combination of higher density and/or lower construction cost must prevail in larger cities. This, in turn, means that, if we hold rent per household constant across cities of different sizes, larger cities must be characterized by some combination of greater density and/or smaller housing units. The 500-square-foot efficiency apartment in Manhattan, stacked 40 on top of each other, might rent for the same as a 1,000-square-foot garden apartment in central Atlanta.

In fact, we can say more than this. We can see that what caused the higher rents in the population example was *not* the population per se, or even the area of the city, but the *length of the radius,* the distance of the urban boundary from the CBD. The rent gradient is fixed, based on transportation costs and density. The rent at the urban boundary is fixed, based on the agricultural opportunity cost and the building construction cost. Therefore, what governs the change in the average rent is the change in the distance each point finds itself from the urban boundary.

This is important because, for a given population and density, the radius of the city (i.e., the distance from the CBD to the urban edge) must be greater if the city cannot avail itself of an entire 360-degree arc. In reality, geographic constraints on the urban arc are quite common as, for example, with a city on a coastline or peninsula.[11] Most of the largest U.S. cities are on coasts or are cut by waterways or mountain ranges that effectively prevent the use of a large proportion of the arc around the CBD. This no doubt extends the radius of cities such as New York, Chicago, Los Angeles, and San Francisco, further adding to their tendency to support high rents.[12]

It is also interesting to note that if incomes were constant across cities of different sizes, then inhabitants of larger cities would either have to consume less housing (i.e., live in smaller houses and/or have less land per house) or spend more on transport costs, compared to residents of smaller cities. Either way, inhabitants of larger cities would have less economic welfare than inhabitants of smaller cities. Over time, such an imbalance in economic welfare between citizens of smaller and larger cities would not be tenable in an integrated economy. People would migrate from larger to smaller cities, *unless the larger cities offered higher incomes,* on average. But this is exactly what happens in the real world. Larger cities do tend to have higher average per capita incomes than smaller cities. Put the other way around, cities that are able to offer higher incomes tend to attract migration and over time grow larger in population relative to other cities, until an equilibrium across cities is reached. Although we residents of medium-size midwestern cities might not like to admit it, the average resident of New York or Los Angeles is, in fact, more productive than the average resident of Cincinnati or Cleveland.[13]

If we consider population changes within one city over time, then the monocentric city model can give some insight into how much, or how fast, rents may change over time, and how such changes may differ in different parts of the city. For example, it is not uncommon for a metropolitan area to increase 10% in population over a 10-year period, or indeed over a five-year period in many Sunbelt cities. Holding density constant as before, such a population increase will result in approximately a 5% increase in the urban radius, from 16 miles to 16.8 miles in our Circlopolis example. All locations now have 0.8 mile additional location rent, or an increase in

[11]The existence of lakes or unbuildable wetlands, slopes, or preserved open spaces or conservation land has the same effect of reducing the effective arc, even if the effect may occur at all points of the compass.

[12]When the arc around which a city can expand is limited by, say, bodies of water or mountain ranges, the same total area must fit into a fraction of a circle. The radius equals $\sqrt{A/(\pi F)}$, where A is the area and F is the fraction (less than or equal to 1) of the full 360-degree arc around the CBD that can be used for growth. This is consistent with our point in Chapter 1 that a rising long-run marginal cost curve (increasing development costs including land cost), implying increasing real rents in equilibrium in the space market, would tend to occur in areas where land supply is constrained in the face of growing demand. Growing demand may be thought of as population growth in the present example. Keep in mind that the radius is the distance from the CBD to the edge of the developed urban area, for example, from Manhattan north up the Hudson Valley.

[13]Hey, we know they're not smarter than us. They must just be taking advantage of the agglomeration and scale economies we talked about in Chapter 3, and of all the capital that's accumulated in those big cities. And, of course, small town residents would all agree that big city dwellers are far too "workaholic."