

ENTREPRENEURSHIP AND URBAN GROWTH: AN EMPIRICAL ASSESSMENT WITH HISTORICAL MINES

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Abstract—We study entrepreneurship and growth through the lens of U.S. cities. Initial entrepreneurship correlates strongly with urban employment growth, but endogeneity bedevils interpretation. Chinitz (1961) hypothesized that coal mines near cities led to specialization in industries, like steel, with significant scale economies and that those big firms subsequently damped entrepreneurship across several generations. Proximity to historical mining deposits is associated with reduced entrepreneurship for cities in the 1970s and onward in industries unrelated to mining. We use historical mines as an instrument for our modern entrepreneurship measures and find a persistent link between entrepreneurship and city employment growth.

I. Introduction

THE role of entrepreneurship for economic growth and development has been a central focus of recent research. Following the enduring themes of Schumpeter (1942), theorists have developed multiple models that link entrepreneurship to dynamic economies and greater growth.¹ Progress to document entrepreneurship's empirical role, however, has been much slower. It is quite striking that we now have several studies evaluating causal links between entrepreneurial finance and industry or city growth (Kortum & Lerner, 2000; Samila & Sorenson, 2011), but we have very little quantitative evidence on entrepreneurship's role more generally. Many policy initiatives to enhance growth seek to encourage new firm formation. This is often done under the presumption that entrepreneurship is a good thing, but the empirical backing for this claim is not well developed.

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¹ These models often combine entrepreneurship with channels of creative destruction (Aghion & Howitt, 1992; King & Levine, 1993b; Akgicig & Kerr, 2010) or growth-enhancing occupational choices (Baumol, 1990; Murphy, Shleifer, & Vishny, 1991). Aghion, Akgicig, and Howitt (2013) provide a recent review.

In one setting in particular, claims about entrepreneurship's role are often strongly advanced. Economists and policymakers frequently argue that urban success depends on a city's level of entrepreneurship. This claim was famously made in Chinitz's (1961) comparison of New York and Pittsburgh, and it is more recently invoked by Saxenian (1994) when contrasting the regional performance of Boston and Silicon Valley. More systematic empirical evidence confirms that a general correlation lies behind these famous case studies. For example, Glaeser et al. (1992) find a strong correlation between small establishment size and subsequent employment growth across sectors within U.S. cities. Glaeser, Kerr, and Ponzetto (2010) also document the strength of this relationship when modeling entrepreneurship through start-up employment shares. Similar conclusions have been reached by Delgado, Porter, and Stern (2010a, 2010b), Rosenthal and Strange (2003, 2010), and Gennaioli et al. (2013).²

Figure 1 provides representative graphs from this work. These patterns are frequently taken as evidence that entrepreneurship is an important ingredient for local job growth. While the empirical association is quite visible, there are clearly many factors that jointly influence initial entrepreneurship levels and subsequent growth of cities (e.g., regional growth trends, local public policies). Without identifying exogenous sources of variation for entrepreneurship, it is premature to make strong claims that entrepreneurship causes urban growth. Establishing this connection would help guide policy and be an important stepping stone toward establishing entrepreneurship's role more generally. While it is difficult to develop causal variation for cities, it surely must be more tractable than using national variations.

We tackle this problem by using an idea suggested in Chinitz's original account. Chinitz (1961) claimed that Pittsburgh's dearth of entrepreneurs in the 1950s reflected its historical concentration in steel, which in turn reflected proximity to large deposits of coal and iron ore (White, 1928). The steel industry has significant returns to scale, and Chinitz argued that its presence crowded out more entrepreneurial activities. This left Pittsburgh with an abundance of company men but few entrepreneurs. Moreover, Chinitz emphasized how this dampening of entrepreneurship comes through both static factors (e.g., access to inputs or financial capital for new businesses) and dynamic factors (e.g., the transmission of skills and attitudes from parents to children). Chinitz's hypothesis was, in a sense, an early conception of the natural

² Fogel, Morck, and Yeung (2008) provide related evidence by documenting how countries with very stable big businesses experience less overall growth than their peers with more dynamic industrial organizations. Agrawal et al. (2012) explore firm size distribution and the nature of innovation in cities, emphasizing a dual role of a large incumbent firm and many start-ups.

FIGURE 1.—CITY GROWTH AND INITIAL ENTREPRENEURSHIP
CROSS-SECTIONAL PLOTS OF URBAN GROWTH, 1982–2002, VERSUS INITIAL TRAITS

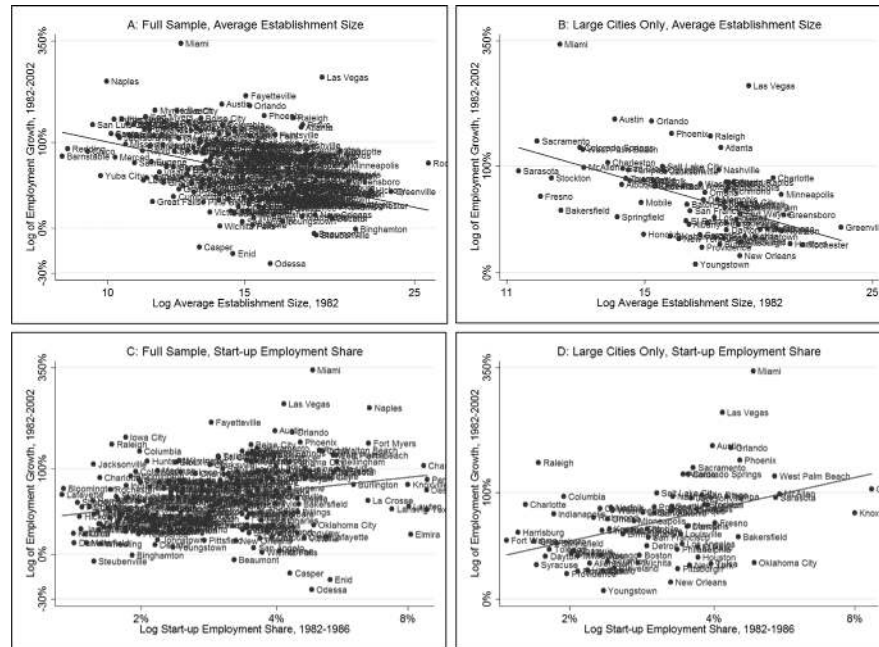


Figure 1 documents the cross-sectional relationship for U.S. cities between urban employment growth from 1982 to 2002 and measures of initial entrepreneurship. Cities are defined through Metropolitan Statistical Areas. Employment growth and entrepreneurship measures are calculated from the Census Bureau’s Longitudinal Business Database. Panels A and B consider average establishment size in 1982 as a measure of initial entrepreneurship. Panels C and D consider the employment share of the city in new start-ups across the 1982–1986 period as a measure of initial entrepreneurship. In panels B and D, the sample is restricted to large cities (metropolitan population exceeding 500,000).

resource curse, which in this case operates through large, resource-intensive activities crowding out the entrepreneurial activity that generates long-term growth.³

We systematically investigate the connection between historical mineral and coal deposits and modern entrepreneurship. There are returns to scale in many extractive industries and their industrial customers, not just coal and steel. The process of bringing ores out of the earth is a capital-intensive operation that often benefits from large-scale operations. Transforming and transporting ores also typically requires large machines and production facilities. Therefore, we hypothesize that cities with a historical abundance of nearby mineral and coal mines will have developed industrial structures with systematically larger establishments and less entrepreneurship. These early industrial traits can influence modern entrepreneurship through persistence and intergenerational transmissions that we elaborate on further below.

We use the existence of mineral and coal deposits in 1900 as our measure of the returns to mining around a city. These

data come from the historical records of the U.S. Geological Survey and economic censuses at the time. Figure 2 is a representative map. We demonstrate that a city’s historical proximity to mineral and coal deposits is strongly correlated with larger average establishment size for manufacturing in 1963 and subsequently. These deposits are also associated with larger average establishment size in quite unrelated industries in the 1970s and 1980s (initial years for sectors are determined by our Census Bureau data). While the relationship is most pronounced in industries that have more occupational overlap with mining, historical deposits are associated with larger establishment sizes throughout the city. These patterns are very similar for other measures of modern entrepreneurship like local employment in start-up firms.

With this background, we use historical mineral and coal deposits as instruments for modern entrepreneurship. Building on historical price regressions described in greater detail below, we report two sets of results that use different spatial distance bands around cities to provide upper and lower bounds on the impact of mines. We continue to find a strong connection between a city’s initial entrepreneurship and subsequent economic growth in these instrumented regressions. A 1 standard deviation decrease in average initial establishment size for a city is associated with a 0.61 to 0.88 standard deviation higher employment growth between 1982 and 2002. Similarly, a 1 standard deviation increase in the initial employment share of start-up firms is associated with a 0.25 to 0.35 standard deviation increase in urban employment

³ If entrepreneurs generate positive externalities relative to employees of U.S. Steel, then this crowding out can be socially harmful, but the Chinitz hypothesis can still operate without any market failures.

Papayrakis and Gerlagh (2007) find with cross-state variation that natural resources limited regional growth in the United States. In more localized studies within regions, Michaels (2010) and Bleakley and Linn (2012) find evidence of economic development and persistence around oil deposits and historical portage sites, respectively. Van der Ploeg (2011) surveys work in a related literature on natural resources and country success.

FIGURE 2.—REPRESENTATIVE MAP OF MINERAL AND COAL DEPOSITS, 1910

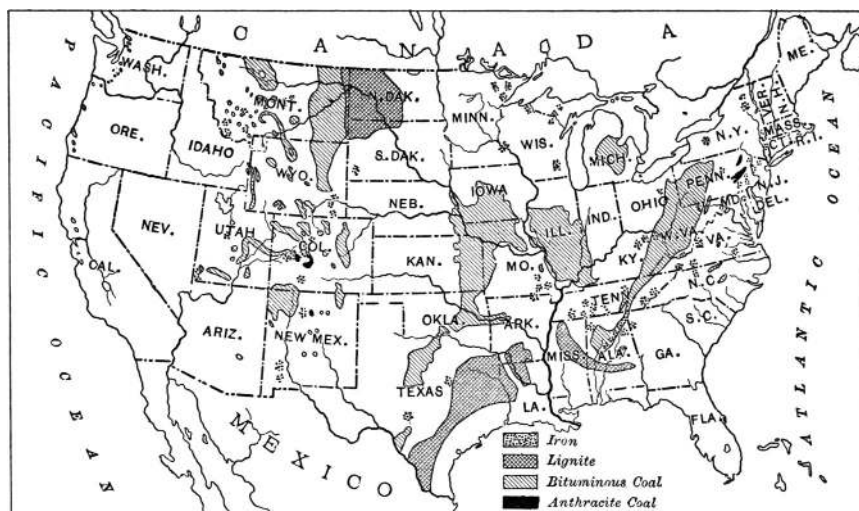


Figure 2 provides a representative illustration of known mineral and coal deposits from the period of study. "Coal and Iron Deposits in the United States, 1910," in Ralph S. Tarr and Frank M. McMurry, *New Geographies*, 2nd ed. (New York: Macmillan Company, 1910). [http://etc.usf.edu/maps \[map #02085\]](http://etc.usf.edu/maps/map#02085).

growth over the next two decades. The instrumented elasticities for average initial establishment size are similar to ordinary least squares estimates; the instrumented elasticities for initial employment share of start-up firms are larger than ordinary least squares estimates.

Our primary concern with these results is that mineral and coal deposits are likely associated with other variables that can have an impact on economic growth. Unionization is a prime candidate (Holmes, 2006), but we can explicitly control for this variable. These correlations may also reflect a general decline in U.S. employment in extractive industries or the decline of rust belt regions. We address the first concern by separately considering industries that are quite different from mining, such as trade, services, and finance. We find that our results are, if anything, stronger for these sectors of the economy. Proximity to mines in 1900 predicts larger establishments, less entry, and less urban growth in trade, services, and finance today.

Sector decompositions do not address the possibility that our results simply reflect the general decline of cities that were initially built around natural resources. The decline of the steel industry in Pittsburgh affected not just steel production but also the financial and service firms that catered to that industry and its employees. We have two complementary approaches to test this concern. Our first approach is to focus on growing regions in the United States. Manufacturing does not predict strong urban decline in the warmer regions of the United States, which have witnessed the most substantial urban growth over the past several decades, and yet we still find that historical mines predict dampened employment growth. Service industries that are highly agglomerated in a small number of areas are typically believed to be oriented toward national and international sales rather than the local market. We also continue to find the negative connection between mines and employment growth effects in

highly agglomerated industries that should be less dependent on local demand. These patterns continue to hold as well in warmer areas, although some sensitivity to the spatial range of the instruments is evident. We also show that our results are robust to including Bartik-style controls for the projected forward employment growth of the city based on its initial industry composition and national growth trends for industries, the observed change in manufacturing employment for the city from 1963 to 1981, and similar dynamic controls.

Our second approach is more technical in nature but less dichotomous than grouping cities and industries. We implement the instrumental variable quantile regression method (IVQR) of Chernozhukov and Hansen (2004a, 2005, 2006). This econometric technique effectively estimates the instrumental variable regressions at various points throughout the city growth distribution, where growth is conditional on specified covariates such as climate, initial housing prices, and regional fixed effects. We show that the impact of initial establishment size on subsequent employment growth is reasonably homogeneous throughout the conditional distribution. That is, entrepreneurship is linked to stronger subsequent employment growth in cities that are growing faster as well as those growing slower than what their initial traits would have predicted. To the extent that it differs by city growth, the connection of entrepreneurship to city growth is most important among cities that are underperforming in their growth.

In the last part of the paper, we consider several extensions that suggest that the up-or-out process outlined by Haltiwanger, Jarmin, and Miranda (2013) at the firm level when linking young firms to employment growth is also holding more systematically at the city level for urban growth dynamics. These extra tests employ several variations on our city growth measures that take advantage of the microdata.

We first show similar results when measuring employment in 2002 contained in establishments that did not exist in 1982, finding stronger elasticities than our overall measures. We also quantify how higher initial entrepreneurship is linked to greater employment shares for entrants since 1982 throughout the establishment size distribution, with new employment being retained relatively more in larger establishments. Higher initial entrepreneurship in 1982 is also associated with lower average establishment ages in 2002 for the city, both generally and among the top 25 employers for the city. These and other tests show that the growth effects are not coming through the endless replication of small firms but instead through an up-or-out process that provides a stronger industrial dynamic to cities.

These results and their stability suggest that mines influenced modern entrepreneurship with a much deeper foundation than U.S. regional evolution. Nevertheless, historical mineral and coal deposits are an imperfect instrument. They will have some correlation with other local variables besides entrepreneurship. Thus, our conclusions must be tentative. Yet empirical work on entrepreneurship and economic growth must begin identifying and exploiting exogenous sources of entrepreneurship. Historical mines are one such instrument, imperfect as they may be. Our work represents a step toward identifying exogenous sources of variation in local entrepreneurship and using that variation to examine whether the strong correlations between city employment growth and entrepreneurship hold when removing the most worrisome endogeneity. The general conclusion from this exercise is that entrepreneurship is systematically related to local employment growth over the past three decades.

This paper is organized as follows. Section II outlines our Census Bureau data and provides some initial least squares analyses. Section III reviews the Chinitz hypothesis, describes our mines data, and presents first-stage relationships between historical deposits and modern entrepreneurship. Section IV presents the core instrumental variable results. Section V provides the extended employment growth results, and section VI concludes.⁴

II. Census Bureau Data and OLS Estimations

A. Longitudinal Business Database

We developed our urban growth and entrepreneurship metrics through confidential data housed by the U.S. Census Bureau. Our primary data source is the Longitudinal Business Database (LBD), which provides annual observations for every private sector establishment with payroll from 1976 onward. The only excluded sector is agriculture, forestry, and fishing. In addition, we draw some statistics from the Census

of Manufacturers, which extends back to 1963. Unfortunately, data for other sectors are available starting only in 1976.

The Census Bureau data are an unparalleled laboratory for studying the industrial structure of U.S. firms. Sourced from U.S. tax records and Census Bureau surveys, the microrecords document the universe of establishments and firms rather than a stratified random sample or published aggregate tabulations. In addition, the LBD lists physical locations of establishments rather than locations of incorporation, circumventing issues related to higher legal incorporations in states like Delaware.

The comprehensive nature of the LBD also facilitates complete characterizations of entrepreneurial activity by cities, industries, types of firms, and so on. Each establishment is given a unique, time-invariant identifier that can be longitudinally tracked. This allows us to identify the year of entry for new start-ups or the opening of new plants by existing firms. We define entry as the first year in which an establishment has positive employment. Second, the LBD assigns a firm identifier to each establishment that facilitates a linkage to other establishments in the LBD. This firm hierarchy allows us to separate new start-ups from facility expansions by existing multiunit firms.

During a representative year, 1997, the data include 108 million workers and 5.8 million establishments. During the 1990s, there were on average over 700,000 entering establishments each year that jointly employed more than 7 million workers. The average start-up had ten workers; notably there were very few entering mining establishments during this period (less than 0.5% of entrants).

Our core estimation examines urban growth and entrepreneurship from 1982 to 2002. We have manufacturing data going back to 1963, but we focus primarily on the period for which our data cover all sectors of the U.S. economy.⁵ This will enable us to run regressions of the form

$$\ln\left(\frac{\text{Employment}_{c,2002}}{\text{Employment}_{c,1982}}\right) = \beta \times \ln(\text{Entrepreneurship}_{c,1982}) + \text{Other Controls}_c + \varepsilon_c, \quad (1)$$

where c indexes cities. We will use this same empirical design with industrial subsets of cities. Our controls are taken from the urban growth literature and include initial employment, census division controls, and city-level variables like average January temperature, the share of adults with college degrees, initial housing prices, and similar categories. The β

⁴Our online appendix provides additional materials referenced below, including further notes about our data, a lengthier literature review about the Chinitz hypothesis, extended estimations, and background econometrics for the IVQR methodology. This appendix is available at <http://www.people.hbs.edu/wkerr/>.

⁵We start our estimations in 1982 rather than in 1976 to be conservative. The period before 1982 includes a substantial amount of economic change and restructuring. Including this period leads to stronger results than those we present below, but we want to be conservative in our approach. Also, the LBD currently extends to 2007. We find very similar results when looking at total city employment growth until 2007. The Census Bureau, however, moved from the SIC industry classification system to the NAICS system in 2002. Because this transition complicates many of our sector-level decompositions, we end the sample period in 2002.

TABLE 1.—LBD DESCRIPTIVE STATISTICS FOR CITIES, CIRCA 1982

	Mean	Standard Deviation
City size, 1982		
Total employment	231,655	411,379
Mining, construction, and manufacturing	28%	
Trade, finance, and services	72%	
Low-agglomeration sectors	57%	
Medium-agglomeration sectors	16%	
High-agglomeration sectors	26%	
Log employment growth, 1982–2002		
Overall	0.361	0.247
Mining, construction, and manufacturing	0.058	0.358
Trade, finance, and services	0.493	0.239
Low-agglomeration sectors	0.440	0.233
Medium-agglomeration sectors	0.358	0.297
High-agglomeration sectors	0.307	0.404
Average establishment size		
Overall, 1982	19.8	3.5
Overall, 2002	19.9	2.8
Mining, construction, and manufacturing, 1982	34.1	14.2
Trade, finance, and services, 1982	15.8	3.2
Start-up share of local firm activity		
Employment, 1982	3.1%	1.6%
Employment, 2002	3.3%	1.3%
Establishment counts, 1982	9.7%	2.2%
Establishment counts, 2002	8.2%	1.7%

Descriptive statistics from the Longitudinal Business Database for 1982. Jarmin and Miranda (2002) describe the construction of the LBD. Sectors not included are agriculture, forestry and fishing, public administration, the U.S. Postal Service, and private households. Start-up shares are calculated for the five-year period following the indicated date. The online appendix provides correlations of our entrepreneurship metrics with other related definitions.

coefficient describes the correlation of initial entrepreneurship and subsequent employment growth.

Our entrepreneurship metrics are average establishment size in 1982 and the share of employment in start-ups from 1982 to 1986. We take the average over several years for the second metric to smooth out business cycles and the data collection patterns of the Census Bureau, but this is not an important factor. Average establishment size is defined as the number of employees divided by the number of establishments. It includes both single-unit firms and multiunit establishments. We define the share of employment in start-ups on an annual basis using the entry rate of new single-unit firms. This approach quantifies gross entry levels rather than the net entry that would be observed through changes in establishments between two points.

Table 1 provides summary statistics for cities and entrepreneurship related to our sample. Throughout this paper, we conduct our analysis at the metropolitan-area level, but we use the convention of referring to metropolitan areas as cities to ease exposition. We refer to industries within metropolitan areas as city-industries.⁶

⁶ We define cities by mapping counties in the LBD to Primary Metropolitan Statistical Areas (PMSAs). We exclude cities in Alaska and Hawaii due to our spatial instrument variable estimations. We also exclude some small PMSAs that are not separately identified in the Census of Population (required for explanatory variables). The results we present are robust to instead considering consolidated MSAs, which are subdivided into PMSAs for very large metropolitan areas (e.g., Chicago has six PMSAs within its CMSA). A PMSA is defined as a large urbanized county or a cluster of counties that demonstrate strong internal economic and social links in addition to close ties with the central core of the larger area.

The average city had about 230,000 employees in 1982 among sectors covered by the LBD. We will generally consider two large subsectors of the economy: mining, construction, and manufacturing (which should be directly influenced by mining opportunities) and trade, finance, and services (which should not make any direct use of coal or mineral ores). On average, a little less than three-quarters of city employments are in trade, finance, and services. The average city experiences employment growth of 0.36 log points, or 44%, from 1982 to 2002. Reflecting national industrial trends, this employment growth is much higher in trade, finance, and services (0.49) than in mining, construction, and manufacturing (0.06). The average establishment has 19 employees, with substantially larger establishment sizes in mining, construction, and manufacturing (34) than in trade, finance, and services (16). About 3% of employees in a city are in entering firms over the 1982–1986 period. Average establishment size in a city has a -0.49 correlation with the city's share of employment in start-up ventures.⁷

B. City Growth Regressions

We quantify the basic relationship between local entrepreneurship and subsequent urban employment growth. Equation (1) is our core empirical specification, but we also report results for growth in total payroll and wages. Panel A in table 2 shows results using average establishment size in 1982 as our measure of entrepreneurship, while panel B uses the initial share of employment in start-ups. Estimations are unweighted and have 291 observations. To guard against excessive outliers, we winsorize variables at their 2% and 98% values.

We report bootstrapped standard errors throughout the paper. This choice is mainly due to this technique yielding the largest standard errors. In both least squares and instrumental variable estimations, bootstrapped standard errors are larger than robust standard errors. Looking forward to our instrumental variable estimates, we will calculate instruments based on spatial distances to historical mines. Thus, our instruments will have some spatial correlation for neighboring cities. Bester, Conley, and Hansen (2011) demonstrate how clustering by large, contiguous groups of approximately similar size with substantial interiors relative to boundaries can appropriately model spatial decay dependency under these conditions. Along these lines, clustering by the nine

⁷ The online appendix provides an extended discussion of approaches to measuring entrepreneurship and documents the correlations between definitions for U.S. cities. Our empirical results focus on average establishment size and employment shares in start-up firms given their prominence in much of the developing empirical literature on entrepreneurship and urban growth. We find very similar results when using other variants, showing stability to how entrepreneurship is measured. We discuss below issues of remaining measurement error in the two core metrics.

Related work includes Miracky (1993), Davis, Haltiwanger, and Schuh (1996), Acs and Armington (2006), Glaeser and Kerr (2009), Ghani, Kerr, and O'Connell (2010), Haltiwanger et al. (2013), Hurst and Pugsley (2012), and Faggio and Silva (2012).

TABLE 2.—ENTREPRENEURSHIP AND GROWTH ESTIMATIONS AT CITY LEVEL, 1982–2002

	Log Employment Growth			Log Payroll Growth			Log Wage Growth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Measuring Entrepreneurship through Average Establishment Size									
Log average establishment size in city at start of period	−0.566 (0.078)	−0.598 (0.072)	−0.693 (0.082)	−0.435 (0.092)	−0.478 (0.120)	−0.640 (0.122)	0.073 (0.041)	0.018 (0.063)	−0.054 (0.036)
Initial employment controls		Yes	Yes		Yes	Yes		Yes	Yes
Census division fixed effects		Yes	Yes		Yes	Yes		Yes	Yes
City growth covariates			Yes			Yes			Yes
B. Measuring Entrepreneurship through Start-Up Employment Share									
Log start-up share of employment in city at start of period	0.200 (0.037)	0.200 (0.053)	0.161 (0.056)	0.200 (0.046)	0.196 (0.060)	0.150 (0.065)	0.016 (0.017)	0.029 (0.016)	0.019 (0.020)
Initial employment controls		Yes	Yes		Yes	Yes		Yes	Yes
Census division fixed effects		Yes	Yes		Yes	Yes		Yes	Yes
City growth covariates			Yes			Yes			Yes

Estimations describe the OLS relationship between entrepreneurship and city growth. City growth is calculated as the log ratio of employment at the end of the period to the beginning of the period. Regressions are unweighted, report bootstrapped standard errors, and have 291 observations. Initial employment controls are log employment levels at start of period and their squared values. City growth covariates include log January temperature, log July temperature, log 1970 share of workers with bachelor's education or higher, log 1970 population density, log 1970 population, and log 1970 housing prices. Nine census divisions are used in the fixed effects. A 2% winsorization is employed on variables. The online appendix provides several extensions to these estimations.

census divisions or similar regional group delivers lower standard errors than bootstrapping does. We also find smaller standard errors when using explicit spatial decay frameworks like Drukker, Prucha, and Raciborski (2011) to calculate standard errors.

The first regression in panel A shows the strong negative relationship between employment growth over 1982 to 2002 at the metropolitan area level and initial establishment size. A 1 standard deviation increase in 1982 establishment size is associated with a 0.57 standard deviation decrease in the growth of employment over the ensuing twenty years. Panel B finds that a 1 standard deviation increase in the share of initial employment in start-ups is associated with a 0.2 standard deviation increase in urban employment growth over the next twenty years. These effects are economically large and statistically significant, which is why it makes sense to refine and test these correlations between entrepreneurship and local job growth.⁸

The second column shows that these coefficient estimates are essentially unchanged by including controls for the log level of initial employment in the city, its square, and fixed effects for the nine census divisions. This stability suggests that the correlations are not simply a product of mean reversion or differences in U.S. regional growth.

The third column shows that these coefficients are also robust to including standard controls for city growth from the urban growth literature: mean January and July temperatures, the 1970 share of workers with college degrees, the 1970 population level and density of the city, and 1970 housing prices. These factors control for documented phenomena like population growth over the last three decades in warm places and the rise of the skilled city. The fact that these controls have so little impact on our entrepreneurship measures

⁸ These results are quite robust to how the growth metric is defined, such as measuring growth relative to average city employment over 1982–2002 (e.g., Davis et al., 1996). Similarly, nonparametric approaches that include indicator variables for quintiles of average establishment size demonstrate regular effects with the most substantial change occurring between the second and third quintiles.

suggests that these measures are unlikely to be proxying for core attributes of the urban area.⁹ The magnitudes of these elasticities are of comparable or slightly larger magnitude to those identified for other major determinants of urban growth like education, climate, and infrastructure (Glaeser & Saiz, 2004; Rappaport, 2007; Duranton & Turner, 2012).

Columns 4 to 6 repeat these results using payroll growth as the dependent variable. Some of the coefficients are slightly smaller, but the overall picture remains the same. Cities with more initial employment in start-ups or smaller average establishment size experienced faster payroll growth between 1982 and 2002. Other local controls have little effect on the core results.

In line with the symmetry of employment and payroll growth, columns 7 to 9 confirm that initial entrepreneurship is not associated with subsequent wage growth or declines. Entrepreneurship generates more job growth for cities, but not faster earnings growth for those employed. One interpretation of these results is that a spatial equilibrium exists across cities, and this equilibrium limits the tendency of any city's wages to rise much faster than its peers (Glaeser & Gottlieb, 2009).¹⁰ A second interpretation is that entrepreneurs have very lean operations that minimize labor costs, putting downward pressure on wage growth for workers. This latter effect could be due, for example, to entrepreneurs operating in more competitive environments. We return to the policy implications of this feature in section VI.

Figure 3 examines patterns of employment growth within various subsets of our data. The online appendix documents

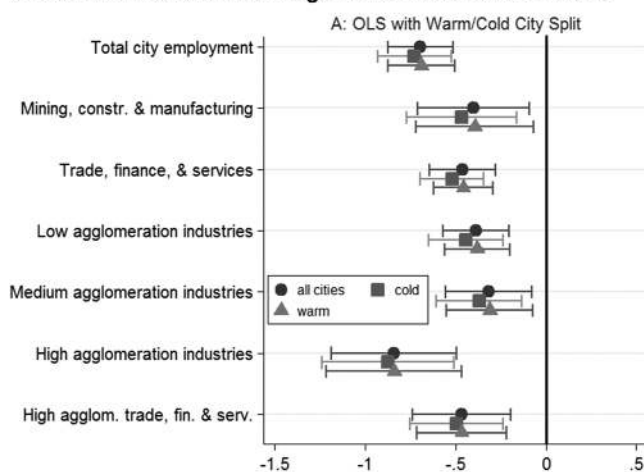
⁹ The results are also robust to additional covariates like Saiz's (2010) geographic features of cities or using hedonic regressions to model climate amenities. We lose several cities in these extensions due to data availability, however, so we focus on the narrower set of controls.

¹⁰ Standard models that assume a spatial equilibrium predict that increases in productivity increase employment. Wages rise with either increases in productivity or decreases in local amenities, but the connection between productivity and wage changes depends on the elasticity of housing supply. Moreover, if declining industries fire their younger, lower-wage workers first, we can see rising average wages in declining sectors.

FIGURE 3.—BASE ESTIMATES

COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

a. Base Estimations of Average Establishment Size Effects



b. Base Estimations of Start-Up Employment Share Effects

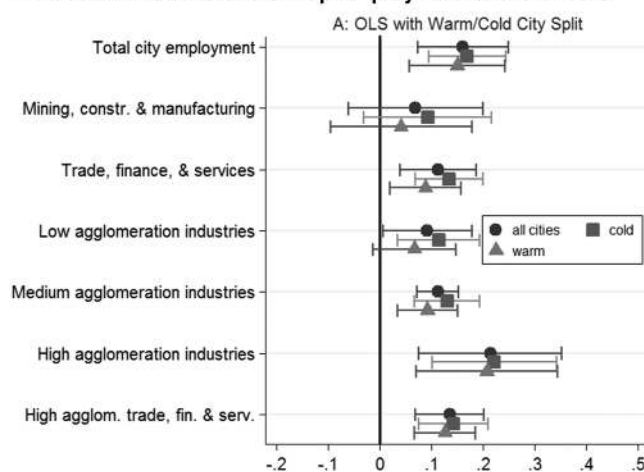


Figure 3 provides visual summaries of OLS results. Panels A and B document average establishment size effects and start-up employment share effects, respectively. Employment growth is considered among subsets of industries, along with interactions for warm/cold cities. Regressions include the extended set of city growth covariates and preparations highlighted in table 2. The online appendix documents all specifications reported in the figure and additional variations that are not graphed.

all specifications reported in figures 3 to 6 and additional variations not graphed. The first entry in panel A repeats the total employment growth finding for initial average establishment size. We then allow the treatment effect to differ by two broad regions of the United States. We group cities into cold cities, defined by having a mean January temperature less than 34 degrees, and warm cities. This cut-off point is approximately the median January temperature in the sample. Colder cities have a longer industrial history, experienced slower growth (or in some cases decline) over our time period, and include the complete rust belt. Entrepreneurship has a stronger association with city growth in colder regions of the United States. While the difference is statistically significant, its economic magnitude is very small relative to overall effect. Panel B shows a similar pattern for start-up employment shares.

The remaining entries in figure 3 repeat these specifications using various outcome variables. We define entrepreneurship at the city level and consider the types of industries in cities where the employment growth is occurring. The second entry examines employment growth in mining, construction, and manufacturing. The results for average establishment size remain strong; the results for start-up employment shares become smaller and statistically insignificant. The third entry shows that both measures are significant for trade, finance, and services, although the start-up employment share has again lost some of its economic magnitude. At the city level, average establishment size appears the more robust correlate of employment growth across sectors.

The fourth through sixth entries separate employment growth by the degree of industrial agglomeration. We split industries by their national level of agglomeration as measured by the Ellison and Glaeser (1997) index. That index looks at the lumpiness of employment across space, correcting for the overall spatial distribution of economic activity and the tendency of industries with big establishments to be more highly concentrated geographically. Our results are strongest for the most agglomerated industries, and we have confirmed that these patterns hold when defining industry agglomeration through the Duranton and Overman (2005) index. These results suggest that entrepreneurship may be most important for industries that have the most powerful interactions among clustered firms. They also suggest that our results extend well beyond the growing demand of home markets. The last column shows a similar impact for highly agglomerated industries within trade, finance, and services.

These estimations demonstrate that the striking cross-sectional relationships in figure 1 have a deeper foundation to them. There are several natural next steps: introducing Bartik-style controls for the expected growth of a city based on its initial industrial composition, testing variations on the outcome variable using the microdata (e.g., growth among 1982 incumbent firms versus new entrants), testing for alternative channels such as unionization, and so on. We pause on these tests until after we have conducted the base instrumental variables analysis, at which time we report these extensions for both specification types together.

C. City-Industry Growth Regressions

While the correlation between entrepreneurship and urban employment growth for cities is quite strong and robust to covariates, our confidence in this link is also based on its strength across industries within cities. Table 3 illustrates these connections. We define industries at the two-digit level of the Standard Industrial Classification system, and we continue to consider the metropolitan area in this analysis. To focus on meaningful variation, we require that city-industries have 100 employees throughout the period. This results in 12,178 observations.

TABLE 3.—ENTREPRENEURSHIP AND GROWTH REGRESSIONS AT CITY-INDUSTRY LEVEL, 1982–2002

	Total Employment	Total Employment	Mining, Construction, and Manufacturing	Trade, Finance, and Services	Cold Cities (January Temperature below 34)	Warm Cities (January Temperature above 34)	1982–1992 Period	1992–2002 Period
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Measuring Entrepreneurship through Average Establishment Size								
Log average establishment size in city-industry at start of period	−0.192 (0.015)	−0.165 (0.015)	−0.291 (0.015)	−0.120 (0.017)	−0.158 (0.022)	−0.175 (0.018)	−0.104 (0.008)	−0.095 (0.008)
Initial employment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region × Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City growth covariates	Yes							
City fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes
B. Measuring Entrepreneurship through Start-Up Employment Share								
Log start-up share of employment in city-industry at start of period	0.054 (0.007)	0.042 (0.007)	0.055 (0.011)	0.039 (0.006)	0.036 (0.006)	0.049 (0.010)	0.027 (0.004)	0.019 (0.004)
Initial employment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region × Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City growth covariates	Yes							
City fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes

See table 2. Estimations describe the OLS relationship between entrepreneurship and city-industry growth. Industries are defined at the two-digit level of the SIC system. Region × Industry fixed effects use the nine Census divisions. Initial employment controls are city-industry specific. City-industries must have 100 employees throughout the 1977–2002 period to be included in the full sample, for 12,178 observations.

Panels A and B again provide the results using average establishment size and start-up employment share, respectively. We refine our initial employment controls to be city-industry specific. We further include Industry × Census Division fixed effects in all specifications. These fixed effects account for the overall employment growth rate and entrepreneurship levels of each industry and region. The first column models the basic city growth covariates also used in table 2. Columns 2 through 8 instead include city fixed effects that restrict variation to within-city differences. We thus look for connections of initial entrepreneurship to subsequent employment growth after removing overall patterns by city and by region-industry.

The correlation between our entrepreneurship measures and subsequent employment growth is typically smaller at the city-industry level. In the first column, we find that a 1 standard deviation decrease in average establishment size is associated with a 0.19 standard deviation increase in subsequent employment growth for the city-industry. A 1 standard deviation increase in the share of employment in start-ups is associated with a 0.05 standard deviation increase in subsequent employment growth. These effects are statistically significant and economically meaningful. The second column shows that these effects are only slightly diminished when we switch from city growth controls to city fixed effects.

These results suggest that the employment-entrepreneurship link is quite strong within cities, but that the effects are somewhat weaker than at the metropolitan area level. One explanation for the weakening of the effect is that perhaps entrepreneurship is proxying for other city-level attributes. Another explanation is that there are cross-industry spillovers from entrepreneurship, as suggested by Chinitz's hypothesis about a local culture of entrepreneurship.¹¹

¹¹ Evidence for these cross-industry links has been identified in micro-data studies of the Chinitz effect like Rosenthal and Strange (2003, 2010), Glaeser and Kerr (2009), Glaeser et al. (2010), and Drucker and Feser

Columns 3 to 8 consider subsamples of the city-industry data; estimations include the most stringent City and Industry × Census Division fixed effects. The first two columns again separate industry groups. The relationship between entrepreneurship and employment growth is robustly present in both groups, being stronger for mining, construction, and manufacturing than for trade, services, and finance. These results confirm our earlier findings for cross-metropolitan area employment growth and show power where the aggregate growth effect was weaker.¹² Columns 5 and 6 show similar results in cold and warm regions. Columns 7 and 8 find similar results by decade. Overall, these city-industry disaggregations show the deep empirical association between initial entrepreneurship and subsequent growth. This association is more stable across decompositions at the city-industry level than at the city level.

III. Chinitz, Mines, and Modern Entrepreneurship

While these patterns are provocative, the potential endogeneity of initial entrepreneurship remains worrisome. An abundance of start-ups in a particular city may reflect unmeasured city-level attributes that make both entrepreneurship and future job growth more feasible. The concentration of entrepreneurship in particular city-industries could signal greater opportunities within that local economic sector or unobserved policy interventions. While the econometric tests

(2012). Hanlon (2012) and Helsley and Strange (2012) provide recent evidence on interindustry linkages more broadly. Saxenian (1994), Davidsson (1995), Hofstede (2001), Lamoreaux, Levenstein, and Sokoloff (2004), Landier (2006), and Falck, Fritsch, and Heblich (2009) are examples of work on entrepreneurial culture.

¹² There is a subtle but important difference between the industry disaggregations in figure 3 and table 3. In figure 3, we maintain the same city-level entrepreneurship metrics to predict employment growth for both groups. In table 3, the entrepreneurship measures are city-industry specific by definition.

reported above create a high bar for these alternative explanations, there is still a need to identify in this literature an exogenous source of variation in entrepreneurship. To address these issues, we now turn to the historical presence of mines close to each city. This section starts by summarizing the Chinitz (1961) hypothesis, with our online appendix providing a more extended discussion. We then introduce our mines data and show some first-stage relationships between historical mines and modern entrepreneurship.

A. Chinitz (1961) Effect and Theoretical Considerations

The core hypothesis of the literature on entrepreneurship and city growth is that some places are endowed with a greater number of entrepreneurs than others and that this endowment of entrepreneurial human capital influences economic success. Chinitz (1961) first formulated this hypothesis in his attempt to explain why postwar New York was experiencing more economic success than postwar Pittsburgh. Chinitz argued that New York's historical garment industry, the nation's largest postwar industrial cluster, was a natural training ground for entrepreneurs. The garment trade had few serious fixed costs or scale economies, and as a result, there were a large number of small entrepreneurs in the industry. Chinitz argued that this entrepreneurship influenced neighboring industries. By contrast, Chinitz depicted Pittsburgh as a big-company city that stifled entrepreneurship, tracing the roots of this mentality to Pittsburgh's dominant steel industry. Chinitz further documents a number of reasons that the broader ecosystem of entrepreneurship can be depressed by large incumbent firms:

- *Intergenerational transmission of entrepreneurship*: Chinitz argued that the "salaried executives" of U.S. Steel were less likely to inculcate entrepreneurial talents and inclinations in their children, which made Pittsburgh less entrepreneurial for years to come.¹³
- *Culture of entrepreneurship*: Chinitz noted that an "aura of second-class citizenship" surrounds entrepreneurship in cities dominated by big firms, a precursor to the modern focus on the "entrepreneurial culture" of some places (see the references in note 11).
- *Capital constraints*: Chinitz highlighted how small firms are more likely to redeploy capital in their local area than large firms, and financial institutions are also more likely to serve small firms in cities with more small firms.¹⁴

¹³ Blau and Duncan (1967), Hout and Rosen (2000), and Niittykangas and Tervo (2005) document the strong parent-child linkages for entrepreneurship. Closely related work comes from the local bias of entrepreneurship literature, including Figueiredo, Guimaraes, and Woodward (2002), Michelacci and Silva (2007), and Dahl and Sorenson (2007). See also Whyte (1956). In a sense, this entrepreneurship hypothesis is a close cousin of the literature relating local human capital levels to area development and growth (e.g., Glaeser et al., 1995; Simon, 1998; Simon & Nardinelli, 2002; Gennaioli et al., 2012).

¹⁴ Examples from various forms of local entrepreneurial finance include Petersen and Rajan (1994), Chen et al. (2010), and King and Levine (1993a, 1993b). Aghion, Fally, and Scarpetta (2007) and Kerr and Nanda (2009) provide extended references.

- *Labor constraints*: Chinitz described how large firms are more likely to locate out of the center city, which makes spousal employment or entrepreneurship more difficult.
- *Access to intermediate goods*: Chinitz depicted how small firms have many needs that must be satisfied by the local economy. Large incumbent firms often source inputs internally or at a distance, which can depress supplier development (e.g., Glaeser & Kerr, 2009).

Our approach to the identification problem of modern entrepreneurship and modern growth starts with Chinitz's claim that industrial history is persistent in entrepreneurship levels of cities. To find exogenous variation in a city's industrial past, we turn to mineral and coal mines. The U.S. Geological Survey has been documenting the existence of such deposits for over a century, and we are able to determine whether deposits exist near any given city. We hypothesize that these deposits were generally associated with bigger establishments and firms, just as coal mines were with U.S. Steel in Pittsburgh, and that those bigger establishments crowded out smaller enterprises and entrepreneurship.

Why would mines generally be associated with larger establishments? Mining itself appears to have substantial returns to scale, probably because of the large fixed investments required to drill, mine, and ship heavy products like ore and coal.¹⁵ Pittsburgh's example suggests that manufacturing establishments that then use the products of mines are also large, perhaps because industries that use large amounts of coal or ores have large-scale economies associated with big plants. In 2008, the average establishment in primary metal manufacturing had 85 employees, more than double the 40 employee national average for manufacturing as a whole. As such, it is plausible that an abundance of mineral and coal deposits led to large establishments in a particular area and that these large establishments meant that typical workers became skilled at working in big firms, not at starting their own companies.¹⁶

Our identification strategy builds on the exogenous spatial distribution of mineral and coal deposits in 1900. We first link these deposits to average establishment sizes and entrepreneurship in the 1960s and onward. If Chinitz is right that big firms reduce the stock of entrepreneurial capital, then these deposits should lead to larger average establishment sizes in closely related industries, such as primary metal manufacturing, and also in less related sectors like services and finance. We then investigate whether the places and sectors

¹⁵ The average establishment size in 2008 across the entire United States was fewer than 16 people (County Business Patterns). By contrast, the average coal mining establishment had 74 people, the average iron ore mining establishment 209 workers, and the average establishment in copper, nickel, lead, and zinc mining 193 workers. In 1919, the average employee counts were similarly high: all mines, 77; anthracite coal mines, 508; bituminous coal mines, 82; and iron ore mines, 158. Calculations are made using the 1930 Statistical Abstract of the United States, table 733.

¹⁶ Related evidence on spin-outs from existing firms includes Elfenbein, Hamilton, and Zenger (2010), Gompers, Lerner, and Scharfstein (2005), Hvide (2009), and Klepper and Sleeper (2005).

that have large average establishment sizes—because of proximity to mineral and coal deposits—experience less growth during the modern era. In this paper, we are not attempting to quantify the relative responsibilities of Chinitz channels but instead to quantify the whole effect. Assessing these channels is an important avenue for future research.¹⁷

It is worth emphasizing that the core theoretical apparatus of urban economics does not handle the Chinitz account very well. Most models assume a spatial mobility of people and firms across locations within a country that would provide for a constant supply curve of entrepreneurs (similar to the link of real wages across places due to the spatial mobility of people). The Chinitz account is instead much closer to models of natural advantage sites and surrounding development (Kerr & Kominers, 2010), but with the twist that the local character of the population adopts a very sticky form of this industrial legacy that persists over time, well after the initial conditions fade. We know, of course, that the supply curve of entrepreneurship across countries is not constant and that these differences can affect economic growth in several ways (see the references in note 1). Chinitz argues the same holds across cities. Several papers have provided theories around specific channels to the stickiness (Michelacci & Silva, 2007; see the references in note 17), but it is safe to say that these issues have not been fully fleshed out theoretically for urban models (Glaeser et al., 2010). The specific connection of these mines to large-scale employment of less educated workers—to the direct exclusion of other activity in the city—seems a particularly worthy piece to pick up on.

Moreover, additional factors may exist across cities in the changing nature of trade or consumer preferences. One possibility, for example, is that some places are endowed with a comparative advantage in increasing-returns-to-scale industries and manufacturing, while other locations have a comparative advantage in services. If only the former manufacturing goods can be tradable, we would observe specialization within the manufacturing sector, but both sectors would be present in the various locations. If trade in services then becomes feasible, one would anticipate a contraction of services in historical mining regions and an expansion of services in the other regions. Insofar as services are more labor intensive and more subject to diseconomies of scale than other industries, this would translate into less firm and job creation in historical mining regions. Layered on top of this could be that consumer preferences change with time in

nonhomothetic ways (e.g., due to rising income levels) that differentially adjust demand for goods sourced from regions. These forces, which are outside the Chinitz framework, are likely to play a role in postwar U.S. development. Some of our empirical tests (e.g., the dynamic projections) attempt to shed light on these issues, but more generally we hope that future theoretical and empirical efforts can better unite these perspectives.¹⁸

B. Historical Mines Data

We develop our instruments on the location of mines using several sources. Our primary data source on the geographic distribution of historical mines is the U.S. Geological Survey (USGS) database, which provides data on present and past mines, including their discovery dates and latitude-longitude spatial locations. We focus on mines that were known to exist in 1900. We believe that this survey provides a relatively complete survey of mineral and ore availability at the start of the twentieth century. Deposits were a great source of wealth, and the government took its surveying responsibilities seriously. Congress established the USGS in 1879 and chose prominent early directors like Clarence King and John Wesley Powell to lead the organization. While it is possible that mineral and ore deposits were more likely to be discovered in areas that were more heavily inhabited or used for manufacturing during the 1800s, maps from the era certainly suggest that the USGS was doing a good job of surveying the entire country.¹⁹

The exact spatial locations of mines allow us to count mines that were known to exist in 1900 in spatial rings around cities. We design these spatial rings to be between 250 and 500 miles and provide an analysis of price data from the time that leads us to these distance horizons. Our first instrument is the logarithm of the count of mines within 500 miles of the geographic centroid of the city in 1900. Cities had on average 943 mines in this spatial range, ranging from a minimum of 10 to a maximum of 2,966. We find very similar results to those reported below when weighting mine counts by the number of different types of ores that each mine extracts. We use the logarithm to allow for concavity in the impact of total mine counts. A few cities are not within 250 miles of a known mine in 1900. For this distance band, we add 1 to the count of mines before taking the logarithm.²⁰

¹⁸ We thank an anonymous referee for very helpful thoughts on these theoretical considerations.

¹⁹ In the 1800s, prospecting often preceded industry, as it had, for example, in the California gold rush or the later Black Hills gold rush. Long before the Upper Peninsula of Michigan was well settled, the state government sent pioneering geologist Douglass Houghton to survey the area. Houghton would help establish the copper and iron ore deposits in the region. Likewise, a 1908 report already identifies the four largest coal deposits to be in Colorado, Montana, North Dakota, and Wyoming, followed by West Virginia and Illinois, despite the fact that formal extraction at the time in Pennsylvania was an order of magnitude higher than any other state. See *1910 Statistical Abstract of the United States*, table 12, and *1930 Statistical Abstract of the United States*, table 767.

²⁰ These data are available and described at <http://tin.er.usgs.gov/mrds/about.php>. The online appendix provides additional descriptive statistics on our mining data.

¹⁷ Chinitz does not discuss political economy factors, but the depression of entrepreneurship by concentrated or oligarchical societies may also be important. Engerman and Sokoloff (1997) and Acemoglu, Johnson, and Robinson (2002) link certain natural resource endowments to extractive institutions that can prove inefficient to long-term growth. Acemoglu (2008) develops a model where concentrated institutions can aid rapid early economic advancement but then hinder longer-term advancement compared to more democratic societies. This literature often notes the erection of entry barriers that stifle potential entrepreneurs. These barriers can particularly limit the ability of entrepreneurs to pursue new sectors and opportunities that can aid growth but perhaps hurt the existing elite.

These initial instruments model the broad availability of natural deposits around cities, as mining and extractive industries, broadly speaking, are associated with larger establishment sizes. We complement this instrument with two additional metrics that describe the character of local deposits for the showcase example of the steel industry in the Chinitz hypothesis. Our first is an indicator variable for whether coal and iron ore is the dominant mining product of a state in 1928.²¹ We take this measure from the *1930 Statistical Abstract of the United States*, table 739. We use this alternative source because the USGS data do not capture very well historical coal deposits, a very important spatial factor in industry location choice. Our final historical measure is the count of iron ore mines within 100 miles of the city in 1900. More than a third of cities do not have an iron ore mine within 100 miles, and we thus use the levels of this variable directly. The three different designs of the instruments (log count, indicator variables, mines count) also allow for capturing different aspects of the relationship.

C. Modern Mines Data

While the historical aspects of our data are important for introducing exogeneity to modern entrepreneurship, an alternative concern is that data quality is compromised by using information from the earlier period. The most important aspect of this liability for our current work is that the USGS data do not list the discovery date for most mines and we have no way of assessing whether unreported dates are generally older (e.g., knowledge of the mine stretches so far back that a discovery date is unknown). Especially with instruments based on natural resources, an argument can be made to use the raw capacity and inherent mineral wealth of a region rather than knowledge of it at a particular point in history.

To address this issue, we report additional results that use current information. For our two instruments developed from the USGS data, log count of total mines and local iron ore mine counts, we simply adjust the metric construction to build off all known mines in the database regardless of discovery date. For this purpose, we also develop a new instrument that uses the nature of coal deposits in a local area.

During the 1970s energy crisis, the USGS initiated a large-scale project to build a national coal information database that contains much deeper information about coal deposits throughout the country.²² This database again includes latitude-longitude spatial locations, and it has a special feature that the types of coal are identified for mines. This is valuable information as coal deposits vary in grade and their spatial distribution. Anthracite coal, a particularly hard and

compact form, is the most valuable but often quite difficult to supply. Bituminous coal, also known as black coal, is softer and less valuable than anthracite, but still widely mined, transported, and used in industrial applications. Lignite coal, also known as brown coal, is of very low grade and often fails to be economical to mine and transport.

Figure 2 shows that these differences in coal type were known in 1900, but we do not have discovery dates that would facilitate instruments using coal grades circa 1900. We use this information, however, to create an alternative modern instrument that is an indicator variable for anthracite and bituminous coal being the predominant form of coal in a 150-mile spatial band around the city. The indicator variable takes a 0 value if no modern coal deposits are within the band or if most deposits are lignite. Unlike our historical measure of whether coal and iron were the top state product in 1928, this modern instrument does not use realized production rates. We also use these data in two supplementary applications discussed next.

D. Selection of Spatial Rings

We now return to our selection of the spatial ring used for the total count of mines instrument. An important starting point is the identification that mineral deposits can influence cities over at least moderate spatial horizons. This reach descends in large part from the durable nature of minerals that aids in shipping them. By the early twentieth century, transportation within the United States had reached a reasonable stage of development. Railroads and water transportation were strong by 1900 (Field, 2011; Duran, 2010), and the average price per ton-mile had declined from 6.2 cents in 1833 to 0.7 cents in 1900 (Carter et al., 2006). In the late 1800s, the cost of 10 miles of wagon transport was roughly equivalent to the cost of 375 to 475 miles of railroad or water transport, and the U.S. transportation network aided resource flows to cities beyond their immediate vicinity (Donaldson & Hornbeck, 2012). The relocation of some steel production from Pittsburgh to Buffalo in the early twentieth century reflected in part the ease of moving coal from Pennsylvania to New York, and Buffalo's location on the shipping routes for iron coming from the west. These and related facts indicate that mines do not need to be immediately proximate to cities to influence their industrial structures.²³

Unfortunately, while these basic concepts are known, the historical record for actual shipments of minerals and coal

²¹ States in this category are Alabama, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, North Dakota, Pennsylvania, Tennessee, Virginia, Washington, and West Virginia.

²² These data are available and described at <http://energy.er.usgs.gov/products/databases/CoalQual/intro.htm>.

²³ The economic history accounts of whether natural advantages or market access determined the spatial placement of large-scale manufacturing by 1900 are mixed. See Krugman (1991), Kim (1995), Klein and Crafts (2009), and Gutberlet (2013). Related work on industry location and natural advantages includes Ellison and Glaeser (1999), Kim (1999), Rosenthal and Strange (2001, 2004), Glaeser and Kerr (2009), Combes et al. (2010), Holmes and Lee (2012), Ellison et al. (2010), Kerr and Kominers (2010), and Storeygard (2012). Localized studies of resource placements include Michaels (2010), Bleakley and Linn (2012), Caselli and Michaels (2013), and Dippel (2012).

TABLE 4.—COAL PRICES AND DISTANCE FROM MINES IN 1925–1930

a. Anthracite				
	Indicator Variable for Anthracite Price Listed		Log Price of Anthracite Coal in City	
	(1)	(2)	(3)	(4)
Count of anthracite mines 0–50 miles	0.067 (0.026)	0.051 (0.011)	–0.043 (0.017)	–0.052 (0.009)
Count of anthracite mines 50–100 miles	0.053 (0.015)	0.062 (0.018)	–0.021 (0.010)	–0.018 (0.011)
Count of anthracite mines 100–250 miles	0.163 (0.027)	0.186 (0.031)	–0.032 (0.016)	–0.041 (0.013)
Count of anthracite mines 250–500 miles	0.062 (0.060)	0.089 (0.074)	–0.009 (0.021)	–0.025 (0.006)
Year fixed effects	Yes	Yes	Yes	Yes
Census division fixed effects		Yes		Yes
Observations	261	261	133	133
b. Bituminous				
	Indicator Variable for Bituminous Price Listed		Log Price of Bituminous Coal in City	
	(1)	(2)	(3)	(4)
Count of bituminous mines 0–50 miles	0.027 (0.013)	0.006 (0.017)	–0.043 (0.012)	–0.036 (0.013)
Count of bituminous mines 50–100 miles	0.026 (0.023)	0.134 (0.040)	–0.053 (0.020)	0.012 (0.032)
Count of bituminous mines 100–250 miles	0.044 (0.039)	–0.019 (0.028)	–0.121 (0.027)	–0.128 (0.035)
Count of bituminous mines 250–500 miles	0.026 (0.042)	0.049 (0.039)	–0.142 (0.049)	–0.124 (0.035)
Year fixed effects	Yes	Yes	Yes	Yes
Census division fixed effects		Yes		Yes
Observations	261	261	216	216

Estimations describe the OLS relationship between anthracite (bituminous) coal prices observed in cities from 1925 to 1930 and their distances from mines. Included city-year observations list an anthracite price, a bituminous price, or both. Price data are available for 47 cities in our sample. Columns 1 and 2 present linear probability models that a price is listed. Columns 3 and 4 consider the log price of coal when listed. Explanatory variables are mine counts by spatial bands from cities; counts are transformed to have unit standard deviation for interpretation. Regressions are unweighted and cluster standard errors by city.

is very sparse and insufficient for detailed assessments. Our best evidence comes from coal price data across 47 cities in our sample for 1925 to 1930 reported in the *1940 Statistical Abstract of the United States*, table 772. This table separately lists prices of anthracite and bituminous coal. For most cities, prices are given only for a single type of coal, reflecting that the city relied almost exclusively on that coal variant. We thus consider the price data in two ways. The first is a simple indicator variable by coal type for whether a price is given; the second is the log price of a coal variant conditional on a price being listed.

Tables 4a and 4b report results of regressions of these outcome variables on the spatial distributions of anthracite and bituminous coal deposits around each city, respectively. We use the modern coal database for these measures given the lack of historical records on coal variants. We report four distance horizons of 0 to 50, 50 to 100, 100 to 250, and 250 to 500 miles. The explanatory variable is the count of deposits within these bands, with counts normalized to have unit standard deviation for interpretation. We pool the data from all six years, clustering standard errors by city and including year fixed effects. We test with and without regional fixed effects; we find similar patterns if also controlling for water access to Great Lakes or the ocean. We have 261 observations where at least one price is listed, 133 where

an anthracite price is listed, and 216 where a bituminous price is listed.

In table 4a, we find that mines up to 250 miles distant from a city are important for explaining whether anthracite coal was in use and its price level. Anthracite mines from 250 to 500 miles exhibit a strong association for log prices only when controlling for region effects. In table 4b, there is not a clear pattern for whether a bituminous price is listed in columns 1 and 2. Columns 3 and 4 find a strong association for regional deposits of 100 to 500 miles, lowering bituminous coal prices in the cities.

Our assessment from these various data points is that the spatial band for total mine counts should be at least 250 miles. Our price rings are built off of coal, a heavy product compared to many other minerals. Thus, the fact that the deposit influence is evident to 500 miles for coal prices suggests that this spatial range is likely to be true for many other minerals. We test setting the bands for total mine counts at 250 and 500 miles. Because our estimations include fixed effects for the nine census divisions, we identify off of city differences only in proximity to historical mining deposits within each region. Levels differences across the nine census divisions account for about a quarter of the total variation across cities at 500 miles. This regional explanatory power is similar when using a radius of 100 or 250 miles.

TABLE 5.—HISTORICAL MINING DEPOSITS AND THE DEVELOPMENT OF INDUSTRIAL STRUCTURES

	Log Average Establishment Size in Manufacturing 1963	Log Average Employments in Mining Near City, 1976–1980	Log Average Establishment Size in City, 1982		Log Start-Up Employment Share in City 1982	
			Total	Mining, Construction, and Manufacturing Sectors		Trade, Finance, and Services Sectors
	(1)	(2)	(3)	(4)	(5)	(6)
A. Log Mine Counts within 500 Miles of City, 1900						
Log mine counts within 500 miles of city, 1900	0.213 (0.045)	1.163 (0.054)	0.075 (0.011)	0.142 (0.022)	0.042 (0.010)	−0.161 (0.021)
B. Panel A, Including Indicator Variable for Coal or Iron Ore Being Top Mineral Product of State, 1928						
Log mine counts within 500 miles of city, 1900	0.204 (0.039)	1.149 (0.049)	0.071 (0.009)	0.133 (0.022)	0.037 (0.011)	−0.154 (0.023)
(0,1) Coal or iron ore is the top mineral product of the state, 1928	0.126 (0.069)	0.187 (0.058)	0.062 (0.017)	0.116 (0.041)	0.060 (0.018)	−0.096 (0.044)
C. Log 1 + Mine Counts within 250 Miles of City, 1900						
Log 1 + mine counts within 250 miles of city, 1900	0.087 (0.020)	0.476 (0.047)	0.034 (0.006)	0.066 (0.014)	0.010 (0.007)	−0.073 (0.014)
D. Count of Mines within Distance Rings of City, 1900 (Coefficients × 100)						
Mine counts within 100 miles of city, 1900	0.085 (0.027)	0.328 (0.060)	0.026 (0.007)	0.065 (0.019)	0.000 (0.008)	−0.091 (0.019)
Mine counts within 100–500 miles of city, 1900	0.039 (0.008)	0.198 (0.015)	0.011 (0.002)	0.020 (0.006)	0.009 (0.002)	−0.030 (0.006)
E. Indicator Variable for Coal Composition within 150 Miles That Favors Anthracite or Bituminous, Present						
(0,1) Composition of coal within 150 miles favors anthracite or bituminous	0.378 (0.069)	1.143 (0.145)	0.095 (0.018)	0.234 (0.047)	0.031 (0.020)	−0.207 (0.049)

See table 2. Regressions include initial employment controls, Census division fixed effects, and city growth covariates. The online appendix provides descriptive statistics regarding mining counts. Coal or iron ore is the top mineral product in 1928 for Alabama, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, North Dakota, Pennsylvania, Tennessee, Virginia, Washington, and West Virginia.

E. Historical Mines and Modern Entrepreneurship

Table 5 shows that our mining metric strongly predicts entrepreneurship late in the twentieth century. Column headings indicate outcome variables, and the regressions also control for census division fixed effects, initial employment, and city growth covariates. Panel A reports estimates with the log count of mines within 500 miles as the central explanatory variable. As the covariates are the same variables that will be included in our final regressions, columns 3 and 6 thus represent first-stage relationships.

The first regression in panel A shows the connection between the number of mines and the average establishment size in manufacturing in 1963. We do not have data for a wider range of industries during that year. As the number of mines increases by 1 standard deviation, the average establishment size in manufacturing increases by 0.21 standard deviations. This relationship is both statistically significant and economically relevant. The t -statistic is about 3. We have also confirmed that mines in 1900 are associated with weaker entrepreneurship for manufacturing in the 1960s.

Column 2 shows the strong relationship between historical mines and mining activity at the start of our time period. A 1 standard deviation increase in the number of mines is associated with a 1.16 standard deviation increase in mining employment near the city over 1976 to 1980. These deposits certainly still matter for the industrial composition of an area.

Column 3 looks at the relationship between historical mining deposits and average establishment size in 1982, the relevant year for our instrumental variables estimations. The estimated elasticity is 0.075, which means that as the number of mines increases by 1 standard deviation, the average

establishment size increases by about 0.08 standard deviations. The t -statistic of this effect is more than 6. Unreported regressions find that the similar effect for 1992 weakens by about a quarter but remains quite significant.

The fourth and fifth columns show the relationship to average establishment size in the two sectors. The estimated elasticity is three times higher in mining, construction, and manufacturing than in trade, finance, and services. A 1 log point increase in the number of mines raises average establishment size in closely related sectors by more than 10% and in unrelated sectors by 4%. Both estimates are statistically significant. The final regression shows that historical mining deposits are also predictive of the city's start-up employment share in 1982. The overall elasticity estimate is -0.16 .

Panel B extends the estimation to also include an indicator variable for whether coal or iron ore was the top mineral product of the state. This starts to model the types of mines that surround a city. This indicator variable is also very predictive of increases in average establishment size and reduced entry rates. This suggests that coal and iron ore deposits are especially important for large-scale operations conditional on the number of mines surrounding a city.

Panel C reports results using the log count of mines within 250 miles by itself. The elasticities at this spatial level are about half of those using the 500-mile spatial bands, and the coefficients are more precisely estimated. The most substantive change is the weaker link of mines to establishment size in trade, finance, and services. Panel D alternatively reports results by two distance rings of 0 to 100 and 100 to 500 miles estimated jointly. As more than a quarter of cities do not have a mine within 100 miles, we use a levels regression that allows for 0 values. Coefficients and standard errors are

TABLE 6.—CITY LEVEL IV ESTIMATIONS OF EMPLOYMENT GROWTH

	Instruments Employed in Estimation						
	Yes	Yes	Yes		Yes	Yes	Yes
Log count of mines 500 miles, 1900							
(0,1) Coal or iron ore top product, 1928		Yes	Yes		Yes	Yes	
Count of iron mines 100 miles, 1900			Yes		Yes	Yes	
Log 1+count of mines 250 miles, 1900				Yes	Yes	Yes	
Log count of mines 500 miles, present							Yes
Coal composition 150 miles, present							Yes
Count of iron mines 100 miles, present							Yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Measuring Entrepreneurship through Average Establishment Size							
Log average establishment size	−0.967	−0.930	−0.878	−0.517	−0.608	−0.783	−0.831
in city at start of period	(0.311)	(0.280)	(0.251)	(0.325)	(0.232)	(0.241)	(0.258)
First-stage partial R^2	0.151	0.186	0.193	0.106	0.175	0.208	0.162
F -test statistic p -value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum 2SLS relative bias	<10%	<10%	<10%	<10%	<15%	<15%	<15%
Overidentification test p -value		0.689	0.357		0.624	0.124	0.457
Exogeneity test p -value	0.168	0.177	0.281	0.470	0.642	0.585	0.471
B. Measuring Entrepreneurship through Start-Up Employment Share							
Log start-up share of employment	0.450	0.455	0.352	0.245	0.245	0.335	0.362
in city at start of period	(0.144)	(0.156)	(0.119)	(0.155)	(0.124)	(0.125)	(0.137)
First-stage partial R^2	0.114	0.128	0.157	0.078	0.129	0.154	0.129
F -test statistic p -value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum 2SLS relative bias	<10%	<15%	<15%	<10%	<15%	<20%	<15%
Overidentification test p -value		0.901	0.083		0.083	0.069	0.341
Exogeneity test p -value	0.004	0.002	0.024	0.440	0.376	0.043	0.034

See tables 2 and 5. Outcome variable is log employment growth for cities. Instruments are indicated by column titles. Regressions are unweighted, report bootstrapped standard errors, and have 291 observations. Regressions include initial employment controls, Census division fixed effects, and city growth covariates. The F -test statistic provides the p -value from the first-stage estimation's test that the instruments are significant. Base F -statistics exceed 19 and 13 throughout panels A and B, respectively. The maximum 2SLS relative bias reports the minimum bias that can be specified and still reject the null hypothesis that the instruments are weak. This level is determined through the minimum eigenvalue statistic and Stock and Yogo's (2005) 2SLS size of nominal 5% Wald test. The null hypothesis in Basman's overidentification tests is that the instruments are valid. The null hypothesis in Wu-Hausman exogeneity tests is that the instrumented regressors are exogenous.

multiplied by 100 for visual clarity. For most of the outcome variables, the presence of mines within 100 miles matters two- and threefold more than mines over 100 to 500 miles.²⁴ On the other hand, similar to panel C, the very localized presence of mines does not predict average establishment size in unrelated sectors of trade, finance, and services. This effect comes mostly through mines in the larger spatial area around the city.

Finally, panel E examines concentrations of anthracite or bituminous deposits using current data. There are visible connections between coal grade composition, mining sector development, and modern establishment size. In another test, we regress the average establishment size of a city in 1982 on the count of anthracite or bituminous deposits within 150 miles, the count of lignite deposits within 150 miles, and our standard covariates. A 1 standard deviation increase in anthracite or bituminous deposits is associated with a 0.030 (0.006) increase in log average establishment size, while the elasticity for lignite is 0.007 (0.007). The elasticities are similarly 0.029 (0.006) and 0.007 (0.008) when using each mine type individually. This test, while admittedly crude, confirms that the nature of deposits is important for our assessment. It also provides some confidence that the use

of minerals is important rather than spurious features of the geographic landscape (e.g., rugged mountain terrain).

These regressions ensure that the problem with our instruments will typically not be in their first-stage fit. Mines in 1900 are strongly related to establishment size and entrepreneurship at the beginning of our regression time period. Our larger concern is that mines could easily be correlated with employment growth for reasons other than initial entrepreneurship. We address this concern after presenting our core instrumental variables results.

IV. Instrumental Variables Results

A. City Growth Estimations

Table 6 describes our key second-stage results of entrepreneurship and local growth using proximity to mines in 1900 as instruments. Panel A considers average establishment size in 1982 as the core independent variable, while panel B models initial entrepreneurship through the local employment share in start-ups. Regressions control for census division fixed effects, initial employment, and city growth covariates.

Column 1 begins with a single instrumental variable regression using the log count of mines in 1900 as the instrument, finding that the effect of average establishment size on subsequent growth increases substantially when using mines as an instrument. The relevant least squares coefficient is -0.69 , and this instrumental variables estimate is -0.97 , which means that a standard deviation increase in a city's

²⁴ These patterns also hold when using more disaggregated bands, suggesting mostly regular declines in the impact of mines on industrial structures with greater distance. When using three distance bands of 0 to 100 miles, 100 to 250 miles, and 250 to 500 miles, the coefficients for average establishment size are 0.016, 0.022, and 0.009, respectively. Those for birth shares are -0.075 , -0.045 , and -0.024 . All estimates are statistically significant.

average establishment size is associated with a standard deviation decrease in employment growth over 1982 to 2002. For panel B's employment share in start-ups, the coefficient increases from 0.16 to 0.45. Both estimates have *t*-statistics greater than 2.5. Associated diagnostic tests indicate that the instrument performs well for the full sample.

Column 2 adds a second instrument of the indicator variable for dominant product type, and column 3 expands to the triple instrument specification that also includes the count of iron ore mines with 100 miles as an instrument. The additional instruments modestly reduce the coefficients and sharpen the precision of the estimates. These results suggest instrumented elasticities of about -0.9 for average establishment size and 0.4 for start-up employment shares, respectively. The various diagnostic tests continue to perform well, with the one exception that the overidentification test for the triple instrument in panel B is rejected at a 10% level. While differences shrink when using multiple instruments, it is still the case that the measured elasticities are higher than in ordinary least squares.

Columns 4 and 5 repeat columns 1 and 3, respectively, using the 250-mile spatial band rather than the 500-mile spatial band. The impact of this change is to lower the estimated second-stage elasticities to be comparable to ordinary least squares estimates. The instrumented effect of average establishment size is -0.52 to -0.61 , smaller than the ordinary least squares coefficient of -0.69 , while it is 0.25 for start-up employment, larger than the ordinary least squares coefficient of 0.16 . Tests do not reject that these coefficients are the same.

Combining these approaches, column 6 reports results using four instruments that include both 250- and 500-mile spatial bands. These results sit in between those of columns 3 and 6. Going forward, we report our results using the two bands individually as they bound this joint effect. We view the 500-mile band as making the maximum case for the role of entrepreneurship and the 250-mile band as making the minimum case based on historical mines. Finally, column 7 shows very similar results when using instruments based on modern data.²⁵

The overall patterns from table 6 suggest that instrumental variables estimates are comparable to or higher than ordinary least squares estimates. What can account for this feature? A first, relatively mundane, explanation is that the instrumental variables are correcting for measurement error in the regressors that downward biases ordinary least squares estimates. Our regressors are measured at a point in time at the start of the sample period, and thus they may be sensitive to idiosyncratic blips in city features. The employment share in start-ups seems the more exposed metric to this issue, and this perhaps explains why its relative increases in instrumented elasticities compared to ordinary least squares estimates are stronger than those for average establishment size.

²⁵ To conserve space, we report employment results only for the instrument variable specifications. We continue to find that employment and payroll growth closely track each other. Disaggregating the 1982–2002 employment growth into five-year intervals, growth effects are evident in each subinterval except 1992 to 1997. We also find similar results using LIML estimators.

A second explanation is that the endogenous aspects of average establishment size and new start-ups actually work against city growth, while the exogenous aspects, captured by the long-run supply of entrepreneurs, have an even stronger positive effect than the ordinary least squares estimates indicate. According to this view, negative aspects of an area kill off large firms and employment in older establishments, making average establishment size smaller and the start-up share larger. This is particularly important if urban decline pushes displaced workers into suboptimal entrepreneurship that is not growth enhancing. By allowing only the variation that comes from the long-run supply of entrepreneurs to influence our estimates, the instrumental variables estimates correctly show a larger elasticity of long-run growth to entrepreneurship.

A third interpretation, less positive, is that mines are positively associated with other aspects of the city that are connected with longer-term decline. According to this view, the orthogonality condition needed for the instrumental variables estimation is violated by a correlation with omitted variables, and this correlation causes the instrumental variables estimates to be artificially high. The overidentification tests are one econometric assessment of this concern, and our key results usually pass these tests. We further focus the rest of this paper on this potential problem using sample decomposition and quantile instrumental variable techniques.

Before starting with the sample decompositions, we explicitly test one alternative story. Holmes (2006) finds a very striking connection between local dependence on mines and unionism. Similar to our analysis, Holmes notes the extent to which unionism “spills out of coal mines and steel mills into other establishments in the neighborhood, like hospitals and supermarkets.” The analysis identified the potential channels of a common local infrastructure for unionism and contagious attitudes among families and friends toward labor organization.²⁶ To ensure that unionism is not driving our results, we develop from Hirsch and Macpherson (2003) estimates of 1982 union membership rates for 214 cities in our sample. Across these cities, our base instrumented elasticity is -0.594 (0.326). This elasticity ranges between -0.600 (0.296) and -0.525 (0.346) after including the union control depending on how it is entered. Thus, while unionism and entrepreneurship are surely connected and both influenced by historical mining legacies, this alternative channel does not appear to be solely driving our results.

B. Sample Decomposition

Figure 4 provides a sample decomposition of the instrumental variable results over the subgroups of industries within a city similar to figure 3. We repeat the least squares estimate for comparison. A first observation is that the general patterns evident in table 6 persist between the two distance

²⁶ We thank Curtis Simon for sharing this lyric: “My daddy was a miner, And I’m a miner’s son, And I’ll stick with the union, Till every battle is won,” from “Which Side Are You On?” by Florence Reese.

FIGURE 4.—AVERAGE SIZE EFFECTS FOR OLS AND IV
COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

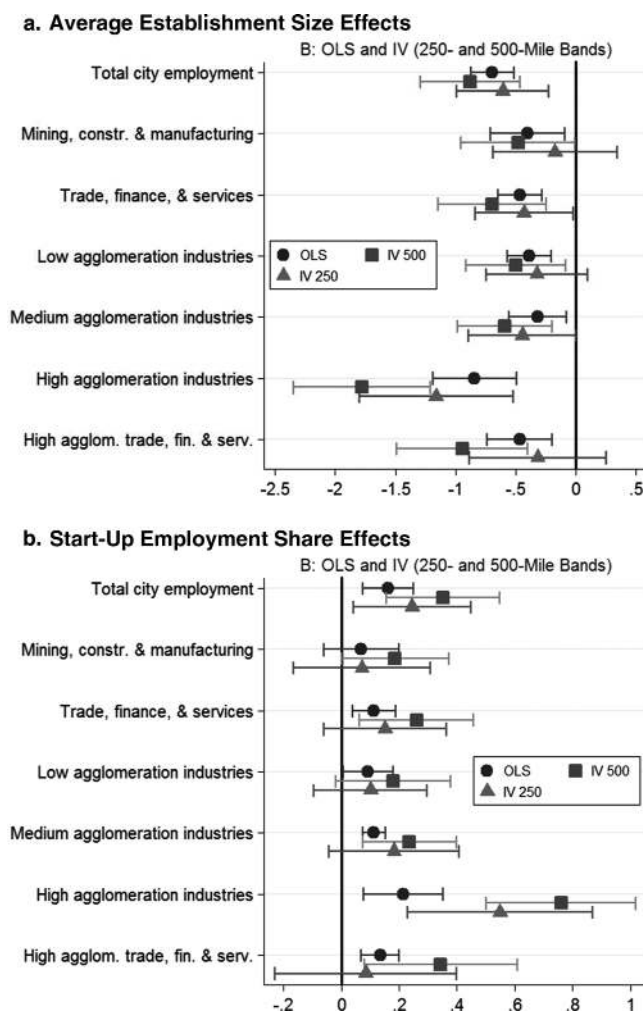


Figure 4 provides visual summaries of OLS and IV results, with IV results using either spatial bands of 250 or 500 miles for distances of total mine counts from the cities. Figure 3 provides additional notes.

bands. Using the 500-mile band leads to larger effects than least squares that are statistically different from 0 with all of our different decompositions. The 250-mile band estimates more closely mirror the least squares results. The effects are statistically different from 0 for trade, finance, and services sectors and for industries with moderate to high levels of agglomeration. The effect is not statistically significant for mining, construction, and manufacturing.

This weaker performance for mining, construction, and manufacturing compared to trade, finance, and services sectors is intriguing. The former is the part of the economy where we would think that the direct effect of mines is likely to be most severe due to the direct input-output linkages from local mines and the very localized nature of construction efforts. These results suggest to us that omitted variables related to sector demand declines are not driving the results. While it is certainly reasonable that declines in manufacturing or mining sectors that are tightly connected to historical mines

would also depress local employment in other industries due to weak demand (e.g., many services are localized), it is hard to believe that this demand-side spillover effect would be larger for those other industries than for mining itself and the interrelated industries.

Likewise, the variation across industries by their level of agglomeration is insightful, as spatial industrial concentration is one measure of the extent to which an industry is focused on supplying the local market. Industries that focus on supplying local customers (e.g., barbers, restaurants) tend to be ubiquitous and therefore nonagglomerated. Industries that focus on serving a global market have less reason to spread themselves out and therefore tend to be more agglomerated (e.g., movie production, automobile manufacturers, investment bankers). The effects we find are most pronounced in agglomerated sectors.

This logic pushes us to focus on the most highly agglomerated industries within the trade, services, and finance sector. These agglomerated industries seem least likely to be directly influenced by any decline in local manufacturing or mining associated with the direct effect of mines. The results here depend on the spatial band. With a 500-mile band, we continue to find a strong role for entrepreneurship and local growth in these specialized sectors. With the 250-mile band, we do not find a strong relationship. This difference relates back to table 5's finding that moderately distant mines appear to have more important effects for the trade, services, and finance sector than very proximate mines.²⁷

Figure 5 presents results where we allow for instrumental variable effects to differ by warm and cold regions. We undertake this split as we suspect *ex ante* that the omitted variables correlations are most severe in colder areas where industrial decline has been acute. As this logic suggests, the estimated coefficients are generally higher in the colder regions than in warmer cities, where manufacturing decline has been far less pronounced. The more substantive message from this decomposition, however, is that differences between warm and cold areas are fairly small. This stability provides comfort that our results are not simply following from the decline of the rust belt or similar.²⁸

C. City Growth Projections

Figure 6 shows our primary employment growth results when including dynamic controls. These controls model the projected path of the city during the period 1982 to 2002 due to the city's industry composition (e.g., whether the city

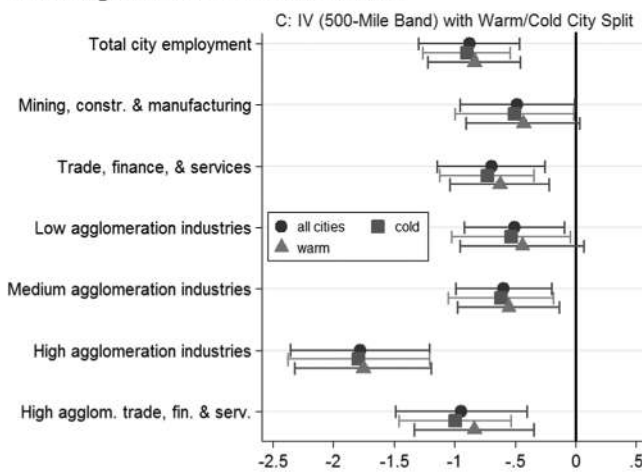
²⁷ We also find a similar emphasis when linking average establishment size by sector with that sector's employment growth. These results again highlight that most of the growth effects that we are capturing come outside sectors traditionally dependent on mines. While we believe that average establishment size across the whole city is the more appropriate metric, it is comforting to find similar patterns when focusing on just the trade, finance, and services sectors.

²⁸ In broader terms, our growth covariates capture many features that are known to increase city attractiveness and urban growth. We find similar results when using hedonic housing price regressions similar to Glaeser et al. (2010) to measure amenities of cities.

FIGURE 5.—EFFECTS WITH WARM/COLD IV SPLIT

COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

a. Average Establishment Size Effects



b. Start-Up Employment Share Effects

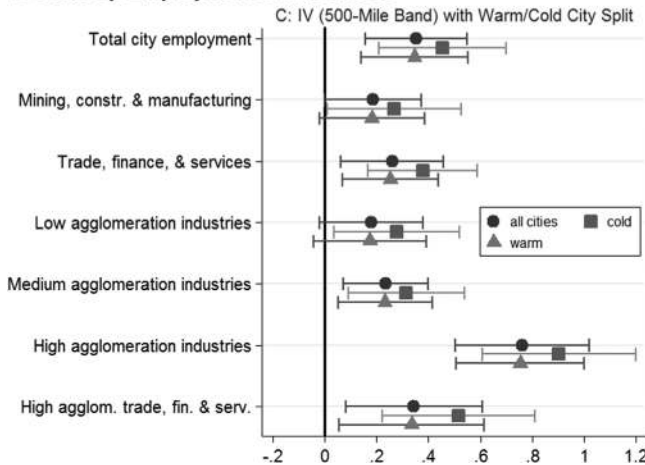


Figure provides visual summaries of IV results that include interactions for warm/cold cities. Figure 3 provides additional notes.

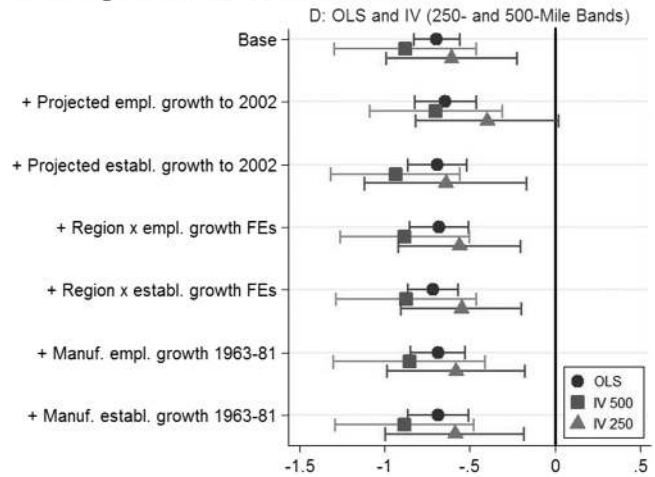
is home to industries is generally growing or contracting). We first test including the projected forward employment growth of the city due to its industry composition. We calculate the projected forward growth by interacting the initial 1982 industry distribution of the city at the two-digit SIC level with the employment growth nationally of the industry from 1982 to 2002 outside the focal city. Introducing this Bartik-style control lowers the role of initial entrepreneurship somewhat. Introducing a similar control based on establishments count distributions and their forward projection raises the role of initial entrepreneurship somewhat.

We next test a variation of this approach. It could be that what matters more for a city than its own predicted path is its relative rank to other nearby cities. To test this, we develop eighteen cells that are the interaction of the nine Census regions with whether a city has an above-average growth projection in 1982. We then introduce fixed effects for these cells so that we compare among cities within a region with similar

FIGURE 6.—EFFECTS WITH EXTENDED GROWTH CONTROLS

COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

a. Average Establishment Size Effects



b. Start-Up Employment Share Effects

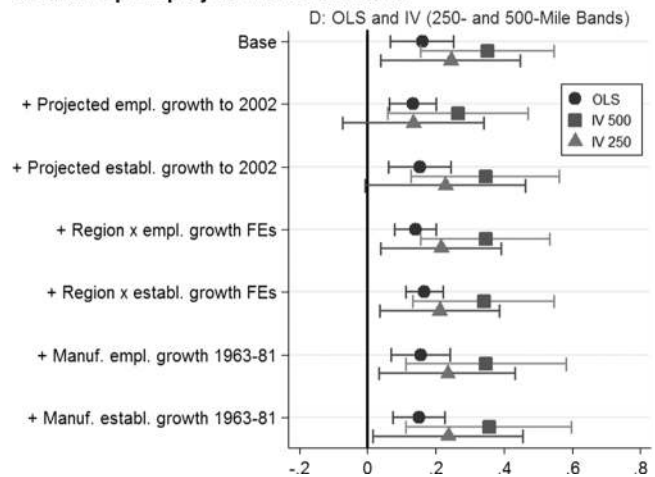


Figure 6 provides visual summaries of OLS and IV results that incorporate extended growth controls. Figure 3 provides additional notes.

growth projections. This approach yields similar results to our primary estimations.

Finally, we have manufacturing data that go back to the 1963 Census of Manufacturers. We include a control for the log growth in manufacturing employment or establishments for the city from 1963 to 1981. This again has little effect on our estimated coefficients. Overall, these results suggest that the link of initial entrepreneurship to employment growth is not reflecting simple trend differences in city growth prospects due to industry composition.

D. Instrumental Variable Quantile Regressions

We complement the decomposition exercises, which focus on differentiating treatment effects by fixed traits of cities or industries, with a second analysis that considers whether the effects of entrepreneurship vary between rapidly and slowly growing cities. Because this approach estimates the effect

FIGURE 7.—QUANTILE IV ESTIMATIONS FOR AVERAGE ESTABLISHMENT SIZE EFFECTS

COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

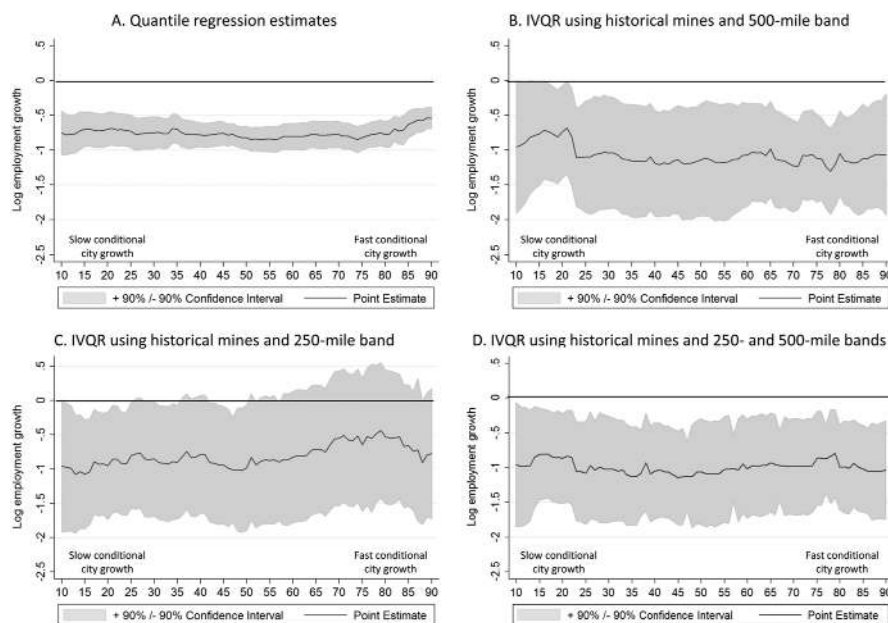


Figure 7 provides quantile IV estimations for average establishment size effects across the conditional city growth distribution. Cities in lower quantiles are growing slower than their initial traits would have predicted, while those in higher quantiles are growing faster. The online appendix documents point estimates at selected quantiles across the distribution. Quantile IV estimates demonstrate a broad uniformity of the results through the conditional city growth distribution.

at different parts of the outcome distribution, it requires a more careful procedure that combines causal inference and heterogeneous treatment effects. The instrumental variable quantile regression method (IVQR) of Chernozhukov and Hansen (2004a, 2004b, 2005, 2006) proves very suitable for our current empirical setting. We provide here a qualitative introduction, with the online appendix and referenced papers providing a technical description.

One can think of IVQR as beginning with a determination of the conditional growth rate of a city. The conditional aspect means that one has controlled for important covariates that systematically determine whether cities are growing fast or slowly, so that one is looking at the unexplained growth above and beyond these basic traits.²⁹ The procedure then estimates local instrumental variable treatment effects for various points in the conditional distribution by weighting nearby points of the distribution more than distant points. Thus, when estimating the instrumental variable elasticity for the 25th quantile of the growth distribution, the procedure places greater emphasis on the empirical links between mines, entrepreneurship, and growth among other slow-growing cities. The experiences of fast-growing cities

would receive more weight when estimating effects at the 75th quantile.

Figures 7 and 8 provide graphical depictions of the IVQR results, with exact values for selected quantiles given in the online appendix. Starting with average establishment size in figure 7, the quantile regression plot in panel A shows remarkable homogeneity across the conditional growth distribution in how entrepreneurship connects with city growth. The lower quantiles on the left-hand side of each graph indicate the role of entrepreneurship among cities that are growing slower than their regional location, climate, 1970s housing prices, and so on would predict. Those on the right are growing faster. The differences appear quite limited, and Wald tests do not reject that the coefficients are the same at the 15th and 85th percentiles of the distribution. The instrumented elasticities when we use the 500-mile bands also display homogeneity and are always statistically significant. When we use the 250-mile bands, statistically significant effects are mostly evident in quantiles up to the median of the distribution, but not in very fast growing cities. Figure 8's depiction of the impact of start-up employment leads to similar conclusions.

The homogeneity of our effects across the conditional growth distribution that this procedure identifies is very important. Our central concern has been that the historical presence of mines depressed city growth due to factors unrelated to reduced modern entrepreneurship. These results suggest that our overall treatment effects in table 6 are not coming from abnormalities in one part of the growth distribution but instead are much broader based. If anything,

²⁹ This methodology has a demanding assumption of rank invariance (or similarity) that makes the inclusion and correct specification of the covariates very important. Rank invariance requires that treatment status not disturb the cities' underlying ranks in the conditional growth distribution. Aspects of spatial distribution of urban growth—like the very strong regularities for faster growth of warm cities or skilled cities over the last few decades—are amenable for this setting. The R^2 value of city growth on the initial growth covariates is 0.43.

FIGURE 8.—QUANTILE IV ESTIMATIONS FOR START-UP EMPLOYMENT SHARE EFFECTS

COEFFICIENT ESTIMATES AND 90% CONFIDENCE INTERVALS

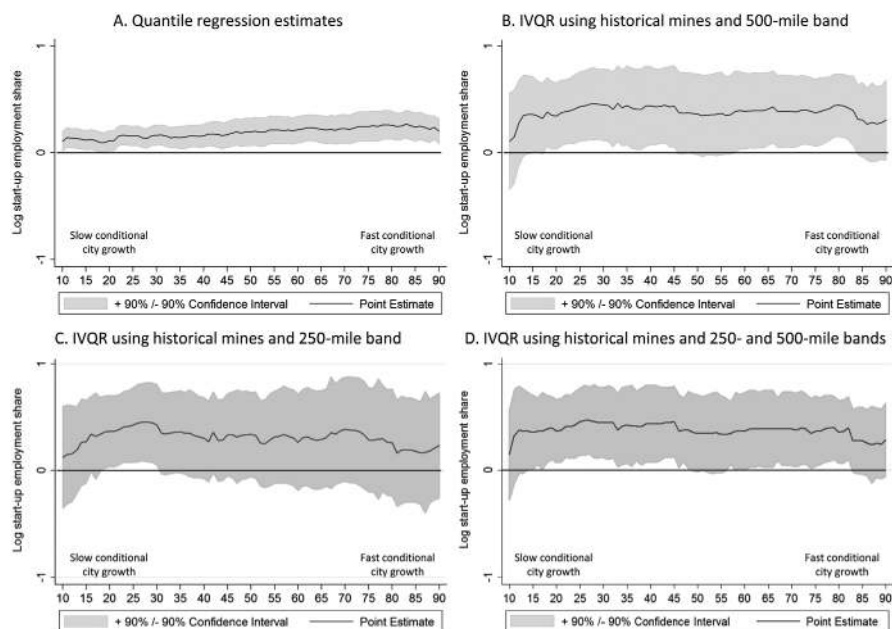


Figure 8 provides quantile IV estimations for start-up employment share effects across the conditional city growth distribution. Figure 7 provides additional notes.

we find that entrepreneurship's role may be more important for employment growth in cities that are underperforming expectations, but the differences are not statistically significant.

V. Extended Employment Growth Results

This section provides several extensions to our work to further clarify entrepreneurship's role in city growth. Table 7a reports these analyses using average establishment size, and table 7b considers start-up employment shares. In both tables, panel A presents least squares results, panel B presents results using the triple instruments and the 500-mile band, and panel C presents results using the triple instruments and the 250-mile band.

The first column tests a redefinition of our employment growth variable. Thus far, we have considered total city growth from 1982 to 2002. Column 1 makes use of the microdata to identify the employment in 2002 of establishments born since 1982. We then measure the log ratio of the net employment generated in new establishments to the initial city size in 1982. This measure thus removes any growth associated with incumbent enterprises in 1982. The elasticities with this measure are quite strong and robust across the instrument designs, unlike those in column 2, which consider employment dynamics in incumbent 1982 firms relative to 1982 city size. This exercise identifies the higher direct employment contribution from the new entrants.

Columns 3 to 5 take a second perspective. We now calculate the share of employment overall and broken down by establishment size in 2002 in the city that is from entrants born after 1982. By considering shares of activity in 2002, we are no longer considering the growth of city employment itself but instead the composition of establishments in 2002. Column 3 of both tables shows that cities with greater entrepreneurship in 1982 have a larger share of their 2002 employment contained in new enterprises. In the instrumented regression, a 10% increase in 1982 average establishment size is associated with a 1.4% decrease in the city's new-entrant employment share in 2002; similarly, a 10% increase in initial birth employment shares is associated with a 1% increase in the city's new-entrant employment share. Columns 4 and 5 partition this effect by 2002 establishment size, finding that higher initial entrepreneurship especially connects to a greater new-entrant share among establishments with more than 100 employees in 2002.

As an alternative, column 6 models the average age of establishments in 2002 for the city. We calculate ages from the LBD's start in 1976, giving a maximum of 26 years old. We weight establishment ages by the 2002 employment in establishments (results are very similar unweighted). In the least squares framework, a 10% increase in average initial establishment size is associated with a 2% older age profile in 2002; a higher birth employment share predicts in a similar way a lower average age for 2002. Column 7 shows that this younger age effect is present when isolating just the unweighted average age of the top 25 employers for 2002 in each city. These age effects are even sharper when instrumenting using

TABLE 7.—EXTENDED CITY OUTCOMES

a. Extended City Outcomes Using Average Establishment Size							
	Log Employment in 2002 from Entrants since 1982 Relative to City Size in 1982	Log Employment in 2002 from 1982 Incumbents Relative to City Size in 1982	Employment Share in 2002 of Entrants since 1982 by Size Category in 2002			Log Average Age of Establishments in City in 2002	
			All	More Than 100 Employees	100 Employees or Fewer	All	Top 25 employers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. OLS Relationship Using Average Establishment Size							
Log average establishment size in city at start of period	-0.937 (0.134)	-0.340 (0.119)	-0.139 (0.030)	-0.133 (0.044)	-0.051 (0.018)	0.202 (0.046)	0.140 (0.077)
B. IV Relationship with Triple Instrument Using 500-Mile Band							
Log average establishment size in city at start of period	-1.208 (0.293)	-0.298 (0.246)	-0.216 (0.059)	-0.265 (0.090)	-0.133 (0.042)	0.365 (0.085)	0.460 (0.130)
First-stage statistics		Partial R ² 0.193; F-test statistic <i>p</i> -value 0.000; maximum 2SLS relative bias below 15%					
Overidentification test <i>p</i> -value	0.596	0.254	0.938	0.878	0.213	0.943	0.194
Exogeneity test <i>p</i> -value	0.188	0.812	0.080	0.067	0.007	0.011	0.003
C. IV Relationship with Triple Instrument Using 250-Mile Band							
Log average establishment size in city at start of period	-0.951 (0.284)	-0.092 (0.226)	-0.206 (0.061)	-0.292 (0.086)	-0.053 (0.034)	0.344 (0.075)	0.536 (0.153)
First-stage statistics		Partial R ² 0.175; F-test statistic <i>p</i> -value 0.000; maximum 2SLS relative bias below 15%					
Overidentification test <i>p</i> -value	0.756	0.444	0.892	0.933	0.895	0.856	0.394
Exogeneity test <i>p</i> -value	0.951	0.179	0.147	0.038	0.942	0.036	0.001
b. Extended City Outcomes Using Start-Up Employment Share							
	Log Employment in 2002 from Entrants since 1982 Relative to City Size in 1982	Log Employment in 2002 from 1982 Incumbents Relative to City Size in 1982	Employment Share in 2002 of Entrants since 1982 by Size Category in 2002			Log Average Age of Establishments in City in 2002	
			All	More Than 100 Employees	100 Employees or Fewer	All	Top 25 Employers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. OLS Relationship Using Start-Up Employment							
Log start-up share of employment in city at start of period	0.216 (0.085)	0.071 (0.025)	0.034 (0.016)	0.029 (0.023)	0.025 (0.007)	-0.062 (0.019)	-0.059 (0.021)
B. IV Relationship with Triple Instrument Using 500-Mile Band							
Log start-up share of employment in city at start of period	0.497 (0.150)	0.095 (0.086)	0.095 (0.027)	0.111 (0.038)	0.058 (0.018)	-0.160 (0.051)	-0.194 (0.064)
First-stage statistics		Partial R ² 0.157; F-test statistic <i>p</i> -value 0.000; maximum 2SLS relative bias below 15%					
Overidentification test <i>p</i> -value	0.140	0.150	0.720	0.502	0.139	0.593	0.093
Exogeneity test <i>p</i> -value	0.007	0.775	0.003	0.014	0.018	0.001	0.007
C. IV Relationship with Triple Instrument Using 250-Mile Band							
Log start-up share of employment in city at start of period	0.403 (0.140)	0.003 (0.097)	0.095 (0.028)	0.126 (0.048)	0.026 (0.018)	-0.158 (0.043)	-0.237 (0.074)
First-stage statistics		Partial R ² 0.175; F-test statistic <i>p</i> -value 0.000; maximum 2SLS relative bias below 15%					
Overidentification test <i>p</i> -value	0.251	0.411	0.712	0.440	0.997	0.593	0.175
Exogeneity test <i>p</i> -value	0.109	0.453	0.009	0.009	0.939	0.004	0.001

See tables 2 and 6. Outcome variables are indicated by column titles. Column 1 reports the log net employment growth by entrants in 2002 compared to 1982 city size. Column 2 considers the employment in 2002 of incumbent 1982 firms relative to 1982 city size. Columns 3 to 5 consider employment shares in 2002 of entrants since 1982 by establishment size category in 2002. Columns 6 and 7 report average establishment ages in 2002 for cities with a maximum age of 26 years. The instruments are the log count of mines within 250 or 500 miles, 1900, as indicated; a (0,1) indicator variable for coal or iron ore being the top mineral product in the state, 1928; and the count of iron ore mines within 100 miles of the city, 1900. Regressions include initial employment controls, Census division fixed effects, and city growth covariates.

historical mines placements. Thus, higher initial entrepreneurship of the city is associated with a younger establishment age profile of the city in 2002, even for top employers.³⁰

On the whole, these patterns support the primary link established for initial entrepreneurship and city growth.

³⁰ Unreported regressions analyze the forward evolution of incumbent firms in 1982 as a function of their local initial entrepreneurship. Both least squares and instrument results find that survival prospects for 1982 incumbents are decreasing in initial entrepreneurship for the city. Least squares finds that incumbent establishments that survive in places with higher initial entrepreneurship tend to also grow more, but the instrumental variable regressions do not support these results. The localized link of entry and exit rates is observed, for example, by Dunne, Roberts, and Samuelson (1988), Davis et al. (1996), and Kerr and Nanda (2009).

Expanded employment is generated in new establishments, and cities with higher initial entrepreneurship show lower age structures, even among their top employers, two decades later. Haltiwanger et al. (2013) describe an important up-or-out dynamic that connects young firms to firm-level employment growth. These patterns suggest a similar process is occurring at the city level, with successful start-ups expanding to become larger establishments and thereby generating employment growth. Evidence of these dynamics sits more closely with industrial legacies like the Chinitz hypothesis and entrepreneurship's role than if, for example, the employment growth came solely through older incumbents or endless replications of very small firms.

VI. Conclusion

The correlation between measures of entrepreneurship, such as the share of local employment in new start-ups or the average establishment size, and subsequent urban employment growth is quite robust both across and within cities. One concern with these measures is that they may capture other aspects of the local environment besides entrepreneurship. This paper tried to push forward on these issues by looking for the historical roots of small establishment sizes and higher entry rates. Progress on this front can aid urban economists seeking to understand how cities grow; they are also informative more generally for how entrepreneurship influences economic development and dynamics.

We followed the intuition of Chinitz (1961), who argues that industries dependent on mineral and coal deposits, like steel, involve large companies that create executives, not entrepreneurs. We use the presence of mineral and coal deposits in 1900 to provide us with variation in the level of resource-intensive industries. These deposits are associated with larger establishment sizes and lower birth employment shares in the 1960s and onward. Using this spatial proximity for instruments, we continue to find a significant link between our measures of entrepreneurship and urban employment growth.

The big concern with this variable is that it is quite plausibly correlated with aspects of the local economy other than entrepreneurship, such as manufacturing decline. We tried to control for these factors with city-level variables, region fixed effects, and so on, but we recognize that our measures are far from perfect. We focused then on industries that were not directly related to mining and on industries that were highly concentrated spatially, which suggests that they do not depend on a local market. We also focused on warmer cities, which should be less sensitive to the decline of the Rust Belt, and we modeled city growth projections. Our core results remain unchanged. Finally, using quantile instrument variable techniques, we identified that our effects are present in both cities exceeding and underperforming growth expectations based on their initial traits.

The weight of this evidence suggests that entrepreneurship is playing an important role in modern urban growth. While we have tried to systematically address concerns about the correlation between our instrument and the error term, we remain overall cautious about our results. We hope that our work prompts other researchers to identify sources of exogenous variation in urban entrepreneurship, within the United States or outside it.

The link documented by this paper between entrepreneurship and urban employment growth is an important input for policymakers. Obviously, current policymakers are not able to directly adjust the industrial origins of their cities, and mines over the long haul presumably yielded plenty of local economic benefits as well. Thus, policy conclusions need to be applications of these lessons. Perhaps the most important conclusion for local policymakers focuses on the stickiness

of entrepreneurship in places and the high degree to which this entrepreneurship relies on local heritage. Policymakers cannot naturally assume that entrepreneurs will flock to their city seeking good opportunities. Likewise, efforts to encourage local entrepreneurship may be justified, and Chatterji, Glaeser, and Kerr (2014) provide an extended description of these policy efforts, their economic rationales, and what we know about their effectiveness. A second conclusion from this work is that directly subsidizing large-scale employers, indigenous or through “smokestack chasing” efforts to lure new plants, can be dangerous if those employers crowd out local entrepreneurship. However, given the benefits that Greenstone, Hornbeck, and Moretti (2010) have found from winning competitions for million-dollar plants, this conclusion must be tentative.³¹ The patterns in figure 1 are exceptionally strong and the backbone for many policy initiatives. It is remarkable how little we know about what lies behind this relationship, especially given how widely held the belief is that entrepreneurship is important for economic performance.

³¹ Our results also demonstrate for policy design that the spatial equilibrium of urban economics is not an abstract theoretical concept; bursts of local economic success show up as higher employment, not higher wages. As many local policymakers want to increase their city’s employment, for reasons as diverse as overcoming nonemployment to building the local tax base, there remains plenty of incentive to the policymakers to pursue job growth associated with a more entrepreneurial city.

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