6 The Economies Model, the Equilibria, and the Number of Specialized Outcomes

To understand more fully our characterization of the equilibria that emerge from the analysis, it is necessary to lay out our analytical model of international trade, the equilibrium concept that we employed, and the calculation that leads to our conclusion about the vast number of candidate equilibria available to the market mechanism in a world of scale economies. This chapter and the chapters that follow are thus primarily written for specialists in the field.

First, it is important to recognize that our equilibria are not the product of a particularly unorthodox model. Indeed, our model deviates from the classical model of international trade in only one respect: We assume that the production relationships are characterized by scale economies rather than by constant or diminishing returns to scale. The model's basic components are a set of demand functions in each country for the different commodities, and a set of production functions in each country for the different commodities. As in the classical model we define equilibrium as a set of outputs and prices that satisfies the following three requirements: (1) for each commodity the quantity supplied equals quantity demanded, (2) with only one input—labor—the total revenue of each industry is exactly equal to labor cost so that there is zero economic profit,[1] and (3) the labor in each country is fully employed.[2]

Each of these requirements yields a set of equations, which together determine the values of the variables of the model. The variables include the quantity of each good consumed in each of the two countries, the quantity of each good produced in each country, the share of the total world output of each particular good produced in each country, the quantity of labor each country devotes to the production of each commodity, the price of each good, the wage rate in each country, and total income in each country. The model also employs four assumptions: first, that the world is composed of only two countries,[3] second, that there is only a single productive input, labor, third, that the quantity of labor available to each country is a fixed and given quantity, and, fourth, that the demand functions in each country can be integrated into a national utility function of Cobb-Douglas form. As is well known, this last premise implies that in each country the total amount spent on each commodity is fixed and does not vary with the price of the commodity, that is, all demands are unit elastic at all prices and quantities. Then the amount spent on some good *I* is a fixed fraction of national income, with that fraction given by the exponent of good *I* consumption in the Cobb-Douglas utility function. These assumptions are adopted to simplify the formal analysis, and we believe that they do not affect our conclusions.

6.1 Perfectly Specialized Outcomes as Stable Equilibria

A perfectly specialized outcome is defined as one in which, for each (and every) commodity *I*, the share of *I* that is produced in one of the two countries is zero while the other country's share of world output of that good is unity (100 percent). Our analysis will focus on such perfectly specialized solutions, because (as is well known) scale economies lead the market mechanism toward perfect specialization ("natural monopoly") and also because, as will be seen later (chapter 9), the inclusion of nonspecialized solutions complicates the analysis, but in the end produces the same results.

Intuitively the reason that equilibria will be specialized under scale economies is straightforward. Moreover the same reasoning indicates that these specialized equilibria will be locally stable, meaning that market forces will return the economy to any such equilibrium outcome after something makes the economy deviate slightly from it. For example, in a perfectly specialized equilibrium, widgets will be produced exclusively in only one country, say, France. By virtue of the resulting scale economies that accrue to France, it will then have a substantial advantage over any potential entrant who hopes to embark on widget production incrementally, beginning on a small scale. Such a small-scale entrant will, because of its relatively high costs, be unable to compete against the incumbent, France, and will soon be driven altogether from the field by market forces. Thus the world economy will automatically be pushed back by market forces toward the initial equilibrium in which France was the sole producer of widgets. It is not too difficult to construct a formal dynamic model encompassing this scenario and confirming the sort of stability just described.

So far we have suggested that equilibria under scale economies tend to be perfectly specialized outcomes. However, somewhat more surprising and more important for our analysis is the converse. Each and every perfectly specialized outcome (assignment) is an equilibrium. A proof is easily sketched. It is sufficient to show that any specialized outcome can satisfy all of the three sets of conditions that define an equilibrium. We now do so, in several steps.

1. Determination of expenditure on a good with the given assignment. First, consider any specialized assignment of production among countries in which France is the sole producer of widgets. We test whether this assignment can be an equilibrium of a given model with known demand and production functions. Given the assumed Cobb-Douglas utility function, the share of each country's income that will be spent on every good is known. For the moment, assume that the income of each country is also given. Then the dollar amount that will be spent on widgets (or any other good) in each country is determined directly by multiplying income by share spent on widgets.

2. Zero profit and level of employment in each industry. With this information we can go on to show that the given specialized assignment can, with the equilibrium quantity of labor in each industry, satisfy the first equilibrium requirement: zero profits. At the same time we will see how the equilibrium level of employment of labor in each industry can be determined. Zero profits in the widget industry can be ensured if exactly the amount that consumers spend on widgets, as already determined, is paid to French widget workers, since no other country produces widgets. Hence the zero-profit condition can be satisfied by the given specialized outcome if the number of French widget workers times the French wage rate equals the (given) world expenditure on widgets. For this reason equilibrium employment in any French industry, call it industry I, in the given specialized outcome equals world expenditure on I divided by the French wage rate. So the next step is to find the French wage rate.

3. Full employment and determination of wage rates and national income. Next we turn to the second equilibrium condition: full employment in each country, and determination of the wage rate in each country. We have just seen that with world expenditure on a good given, employment in an industry will vary inversely with the national

wage rate. Therefore the full employment requirement of equilibrium can clearly be satisfied by selecting a wage-rate figure at which the sum of the employment figures for all of the individual industries in which France is a producer in our given assignment equals the total French labor force.[4] That wage rate multiplied by the size of the total French labor force also tells us French national income. Thus for any specialized outcome the zero-profit and the full employment requirements of equilibrium can be satisfied by a unique wage rate and a unique employment figure in every industry.

4. Supply-demand equality and determination of prices. To complete our proof that a specialized outcome is compatible with the requirements of equilibrium, it is left only to show that this is true for the remaining requirement—that quantity supplied equals quantity demanded in each industry. Given the amount of labor employed in each industry, as obtained in the preceding paragraphs, the production function tells us the quantity of each product supplied. With total world expenditure on each product fixed, the quantity demanded varies inversely with the price. That is, quantity of good *I* demanded must equal the given world expenditure on *I* divided by the price of *I*. Hence one can always select a price for *I* at which the quantity demanded equals the (known) quantity supplied. This completes the argument.

In summary, any perfectly specialized outcome, that is, any preselected assignment of the world's traded commodities specifying which good will be produced in what country (and only in that country), can satisfy the three requirements of an equilibrium at a suitable level of employment in each industry, an appropriate wage rate in each country, and an appropriate price for each good. The level of employment in each industry and the wage rate can ensure zero profit in each industry and full employment in each country, while the price of each good can ensure that the quantity of that item demanded equals the quantity supplied. Thus, given any specialized outcome, market forces will presumably drive prices, wages, and employment level in each industry toward these equilibrium levels. We conclude that every perfectly specialized outcome can, indeed, satisfy the requirements of equilibrium.

We have also seen that those equilibria must all be locally stable—that a small deviation from such an equilibrium (in which one of the countries tries to enter on a small scale[5] an industry from which it was previously absent) cannot persist because the small-scale entrant's cost must then be too high to permit it to compete. This is a result that has previously been described clearly in the literature (e.g., see Krugman and Venables 1992, pp. 4–5).

6.2 Number of Perfectly Specialized Equilibria

The fact that all specialized solutions are equilibria led to the vast number of equilibria, upon which the discussion of chapter 2 of part I focused. It is now easy to determine just how many specialized equilibria there will be in a model with two countries and n different traded goods. This is simply a matter of determining how many specialized assignments of production of the n goods are possible. For each good there are two possible specialized assignments: Widgets can be produced exclusively in France or exclusively in the U.K. Assignment of the task of production of a second good doubles the number of possible outcomes, because for any assignment of the first good there are two possible assignments of the second, yielding 2^2 possible assignments. Continuing in this way, there must be 2^n possible assignments of n goods. If we exclude the two extreme cases in which one of the countries is not assigned any good at all to produce, we are left with a total of $2^n - 2$ possible specialized assignments. This number grows far faster than the number of goods that are traded, with the number of possible equilibria consequently soon reaching enormous levels.

We have thus described the relationships, the variables, and the assumptions that constitute our model. Aside from a few simplifying premises, it differs from the classical trade model only in its scale economies assumption. We have provided a definition of equilibrium and its formal requirements, and have given reasons why, under scale economies, equilibria tend to be perfectly specialized assignments, and why those equilibria tend to have stability properties. We outlined a proof of the theorem that every specialized assignment is an equilibrium. Finally, we demonstrated the central result of this chapter: The scale economies case does, indeed, yield a vast number of perfectly specialized equilibria.

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