

# Geography, History, Economies of Density, and the Location of Cities\*

BY JEFFREY LIN

**E**conomists believe that people choose to live and work at sites that have productive or amenity value such as a river, harbor, or some other natural resource. Another factor that may determine the location of a city is the benefits derived from density itself: *agglomeration economies*. Although these complementary explanations both have something useful to say about the locations and sizes of cities, they also have important limitations. While natural features seem important, it is difficult to point to one or even several that are valuable enough to explain a very large metropolitan area. And if there are large economies of density, then *any* location could be the potential site for a city, since density itself provides a reason for further concentration. If you were to replay the settlement of some large expanse of land, perhaps cities in this alternative history would be of different sizes and locations. This “path dependence” or “history dependence” is a potentially important theoretical implication of models featuring economies of density. In this article, Jeff Lin helps shed light on why cities are located where they are.

What determines the location of cities? Sometimes, we can clearly identify instances when city locations were



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chosen to achieve specific development or political goals, in remote or sparsely populated areas. For example, the site of Canberra, Australia’s capital city, was selected in the early 20th century as a compromise between rival cities Sydney and Melbourne. For many older cities, we can make only educated guesses about their origins. In general, economists believe that people choose

\*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

to concentrate at sites that have some productive or amenity value. A river, a harbor, or some other natural resource nearby might encourage settlement. There is also the role of local institutions — for example, well-defined property rights — that might make some places more attractive. If these kinds of local features aren’t available everywhere, economic activity will be attracted to locations that are superior in resources and institutions.

Another factor that may determine the location of cities is the benefits derived from density itself — so-called agglomeration economies. Living or working in close proximity to businesses or other people can make workers more productive. For example, similar businesses might cluster together in order to have access to cheaper specialized inputs. Jerry Carlino’s 2001 and 2009 *Business Review* articles and my own from 2011 discuss several potential sources of these agglomeration economies. (Of course, the effect of agglomeration economies on the location of cities does not preclude the influence of natural amenities.)

These complementary explanations both have something useful to say about the locations and relative sizes of cities. Of course, great agglomerations today are located near rivers, oceans, or other prominent features of the natural landscape. And many people who live in densely populated areas experience clear benefits from proximity to customers, employers, and producers.

What is perhaps less clear is how to judge the contributions of locational “fundamentals” and agglomeration economies — or more generally,

economies of density — independently. Note that both natural fundamentals and economies of density have important limitations as stories for understanding the geographic distribution of economic activity. While natural features seem important, it is difficult to point to one or even several natural features that are valuable enough to explain a very large metropolitan area. For example, in Philadelphia, is proximity to the Delaware and Schuylkill rivers alone really so valuable as to encourage millions of people to crowd together on their banks? Similarly, on their own, stories featuring economies of density are also limited. If there are large economies of density, people will want to locate near existing concentrations of population, but these stories are silent on how a city comes to be in a particular location in the first place. Why is the greatest agglomeration in the Third Federal Reserve District<sup>1</sup> near the confluence of the Delaware and Schuylkill rivers and not, say, further upstream on the Schuylkill or closer to the Atlantic Ocean?

Furthermore, if there really are large economies of density — that is, density itself provides incentive for people to concentrate, in a virtuous circle — it's possible that *any* location could be the potential site for a city. All that is required for a large agglomeration is a smaller agglomeration or, in a sense, a city “seed.” Intuitively, if you were to rewind history and replay the settlement of some large expanse of land, perhaps cities in this alternative history would be of different sizes and locations. Economists sometimes call this “path dependence” or “history dependence” — that is, present-day or long-run outcomes can depend on a series of historical events or shocks — and it is a potentially important, and

<sup>1</sup> The Third District covers eastern Pennsylvania, southern New Jersey, and Delaware.

unique, theoretical implication of models featuring economies of density.

### EVIDENCE ON GEOGRAPHY FROM WAR AND DISEASE

In two papers, economists Donald Davis and David Weinstein reported a historical example paralleling this thought experiment. They analyzed settlement patterns in Japan before and after widespread Allied bombings during World War II. They interpreted these devastating bombings, and the resulting destruction of homes, capital, and lives, as akin to “starting history over” — many new location decisions were to be made in the vastly changed human geography of postwar Japan. However, contrary to their expectations, they found that the locations and relative sizes of Japanese cities remained unchanged from the prewar period — even Hiroshima and Nagasaki returned to their prewar growth trends

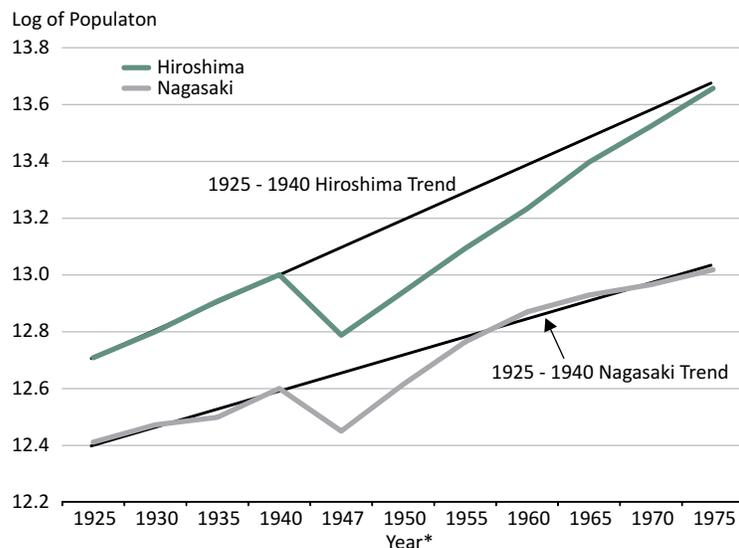
within 20 years (Figure 1). Similarly, a 2006 working paper by economists Patricia Beeson and Werner Troesken found that epidemics of yellow fever in Philadelphia in the 17th and 18th centuries had no long-run effects. Despite severe epidemics in 1699, 1792–1793, and 1797–1799, each of which killed about 8 to 10 percent of the city's population, Philadelphia, after each episode, returned quickly to its preexisting population growth trend.<sup>2</sup>

The tendency for Japanese cities to quickly revert to preexisting trends suggests that there was very little history dependence following the shocks of World War II. Otherwise, Davis and

<sup>2</sup> Papers by Steven Brakman, Harry Garretsen, and Marc Schramm; Paul F. Paskoff; and Edward Miguel and Gérard Roland show similar results for cities following war-related destruction in Germany after World War II, the U.S. South after the Civil War, and Vietnam after the Vietnam War.

**FIGURE 1**

### Populations of Hiroshima and Nagasaki Returned to Trend Growth Quickly



\* Data for 1945 were unavailable, so the authors used data for 1947.

Source: Davis and Weinstein (2002), used with permission

Weinstein might have found different patterns of concentration in postwar Japan; perhaps cities that had experienced relatively less destruction would have grown faster. Instead, the authors' preferred interpretation was that natural features are probably very important for understanding the locations and sizes of cities, with economies of density perhaps playing a secondary role. Their research left open an important question: If economies of density really do play an important role in determining location patterns, why didn't they observe any changes in the geographic distribution of activities following the massive destruction of World War II?

#### INTEGRATING EXPLANATIONS BASED ON NATURAL FEATURES AND ECONOMIES OF DENSITY

A satisfying understanding of the locations and sizes of cities probably includes *both* economies of density and natural features. However, finding evidence on the relative contributions of locational fundamentals and economies of density can be challenging. First, there are many natural features (e.g., rivers, forests, minerals, climate, etc.), and we may not have been able to include the value of all of these features. This leads to an "unobservable variables" problem: Although there may be a preferred explanation for a particular agglomeration, there lurks the possibility that some unobserved factor is the true reason for concentration at that site.

Furthermore, the natural features that first attracted people and businesses to a location very often continue to have value, even today. Consider long-lasting features like access to an ocean port or nice weather. These things continue to attract economic activity to particular locations to the present day and provide value to households who live there. Their con-

tinued value can confound attempts to attribute today's spatial distribution of population to economies of density.

In a previous *Business Review* article, Satyajit Chatterjee discussed one way to better understand the relative roles of natural features and agglomeration economies. His strategy was to construct an economic model

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that included *both* natural features and agglomeration economies. Then, he used this model to match the observed distribution of employment across U.S. counties and metropolitan areas. This exercise implied certain values for key parameters of the model. Having matched the *actual* geographic distribution of employment with this model, he then simulated a counterfactual geographic distribution of employment *without* agglomeration economies; that is, he assumed that the benefits to density were zero, but the other parameters were the same as before. Chatterjee found that, in the simulated economy, the distribution of economic activity without agglomeration economies was very similar to the observed distribution. His work supports the idea that some factor *besides* agglomeration economies is important for understanding the distribution of economic activity, although his method is silent on what the factor or factors might be.

#### EVIDENCE ON HISTORY DEPENDENCE AND INDUSTRY LOCATION FROM GERMANY

Economists Stephen Redding, Daniel Sturm, and Nikolaus Wolf

have also explored these issues in two papers. They examined the effects of Germany's division and reunification on its economic geography. In their 2011 paper, Redding, Sturm, and Wolf found that the division of Germany led to a shift in the location of air hub traffic from Berlin, where it had been concentrated, to Frankfurt. Following

reunification, they found no evidence of a shift back to Berlin. They interpreted this evidence in the following way: The division of Germany after World War II made continued hub operations in Berlin less profitable because that city became more isolated relative to other cities in the new West Germany. Frankfurt became relatively more attractive and subsequently became the preeminent air hub. Finally, reunification made Berlin less isolated and therefore a more attractive location for hub activities relative to its Cold War value. However, the authors found no evidence of a return of air traffic to Berlin; in fact, hub traffic continued to rise in Frankfurt and decline in Berlin following reunification. Thus, a historical shock had a permanent effect on the distribution of economic activity.

The authors interpreted this as evidence of history dependence. While these facts suggest the importance of economies of density (versus natural fundamentals), there remains the possibility that the division of Germany also created some unobservable, persistent change in the attractiveness of Berlin (or Frankfurt) as a

hub, so that following reunification, Berlin's value was not high enough to serve as a viable hub, no matter what the alternative historical sequence of events. (Alternatively, perhaps some event after German division greatly increased Frankfurt's value as an air traffic hub.) Much of Redding, Sturm, and Wolf's paper focuses on ruling out changes in locational fundamentals. In fact, probably the strongest case for history dependence (and against this criticism) is that hub traffic has not returned to Berlin, despite its being by far the largest city in Germany. Still, there is some ambiguity to interpreting these facts.

#### EVIDENCE ON HISTORY DEPENDENCE FROM PORTAGE SITES IN THE U.S.

Having better knowledge about some fundamental natural feature that affected economic geography and the change in its value over time might provide better evidence of history dependence. In addition, perhaps it would be interesting to examine population in general, rather than a specific (but interesting) industry like airline services. In a recent working paper, Hoyt Bleakley and I attempt to provide this kind of evidence. We examine historic *portage sites* in the U.S. South, Mid-Atlantic, and Midwest.

Portage is the carrying of a boat or its cargo over land between navigable waterways or to avoid a navigational obstacle such as rapids or falls. Portages are the places where this activity occurs. During the settlement of North America, when long-distance shipping was mostly waterborne, portages were a focal point for commerce. Traders were obliged to stop because of the natural obstacle to navigation; in turn, these sites offered easy opportunities for exchange and commerce. While these opportunities were valued historically, they became obsolete long ago. Thanks to changes in transportation

technology (e.g., railroads, trucks), traders no longer walk canoes around rapids. Similarly, some falls were sources of waterpower during early industrialization, and these advantages also declined with the advent of other, cheaper power sources. (Electrification, by allowing for transmission of power over long distances, uncoupled the location of manufacturing from the location of power generation.) Notably, despite the obsolescence of canoe transport and water wheels, concentrations of economic activity continue to exist at many of these sites.

**Historical Portages and the Economic Geography of the Third District.** Historical portage sites affected the economic geography of the Third District in early America and continue to do so even today (selected historical portages are shown in Figure 2 as green points). Several places in the Third District are portage-descended cities, including Trenton, Philadelphia,

and Wilmington.

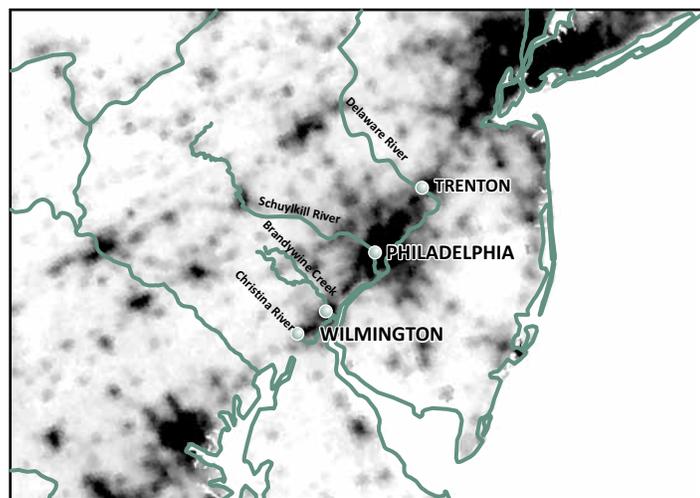
For example, the Schuylkill River was a major water transportation route in early America, and the falls of the Schuylkill (near the present-day section of East Falls in Philadelphia) first attracted Delaware and Iroquois Indian activity prior to European settlement.<sup>3</sup> (Later, William Penn directed his surveyors to find a site on the Delaware River where it was "most navigable, high, dry, and healthy; that is, where most ships may best ride, of deepest draught of water, if possible to load or unload at the bank or key side, without boating or lightering of it. *It would do well if the river coming into that creek be navigable, at least for boats, up into the country.*"<sup>4</sup> Thus, a key feature

<sup>3</sup> See p. 11 of the book by Thomas Scharf and Thompson Westcott.

<sup>4</sup> See the article by John Reys, p. 29, emphasis mine.

## FIGURE 2

### Selected Historical Fall-Line Portages in the Third District



Background is nighttime lights layer from National Geophysical Data Center (2003); Version 2 DMSP-OLS Nighttime Lights Series, Boulder, CO; [http://www.ngdc/noaa.gov/](http://www.ngdc.noaa.gov/). DMSP data collected by U.S. Air Force Weather Agency.

that Penn sought for his city, Philadelphia, was access to and trade with the interior of Pennsylvania. Penn's commission set out for Pennsylvania in the early summer of 1682 with these instructions for finding a suitable site for Philadelphia. There is some evidence that the commission initially selected a more southerly site in present-day Chester County.<sup>5</sup> It's plausible that recognizing the value of better navigation and waterpower along the Schuylkill, Penn's surveyors rejected the Chester County site in favor of the present-day site near the falls of the Schuylkill River.

Swedish, Dutch, and later English settlers took advantage of both the trading opportunities and waterpower at the falls of the Schuylkill. Farmers used the Schuylkill to transport goods and exchange grew near the falls. In 1706, farmers in Lower Merion asked for a road to the landing place just below the falls to better facilitate trade.<sup>6</sup> As early as 1686, water mills were erected to take advantage of the falls.<sup>7</sup> And Donald Davis, who owned a mill near the falls, said in 1749 that the site of the falls was "very convenient for water carriage, both for bringing loads to the mill, and rafting timber to Philadelphia, it being by the river Schuylkill."<sup>8</sup> Thus, early Philadelphia benefitted from its location near the falls of the Schuylkill and was able to attract both commerce and industry.

The site of present-day Trenton is at the falls of the Delaware River and its head of navigation, that is, the point at which navigation is no longer possible. It was inhabited by the Sanhican tribe of the Lenape Indian nation as early as 1400. The first Europeans

settled there in 1679. William Trent, a Philadelphia merchant, recognized the value of the falls and bought 800 acres near them; he then began developing the area, including a stone mill. "Trent's energy and financial backing launched the settlement, which he called Trent's Town, into a period of steady growth. Its position at the head of sloop navigation made the town a shipping point for grain and other products of the area, and a depot for merchandise between New York and Philadelphia."<sup>9</sup>

The first permanent European settlement in Delaware — by Swedes in 1638 — was near the confluence of the Delaware and Christina rivers and the falls of the Brandywine Creek, the present-day site of Wilmington. The falls of the Brandywine and several smaller nearby rivers provided waterpower for early mills and attracted industrial activity. The first mill on the Brandywine opened in 1687. By the 1790s, the flour mills near Wilmington and the falls of the Brandywine were the largest in the U.S.<sup>10</sup>

### THE PERSISTENCE OF PORTAGE CITIES AFTER THE OBSOLESCENCE OF PORTAGE

Of course, in our District many portage cities are close enough to the ocean to continue to serve as port cities. In that sense, some natural advantage survives to this day. However, the Schuylkill, Christina, and Brandywine rivers serve little commercial traffic today. Similarly, the waterpower produced at these falls today is negligible, compared with power from other sources.

In my study with Hoyt Bleakley, we consider many other portage sites where the disappearance of the origi-

nal advantages is even clearer. In spite of the obsolescence of these original natural advantages, these portage sites are often still the location of major agglomerations today. In our study, we pay particular attention to rivers that intersect the *fall line*, a geomorphological feature dividing the Piedmont and the coastal plain. The fall line describes the last set of falls or rapids found along a river before it empties into the Atlantic Ocean or the Gulf of Mexico. Many historical portages, at intersections between the fall line and major rivers, are sites of major cities today (Figure 3).

An advantage of examining fall-line portages is that nearby locations are often very similar, in terms of other natural advantages. On land, the transition from the coastal plain to the Piedmont is quite gradual. This smoothness allows us to use comparison areas — places along the same river — that, except for an initial portage advantage, share features similar to these historical portage sites. For example, we can compare Philadelphia with other locations along the Schuylkill. This similarity also helps to rule out the existence of features co-located with portage that might continue to have value today. We also control for other observable differences, such as topography and climate. Thus, the main comparison is between sites that seem nearly identical *except for* the initial difference in value due to portage.

We found that not only are present-day populations concentrated at portage sites (relative to similar locations), these differences have shown no tendency to diminish over a long period of time — over a century after portage-related advantages became obsolete. Figure 4 shows the difference between population densities at portage sites and comparison sites for each decade relative to 1850. We also control for other observable differences. What the graph shows is that the dif-

<sup>5</sup> See p. 594 in the book by Samuel Hazard.

<sup>6</sup> See the article by Charles Barker, p. 345.

<sup>7</sup> See the article by Edwin Iwanicki, p. 326.

<sup>8</sup> See Barker, p. 345.

<sup>9</sup> See the Federal Writers' Project, p. 400.

<sup>10</sup> See the book by John Munroe, p. 58.

ferences in density have actually gotten larger over time. (In a separate analysis, we also compared portage cities to other cities of comparable density in 1850. There is no tendency for portage cities to decline relative to these cities as portage's value declined.)

Thus, even though initial differences in value due to portage have declined to zero, there is no tendency

for populations to equalize across these comparison locations. If fundamentals were the only force that mattered, we would expect, over the long run, that these differences would attenuate toward zero. However, the evidence suggests otherwise. Thus, a historical difference, now obsolete, strongly and permanently affected the pattern of development across a wide swath of the

U.S. We view this as strong evidence for path dependence in the location of economic activity.<sup>11</sup>

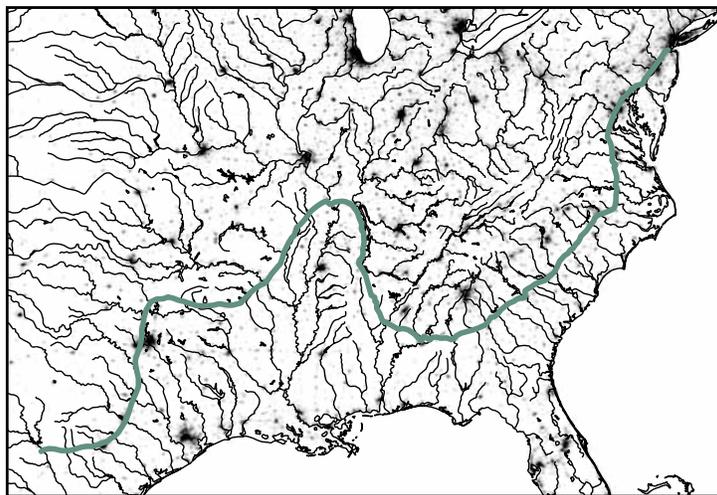
So why didn't Davis and Weinstein find permanent responses to the bombings of World War II in their study of Japan? A comparison with the studies of Germany and the fall line in the U.S. suggests a few hypotheses. Perhaps the magnitude of the shock associated with the Allied bombings of Japan was transitory, that is, not "large" enough to have permanent effects. Roads, lot divisions, and many other forms of capital survived the bombings and may have provided anchors for redevelopment. Also, the division of Germany lasted a half-century and, at the time, was likely to have been perceived as permanent or near permanent. Similarly, many portage sites in the U.S. were in active use and provided value for many decades or even a century or more. A plausible explanation is that these latter two episodes were larger shocks to the economic geography of the respective regions, which accounts for the difference in results.

Another possibility relates to the large amount of geographic variation in Japan. Japan's islands contain rugged mountainous areas and a few flat coastal plains. These large differences can actually suppress the effects of history. Intuitively, if only a few locations in a larger region are suitable for economic activity, it seems likely that, no matter the sequence of historical events, people would continue to

<sup>11</sup> If we were to replay the history of the U.S., it seems likely that a similar sequence of location decisions might have taken place near fall-line portages, given the existence of these physical obstacles to water navigation. However, a broader definition of path dependence, in which the location of economic activity depends on the past sequence of events and not necessarily locational fundamentals, seems applicable to the history of portage cities. In this view, portages are like accidents of *geography* that affected the historical location of population, which, in turn, affected the location of cities today.

**FIGURE 3**

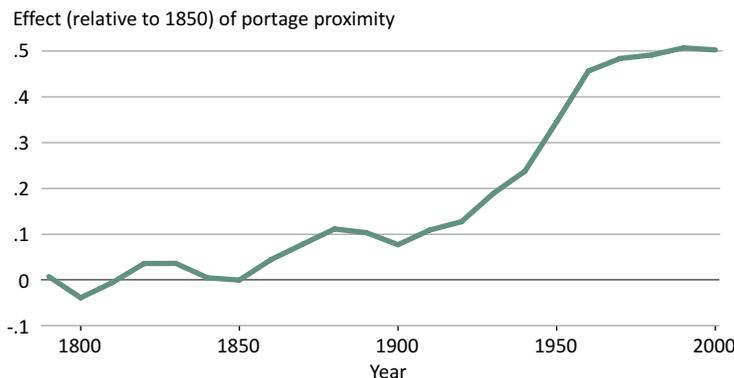
**Fall Line, Rivers, and Population Density Today**



Source: Adapted from Bleakley and Lin, Figure A.1

**FIGURE 4**

**Population Density Differences Over Time, Portage vs. Nonportage Sites**



Source: Adapted from Bleakley and Lin, Figure 5

settle in the same places. By analogy, as a thought experiment, if we were to replay the history of settlement in California (a very heterogeneous region), it seems likely that in our alternative history, the views of the Pacific coast, the harbors in San Francisco and San Diego, the soil quality in the Central Valley, and the sunshine in the Los Angeles basin would result in similar kinds of economic activity locating in similar places.

In contrast, in our study of portages, we are examining an area of the world that is relatively homogeneous:

The U.S. South, Midwest, and Mid-Atlantic are all relatively featureless plains, or, at least, the terrain and other natural features change slowly over space. Compared with Japan, a sample area that minimizes changes in natural features seems like a more ideal laboratory for testing for the presence of path dependence in the location of cities.

Recent research in economic geography suggests that, in different contexts, geography, history, and economies of density can each be major contributors to the distribution of economic activity. If geography mat-

ters a lot, as in Japan, then history and economies of density are unlikely to be major explanations for the distribution of people and businesses. If economies of density are strong, as with airport hub activities, then perhaps geographic fundamentals matter little and historical chance plays a larger role. And if geographical variation means little, as in the U.S. South and Midwest, then history seems to play a large and persistent role in determining the location of economic activity. 

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