{Old}}^{(x)}_{cs,t-10}}{\widehat{\text{Adults}}^{(x)}_{cs,t-10}} \right). \tag{5}$$

The two-stage least squares (2SLS) model is then estimated as follows:

First Stage:

$$\text{Aging}_{cst} = \pi_x \cdot \text{PredAging}^{(x)}_{cst} + X'_{cst}\rho_x + \delta_{st} + \nu_{cst}. \tag{6}$$

Second Stage:

$$\text{Growth}_{cst} = \beta_x \cdot \widehat{\text{Aging}}_{cst} + X'_{cst}\gamma_x + \delta_{st} + \varepsilon_{cst}. \tag{7}$$

[3]For the 30-year lag ($x = 30$), we cannot predict individuals aged 20–29 at time t using the population observed at $t - x$, since these individuals had not yet been born. We therefore set their predicted counts to zero.

We estimate the model using separate instruments constructed from 10-, 20-, and 30-year lagged age distributions. Comparing estimates across instrument lags allows us to assess the sensitivity of the results to the historical age structure used to predict aging. Longer lags may reduce the direct influence of more recent demographic conditions and increase the plausibility of the exclusion restriction, although they may also introduce additional measurement concerns or weaken the relationship between predicted and actual aging. We therefore report first-stage diagnostics to evaluate instrument relevance across specifications.

3.3 Weighting

Our preferred specification is unweighted, reflecting the place-based focus of our analysis. We are primarily interested in how population aging affects local economic growth across counties, regardless of their population size. Unweighted estimation gives each county-period observation equal importance, allowing the experiences of smaller rural counties to contribute equally to those of larger counties. This approach is particularly relevant for understanding geographic disparities in economic development, where smaller communities may face distinct challenges associated with demographic change.

We also report population-weighted estimates to examine the sensitivity of our findings to county size. Weighting places greater emphasis on more populous counties and allows us to assess whether the estimated effects are disproportionately influenced by the smallest counties, where economic growth can be particularly volatile. Because population weighting changes the relative contribution of counties to the IV estimates, particularly when treatment effects are heterogeneous, the weighted and unweighted specifications need not identify identical effects. We therefore view the two approaches as complementary, with the unweighted estimates serving as our primary specification.

3.4 Geographic and Commuting Heterogeneity

Our primary objective is to examine whether the economic consequences of population aging differ across the urban-rural divide. We first estimate Equation (7) separately for metro and non-metro counties. We then investigate finer geographic heterogeneity using the nine RUCC categories and distinguish non-metro counties adjacent to metro areas from those that are non-adjacent.

The RUCC classifications distinguish counties according to both metro status and the size of their urban population. In particular, the non-metro categories allow comparisons between counties with similar levels of urbanization but different proximity to metro areas. These comparisons help assess whether the economic consequences of aging vary with access

to larger regional economies rather than simply with county population size or urbanization.

We further investigate geographic heterogeneity using commuting openness as an alternative measure of integration into regional labor markets. Following Monte et al. (2018a), we define county openness as

$$\text{Openness}_c = \frac{\text{Nonresident Workers}_c}{\text{Total Jobs}_c}, \tag{8}$$

where the numerator is the number of workers employed in county c who reside outside the county, and the denominator is total employment within the county. This measure captures the extent to which local employers rely on workers from surrounding areas rather than exclusively on county residents.

We divide non-metro counties into terciles based on commuting openness, constructing the tercile thresholds separately for each study period using the combined non-metro sample. The same thresholds are applied to metro-adjacent and non-adjacent counties within each period. We then estimate our baseline IV specification separately for each commuting tercile within the adjacent and non-adjacent non-metro groups.

This approach allows us to investigate whether the relationship between population aging and economic growth differs across counties with varying degrees of labor-market integration, without imposing a linear interaction between aging and commuting openness. However, commuting patterns may themselves be influenced by local economic conditions and are not independently instrumented. We therefore interpret differences across commuting terciles as evidence of heterogeneity associated with regional labor-market integration, rather than as causal estimates of the moderating effect of commuting openness.

3.5 Industry-Specific Effects

To examine how the economic consequences of population aging vary across sectors, we estimate Equation (7) separately using changes in log real industry GDP per capita as the dependent variable. We retain the same instrumental variables strategy, baseline county controls, and fixed effects as in the aggregate analysis.

We estimate industry-specific regressions separately for metro counties, adjacent non-metro counties, and non-adjacent non-metro counties. These comparisons allow us to examine whether particular industries respond differently to population aging across geographic environments and whether the sectoral patterns are consistent with the broader geographic differences in aggregate economic growth.

As previously discussed, county-level industry GDP data are subject to suppression, particularly in smaller and more rural counties. Consequently, these regressions are estimated

using the subset of counties for which industry GDP data are available, and the composition of the estimation sample may differ across industries and geographic groups. We therefore interpret the results cautiously, particularly when comparing industries with different levels of data coverage. Moreover, because the dependent variables are changes in log industry GDP per capita, these estimates represent sector-specific responses rather than an accounting decomposition of the aggregate GDP effect.

4 Results

4.1 Descriptive Statistics

Table 2 summarizes demographic and economic characteristics across metro, metro-adjacent, and non-adjacent counties. Metro counties have substantially larger populations and greater labor market openness where non-residents hold an average of 27 percent of jobs, compared with 21 percent in metro-adjacent counties and 17 percent in non-adjacent counties. Employment composition also differs, with farm employment accounting for a larger share in non-adjacent counties. Population aging occurs across all three groups, with the average decadal change in the log share of adults aged 60 and older ranging from 0.14 in non-adjacent counties to 0.18 in metro counties. Non-adjacent counties nevertheless exhibit higher average GDP per capita growth and greater dispersion in growth. However, these group averages do not reveal how aging and growth vary within each group.

Figure 2 examines the relationship between aging and economic growth and how it differs with proximity to metro areas and labor market openness. Each panel displays a binned scatter plot in which counties are grouped into quantiles based on the decadal change in the log share of adults 60 and older, and the average growth rate is plotted for each bin. The fitted line represents the unweighted linear correlation.

Panel A shows a clear negative correlation across all counties, with a slope of approximately –0.33. In metro counties (Panel B), the slope is essentially flat (0.04) and statistically indistinguishable from zero, suggesting no meaningful correlation between aging and economic growth. In contrast, non-metro adjacent (Panel C) and non-adjacent (Panel D) counties show a substantially steeper negative slope (–0.34 and -0.56), consistent with greater vulnerability to aging-related slowdowns. The final two panels divide counties based on whether their openness measure is above or below the median. For counties with above-median openness (Panel E), the slope is relatively flat at -0.14. In contrast, for less open counties (Panel F), the slope is noticeably steeper and strongly negative (-0.47). This suggests that more economically integrated counties may be better able to mitigate the adverse

Table 2: Descriptive statistics by county type

	Metro		Metro-adjacent		Non-adjacent	
	Mean	SD	Mean	SD	Mean	SD
GDP growth	0.09	0.15	0.10	0.18	0.14	0.22
60+ growth	0.18	0.09	0.15	0.08	0.14	0.11
Openness	0.27	0.13	0.21	0.09	0.17	0.10
Population (000s)	218.78	477.80	29.95	24.52	16.91	17.53
B.A. share	0.22	0.10	0.15	0.06	0.16	0.06
Foreign share	0.06	0.06	0.03	0.04	0.03	0.05
Farm share	0.04	0.05	0.09	0.07	0.13	0.10
Non-farm share	0.80	0.09	0.73	0.10	0.69	0.13
Gov't share	0.16	0.07	0.18	0.07	0.18	0.07

Notes: GDP growth is the change in log real GDP per capita over 2001–2010 and 2010–2019. Aging is the change in the log share of adults aged 60 and older among the population aged 20 and older over 2000–2010 and 2010–2020. Openness is the share of workers employed in a county who reside outside the county, measured using 2006–2010 ACS commuting data. Population is measured in thousands. B.A. share is the proportion of residents aged 25 and older with a bachelor's degree or higher, and Foreign share is the proportion of residents who are foreign born. Farm share, Non-farm share, and Gov't share represent the respective shares of total county employment. Demographic and employment characteristics are measured at the beginning of each study period. County types are defined using the 2003 and 2013 RUCC.

effects of population aging on economic performance.

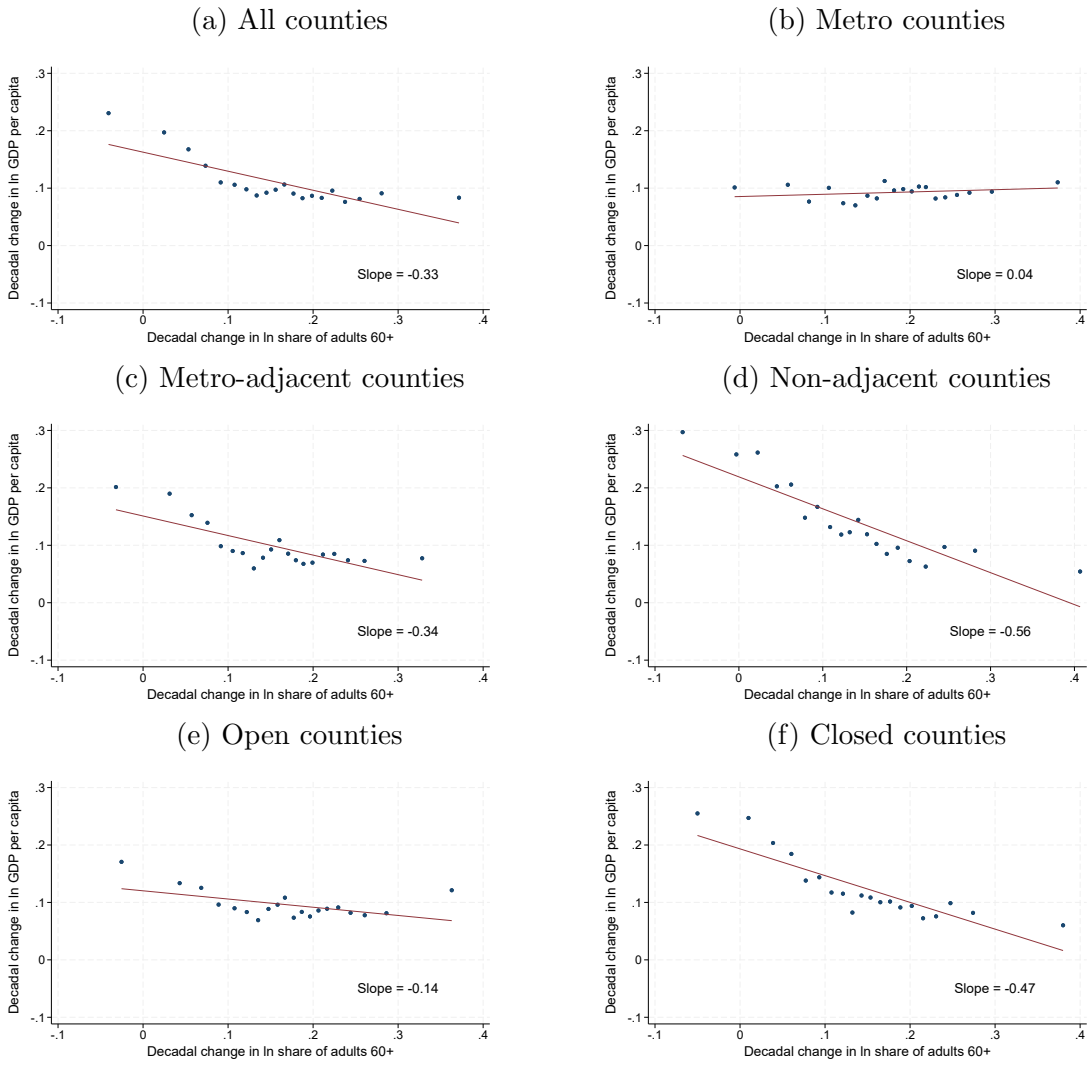
Taken together, these descriptive patterns point to substantial heterogeneity in how population aging manifests across places. While aging is widespread, its implications for growth appear contingent on both county type and the degree of regional labor market integration. These insights motivate the formal econometric analyses in the sections that follow.

4.2 Aggregate Effects of Aging on Economic Growth

We begin by estimating the effect of population aging on economic growth separately for metro and non-metro counties. Table 3 presents the 2SLS estimates using instruments constructed from 10-, 20-, and 30-year lagged age distributions. Panel A reports our preferred unweighted estimates, while Panel B reports population-weighted estimates. All specifications include baseline county characteristics, RUCC fixed effects, and state-by-period fixed effects, with standard errors clustered at the state level.

The results reveal a substantial difference between metro and non-metro counties. In metro counties, the estimated effects of aging are small and statistically insignificant across all three instrument lags. Using the 10-year lag instrument, the unweighted coefficient is -0.02,

Figure 2: Correlation between population aging and economic growth across counties



Notes: Binned scatter plots showing the average decadal change in ln GDP per capita for each of 20 quantiles of decadal change in ln share of adults aged 60+. Regression line is the unweighted correlation in underlying data. Open/closed counties defined as above/below the median of the openness variable. County types are defined using the 2003 and 2013 RUCC.

indicating essentially no measurable effect of population aging on GDP per capita growth. In contrast, the corresponding estimate for non-metro counties is -0.27 and statistically significant at the 1 percent level. This implies that a 10 percent increase in the share of adults aged 60 and older reduces GDP per capita by approximately 2.7 percent over the study period. The non-metro estimates are consistent across instrument lags, ranging from -0.26 to -0.29, while the metro estimates remain statistically indistinguishable from zero.

The population-weighted estimates in Panel B reinforce this broader geographic pattern. Despite placing greater emphasis on more populous counties, the estimated effects in non-

Table 3: Aging and economic growth by instrument lag and county type

	Metro			**Non-metro**		
	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Unweighted 2SLS						
Aging	-0.020	0.047	0.081	-0.270***	-0.266***	-0.290***
	(0.043)	(0.057)	(0.093)	(0.102)	(0.101)	(0.088)
N	2,168	2,166	2,165	3,877	3,870	3,863
F	853.48	379.01	80.44	886.09	306.80	147.52
Panel B: Weighted 2SLS						
Aging	0.035	0.064	0.137	-0.268***	-0.321***	-0.244***
	(0.060)	(0.058)	(0.085)	(0.070)	(0.068)	(0.068)
N	2,167	2,166	2,165	3,872	3,870	3,863
F	407.53	191.53	35.42	623.61	164.96	113.18

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects. Panel B uses year 2000 population weights.

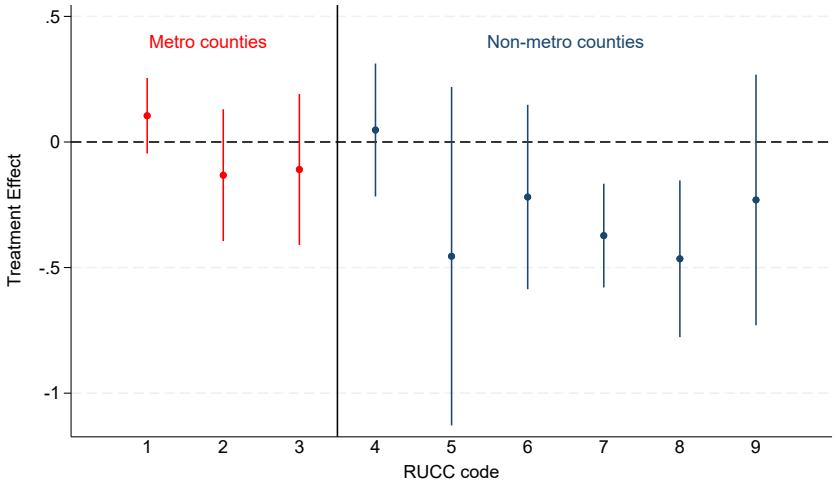
metro counties remain negative and statistically significant across all three instrument lags, with coefficients ranging from -0.24 to -0.32. In contrast, the weighted estimates for metro counties remain statistically insignificant. Thus, the negative effects estimated for non-metro counties do not appear to be driven exclusively by the smallest rural counties. Although our preferred unweighted specifications reflect the place-based focus of the analysis, the weighted results demonstrate that the adverse effects of aging remain substantial when larger non-metro counties receive greater influence in estimation.

The first-stage F-statistics are well above conventional thresholds across specifications, indicating strong instrument relevance. For completeness, Appendix Table 9 presents the full set of unweighted and population-weighted 2SLS estimates for all counties pooled together and separately for metro and non-metro counties, along with their corresponding first-stage and reduced-form estimates. These additional results allow readers to examine both the relationship between predicted and actual aging and the reduced-form relationship between predicted aging and economic growth.

To explore finer geographic heterogeneity, Figure 3 presents estimated effects separately for each of the nine RUCCs, using the 10-year lag instrument. Estimated effects are generally small and statistically insignificant across the three metro categories (RUCC 1–3). However, the RUCC classifications allow us to compare non-metro counties with similar levels of urbanization but different proximity to metro areas. For example, RUCC 4 and 5 counties both have urban populations of at least 20,000, but differ in whether they are adjacent to a metro area. The estimated effect is close to zero for RUCC 4 counties, compared with a

substantially more negative point estimate for RUCC 5 counties, although neither estimate is statistically significant. Consider two illustrative cases in Colorado: Fremont County (RUCC 4), anchored by the city of Cañon City, lies just southwest of Colorado Springs and is closely tied to that metro area's labor market through commuting and service spillovers. In contrast, Montrose County (RUCC 5) is a similarly sized urban county on Colorado's Western Slope, geographically distant from major metro areas. Despite similar urban scale, the economic insulation of Montrose may leave it more vulnerable to the growth challenges posed by population aging.

Figure 3: Aging and economic growth by rural-urban continuum codes (RUCCs)



Notes: Results using 10 year lag instrument and robust standard errors clustered at the state level. The vertical lines show 95% confidence intervals for each estimated coefficient. All regressions include baseline county controls and state-by-period fixed effects.

A similar pattern emerges when comparing RUCC 6 and 7 counties, which have urban populations between 2,500 and 19,999. However, the pattern is not uniform across all categories: RUCC 8 counties, which are adjacent to metro areas but have very small urban populations, also exhibit large negative effects. These findings suggest that both metro proximity and local urbanization may be relevant to understanding geographic variation in aging effects. Appendix Table 11 reports the underlying coefficient estimates for all nine RUCC categories across all three instrument lags, using both unweighted and population-weighted specifications. Although the broad patterns are generally consistent, estimates for individual RUCC categories are often imprecise, reflecting the smaller samples when counties are divided into nine groups. Thus, while the point estimates suggest potentially important differences by metro proximity, the uncertainty surrounding individual estimates limits the conclusions we can draw from these comparisons.

To obtain more precise estimates of these geographic differences, we next combine the non-metro RUCC categories into broader adjacent and non-adjacent groups. Table 4 presents the corresponding estimates (see Appendix Table 10 for first-stage and reduced-form results). In the unweighted specifications, aging has a negative effect on GDP per capita growth in both groups. Using the 10-year lag instrument, the estimated coefficient is −0.25 for adjacent counties and −0.30 for non-adjacent counties, both statistically significant. The estimates for non-adjacent counties become somewhat more negative with longer instrument lags, while those for adjacent counties are less consistent. Overall, the unweighted results suggest that population aging adversely affects growth across non-metro counties, with somewhat larger point estimates in non-adjacent counties.

Table 4: Aging and economic growth by instrument lag and county type

	Metro-adjacent			**Non-adjacent**		
	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Unweighted 2SLS						
Aging	-0.257***	-0.269**	-0.179	-0.301**	-0.333**	-0.401***
	(0.099)	(0.124)	(0.118)	(0.137)	(0.139)	(0.129)
N	2,016	2,015	2,012	1,861	1,855	1,851
F	496.24	338.56	173.19	295.64	154.98	109.86
Panel B: Weighted 2SLS						
Aging	-0.151	-0.237**	-0.104	-0.463***	-0.555***	-0.522***
	(0.097)	(0.093)	(0.112)	(0.071)	(0.090)	(0.106)
N	2,016	2,015	2,012	1,856	1,855	1,851
F	301.41	202.17	128.15	273.41	81.82	58.20

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects. Panel B uses year 2000 population weights.

The population-weighted estimates reveal an even more pronounced distinction between the two groups. For adjacent non-metro counties, the estimated coefficients range from −0.10 to −0.23 and are statistically significant in only one of the three specifications. In contrast, the coefficients for non-adjacent counties range from −0.46 to −0.55 and are statistically significant at the 1 percent level across all three instrument lags. Using the 10-year instrument, a 10 percent increase in the older adult share is associated with approximately a 4.6 percent decline in GDP per capita in non-adjacent counties, compared with an estimated decline of 1.5 percent in adjacent counties.

Comparing the weighted and unweighted estimates provides additional insight into the geographic distribution of aging effects. In adjacent non-metro counties, population weighting generally attenuates the estimated negative effects, suggesting that the adverse conse-

quences of aging may be more pronounced among smaller counties within this group. In non-adjacent counties, however, population weighting produces substantially larger negative estimates, indicating that the estimated effects are not confined to the smallest and least populous communities. Because weighting changes the relative contribution of observations to the IV estimates, these differences may reflect heterogeneity in the effects of aging as well as differences in instrument-induced variation across counties.

Taken together, the results indicate that the negative economic effects of population aging are concentrated in non-metro counties. Our preferred unweighted estimates suggest adverse effects across both adjacent and non-adjacent counties, while the population-weighted estimates reveal particularly large effects in non-adjacent counties. These patterns highlight the importance of geographic context in understanding the local consequences of population aging. Proximity to metro areas may provide access to larger labor markets and broader economic opportunities, potentially influencing how counties adjust to demographic change. We investigate this possibility further in the following section using commuting flows as a more direct measure of regional labor-market integration.

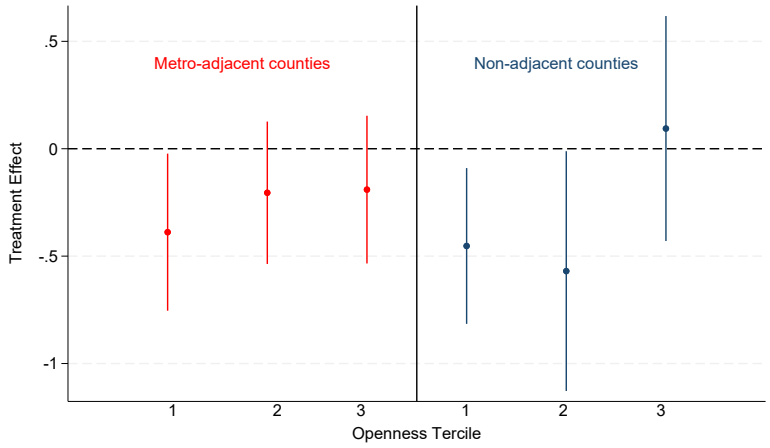
4.3 Commuting Openness

We next investigate whether differences in commuting openness are associated with heterogeneity in the economic effects of population aging. While the RUCC classifications distinguish non-metro counties based on their proximity to metro areas, commuting openness provides a more direct measure of integration into surrounding labor markets. In particular, even counties that are not adjacent to metro areas may maintain substantial commuting connections with neighboring communities. These connections could allow local employers to draw on workers from outside the county, potentially mitigating some of the labor supply pressures associated with population aging.

Figure 4 presents the estimated effects of aging on GDP per capita growth across terciles of commuting openness, separately for adjacent and non-adjacent non-metro counties. Terciles are defined using the distribution of commuting openness among all non-metro counties, with higher terciles indicating a larger share of workers commuting into the county from elsewhere. The figure reports our preferred unweighted 2SLS estimates using the 10-year lag instrument. Appendix Table 12 provides the corresponding estimates for all three instrument lags under both unweighted and population-weighted specifications.

Among adjacent non-metro counties, the estimated effects are generally negative, although the pattern across commuting terciles is not particularly consistent. In Figure 4, counties in the lowest tercile of openness exhibit a negative and statistically significant ef-

Figure 4: Aging and economic growth by commuting openness tercile



Notes: Results using all non-metro counties and 10 year lag. Robust standard errors clustered at the state level. The vertical lines show 95% confidence intervals for each estimated coefficient. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects.

fect of aging, with an estimated coefficient of −0.38. The corresponding estimates for the middle and highest terciles are smaller in magnitude and statistically insignificant. However, Appendix Table 12 shows that this pattern is not robust across instrument lags and weighting schemes. The magnitudes and statistical significance of the estimates vary considerably across terciles, providing limited evidence of a systematic relationship between commuting openness and the effects of aging among adjacent non-metro counties.

A much clearer pattern emerges among non-adjacent counties. In Figure 4, the estimated effects of aging are negative and statistically significant in the lowest and middle terciles of commuting openness, with coefficients of −0.45 and −0.57, respectively. In contrast, the estimated coefficient for the highest tercile is 0.09 and statistically insignificant. This distinction is remarkably consistent across the alternative specifications reported in Appendix Table 12. For non-adjacent counties, the estimated effects in the lowest and middle terciles remain negative and statistically significant across all three instrument lags, regardless of whether the regressions are weighted by population. The estimated effects for the highest tercile are consistently smaller in magnitude and statistically insignificant across all six specifications.

These findings suggest that commuting integration may be particularly relevant to the economic consequences of aging in non-adjacent counties. Although these counties are geographically separated from metro areas, those with greater reliance on workers from outside their boundaries appear less exposed to the negative growth effects associated with population aging. One possible explanation is that commuting connections expand the labor pool available to local employers, allowing them to partially offset changes in the resident

working-age population. Such connections may therefore provide opportunities for economic adjustment even in counties without direct proximity to metro labor markets.

Nevertheless, these results should be interpreted cautiously. Commuting openness may reflect other county characteristics associated with economic resilience, and the differences in estimated coefficients across terciles do not establish a causal moderating effect of commuting integration. Rather, the consistent pattern among non-adjacent counties is suggestive of an important role for regional labor-market connections in shaping local responses to demographic aging.

4.4 Industry-Specific Effects

To better understand how population aging affects different components of local economic activity, we estimate separate IV regressions using growth in real GDP per capita by industry as the outcome. Table 5 presents our preferred unweighted estimates using the 10-year lag instrument, separately for metro, adjacent non-metro, and non-adjacent counties. The ten industries are ordered by their average share of national GDP, from finance and real estate to agriculture. Because smaller industries are generally more likely to have suppressed county-level GDP observations, the estimation sample tends to be smaller for industries appearing toward the bottom of the table. Appendix Table 13 reports the corresponding population-weighted estimates.

A notable feature of the results is that several industries exhibit different patterns across county types. In particular, finance and real estate, manufacturing, and retail trade generally have more favorable estimated responses to aging in metro counties than in non-adjacent counties. These contrasts suggest that the economic adjustments associated with population aging may depend not only on industrial composition, but also on the geographic context in which those industries operate.

Finance and real estate provides a particularly interesting example. In the unweighted specifications, aging has a positive and statistically significant effect on GDP per capita in this industry for both metro and adjacent non-metro counties, with estimated coefficients of 0.22 and 0.16, respectively. In contrast, the coefficient for non-adjacent counties is negative (-0.16), although statistically insignificant. The population-weighted estimates preserve this general directional pattern, with positive coefficients for metro and adjacent counties and a statistically significant negative coefficient (-0.21) for non-adjacent counties. One possible explanation is that metro and adjacent counties are better positioned to accommodate changes in housing, financial, and property-related economic activity associated with an aging population, while more geographically isolated counties may face greater constraints in

Table 5: Aging and economic growth by industry and county type

Industry	**Metro**	**Metro-adjacent**	**Non-adjacent**
Finance and Real Estate	0.220***	0.164**	-0.167
	(0.083)	(0.078)	(0.123)
N	2,077	1,876	1,632
Government	-0.045	-0.130***	-0.106**
	(0.037)	(0.050)	(0.043)
N	2,148	2,017	1,878
Manufacturing	0.242	-0.166	-0.097
	(0.178)	(0.263)	(0.231)
N	2,048	1,767	1,374
Education and Health	0.110	0.099	0.493***
	(0.086)	(0.143)	(0.104)
N	1,949	1,660	1,476
Retail Trade	0.249***	0.014	-0.186**
	(0.088)	(0.144)	(0.079)
N	2,136	1,961	1,731
Construction	-0.766***	-0.209	-0.972***
	(0.172)	(0.312)	(0.159)
N	2,008	1,756	1,376
Arts and Hospitality	0.047	0.004	-0.038
	(0.135)	(0.160)	(0.123)
N	1,987	1,728	1,480
Utilities	0.173	0.218	-0.518
	(0.384)	(0.478)	(0.475)
N	1,602	1,500	1,356
Mining	-0.314	0.050	0.131
	(0.340)	(0.682)	(0.580)
N	1,813	1,468	1,331
Agriculture	-1.090**	-2.670***	-0.443
	(0.465)	(0.687)	(0.597)
N	1,356	1,461	1,280

Notes: Results using 10 year lag instrument. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. Outcomes trimmed at the 1% level within each industry. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects.

responding to these changes.

Retail trade exhibits a similar geographic contrast. In metro counties, the unweighted estimate is positive and statistically significant (0.24), while the estimated effect in adjacent non-metro counties is close to zero. In non-adjacent counties, however, the coefficient is negative and statistically significant (-0.18). Although the positive metro effect is not robust to population weighting, the negative effect in non-adjacent counties persists, with a weighted coefficient of -0.22. These findings suggest that retail activity in non-adjacent counties may be particularly vulnerable to demographic aging, potentially reflecting differences in local consumer demand, market size, or connections to surrounding economic activity.

Manufacturing also exhibits potentially important geographic differences, although the evidence is less precise. The unweighted point estimate is positive for metro counties (0.24) and negative for both adjacent and non-adjacent counties, but none of these coefficients is statistically significant. Under population weighting, however, the metro coefficient becomes substantially larger and statistically significant (0.75), while the estimate for non-adjacent counties remains negative and insignificant (-0.25). This pattern is consistent with the possibility that metro counties have greater capacity to maintain or expand manufacturing activity as their populations age, perhaps through access to larger labor markets, capital investment, or adjustments in production processes. Nevertheless, the estimates do not identify these specific mechanisms, and the manufacturing results provide more suggestive evidence than those for other industries.

Other sectors reveal important responses that do not follow the same geographic pattern. Construction exhibits large negative effects in both metro and non-adjacent counties, with unweighted coefficients of -0.76 and -0.97, respectively. Both remain negative and statistically significant in the population-weighted specifications. In contrast, construction estimates for adjacent non-metro counties are smaller and statistically insignificant under both weighting schemes. These results suggest that construction activity may be especially sensitive to population aging in certain geographic environments, although the pattern is not simply one of increasingly negative effects with greater rural isolation.

Education[4] and health services stand out as an industry with positive estimated effects in non-adjacent counties. The unweighted coefficient is 0.49 and statistically significant at the 1 percent level, while the weighted coefficient remains positive and significant at 0.34. The corresponding unweighted estimates for metro and adjacent non-metro counties are positive but statistically insignificant. This result suggests that education and health-related

[4]Note that in the Bureau of Economic Analysis industry breakdowns, public K-12 education falls in the government sector. The education sector includes private K-12 schools along with a broader range of educational services such as trade schools and educational support services like testing services.

economic activity may expand in response to population aging even in counties experiencing declines in aggregate GDP per capita. Increased demand for health services among older residents offers one possible explanation, although the combined industry category does not allow us to distinguish the contributions of healthcare separately from education.

Among adjacent non-metro counties, agriculture exhibits a particularly large negative effect. The unweighted coefficient is -2.67 and statistically significant at the 1 percent level, while the population-weighted estimate is even more negative (-3.52). The agriculture coefficients are also negative in metro and non-adjacent counties, although they are less consistently significant across weighting schemes. The magnitude of these estimates suggests that agricultural activity in adjacent non-metro counties may be especially sensitive to demographic change. However, the relatively small and selective industry-level samples warrant caution when interpreting these estimates.

The remaining industries provide more limited evidence of systematic effects. Government GDP per capita declines significantly in both adjacent and non-adjacent counties in the unweighted specifications, but these effects are not robust to population weighting. Estimates for arts and hospitality, utilities, and mining are generally imprecise, with no consistently significant patterns across the three geographic groups.

Taken together, the industry results suggest that population aging produces uneven effects across different components of local economic activity, and that these responses vary meaningfully by geography. The contrasting patterns in finance and real estate, manufacturing, and retail trade are particularly noteworthy: metro counties generally exhibit more favorable estimated responses, while non-adjacent counties experience negative or less favorable outcomes. At the same time, the positive effects in education and health services in non-adjacent counties indicate that some sectors may expand even where aging reduces aggregate economic growth.

These patterns are consistent with differences in the capacity of local economies to adjust to demographic change. Counties with access to larger labor markets, broader consumer markets, or more diversified economic activity may be better positioned to accommodate aging-related shifts in demand and production. However, the industry regressions do not directly identify these mechanisms. Moreover, because industry-specific regressions use different estimation samples and dependent variables expressed in log changes, the coefficients should not be interpreted as an accounting decomposition of the aggregate GDP effect.

4.5 Robustness Checks

We conduct several robustness checks to assess the sensitivity of our findings to alternative sample restrictions, outcome definitions, demographic controls, and geographic units of analysis. Table 6 reports estimates for metro and non-metro counties using all three instrument lags. The first row reproduces our preferred unweighted baseline estimates, which exclude observations in the top and bottom 1 percent of the distribution of changes in log real GDP per capita. The remaining rows examine alternative specifications. Across these checks, the central finding remains consistent: population aging has a negative and statistically significant effect on economic growth in non-metro counties, while the estimated effects in metro counties are generally small and statistically insignificant.

Table 6: Aging and economic growth robustness results

	Metro			**Non-metro**		
	10-year	20-year	30-year	10-year	20-year	30-year
Baseline	-0.020	0.047	0.081	-0.270***	-0.266***	-0.290***
	(0.043)	(0.057)	(0.093)	(0.102)	(0.101)	(0.088)
Trim at 3%	-0.011	-0.016	-0.042	-0.300***	-0.396***	-0.348***
	(0.033)	(0.039)	(0.058)	(0.070)	(0.091)	(0.086)
Winsorize 3%	-0.017	0.038	0.064	-0.281***	-0.256**	-0.238**
	(0.046)	(0.056)	(0.077)	(0.100)	(0.105)	(0.101)
Winsorize 5%	-0.019	0.025	0.039	-0.278***	-0.277***	-0.247***
	(0.040)	(0.047)	(0.064)	(0.086)	(0.090)	(0.086)
2020 GDP	-0.023	0.058	0.100	-0.301***	-0.282***	-0.266***
	(0.049)	(0.058)	(0.091)	(0.096)	(0.098)	(0.090)
Age controls	-0.074*	0.105	0.003	-0.242**	-0.213**	-0.227***
	(0.044)	(0.113)	(0.083)	(0.096)	(0.097)	(0.085)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All estimates are from unweighted 2SLS regressions with standard errors clustered at the state level. The baseline specification trims observations in the top and bottom 1 percent of the distribution of changes in log real GDP per capita. Alternative outlier specifications trim at the 3rd and 97th percentiles or winsorize at the 3rd and 97th or 5th and 95th percentiles. The 2020 GDP specification uses 2020 rather than 2019 as the endpoint of the second growth period. The age-controls specification additionally includes changes in the shares of adults aged 30–39, 40–49, and 50–59, instrumented using predicted cohort measures. The 30–39 age group is excluded from the 30-year instrument specification as the IV is not available. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects.

4.5.1 Handling of Outliers

We first examine whether the results are sensitive to the treatment of extreme economic growth observations. County-level GDP growth can be particularly volatile in small counties, where changes in activity at a few establishments may generate substantial fluctuations in measured output. Our baseline specification trims the top and bottom 1 percent of the growth distribution. We consider a more restrictive trimming threshold of 3 percent, as well as specifications that winsorize growth at the 3rd and 97th percentiles or the 5th and 95th percentiles. Across alternative trimming and winsorization thresholds, the non-metro estimates remain negative and statistically significant, while the metro estimates remain statistically insignificant. Thus, the main findings are not sensitive to the treatment of extreme growth observations.

4.5.2 Using 2020 GDP Data

We also examine the sensitivity of our results to the endpoint used to measure economic growth. Our baseline specification uses 2019 GDP to avoid the economic disruptions associated with the COVID-19 pandemic. As an alternative, we extend the second growth period through 2020. The resulting estimates remain similar to the baseline. In non-metro counties, the coefficients range from -0.26 to -0.30 across instrument lags and remain statistically significant at the 1 percent level. Metro estimates continue to be statistically insignificant. Thus, our main findings are not sensitive to whether we include 2020 in the economic growth measure.

4.5.3 Controlling for Younger Age Groups

A further concern is that changes in the share of older adults may be correlated with changes in other age groups that independently influence economic growth. To investigate this possibility, we augment the baseline specification with changes in the population shares aged 30–39, 40–49, and 50–59. We instrument these additional demographic changes using predicted cohort measures constructed from historical age distributions, following the same general approach used for our primary aging measure.[5] Including these additional age controls modestly attenuates the estimated effects of aging in non-metro counties, but the coefficients remain negative and statistically significant across all three instrument lags, ranging from -0.21 to -0.24. The metro estimates remain generally insignificant. These results suggest that the negative effects identified in non-metro counties are not simply explained by corre-

[5]The 30–39 age group is excluded from the specification using the 30-year lag because the corresponding historical age distribution does not allow us to construct its instrument.

lated changes in the relative sizes of younger adult cohorts. Rather, the aging effect appears robust to controlling for broader demographic restructuring within counties.

4.5.4 Commuting Zone Analysis

As an additional robustness check, we aggregate our analysis to 2020 commuting zones (CZs), which more closely approximate integrated local labor markets than individual counties. County boundaries may divide economically connected communities, particularly where residents routinely commute across county lines. Consequently, some of the effects attributed to aging within individual counties could reflect changes in economic activity across neighboring jurisdictions. Estimating the model at the CZ level allows us to examine whether the negative effects of aging persist when economic activity and demographic change are measured over broader labor-market areas.

Table 7 reports the results using the same three instrument lags. Across all CZs, the estimated effects of population aging are negative and statistically significant, with coefficients of -0.56, -0.54, and -0.38 for the 10-, 20-, and 30-year instruments, respectively. These estimates are more negative than the corresponding pooled county-level estimates, indicating that geographic aggregation changes the magnitude of the estimated effect. Nevertheless, the negative relationship persists when the unit of analysis more closely approximates an integrated local labor market.

Table 7: Aging and economic growth at the commuting zone level

	All Commuting Zones			**Population >250k**			**Population <250k**		
	10-year	20-year	30-year	10-year	20-year	30-year	10-year	20-year	30-year
Aging	-0.566***	-0.549***	-0.384***	-0.281**	-0.151	-0.106	-0.599***	-0.579***	-0.459***
	(0.102)	(0.111)	(0.111)	(0.113)	(0.107)	(0.108)	(0.115)	(0.131)	(0.153)
N	1,121	1,121	1,118	430	430	430	691	691	688
F	735.70	551.21	259.44	257.64	153.67	158.25	552.14	430.40	140.50

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the commuting zone level. Split based on 2000 population. All regressions include baseline CZ controls and period fixed effects.

We further divide CZs according to their population in 2000, using a threshold of 250,000 residents to distinguish larger and smaller labor markets.[6] Among smaller CZs, the estimated effects are consistently negative and statistically significant across all three instrument lags, ranging from -0.45 to -0.59. In larger CZs, the estimates are substantially smaller in

[6]This population split for commuting zones mimics the ratio of metro to non-metro counties. Specifically, our baseline result has about 36% metro counties and the commuting zone population cutoff yields 38% of commuting zones above 250,000 people.

magnitude. The 10-year lag coefficient is −0.281 and statistically significant, while the 20- and 30-year estimates are smaller and statistically insignificant.

These findings broadly reinforce the geographic heterogeneity documented in our county-level analysis. In particular, the adverse effects of population aging appear more pronounced in smaller local labor markets, consistent with the larger negative estimates found in non-metro counties. Although CZ population size is not equivalent to metro status, the results suggest that the relative scale of local labor markets is an important dimension of the economic consequences of aging. More generally, the persistence of negative effects at the CZ level indicates that our findings are not solely an artifact of using county boundaries to measure local economic growth.

5 Placebo Tests

A central identifying assumption of our IV strategy is that predicted population aging, constructed using historical county age distributions and national cohort population changes, affects economic growth through its relationship with subsequent demographic aging rather than through persistent local economic conditions. One concern is that historical age structure may be correlated with county characteristics or long-run economic trajectories that independently influence growth. We investigate this concern using a pre-period placebo test that examines whether predicted future aging is associated with economic growth in an earlier period.

Specifically, we examine whether predicted changes in the share of adults aged 60 and older between 2010 and 2020 are associated with real GDP per capita growth between 2001 and 2010.[7] The placebo specification follows our baseline model, retaining the same beginning-of-period county controls and geographic fixed effects, but replacing the aging variable with predicted aging in the subsequent decade. Because the placebo uses a single economic growth period, the state-by-period fixed effects in our baseline specification reduce to state fixed effects. We estimate the placebo regressions using OLS, separately for metro and non-metro counties, and report both unweighted and population-weighted specifications.

This exercise provides a diagnostic for whether the historical age structures underlying our instruments capture persistent local economic conditions that may independently predict growth. If predicted aging in 2010–2020 is systematically associated with economic growth in the preceding period, this could indicate that the instrument reflects broader differences in local economic trajectories rather than exclusively demographic momentum. However,

[7] We focus on 2001–2010 because county-level GDP data are only available beginning in 2001, preventing construction of earlier economic growth measures.

because population aging may be persistent across decades, predicted future aging could also be correlated with actual aging during the earlier period. A significant placebo coefficient could therefore partly reflect the effects of earlier aging on earlier economic growth, rather than a violation of the exclusion restriction. We consequently interpret these tests as diagnostic evidence rather than definitive tests of instrument validity.

Table 8 presents the placebo results using predicted future aging constructed from 10-, 20-, and 30-year lagged age distributions. In our preferred unweighted specifications (Panel A), the coefficients are small and statistically insignificant across all three instrument lags for both metro and non-metro counties. Thus, we find no evidence in the unweighted specifications that predicted population aging in 2010–2020 systematically explains economic growth in the preceding decade.

Table 8: Aging and economic growth placebo results

	Metro			**Non-metro**		
	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Unweighted OLS						
Future PredAging	-0.018	-0.052	0.098	-0.046	-0.059	0.041
	(0.095)	(0.102)	(0.142)	(0.070)	(0.080)	(0.079)
Panel B: Weighted OLS						
Future PredAging	0.278***	0.166**	0.089	-0.038	-0.112*	-0.010
	(0.073)	(0.082)	(0.083)	(0.070)	(0.060)	(0.057)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All estimates are from OLS regressions of real GDP per capita growth during 2001–2010 on predicted population aging during 2010–2020. The regressions use the same baseline county controls as the main specification, including log population, bachelor's degree share, foreign-born share, farm employment share, and private nonfarm employment share. State and RUCC fixed effects are included. Panel B uses year 2000 population weights.

The population-weighted results in Panel B provide somewhat more mixed evidence. Among non-metro counties, the placebo coefficients remain relatively small and are statistically insignificant for the 10- and 30-year instruments. The 20-year instrument produces a negative coefficient of -0.11, significant at the 10 percent level. In metro counties, however, the placebo estimates are statistically significant for the 10- and 20-year instruments, although the 30-year estimate is insignificant. Notably, the placebo coefficients in metro counties are positive. Given the positive first-stage relationship between predicted and actual aging, these associations would be consistent with upward rather than downward bias in the IV estimates if they reflected persistent unobserved determinants of economic growth. Thus, while these findings raise concerns about instrument validity in the population-weighted metro specifications, they do not suggest a source of spurious negative IV estimates. Nev-

ertheless, the placebo coefficients cannot establish the direction or magnitude of any bias in the main specifications.

Overall, the placebo results are broadly consistent with the credibility of our preferred unweighted estimates. In particular, the absence of significant placebo effects in non-metro counties is reassuring given that these counties exhibit the largest negative effects of aging in our main analysis. The population-weighted placebo results also provide relatively reassuring evidence for non-metro counties, with only one marginally significant coefficient across the three instrument lags. Nevertheless, the significant placebo coefficients in some population-weighted metro specifications suggest that historical age structure may capture persistent economic characteristics in certain county groups. While these tests cannot establish the exclusion restriction, they provide an additional diagnostic that complements our main IV analysis and robustness checks.

6 Discussion and Conclusion

Our findings highlight substantial geographic differences in the economic consequences of population aging across U.S. counties. In our preferred unweighted specifications, a 10 percent increase in the share of adults aged 60 and older reduces real GDP per capita by approximately 2.7 percent in non-metro counties, while the estimated effects in metro counties are statistically insignificant. Within non-metro counties, both adjacent and non-adjacent counties experience negative effects, although the estimates are somewhat larger in the latter group. Population weighting reveals a more pronounced distinction, with particularly large negative effects in non-adjacent counties. These results suggest that population aging may reinforce geographic disparities in economic performance, with the consequences depending importantly on the characteristics of local economies.

A central question is why some places appear better able to accommodate population aging than others. One possibility is that connections to surrounding labor markets allow local employers to draw on workers beyond their aging resident populations. Our analysis of commuting openness provides evidence consistent with this explanation. Among non-adjacent non-metro counties, the estimated effects of aging are consistently negative and statistically significant in counties with low or moderate commuting openness, but smaller and statistically insignificant among those with the greatest reliance on outside workers. The corresponding patterns are less consistent among adjacent non-metro counties. These findings suggest that geographic proximity to metro areas and actual commuting connections capture distinct dimensions of regional integration. However, because commuting openness may be related to other economic characteristics, these results should be interpreted as

suggestive rather than causal evidence of a mitigating role for labor-market connectivity.

Our industry-specific results further illustrate how the economic consequences of aging vary across geographic environments. In finance and real estate, retail trade, and manufacturing, the estimated effects of aging are positive in metro counties but negative in non-adjacent counties, although some of these estimates are statistically insignificant. Construction exhibits substantial negative effects in both metro and non-adjacent counties, while agriculture experiences particularly large estimated declines in adjacent non-metro counties. Importantly, education and health services exhibit a positive and statistically significant response in non-adjacent counties, even as these counties experience declines in aggregate GDP per capita. Thus, the economic consequences of aging are not uniformly negative across industries, even in places facing substantial aggregate losses.

These sectoral patterns are consistent with the possibility that local economies differ in their capacity to adjust production and demand in response to demographic change. Larger or more economically connected places may be better positioned to maintain activity in industries that serve broader markets, while geographically isolated counties may face greater constraints on their labor supply and customer base. At the same time, an aging population may generate additional demand for certain services, creating opportunities for expansion even in counties experiencing slower aggregate growth. Our estimates do not directly identify these mechanisms, however, and the industry-specific results should not be interpreted as a decomposition of the aggregate growth effects.

Much of the policy debate around population aging has focused on national-level levers, such as the retirement age, immigration, and fertility incentives. However, from a local policy perspective, our results underscore the importance of targeted strategies to bolster economic resilience in aging, non-integrated regions. Investments in transportation infrastructure, broadband connectivity, and workforce development could help strengthen ties to larger labor markets and expand local capacity to attract or grow service-based industries. Regional planning efforts that promote integration may therefore not only support short-term labor mobility, but also foster long-run adaptability to demographic change. More broadly, these results suggest that demographic aging may contribute to widening regional economic disparities if economically isolated areas lack the connectivity needed to adjust.

Our findings contribute to the literature on population aging by demonstrating that its economic effects vary considerably across local economies. While previous research has documented the broader consequences of aging for economic growth and productivity (e.g., Maestas et al. (2023)), our analysis emphasizes the importance of the urban-rural divide and differences in regional economic integration. The results also reveal geographic variation in industry-specific responses, suggesting that the economic adjustment to aging may involve

both contractions and expansions in local production. Together, these findings underscore the value of examining demographic change at a geographic scale that captures differences in local economic structure and connections to surrounding markets.

Our study has limitations that suggest directions for future research. First, because our approach instruments for aging using lagged age shares, it estimates the impact of demographic momentum rather than aging driven by recent migration. That is, our results capture the effects of aging due to underlying cohort aging and long-run settlement patterns, not selective in- or out-migration of older or younger populations. Second, while we emphasize regional integration through geographic proximity and commuting flows, other dimensions, such as institutional collaboration, trade linkages, or governance structure may also shape resilience to aging. Future work could incorporate these additional channels. Lastly, while we focus on economic growth, aging may affect other dimensions of well-being, such as health outcomes, inequality, or civic engagement that merit further attention. Additional research using firm- or worker-level data could also help clarify the mechanisms through which demographic change affects productivity, labor demand, and industrial structure across regions.

In sum, the economic consequences of population aging depend not only on demographic change itself, but also on the geographic and economic environments in which it occurs. Metro counties exhibit little measurable reduction in growth, while non-metro counties, particularly those with limited connections to surrounding labor markets, experience substantial negative effects. As population aging continues, understanding these geographic differences will be important for developing place-based economic strategies that respond to the distinct challenges and opportunities facing aging communities.

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7 Appendix

Table 9: Aging and economic growth by instrument lag and county type

	All counties			**Metro**			**Non-metro**		
	10-year	20-year	30-year	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Unweighted 2SLS									
Aging	-0.189**	-0.142*	-0.134	-0.020	0.047	0.081	-0.270***	-0.266***	-0.290***
	(0.075)	(0.081)	(0.089)	(0.043)	(0.057)	(0.093)	(0.102)	(0.101)	(0.088)
N	6,045	6,036	6,028	2,168	2,166	2,165	3,877	3,870	3,863
F	1,098.18	476.92	238.36	853.48	379.01	80.44	886.09	306.80	147.52
Panel B: Unweighted First Stage									
PredAging	0.695***	0.622***	0.547***	0.743***	0.679***	0.558***	0.674***	0.595***	0.537***
	(0.021)	(0.028)	(0.035)	(0.025)	(0.034)	(0.060)	(0.022)	(0.033)	(0.043)
Panel C: Unweighted Reduced Form									
PredAging	-0.131**	-0.088*	-0.074	-0.015	0.032	0.045	-0.182**	-0.158**	-0.156***
	(0.053)	(0.052)	(0.051)	(0.032)	(0.039)	(0.051)	(0.072)	(0.062)	(0.051)
Panel D: Weighted 2SLS									
Aging	-0.034	-0.004	0.079	0.035	0.064	0.137	-0.268***	-0.321***	-0.244***
	(0.050)	(0.048)	(0.069)	(0.060)	(0.058)	(0.085)	(0.070)	(0.068)	(0.068)
N	6,039	6,036	6,028	2,167	2,166	2,165	3,872	3,870	3,863
F	626.61	272.40	46.61	407.53	191.53	35.42	623.61	164.96	113.18
Panel E: Weighted First Stage									
PredAging	0.765***	0.718***	0.585***	0.793***	0.761***	0.603***	0.693***	0.584***	0.520***
	(0.030)	(0.043)	(0.084)	(0.038)	(0.053)	(0.098)	(0.027)	(0.044)	(0.048)
Panel F: Weighted Reduced Form									
PredAging	-0.026	-0.003	0.046	0.028	0.048	0.082*	-0.185***	-0.187***	-0.127***
	(0.038)	(0.035)	(0.038)	(0.048)	(0.044)	(0.047)	(0.050)	(0.044)	(0.039)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects. Weighted results use year 2000 population weights.

Table 10: Aging and economic growth by instrument lag and non-metro county type

	Metro-adjacent			**Non-adjacent**		
	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Unweighted 2SLS						
Aging	-0.257***	-0.269**	-0.179	-0.301**	-0.333**	-0.401***
	(0.099)	(0.124)	(0.118)	(0.137)	(0.139)	(0.129)
N	2,016	2,015	2,012	1,861	1,855	1,851
F	496.24	338.56	173.19	295.64	154.98	109.86
Panel B: Unweighted First Stage						
PredAging	0.723***	0.577***	0.499***	0.654***	0.616***	0.563***
	(0.031)	(0.030)	(0.037)	(0.037)	(0.048)	(0.052)
Panel C: Unweighted Reduced Form						
PredAging	-0.186***	-0.155**	-0.089	-0.197**	-0.205**	-0.226***
	(0.068)	(0.071)	(0.062)	(0.096)	(0.091)	(0.077)
Panel D: Weighted 2SLS						
Aging	-0.151	-0.237**	-0.104	-0.463***	-0.555***	-0.522***
	(0.097)	(0.093)	(0.112)	(0.071)	(0.090)	(0.106)
N	2,016	2,015	2,012	1,856	1,855	1,851
F	301.41	202.17	128.15	273.41	81.82	58.20
Panel E: Weighted First Stage						
PredAging	0.695***	0.578***	0.507***	0.707***	0.616***	0.538***
	(0.039)	(0.039)	(0.043)	(0.041)	(0.066)	(0.068)
Panel F: Weighted Reduced Form						
PredAging	-0.105	-0.137**	-0.053	-0.327***	-0.341***	-0.280***
	(0.066)	(0.053)	(0.057)	(0.056)	(0.066)	(0.060)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects. Weighted results use year 2000 population weights.

Table 11: Aging and economic growth by rural-urban continuum codes (RUCCs)

	Unweighted			**Weighted**		
RUCC	10-year	20-year	30-year	10-year	20-year	30-year
1	0.105	0.177**	0.137	0.042	0.057	0.097
	(0.077)	(0.074)	(0.090)	(0.082)	(0.074)	(0.097)
2	-0.132	-0.072	0.044	-0.022	-0.050	0.019
	(0.134)	(0.173)	(0.231)	(0.136)	(0.127)	(0.182)
3	-0.110	-0.112	0.036	0.173	0.403**	1.825
	(0.153)	(0.156)	(0.296)	(0.162)	(0.173)	(2.643)
4	0.048	-0.083	-0.071	0.106	-0.013	-0.008
	(0.135)	(0.149)	(0.171)	(0.143)	(0.143)	(0.167)
5	-0.455	-0.344	-0.385	-0.435	-0.342	-0.346
	(0.344)	(0.327)	(0.261)	(0.362)	(0.332)	(0.279)
6	-0.219	-0.304*	-0.069	-0.261	-0.415**	-0.189
	(0.187)	(0.182)	(0.221)	(0.176)	(0.208)	(0.181)
7	-0.373***	-0.515***	-0.412***	-0.497***	-0.615***	-0.489***
	(0.105)	(0.119)	(0.144)	(0.107)	(0.111)	(0.101)
8	-0.465***	-0.499*	-0.729***	-0.514***	-0.727***	-0.855***
	(0.159)	(0.275)	(0.211)	(0.178)	(0.259)	(0.272)
9	-0.231	-0.058	-0.241	-0.371*	-0.332	-0.389
	(0.255)	(0.267)	(0.272)	(0.208)	(0.277)	(0.287)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls and state-by-period fixed effects. Weighted results use year 2000 population weights.

Table 12: Aging and economic growth by tercile of openness in non-metro counties

	Unweighted			Weighted		
Openness	10-year	20-year	30-year	10-year	20-year	30-year
Panel A: Metro-adjacent counties						
1	-0.389**	-0.092	-0.138	-0.162	-0.131	-0.180
	(0.187)	(0.272)	(0.256)	(0.208)	(0.211)	(0.206)
2	-0.205	-0.423***	-0.210	-0.121	-0.167	0.042
	(0.169)	(0.159)	(0.238)	(0.164)	(0.167)	(0.215)
3	-0.190	-0.315	-0.316*	-0.218	-0.499**	-0.406
	(0.175)	(0.199)	(0.171)	(0.183)	(0.250)	(0.249)
Panel B: Non-adjacent counties						
1	-0.453**	-0.383**	-0.488***	-0.479***	-0.484***	-0.483***
	(0.185)	(0.169)	(0.166)	(0.101)	(0.107)	(0.125)
2	-0.570**	-0.938**	-0.727**	-0.726***	-1.006***	-0.749***
	(0.285)	(0.376)	(0.358)	(0.203)	(0.226)	(0.229)
3	0.094	0.165	-0.010	-0.175	-0.119	-0.171
	(0.267)	(0.283)	(0.204)	(0.201)	(0.240)	(0.242)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects. Weighted results use year 2000 population weights.

Table 13: Aging and economic growth by industry and county type weighted by population size

Industry	**Metro**	**Metro-adjacent**	**Non-adjacent**
Finance and Real Estate	0.098	0.171*	-0.218**
	(0.098)	(0.096)	(0.091)
N	2,076	1,876	1,628
Government	0.027	0.028	-0.082
	(0.067)	(0.073)	(0.065)
N	2,147	2,017	1,873
Manufacturing	0.752***	0.299	-0.251
	(0.261)	(0.270)	(0.311)
N	2,047	1,767	1,371
Education and Health	0.172*	0.017	0.346***
	(0.088)	(0.142)	(0.123)
N	1,948	1,660	1,473
Retail Trade	0.045	0.030	-0.226**
	(0.078)	(0.135)	(0.106)
N	2,135	1,961	1,726
Construction	-0.518**	-0.157	-0.985***
	(0.230)	(0.273)	(0.161)
N	2,007	1,756	1,372
Arts and Hospitality	0.073	-0.033	-0.147
	(0.153)	(0.158)	(0.108)
N	1,986	1,728	1,475
Utilities	-0.454	0.021	-0.999*
	(0.398)	(0.555)	(0.580)
N	1,601	1,500	1,353
Mining	-0.506	1.213	-0.234
	(0.521)	(0.876)	(0.716)
N	1,812	1,468	1,330
Agriculture	-0.624	-3.521***	-1.276*
	(0.496)	(0.764)	(0.679)
N	1,355	1,461	1,277

Notes: Results using 10 year lag instrument. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the state level. Outcomes trimmed at the 1% level within each industry. All regressions include baseline county controls, RUCC fixed effects, and state-by-period fixed effects.