9 Three-Country Models and Other Complications

Like any simplified theoretical construct, the model we have described so far has some features very different from what is observed in reality. However, if a model is useful, such features can be changed and adapted without undermining the important conclusions of the original, simpler version. We will take up that task in this chapter.

The most obvious example to discuss in our story is the premise that the world is composed of only two countries. Second, there is our discussion's assumed tendency of stable equilibria to be perfectly specialized, with no commodity produced in more than one country. Third, there is the obviously unrealistic situation toward both the rightward and leftward ends of our graph, where one country or the other finds itself driven from almost all of the world's industries. None of these phenomena are common in the real world. Few, if any, widely used products come from only a single country. This is true even of products with substantial scale economies. Moreover all countries produce many goods and services, even the countries with the very lowest per-capita incomes.

Our model can be modified to eliminate these three urealistic features. We will show explicitly how the three-country case can be dealt with, and by implication, how one can analyze trade among more than three countries. Both other anomalies are ascribable to two other unrealistic features of the model as described so far. These features, adopted for expository and analytic simplicity, are easily modified and with that modification the peculiarities described in the preceding paragraph also disappear. Both oversimplified premises relate to scale economies.

First, we have so far assumed that each and every one of the world's outputs is produced under conditions of economies of scale. Second, we have assumed that scale economies are never exhausted, no matter how large the volume of production of a good. That is, we have assumed that the larger the output of any item the cheaper it will always become, with no possibility that the size of an industry can become excessive from the viewpoint of productive efficiency. Both premises clearly require modification. Many goods are produced under conditions of diminishing returns, at least beyond some relatively modest level of output. And, as we will see, in our analysis there is no reason for countries, even those that are least developed, to be driven out of such industries when their relative incomes decline further, that is, as one approaches the vertical axis in the graph at which that country's share of world income is zero. Second, in many if not all of the industries in which scale economies are substantial, there comes a point where further expansion yields no additional efficiency benefits, so beyond that point total cost either rises proportionately when output expands, or rises even more rapidly than that. The implication is that equilibria tend to be characterized by a relatively small number of suppliers of any commodity, but not generally by just a single supplier.

We will proceed to deal with several other features of reality: nontraded goods, and a world containing both linear production and retainable industries. It turns out that none of these complications fundamentally affects our main results.

9.1 Graphs of Three-Country Models

As is true of much of the international trade literature, our analysis so far has been conducted with the aid of a two-country model. But as is well-known, results obtained for models containing only two countries or two goods or two critical entities of some other sort are not always valid when the number of such entities is increased to three or more (e.g., see Dixit and Norman 1980, p. 8, for just one of a number of examples provided in that book). In this chapter we will, however, demonstrate graphically that our main qualitative results continue to hold, albeit with some illuminating modifications, in a three-country world. The argument suggests also that the analysis remains fundamentally valid when more than three trading countries are contained in the analysis.

Figure 9.1 is the three dimensional representation of the world upper income boundary and the country 1 upper income boundary for the three-country case. These are the pertinent surfaces analogous to the

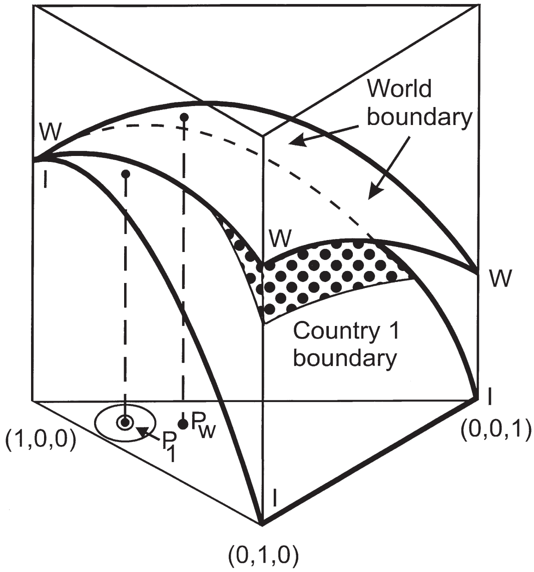

Figure 9.1
The three-country case I

world and country 1 boundaries in the two-country model. There are now three origins, at each of which two of the countries have zero share, while the share of the remaining country, J, is $Z_j = 1$, and three axes, one for each pair of countries, along which the share of the remaining country is zero. Thus the corner of the graph in the foreground is labeled (0, 1, 0), meaning that at this point countries 1 and 3 each have zero share of world income, while country 2 has 100 percent of that income. The axis to the right of that point ends at (0, 0, 1) where country 1 still has zero share, indicating that this is the $Z_1 = 0$ axis. The floor of the diagram constitutes an equilateral triangle, and any point inside it represents a division of world income among the three countries, with the coordinates of that point indicating the shares of the three countries, share of country J being indicated by the length of the line segment from the point in question to the $Z_j = 0$ axis, that line segment being drawn perpendicular to that axis.

The vertical axis represents absolute income, and the world upper income boundary is the hill-shaped surface, WWW. The country 1 surface is shown below the world boundary, and is obtained from the latter as before, from the expression $Y_1 = Z_1 Y_w$, where Y_w and Y_1 are, respectively, the absolute world income and country 1 income at any

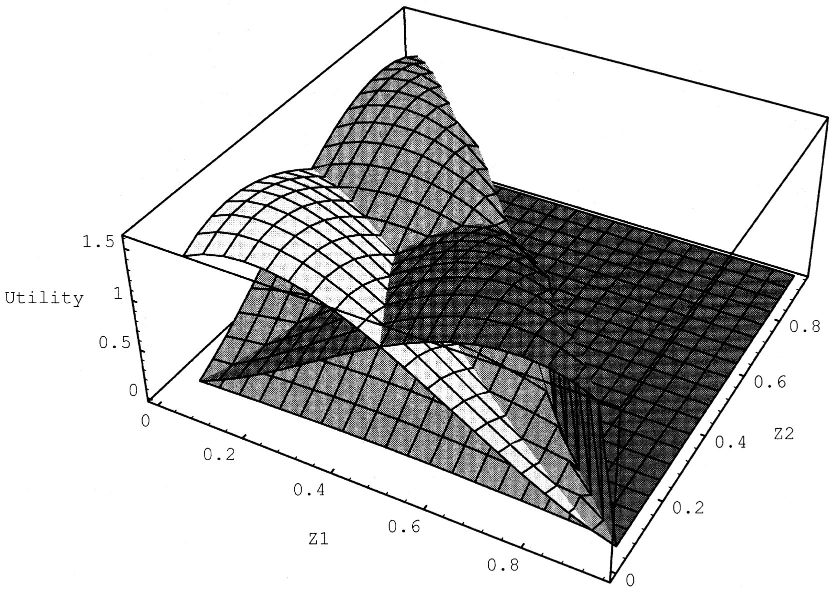

Figure 9.2
The three-country case II

given shares. That is, they are the heights of the two surfaces above any selected point P on the floor of the graph. In particular, P_w, and P_1 correspond respectively to the peaks of the two surfaces. As before, P_1 must lie closer to point (1, 0, 0) than does P_w if the surfaces are differentiable and concave, because at P_w (where the partial derivative of Y_w with respect to the share of any country must be zero) we must have, differentiating with respect to Z_1, $Y_1' = Z_1 Y_w' + Y_w = Y_w > 0$.

Figure 9.2 is a computer-generated graph for a particular illustrative model, showing the upper boundaries for all three countries.

9.2 Zones of Pure Conflict, Pure Mutual Gain and Multiple Possibilities

Figure 9.3 is the projection for all three countries on the base of figure 9.1. In the three-country case, as we have seen, the horizontal projection of the relevant graph is an equilateral triangle with the length of each side equal to unity. It corresponds to the horizontal axis in the two-country graph. The points P_1, P_2, and P_3 are the projections of the

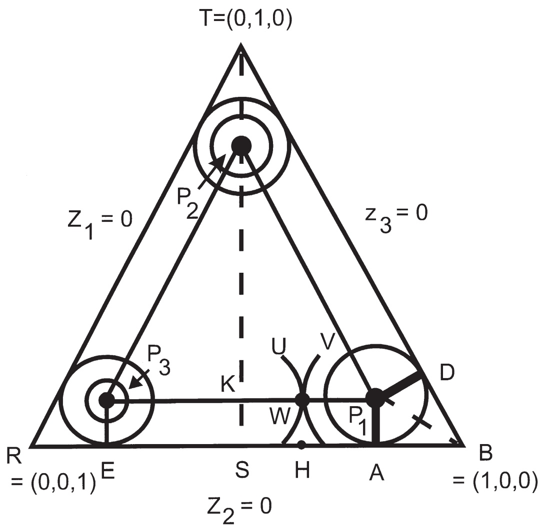

Figure 9.3
Projection: Three-country equilibria

income peaks of the three countries and the curves surrounding those points are iso-national income (contour) curves. For simplicity of discussion, we assume perfect symmetry, with the peak for each of the three countries located in exactly the same position relative to its adjacent origin (the points *R*, *B*, and *T*). The iso-income curves surrounding the three peaks are drawn, also for simplicity, to be circular.

As far as regions of conflict and mutual gain are concerned, we will see that matters are now rather more complicated than in the two-country model. Because there are regions in which moves can either benefit or harm some or all of the countries, we speak of three kinds of region: the zone of pure conflict, the zone of pure mutual gain and the zone of multiple possibilities. In the sequel, for brevity the term "pure" will be omitted when discussing the zone of conflict and the zone of mutual gain, with the adjective, however, always to be kept in mind. We will show that the zone of conflict in figure 9.3 is the interior of the smaller triangle joining the three country peaks. Specifically, it will be seen that:

PROPOSITION 1 Some country always loses from a move in the zone of conflict. Starting from any point in the interior of this triangle, any move to another such point must harm at least one of the countries.

This result is obvious, for any such step must move the equilibrium point further from one of the corners of the inner triangle. Hence this situation must yield a reduced income to the country whose income peak is located at that corner.

The zone of conflict for any pair of countries taken by themselves is a portion of the corresponding axis. For example, for trade between countries 1 and 3, with country 2 totally excluded from trade, the zone of conflict is the portion of the horizontal axis, *EA*, directly below the inner triangle. If we use r as the length of *EA*, since the length of the horizontal axis is $RB = 1$, the share of the zone of conflict in a two-country model becomes $EA/RB = r$. The corresponding figure for the three-country case is the ratio of the areas of the two triangles, area $P_1P_2P_3$/area $RBT = r^2$. Hence, since $r < 1$, it follows that in the three-country case the zone of pure conflict becomes relatively smaller than it is in the two-country case.

While in the two-country case we had only zones of conflict and zones of mutual gain, we now have a much greater and more varied list of possibilities. Furthermore the interpretation of the remaining zones becomes more complex in the three-country case. There, starting from any point, there will generally exist moves that benefit all three countries, but it is also possible to move in directions that are damaging to any one, or any pair or even all three of the countries. A mutually beneficial move from such a point may also require one country to give up industries to both of the others (in regions such as $ABDP_1$) or two of the countries to give up industries to the third, as in region EAP_1P_3. We turn now to explanation of these assertions. We will interpret the three quadrilateral regions such as $ABDP_1$, which include a corner of the large triangle, as the zones of mutual gain. In contrast, the three rectangular regions, such as EAP_1P_3, will be considered zones of multiple possibilities, a concept that is explained in the next section.

9.3 Interpretation and Sizes of the Subregions

The area of the entire triangle RBT is determined by its two attributes: that it is an equilateral triangle, with sides of length unity. (Its area is half the product of ST and RB, a product which equals 0.5 length *ST*, since $RB = 1$. But $ST = (BT^2 - SB^2)^{1/2} = (1 - 0.25)^{1/2} = 0.89$ approximately. So the area of that entire triangle is approximately half that amount, 0.445. But this number does not really matter for our analysis.) The smaller inner triangle is also equilateral, with each side of length r, so that the vertical line segment, KP_2 has length rST, and therefore the area of the inner triangle clearly is r^2 times the area of the larger triangle.[1] This demonstrates, since $r^2 < r$, that the zone of conflict is a smaller share of the total region in the case of three countries than it is when only two countries are included in the model.

Next, we show that the remaining zones are as was just described. We have assumed that the iso-income curves of country 1 are circles with the peak of country 1 at the center. Then the zone of mutual gain generated by that peak includes the quadrilateral region $ABDP_1$, as well as the two corresponding quadrilateral regions corresponding to the peaks of the other two countries. These are interpretable as zones of mutual gain because everywhere in the region $ABDP_1$, for example (in analogy with the zone of mutual gain in the two-country case), the incomes of all three countries will be declining as country 1 moves from its peak toward large triangle corner B, thereby increasing its share, Z_1, toward unity. Looked at in the opposite way, in this region, starting from a point near triangle corner B, country 1 always gains by moving upward and to the left, taking the shortest path toward its peak, P_1, thereby increasing the shares of both other countries and benefiting them both as well as itself.

In the rectangle EAP_1P_3 matters are different. Since the iso-income curves of any one country are concentric circles, the line segment P_3P_1 is the locus of points of tangency between the iso-income curves of countries 1 and 3. Consequently any point below that line segment will be surrounded by two such tangent curves. For example, point H is surrounded by the two curves U (for country 3) and V (for country 1), that are tangent at W. This means that a move from H to W must benefit all three countries. But such a move gives country 2 more industries at the expense of both other countries. In other words, such a mutually beneficial move can require the coordination of policy of developed countries 1 and 3 to get them both to agree to give up industries to underdeveloped country 2.

More important, examination of the graph readily confirms that starting from a point above H in the rectangular region there are moves that are damaging to any one preselected country, moves that harm any pair of the three countries, and moves (straight downward) that are detrimental to all three. We therefore refer to the three rectangular areas like EAP_1P_3 as zones of multiple possibilities.

To find the size of region $ABDP_1$, one of the three zones of mutual gain, note that it is made up of two identical 30–60–90 degree triangles, ABP_1 and DBP_1. This is so since A and D are right angles and B is a 60 degree angle. For comparability with the two-country case, we take $AB = 0.5(1 - r) = DB$. Write $s = 0.5(1 - r)$. For a two-country model, the share of the zone of mutual gain is $1 - r = 1s$. For the three-country model, note first that, with DBP_1 a 30 degree angle, its tangent is 0.58. Thus we have $DP_1 = 0.58s$, so the area of this subzone of mutual gain is twice that of triangle DBP_1, or $0.58s^2$. The total area of the three corner zones of mutual gain, one adjacent to each country peak, is approximately $1.73s^2$, and its share of the area of the total triangle RBT is $s^2(1.73/0.445) = 3.9s^2$, approximately. Since $s \leq 0.5$, because $2s$, the size of the two-country zone of mutual gain, cannot exceed unity (and s is likely to be far less than 0.5), we have $s^2\,(3.9) < 2s$; that is, the corner zones of mutual gain in the three-country case must add up to a smaller (and presumably far smaller) share of the region of equilibria in the three-country case than in the case of two countries.

We also note that since $\tan 30° = 0.58$, then P_1B must be almost twice as long as $P_1D = AP_1$. But the move from P_1 to D amounts to reduction of the share of country 3 to zero, while the move from P_1 to A reduces country 2's share to zero. In contrast, a move from P_1 to B entails reduction to zero of the shares of *both* country 2 and country 3. This implies that the latter (two-country deprivation) move will entail a larger loss of income to country 1 (a move to a lower iso-income curve) than will either of the former (one-country deprivation) moves.

This completes our discussion of the three-country model.

9.4 A Mixture of Retainable and Linear-Production Industries

In chapter 3 we populated our model of the trading world exclusively with retainable industries. In chapter 4 we examined industries that were not retainable but whose production was linear and whose productivity could be changed, by acquisition of the skills required to raise productivity. Each of these chapters, following the dictates of simplicity, described an unmixed model. In the one case, all the industries were assumed to be retainable, while in the other case, all the industries were linear with a wide range of possible productivity levels. Here we will mix the two, as is true in reality, where some industries are retainable and some are not.

It will not be surprising that the composite model behaves very similarly to the simpler unmixed versions, since our results in the two cases were so similar. If some of the industries entering into international trade are retainable, and the others face a range of productivity levels, we obtain substantially the same diagrams as before. There are variations, but these variations do not affect the economic conclusions.

More specifically, what we find is that the upper boundary of the region of equilibria still has its characteristic shape, a hill-shaped region with a single hilltop. The difference, it can be shown, is that there is a lower boundary over part of the diagram, and the region is filled in solidly to the bottom of the graph in part of the diagram. While the resulting boundaries are different from those of the simpler models, they are not different in the part of the diagram that matters for our economic conclusions. The upper boundary is the same, though the lower boundary is different. But it is those upper boundary shapes that determine the conflicts between the best outcomes for the two trading partners. The U.K. hilltop outcome is still bad for France and the French hilltop is still bad for the U.K. The new lower boundary does not affect the outcome.

9.5 Goods with Fixed Productivity Coefficients Subject to Diminishing Returns

There are two clear reasons why even countries that are impoverished and earn a minuscule proportion of the world's GDP nevertheless produce a substantial variety of products, contrary to the implication of the most simplified variant of our model. First, there are many items, notably personal services, that do not enter international trade at all, or of which a considerable portion is produced only for domestic use. The overused illustration is haircuts. These nontraded goods are treated in section 9.12.

Besides ignoring nontraded goods, our model has up to now dealt in a special way with goods whose production process is characterized by diminishing or even constant returns to scale. Up to now, we have studied how the equilibrium in a world of such goods changes as productivity grows. Now we will briefly examine what occurs in our analysis when such goods, like the goods with scale economies, have productivity values that do not change during the period studied, and the economy contains both types of goods—scale economies and scale diseconomies products. Since the real world does contain both, it is clearly desirable to incorporate such diminishing-returns goods and services into the model, and it is not too difficult to do. But before we explain how we do it and describe the implications of this modification in our model, we must review briefly several important and very well-known features of the diminishing-returns case.

Many Small and Competing Producers

A diminishing-returns industry is characterized by the presence of a substantial number of small producers in direct competition with one another. Since, in such an industry, small is economical and large is expensive, competitive market forces will prevent any firm from growing very large. For similar reasons its products are generally produced simultaneously in many countries. Which economy, for example, is entirely without an agricultural sector?

Asymmetry in the Competition between Industrialized Economies and LDCs (Less-Developed Countries)

All asymmetry means is that with diminishing returns, even if all the industries with substantial scale economies are taken over by the dozen or so advanced industrial countries, the other countries will still be able to participate in the remaining industries, with scale diseconomies or constant returns to scale. However, the less-developed countries do not generally find themselves alone in such activities. Industrialized countries are not necessarily more handicapped as suppliers of diminishing-returns products than any other nations, so long as their superior technology offsets the higher wages of the wealthier countries. The United States continues to be one of the world's leading agricultural producers, in competition with many of the less-developed countries. In other words, while the United States faces no competition from less-developed economies in the manufacture of large passenger aircraft, the LDC's continue to encounter the American farmer as a rival in the grain market.

Equal Marginal–Cost Ratios

A last, well-known implication of diminishing returns is critical for their incorporation into our analysis. Elementary economic theory tells us that in competitive markets if two goods, call them *A* and *B*, are supplied simultaneously by two producers, *X* and *Y*, then in equilibrium the ratio of the marginal costs of the two products to supplier *X* must be equal to the corresponding ratio for supplier *Y*, and both of these must be equal to the ratio of the market prices of the two goods. Indeed, where any one producer is sufficiently small to be deprived of any influence over world price, which is clearly to be expected in a diminishing-returns scenario, it must be true that in a stable equilibrium any commodity that is produced simultaneously in two countries must have the same marginal cost in both countries, and that common marginal cost must be equal to the international price of that item (expressing the currencies of the two counties in common terms, say, in dollars at the current exchange rate).

9.6 Inclusion of Products with Diminishing Returns to Scale: Hints on Method and Results

We have also extended our analysis to the case where some industries operate under economies of scale while others are subject to diseconomies. Very roughly, in the calculation procedure one first separates out the scale economies and scale diseconomies industries. The scale economies industries are analyzed just as in chapters 2 and 3. However, the scale diseconomies industries, since they generally entail production by both countries, are constrained by the requirement that in equilibrium the marginal cost of any good supplied simultaneously by both countries must be the same in country 1 as in country 2. As an example, let us indicate how one can now go about finding the point on the country 1 upper frontier of the region of equilibria, corresponding to any given point on the horizontal axis of the graph. For this purpose, one solves the linear program that maximizes country 1's national income, subject to the normal requirements of equilibrium as the constraints of the program, as before, but adding to those constraints the requirement that the marginal costs of any diminishing-returns commodities produced in both countries be equal to one another.

The general results of this analysis[2] are illustrated in the four graphs of figure 9.4a–d, and contrast with figure 3.2, our basic graph on page 29 in chapter 3. The two ends of figure 3.2 depict the sort of extreme situations already reviewed at the beginning of this chapter. Near either vertical axis, one of the countries has been shut out of most trade activities, with the other nation having co-opted almost every product for

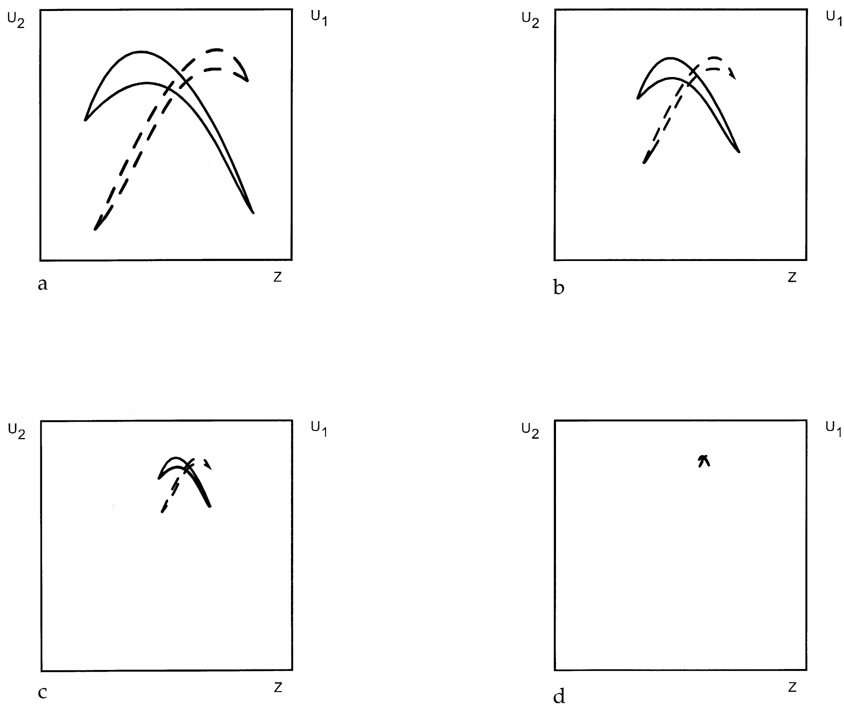

Figure 9.4
Shrinking region of equilibria when share of diminishing-returns industries grows

itself. In contrast, figure 9.4a–d shows a steady contraction from a large region of equilibria toward a single point. While in the basic graph all products are characterized by scale economies, in our new series of graphs the share of diminishing-returns products varies from 25 percent (in figure 9.4a) to 50, to 75 and, finally, to 95 percent of the total in the succeeding graphs. In all of these new graphs, even the last, the national income frontiers retain their characteristic hill shape, and in every figure in the central areas the gains of one country tend to come at the expense of the other. But as scale diseconomies dominate the world economy increasingly, the horizontal range over which the frontiers extend grows increasingly narrow, and the vertical range over which national income values extend also diminishes. Finally, when the world is exclusively devoted to the production of items with scale diseconomies, the frontiers of the two economies degenerate into a single and common point. This point corresponds to the single Ricardian equilibrium point in the classical model of international trade with its world of diminishing or constant returns, so that our analysis meshes perfectly with the classical analysis.

Why does this contraction of the region of equilibria happen? The answer is straightforward. One country can conceivably acquire for itself all or nearly all of the *scale economies* industries in the world, driving the other country out of these fields of activity. However, as we have seen, a country cannot in the same way drive another out of the production of a commodity that is subject to diminishing returns. The fact that even a poor nation can retain a position in production of these items places a floor under that poor nation's relative income—its relative income therefore can never be driven to zero. This prevents any equilibrium from occurring very near the left-hand end of the graph (where, in terms of the illustrative designations of the countries in earlier chapters, the relative income of the U.K. is close to zero) and does the same for points very close to the rightward end of the graph, where the relative income of France is near zero. This immediately forces a contraction of the region of equilibria away from the edges of the graph and toward its center. Moreover it should be evident why this contraction will be greater the smaller the proportion of scale-economies products among the world's outputs: When the share of such products is small, the share of industries from which any country can potentially be excluded is correspondingly reduced, and the larger its minimum relative income will consequently be. Clearly, a large minimum for the relative income of each country means that the region of equilibria must be far from either the rightward and the leftward ends of the graph.

The reason that the region shrinks toward a single point as diminishing-returns products near 100 percent of the world's outputs is also not difficult to envision. When all products are subject to diminishing returns, all countries can, prospectively, share in the production of every good. Thus competition is universal and unimpeded by startup costs, and the diminishing-returns attribute means that entry on a small scale into any industry provides a cost advantage rather than constituting a handicap. The result is that any production arrangement that is inefficient or does not most effectively serve the preferences of consumers cannot long endure. Such an arrangement will constitute a standing invitation for the entry of firms that can produce more efficiently or serve consumer preferences more effectively than the incumbent producers are doing. Thus, in a world of universal diminishing returns only one equilibrium will generally be possible. It is the equilibrium extolled by classical economics as the virtuous end-product of a regime of perfect competition—the equilibrium that maximizes the general welfare, given the distribution of income and the constraints constituted by limited availability of resources and the state of technological knowledge.

9.7 Extreme Cases: Many Producers or One Producer of a Given Commodity

We have now reviewed two polar scenarios in terms of the number of countries in which, according to the model, a particular commodity will be produced. At the one extreme, the case of ubiquitous scale diseconomies, the norm is production in many countries of any commodity for which world demand is substantial. The reasons have just been reviewed, and indeed, we encounter many examples of this sort in reality. The production of textiles, footwear, grains, and many other such items is widely diffused among the world's countries.

The other extreme case, the focus of earlier chapters, is considerably less realistic in this regard. For in the theoretical case of universal and substantial scale economies that continue whatever the volume of production of a good, single-country production is the rule. Any arrangement in which an item is produced in two such economies is inherently unstable. That is now easily seen with the aid of the proposition on the equality of marginal costs described earlier in this chapter. In any equilibrium in which a given commodity is produced in each of two countries, the marginal costs can be expected to be equal in the two countries. The argument for this conclusion continues to apply even under scale economies.[3] In such a situation, if either producer happens to expand its output even slightly, its marginal costs will be reduced below that of its rival. That competitive edge will enable the former to expand even further, each such move adding to its competitive advantage until, finally, the rival is driven from the field altogether.[4] That, in essence, is why in the theoretical case of universal scale economies unbounded in the range of outputs over which they prevail, we expect not only that some stable equilibria will be perfectly specialized, but that stability requires all candidate equilibria to be so.

The assumption of persistence of scale economies that is critical here is that scale economies must result from any expansion of output of good *I* whether the initial volume of output of *I* happens to be relatively small, intermediate, or very great. Whether a supplier of *I* happens to be producing ten or ten thousand or ten million units of its output per year, it is critical to assume for perfect specialization to occur that any further expansion in the amount it is producing, whether minuscule or very large, will reduce its marginal and/or its average cost. There must come no point in the relevant range of output at which it will have used up all the available opportunities for further scale economies.

9.8 Bounded Scale Economies and Multiple Producers of a Good

The empirical evidence and casual observation suggest that reality is not like that. Few, if any, goods with any substantial demand are supplied by only a single country, and few, if any, goods benefit from scale economies that are not exhausted beyond some volume of production. The empirical evidence, it is true, indicates that scale economies are hardly rare (e.g., see Nadiri and Banani 1999, especially table 3, pp. 30–31). But the studies of particular industries that report the presence of scale economies at current output levels offer no reason to conclude that all further expansions of output will continue to yield additional economies.

Discussions with experienced businesspeople suggest that a pattern rather different from unbounded scale economies is far more common. They have come to expect, on the basis of their experience, that there will indeed be substantial savings that expansion of output can initially provide. Beyond some point, however, costs will tend to increase more or less proportionately when output expands further. This view often leads business statisticians who seek to estimate the firm's cost function to specify a relationship consistent with sharp initial scale economies followed by a linear segment along which marginal costs are constant.

The empirical evidence seems to be consistent with the hypothesis that a cost pattern something like that is common. A number of studies report evidence of this phenomenon. In the literature it is commonly referred to as the "flat-bottomed average cost curve." This is an average-cost curve (figure 9.5) in which average cost initially descends, perhaps rapidly, when volume rises. Ultimately, however, toward the right-hand end of the graph, average costs rise, as excessive size brings with it bureaucratization, communication problems, loss of personal

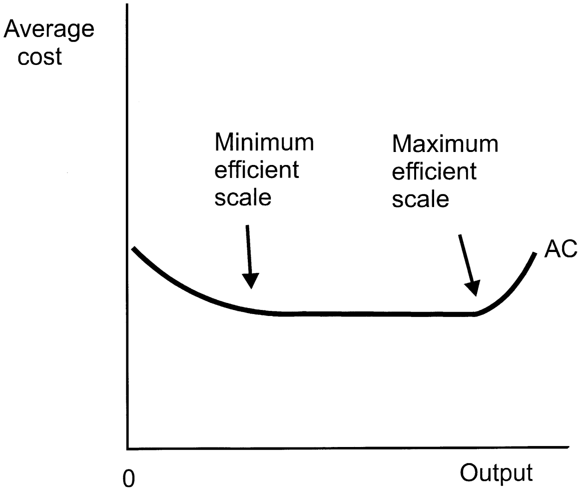

Figure 9.5
Flat-bottomed average-cost curve

touch, and the like. In between, in such a case, there is a (presumably considerable) output range in which average cost is horizontal, neither increased nor reduced by expansion. This is an activity whose scale economies are bounded.

Here the importance of flat-bottomed cost curves is that they characteristically result in equilibria with several producers supplying the commodity in question. Indeed, it is not only easy to see why this is so, but also to indicate the cost influences that may determine the number of producers of such a commodity. It should, however, be clear already that where the average cost curve is flat-bottomed the forces making for perfect specialization are undercut. So long as the quantity of the product demanded permits several suppliers to take full advantage of the available scale economies—that is, if each supplier can produce enough to end up in the flat-bottomed section of the curve—then none of them can gain any advantage over the others by further expansion. In short, so long as they all operate in the flat-bottomed portion of the curve, several suppliers of the commodity can coexist profitably. We can learn considerably more about the resulting multisupplier equilibrium.

9.9 Efficient Number of Suppliers of a Commodity with a Flat-Bottomed Average-Cost Curve

We have already noted that competitive market forces can drive the economy toward efficient arrangements, though we have also seen that, where scale economies are present, candidate equilibria that are stable and yet inefficient are not only possible but can even be common. Yet it is useful to ignore this phenomenon for now and consider the number of suppliers required for efficiency in providing a commodity with a flat-bottomed average-cost (AC) curve.

That number depends on three things: the locations of the lower and upper ends of the range of horizontal average cost and the total amount of the commodity that is purchased in the world market. The lower end of the flat segment of the curve is referred to as a producer's minimum efficient scale. It is the smallest level of output at which the supplier's average cost is reduced to its lowest attainable level; that is, it is the output at which economies of scale are exhausted. Similarly one may refer to the largest output on the flat segment as the maximum efficient scale.

Now suppose that every supplier of a given commodity were to produce at its minimum efficient scale. Then total world output of that item would clearly equal minimum efficient scale multiplied by the number of producers. Thus, with supply equal to demand, we must have:

$$\text{Number of producers } (N_{\text{min}}) = \frac{\text{Total amount of the commodity purchased}}{\text{Minimum efficient scale}}$$

This intuitive result tells us that the greater the amount of the commodity demanded, the greater the number of producers it will require to meet that demand, given that each of them is producing at minimum efficient scale.

Exactly the same reasoning applies if the producers are each providing an output quantity equal to maximum efficient scale:

$$\text{Number of producers } (N_{\text{max}}) = \frac{\text{Total amount of commodity purchased}}{\text{Maximum efficient scale}}$$

The market will obviously provide room for fewer suppliers when they all operate at maximum efficient scale than when they each produce at minimum efficient scale, given the amount that is purchased. For if each supplier produces the larger quantity, it will require fewer suppliers to provide the total quantity that is purchased.

We conclude that the minimum number of suppliers that can produce the given world purchase quantity is obtained when each firm produces at maximum efficient scale, while the maximum efficient number of suppliers is that corresponding to the case where each supplier produces at minimum efficient scale. However, efficiency is also attained when some suppliers produce at minimum efficient scale, some at maximum efficient scale, and some produce an output that lies in between the two. Then efficiency will clearly be preserved because each supplier will still be operating somewhere along the flat and lowest segment of the AC curve, and the number of suppliers needed to meet world demand will be somewhere in between the two extreme cases that have just been described. That is, efficiency requires that the number of firms is given by any number between $N_{\min}$ and $N_{\max}$.[5]

We can now readily see what is to be expected if market forces do drive the world economy toward an efficient equilibrium. In that case, if the number of nations supplying a commodity is below its maximum, then there is room for another nation to enter without displacement of any of the others. To succeed in its attempt, the entering country will have to produce at least at minimum efficient scale. The result of its successful entry will be some reduction in the sales of some or all of the incumbents, but it will not require any of them to be ejected. In contrast, if the number of suppliers is already at its maximum, then successful entry by a nation that was previously not providing the good will mean that some current supplier will find itself unable to retain its position in the field. Because its sales will be driven below minimum efficient scale, it will be unable to compete, having to charge a price above that prevailing in the market if it is to cover its costs.

9.10 General Characteristics of a Market with a Flat-Bottomed Average-Cost Curve

Several attributes of the case of the flat-bottomed average-cost curves can now readily be recognized. First, as already noted, unless demand for the commodity is very limited, it is characterized by simultaneous production of the commodity by several suppliers. Second, even here, a country that is initially not producing the commodity will find entry difficult, because success in that undertaking requires production on at least the minimum efficient scale virtually from the beginning. Third, entry into such an industry is indeed possible, and once entry has succeeded, the new supplier can feel a degree of confidence that displacement of its new position will not be easy. In other words, such an industry is retainable. Fourth, even if the number of suppliers of the good is initially less than the maximum, entry will come at the expense of the incumbents, who will find that they have lost sales as a result. In other words, entry is inherently an act of direct rivalry. Finally, the rivalrous character of the entry process takes its extreme and most obvious form when the number of suppliers is initially at its maximum, so that success of an entrant necessitates departure of an incumbent.

9.11 Divided Industries

The analysis of the retainable industries model in chapter 3 emphasized the perfectly specialized case that is simplest to analyze, that is, the case in which only one country is an active producer in any given industry. But we also asserted there that our results about conflict in international trade hold just as well when nonspecialized industries are included in the model, that is, when, despite high entry costs, industries are shared between countries. We now show why the inclusion of shared industries in our model does not affect the conclusions we reached earlier from the simpler specialized industries model.

To illustrate this point, we will compare graphs like those generated in chapter 3 with graphs to which shared industry outcomes have been added. For this purpose we have modeled a world of nine industries and two countries. Inclusion of all outcomes, not just those that are specialized, in the retainability model of chapter 3 has the effect illustrated in figure 9.6a and b. In figure 9.6a, we see the specialized equilibria for the U.K. generated by the nine-industry model. The more than 500 specialized outcomes are the black dots between the upper and lower boundaries. If in addition we now include all the nonspecialized equilibrium outcomes—that is, the equilibria in which there are industries that are shared between the two trading partners—we obtain a whole new array of equilibrium outcomes. These are the gray dots in figure 9.6b. These new shared-industry outcomes are much more numerous than the specialized ones. In this example, there are more than 18,000 nonspecialized outcomes. However, despite their great numbers, they do not substantially change the shape of the region of equilibria.

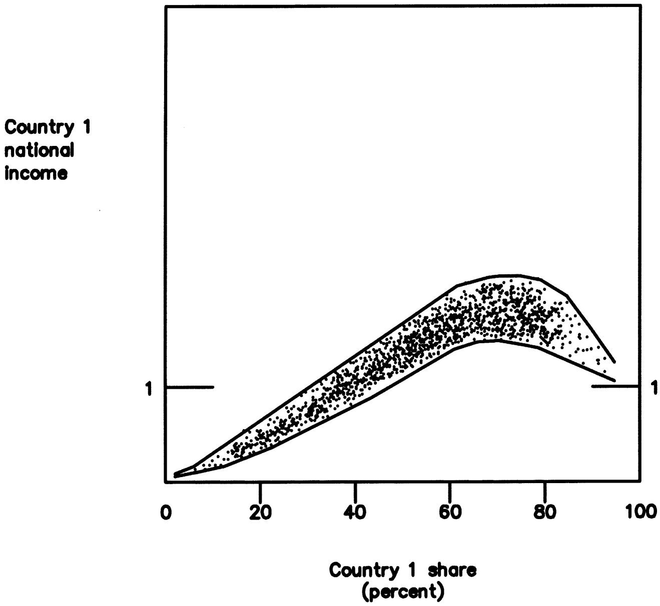

Figure 9.6a
Specialized equilibria

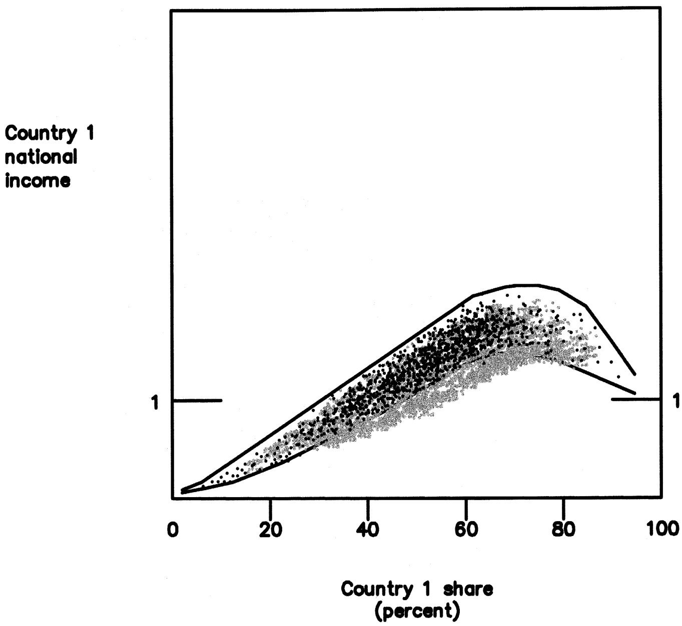

Figure 9.6b
Specialized and unspecialized equilibria

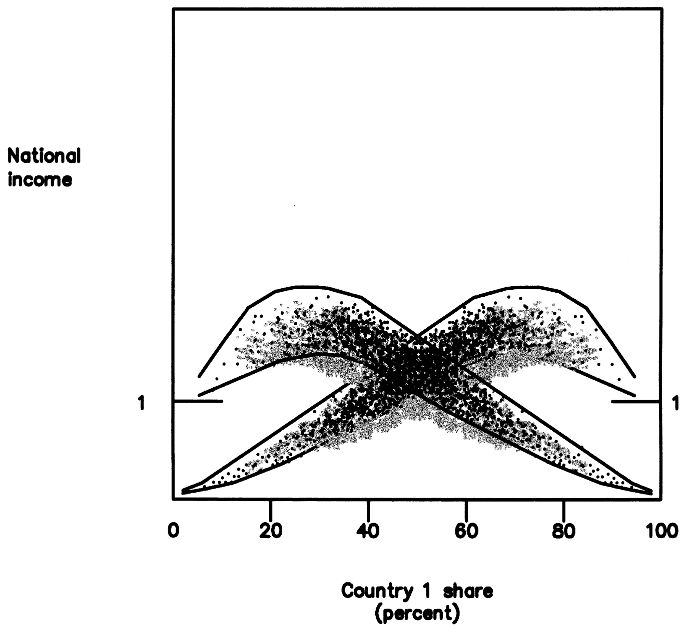

Figure 9.6c
The two countries with unspecialized equilibria

Figure 9.6b shows that most of the new shared-industry outcomes lie in and around the specialized ones. The main effect of including them is only to fill out more completely the region between the upper and lower boundary curves, but without changing its shape. The remaining shared-industry outcomes all lie below this region. None lies above it. For any given U.K. share, these low-lying equilibria represent outcomes that are worse than any specialized outcome with the same share. These outcomes are very poor because they contain many industries that are divided between the countries. Production tends to be costly in each of these divided industries because in each such industry no one country obtains the full cost-saving benefits of operation on the largest possible scale. Each such industry therefore produces in a more costly fashion than it would if the industry were concentrated in one country or the other. Many such divided industries can produce a very poor outcome.

In figure 9.6c we show all the outcomes for both countries. We can see from this figure, which is typical of the graphs obtained by including shared outcomes, that the presence of the shared industries does not change our conclusions about conflict in international trade. The graph for each country still retains its familiar hill shape, and the top of the hill for the U.K. is still a low point for France. The addition of all the equilibrium outcomes has not changed our fundamental conclusion: The outcomes that are best for one country still tend to be poor for the other.

9.12 Goods and Services Not Traded Internationally

Home construction and retailing are clear examples of goods and services that are rarely traded internationally. These goods and services are provided in each country mainly by those who work there. This category is enormous. It includes health care, transportation, the provision of local telephone service, haircutting, legal services, and so on, in an almost endless list of economic activities that are primarily domestic. An economy produces almost all of these goods and services at home and for home consumption, and this provides a large, relatively stable, base sector of national income consisting of goods and services that are exchanged almost entirely within its own borders.

Our analysis so far has dealt with the (internationally) traded sector only, the sector containing the industries that can be won or lost to international competition. We have discussed industries in which a country can have an entrenched position as a world supplier in a retainable industry. Or, in our linear production model, it can lose an industry position to another country whose productivity grows, or equally well, it can improve its own capabilities and acquire the world market in something another country used to make. None of this applies to haircutting or health care, nor to any of the other nontraded goods in the economy, so they have had no role in our analysis.

But it is not hard to add this sector to our model, and we have done so for the U.K. in figure 9.7. The graph has exactly the same shape as before, but the height of every equilibrium point has been raised by the addition of the dollar value of the goods produced in the nontraded sector of the U.K. In other words, in figure 9.7 the contribution to national income from the traded sector of the economy literally sits on top of that from the nontraded sector. We continue to use share of traded goods as our horizontal measure. But now, if the U.K. has lost out in every traded industry, and has zero share of international trade, it still can fall back on a substantial national income produced by all the things it makes and consumes at home. Our graph has exactly the

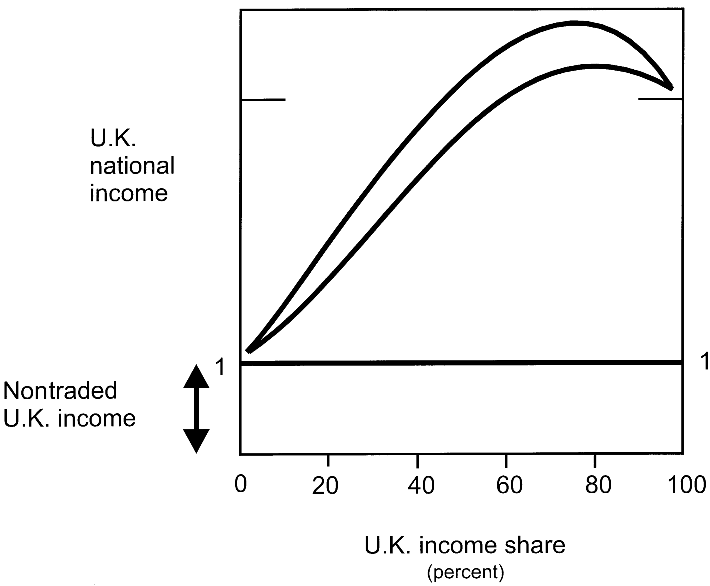

Figure 9.7
Equilibrium region with nontraded goods

same shape as before. The addition of the nontraded economy has simply raised every point in the graph.

Since the shape of the graph is unchanged by the inclusion of the nontraded sector, our conclusions about conflict in international trade are unchanged also. There is still conflict, and what is best for one country is still poor for the other one. With the international trade part of the graph now added to by the relatively unchanging base of domestic production, the outcomes that were originally undesirable for one of the countries are now not quite as bad, because the disadvantaged country's income is bolstered by the nontraded sector. Similarly the benefits to a country contributed by an equilibrium that serves its interests well are not quite as dramatically different from those of a less beneficial equilibrium, because the difference between the two equilibria now only represents an improvement over what may be a substantial base of internal economic activity.

Nevertheless, the effects of a change in outcome can still be very substantial. Exactly how large they are depends of the relative size of the traded and nontraded parts of the economy. The ups and downs of international trade cannot affect a country that, for one reason or another, barely participates in it. But there are few isolated countries left in the industrialized world, and there is a marked trend of growing internationalization of industries and growth in the traded sector, thus steadily increasing the relative magnitude of the effects we have described.

Two clear examples of this trend are the entertainment industry and the field of industrial design. In the past, a visit by a foreign theater company or an orchestra from another country was a rare, costly, and noteworthy event. Today television broadcasts and recordings cross oceans regularly with speed and ease. Similarly, for example, industrial blueprints were, until recently, typically created at sites that were in close physical proximity to those in which engineers worked. Today U.S. engineers can have blueprints prepared in India at lower cost and with no delay.

9.13 Conclusion

We have seen in this chapter that the analysis of this book is readily modified to incorporate various features of reality. We have extended the model to the multi-country case. Some new features do arise in that case, notably the zone of multiple possibilities. We have also seen that as the number of countries grows, the relative sizes of both the zone of conflict and the zone of mutual gain shrink in comparison to the total region of equilibria. But the fundamental point remains intact: There is conflict in the interests of countries similar in their wealth, while the wealthier countries can gain by improvements in the incomes of impecunious countries.

We have seen how the logic of our model can be modified to deal with the presence of a number of commodities characterized by diminishing returns to scale and how one can incorporate goods that benefit from scale economies up to some level of output, beyond which further gains from scale are exhausted. The former modification leads us to expect both a smaller region of equilibria and a considerable multiplicity of countries engaged in the production of overlapping sets of commodities. The latter modification also entails the likelihood of multi-country production of the commodities in question, though it is plausible that the number of producers of a given good with bounded scale economies will typically be smaller than that for a diminishing returns commodity. Finally, the case of bounded scale economies is characterized by a degree of direct rivalry among the nations supplying a given product that has no counterpart in the diminishing-returns cases. A nation initially excluded from production of that item may be able to embark successfully on its production but only at a sufficient initial scale of output. In addition it may well entail direct displacement of one of the nations initially participating in production of the item. This surely is what noneconomists have in mind when they express the fear that some industry in their economy will be unable to compete, with consequent loss of the industry to a foreign rival.

In this chapter we also stepped a little closer to the actual world by adding a few other elements of realism to our basic model. First, we examined models whose outcomes include equilibria in which some industries are not specialized. In other words, we dropped our simplifying assumption that each and every industry operates in only one producing country and looked at a more realistic world, where even for retainable industries, there are outcomes in which the production of some or all industries is divided between countries. Next, we dropped the premise that all goods and services in the world must be traded in the international marketplace, moving to a model that includes those many tangible and intangible products that never leave their home country. Finally, we looked briefly at situations where we neither assume, as we did in chapter 3, that all industries are retainable nor, as we did in chapter 4, that all are not retainable. We included in our analysis situations in which some industries have high start-up costs and economies of scale, and some do not. The basic overall conclusion is that none of these modifications of the model changes our results about inherent conflict in international trade or about the regions of mutual gain.

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