Chapter 5
Economic Geography

5.1 Economic Geography

So far we've looked at how economic activity is organized within a city, and described agglomeration as a fundamental force driving firms close to each other. We now move to study of the distribution of economic activity over a larger space: a country. We call this object of study and its accompanying field Economic Geography.

If we look at the spatial distribution of people in almost any country, we can make a few robust and striking observations. First, a large majority of the population is concentrated in a very small share of land. Figures 5.1 and 5.2 show this plainly. This observation is not only a geographic curiosity: it has important consequences for welfare. Development and urbanization are closely related. Cities provide public services, such as education, electricity, clean water, culture, and parks, to a large population. To the extent we understand the drivers of this concentration of people in space, we can also understand an important aspect of economic development.

In this chapter, we will look at the paper that started off the theoretical study of the spatial distribution of population, its determinants, and its economic consequences. This paper, Krugman (1991), essentially started the modern study of economic geography. It builds a model that includes some of the fundamental forces that locate labor and production in space. By including transportation costs, and leveraging the increasing returns to scale of the industrial sector, Krugman's model is capable of explaining when a country's production will concentrate in a central core, leaving agricultural production to the periphery.

5.1.1 Increasing Returns and Economic Geography

Krugman's paper starts by pointing out that labor and production are highly concentrated in space, and that academic economists had, until his time, rarely tried to

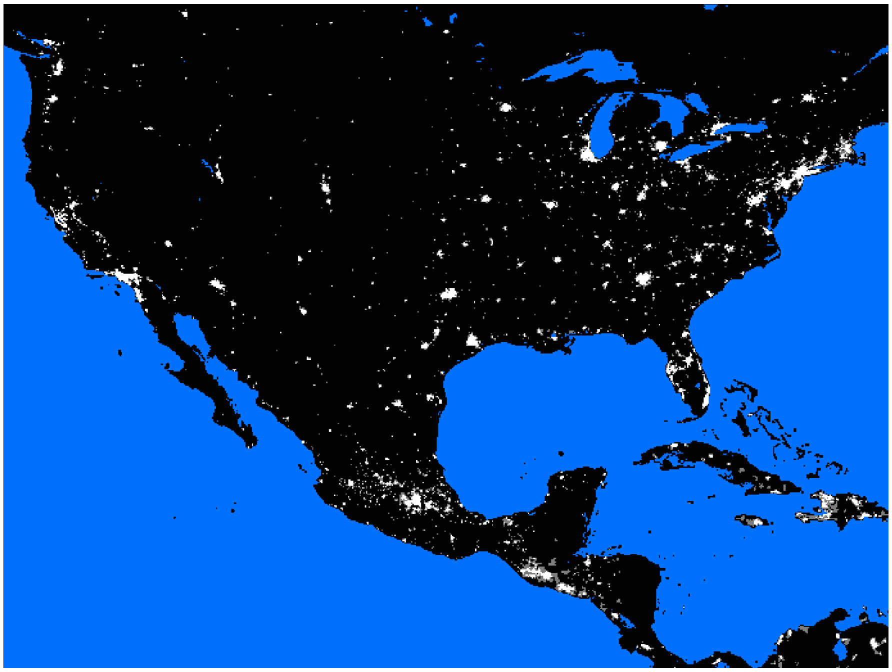

Fig. 5.1 Population, North America.

grapple with the question. In his Nobel Prize lecture Krugman (2008), he attributes this omission to the complexity of modelling increasing returns. Increasing returns are central in explaining the spatial concentration of production. If industrial production displayed decreasing or constant returns, it would be distributed in space according to where consumers were, in the presence of transport costs. However, until Krugman came along, there were no tractable general equilibrium models that allowed for increasing returns.

This paper provides exactly that model. Krugman developed its first version to explain patterns in international trade. Some years later, he noticed that international trade is formally very similar to intra-national trade. This meant that his new tools could be used not only to explain the specialization of countries, but also the specialization of regions within a country.

5.1.1.1 Intuition

Let's build some intuition before writing the full model down.

Consider a firm in a country with two regions. Production is costless, but transportion costs τ per unit. Sales in each region are fixed. Let these be $S > S^*$. The firm can choose to open a plant in one or both regions, but opening a second plant costs F.

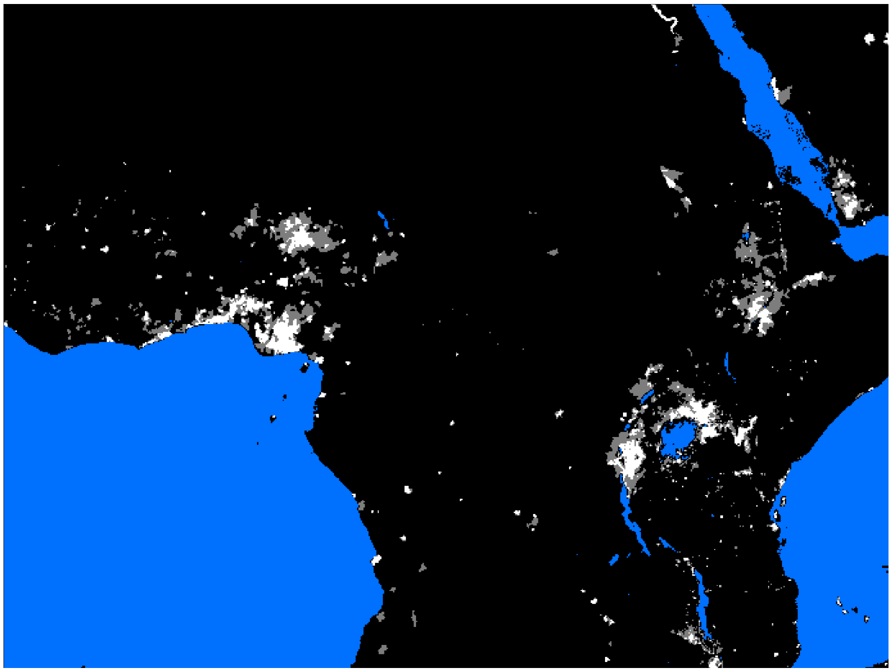

Fig. 5.2 Population, Africa.

The question is: when will production be concentrated in a single region? If it opens a single plant, it will be in the larger market. And it will be more profitable to serve the smaller market by shipping goods rather than opening the second plant when

$$F \geq \tau S^*$$
$$\iff \frac{F}{S^*} \geq \tau$$

The left hand side is average cost in the second market, and measures how large returns to scale are. The larger is F, the larger the savings from not building the second plant, and therefore more advantageous it is to produce every unit in a single plant. The smaller is $S*$, the smaller is the total cost of shipping goods to the second region, and so the more attractive shipping is. So as long as returns to scale are large enough relative to transport costs, all production will happen in the sample place.

Now imagine there are two sectors: agriculture and industry. The essential difference between them is that agricultural production requires fertile land, and therefore its distribution in space is exogenous - not chosen by the agents in the model. Industry, on the other hand, can produce anywhere. Firms must again decide where to locate their production.

Suppose that the total size of the market that firms need to serve is S, and that industrial goods are a share μ of that market. Suppose that both regions are identical, so that each demands $\frac{S(1-\mu)}{2}$ manufactures. Then the condition for concentration of production is

$$F \geq \frac{\tau S(1-\mu)}{2}$$

Then, when the industrial sector is large, it will tend to concentrate, since returns to scale will increase incentives for localized production. Notice that the sectors are identical in their characteristics: concentration can happen in either region.

Despite how simple and unrealistic the model is, its predictions are in line with the economic history of many countries. Large industrial cities come into existence fueled by the emergence of large scale production, investment in transport infrastructure, and the growth of the demand for manufactures.

Let us now describe Krugman's model in full. It will have a few advantages over our intuition-building sketch. First, it will include workers/consumers, meaning it will make predictions about the location of people in general equilibrium. The distribution of population is easier to observe in data than production, and is interesting in itself.

Second, it will introduce two mechanisms that amplify the agglomerating effect of market size. Industry will bring along some of its own demand, since the labor it employs will also demand manufactures. In addition, labor will find it more attractive to live where production happens, since manufactures will be cheaper when they don't have to be shipped.

5.1.1.2 Krugman's model of economic geography

Labor

All individuals are assumed to consume an agricultural product A and manufactures M, with the following utility function:

$$U = C_M^{\mu} C_A^{1-\mu}$$

This Cobb-Douglas form will ensure manufactures make up a share μ of consumption, as before.

There are many kinds of manufactured goods, indexed by i. C_M is an aggregate of all of these, defined by:

$$C_M = \left[\sum_i c_i^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

There are two regions, 1 and 2, and two factors of production in each region, workers and peasants. As before, there is an agricultural and an industrial sector. Each sector uses only one factor: agriculture employs peasants and industry employs workers. Peasants are immobile and distributed equally between regions. Then, $\frac{(1-\mu)}{2}$ peasants live and produce in each region.

Workers can move: let L_1 and L_2 be worker supply in regions 1 and 2, respectively. For convenience, we pick labor units so that

$$L_1 + L_2 = \mu$$

The production of manufacture i has a fixed cost α and a marginal cost β, both measured in units of labor:

$$L_{M_i} = \alpha + \beta x_i$$

where L_{M_i} is labor input and x_i is output.

Transportation

Transportation of the agricultural good is assumed to be costless. Transporting manufactures has an iceberg cost $1 - \tau$, meaning that for each unit of the good shipped, only τ arrives.

Firms

Each firm produces only a single variety of manufacturing products. It is easy to show, from the consumer's problem, that each firm faces the following demand c_i for its product:

$$c_i = p_i^{-\sigma}$$

Since all firms are identical, we drop firms' indices in what follows. However, prices and quantities will vary by region, so we keep region subindices. Profit maximization by the firm implies:

$$p_1 = \frac{\sigma}{\sigma - 1} \beta w_1 \tag{5.1}$$

where w_1 is the wage in region 1. We assume there is free entry of firms into manufacturing, meaning that profits are driven to zero. Then:

$$p_1 x_1 = w_1(\alpha + \beta x_i) \tag{5.2}$$

Then (5.1) and (5.2) imply that production per firm will be the same in both regions:

$$x_1 = x_2 = \frac{\alpha(\sigma - 1)}{\beta} \tag{5.3}$$

This means that all firms will produce the same amount of manufactures, and every firm in the same region will employ the same amount of labor. Let n_1 and n_2 be the number of firms in 1 and 2, respectively.

Equilibrium

All that remains is to write down the ”adding-up” constraints and using them to solve for an equilibrium. Define z_{11} as the ratio of region 1 expenditure on local manufactures to manufactures from the other region.

$$z_{11} = \frac{n_1}{n_2}\frac{p_1\tau}{p_2}\frac{c_{11}}{c_{12}} = \left(\frac{L_1}{L_2}\frac{w_1\tau}{w_2}\right)^{1-\sigma} \tag{5.4}$$

Analogously for region 2 expenditure on region 1 products:

$$z_{12} = \left(\frac{L_1}{L_2}\frac{w_1}{w_2\tau}\right)^{1-\sigma} \tag{5.5}$$

Let Y_1 and Y_2 be regional incomes. Total income of region 1 workers must equal total spending on manufactures produced in 1. Then, the incomes of region 1 and 2 workers are

$$w_1L_1 = \mu\left[\frac{z_{11}}{1+z_{11}}Y_1 + \frac{z_{12}}{1+z_{12}}Y_2\right] \tag{5.6}$$

$$w_2L_2 = \mu\left[\frac{1}{1+z_{11}}Y_1 + \frac{1}{1+z_{12}}Y_2\right] \tag{5.7}$$

Finally, total regional income must equal the sum of peasant and worker income:

$$Y_1 = \frac{1-\mu}{2} + w_1L_1 \tag{5.8}$$

$$Y_2 = \frac{1-\mu}{2} + w_2L_2 \tag{5.9}$$

Equations (5.4) to (5.9) define a system of six equations in six unknowns, given L_1 and L_2.

With the model in hand, we will study the conditions that lead to the concentration of manufactures in two ways. First we will assume each region starts out with half the total number of workers. What would happen then if some workers moved to region 1? Under which conditions would other workers want to follow? We will study this model in the short run, taking the workforce to be exogenous in order to do comparative statics, and in the long run, where we will allow workers to choose where to live, thus fully closing the model.

In the second exercise, we will assume all workers already live in the same region, and study whether it would be a stable allocation. In order to do this, we will ask whether any firm would have something to gain from moving away from the industrial region.

Short run equilibrium

As a first step towards solving the model, we take the location of labor, L_1 and L_2, as given. What mechanisms would be at play when we moved some population into region 1? The most interesting of these is called the ”home market effect”, where being in a place with a larger market is more desirable for firms. Suppose we start out with equal number of workers in both regions and some labor moves to region 1 from region 2. First, notice that wages are higher in the larger market. As labor concentrates, some of the total transport costs are now paid to workers instead of being lost. This means that wages increase, since firms must make zero profits. Since both wages and labor have increased in region 1, and workers spend a fixed share of their income on manufactures, expenditure on manufactures increases even more. (We see this in (5.4)) A larger market means higher expenditure on manufactures, which attracts firms (as we saw at the beginning of this section).

We then see a positive feedback loop that will tend to bring manufacturing in the country together. However, the argument must also depend on τ and σ, since they appear in (5.4). We will see this shortly. We must also consider that workers are mobile and will decide to live wherever their real income is larger. Krugman calls an equilibrium where workers can move the long-run equilibrium, which we study next.

Long-run equilibrium

In this model, indirect utility of workers is increasing in real wages. Then we only need to know where real wages are larger to know where workers will choose to locate. If relative real wages increase when a region receives more workers, then a country with symmetric regions will eventually split into an industrial core and a rural periphery. This is because a small shift in population will set off a feedback loop that will gather all population in the same place. The model becomes intractable analytically, but we can check solve it in a computer for given parameter values. Then, we can see how the ratio of real wages, $\frac{\omega_1}{\omega_2}$ depends on the share of workers living in region 1, $f = \frac{L1}{\mu}$. If $\frac{\omega_1}{\omega_2}$ increases with f, then from a symmetric allocation of workers, a small population movement will set off a process where all workers move to the same place. On the other hand, if $\frac{\omega_1}{\omega_2}$ decreases with f, then small movements away from a region will correct themselves. Figure 5.3 shows, for two values of the transport cost τ, how the ratio of real wages depends on the share of workers. When τ is low, meaning transport costs are high, region 1 becomes relatively less attractive for workers when more workers move to 1. In this case, regions would tend to converge. If transport costs are low, however, an increase in f makes region 1 more attractive, starting the feedback loop.

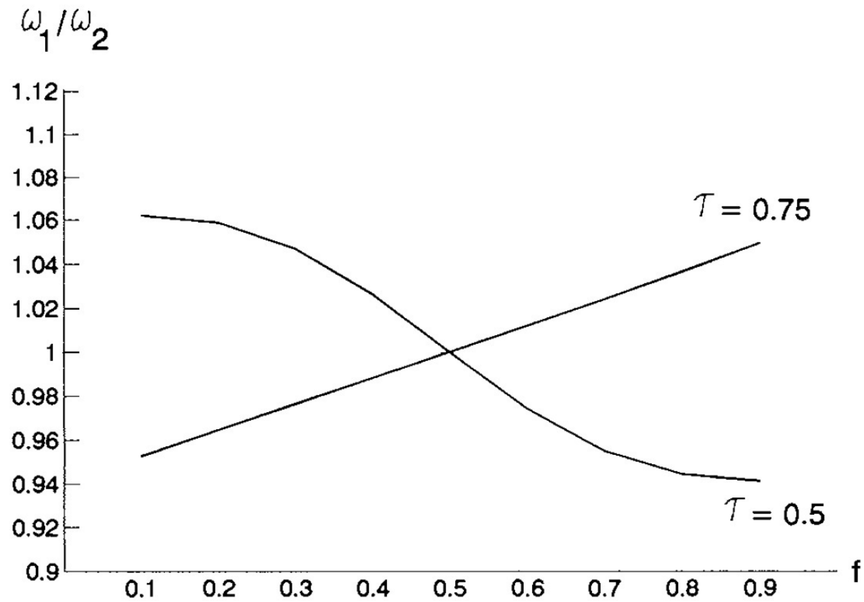

FIG. 1

Fig. 5.3 Conditions for convergence