# 7

# A Model of Trade in Imperfect Substitutes with Intercontinental Transport Costs

In this chapter and the next, we develop a framework for evaluating whether the regionalization of world trade is good or bad. This will entail developing the notion of ''optimal degree of regionalization.'' By ''optimal,'' we mean the degree of regional preferences that maximizes world economic welfare, taking as given the level of interbloc tariffs. It turns out that we can think of this as the degree of regionalization that is ''natural,'' in the sense that it can be justified on the basis of geography. At lower levels of regionalization, there are potential gains from trade creation that have not yet been exploited. With more regionalization, the harm done by trade diversion begins to outweigh the good done by trade creation.

The initial model is highly stylized. Our central results concern a system in which blocs are symmetric, each adopting the same degree of regionalization. We eventually bring in additional complications. Toward the end of chapter 8, for example, we will consider the problem from the viewpoint of individual blocs. The goal is to see what level of regionalization would be chosen in general equilibrium. The outcome will depend importantly on any multilateral rules allowing free trade areas (FTAs) that may be in effect.

## The Question of a Rationale for Article XXIV

One issue at stake here is whether Article XXIV of the General Agreement on Tariffs and Trade (GATT) makes sense. What is the justification for

Article XXIV in the first place? It was, of course, written on the assumption that worldwide free trade, which is in theory best, is for political reasons not readily attainable in practice. Why not be content, then, with the principle of nondiscriminatory most-favored nation (MFN)? Why allow deviations from MFN in this particular form, FTAs, and not in other forms?

Supporters of Article XXIV could argue, in a static economic sense, that the formation of FTAs under the conditions specified in Article XXIV is likely to raise economic welfare and that other deviations from MFN are not.[1] Second, they could argue, in a dynamic political-economy sense, that FTAs can act as steppingstones, which help build the political support necessary to negotiate freer trade worldwide. The case for neither of these arguments is especially clear or well-established. It is the first that we examine critically in the next three chapters. The second question, regarding whether FTAs are stumbling blocs or building blocs, is examined in chapter 10. Bhagwati (1993a) has labeled the two issues the question of the static impact effect and the question of the dynamic time path.

## The Krugman versus Krugman Debate

Paul Krugman has helped focus the recent debate on whether a global trend toward the formation of trading blocs would be a good thing or a bad thing. But he has supplied equally clever arguments for both sides.

In his first contribution (Krugman 1991a), he focused on the idea that when individual countries form blocs, they are liable to become more protectionist and thus to move further from the ideal of world free trade. The reasoning was as follows. An individual country knows it will suffer a large loss in demand for its exports if it tries to raise the relative price of its exports unilaterally. As a bloc, however, a group of countries has more monopoly power to exploit and so will be tempted to set higher tariff levels vis-a-vis the rest of the world in order to shift the terms of trade in their favor. Other blocs will retaliate, and in the noncooperative equilibrium, each bloc will have high tariffs against the others.

Krugman assumed that, whatever the level at which the decision is made, units set their tariffs at a self-maximizing optimal level.[2] World

1. Jackson (1993, 123), for example, has suggested that the goal of the Article XXIV exception to the MFN principle is that FTAs would be trade-creating rather than trade-diverting.

2. Trade barriers are in practice seldom raised on optimal-tariff grounds. In the first place, the exploitation of national monopoly power does not play a prominent role in the political economy of protectionism. In the second place, Article XXIV forbids blocs raising tariffs against nonmembers. A later contribution, Krugman (1993), dropped the assumption of optimal or endogenous tariffs. The conclusions were similar. Why is a large number of small blocs still better than a few large blocs, even when the latter do not exploit their monopoly power by raising tariffs? The explanation can be phrased in terms of trade diversion versus trade creation. The results are developed below in a model that rules out the raising of tariffs to exploit monopoly power.

welfare is lower with a few trading blocs than with one worldwide bloc, which is an unsurprising result because the latter would constitute worldwide free trade. But he showed that world welfare is also lower with a few large trading blocs than with many small ones and that the latter turns out to be almost as good as worldwide free trade. In other words, an intermediate point with a few blocs is worse than both extremes—one bloc or many blocs. For specific plausible parameter values, three turned out to be the worst possible number of blocs to have. Quite a bad stroke of luck for planet Earth, since three is exactly the number of blocs that we may be headed for!

Consider the stylized world illustrated in figure 8.1. The world consists of three ''continents'': Europe, Pacific Asia, and the Americas. Assume that each continent consists of two countries. We make this assumption for simplicity. The logic would be the same with a larger number of countries. When we turn to numerical results, however, we will have to distinguish explicitly between this stylized six-country case and more realistic many-country cases.

For the moment, we can embellish the example further by imagining that in the year 2005, trading arrangements have coalesced into two free trade areas within each of the three continents. For fun, let us say that Europe consists of the European Union plus a Central European FTA, Asia consists of an ASEAN FTA plus a Northeast Asian FTA (or a yen bloc plus Australia-New Zealand), and the Western Hemisphere consists of the North American Free Trade Agreement (NAFTA) plus a South American FTA. (We are calling the units FTAs for short. But we really mean them to be full customs unions.) Each of these six FTAs maintains equal trade barriers against the other five. In other words, MFN reigns. Should the six combine into three larger FTAs: one in Europe, one in Asia, and one in the Americas?

## Krugman I: A World of Three Continental Trading Blocs Is Protectionist

In answer to the foregoing question, Krugman (1991a) says no. Economic welfare will be reduced by the move from six blocs to three. On the one hand, it is true that North Americans will now have the opportunity to trade with South Americans at undistorted prices. That is a benefit. (Call it trade creation.) On the other hand, a distortion has been introduced, from the viewpoint of North Americans, into the relative price of goods from South America versus those from other countries. European and Asian goods used to be no more expensive than South American goods, but now they are. The North American may now buy a South American blanket because it is cheaper without the tariff, even though it is economically more efficient to buy a Southeast Asian blanket and even though he

would have done so before. Whether the costs or benefits dominate depends on specifics, such as how close substitutes the goods are. But for a fairly wide range of parameter values, the move from six to three blocs turns out to generate more distortions than it eliminates. Regionalization reduces economic welfare.

## Krugman II: A World of Three Continental Trading Blocs Is Natural

To the same question—should the six combine into three larger customs unions?—Krugman (1991b) says yes. This second contribution adds to the discussion a very simple argument, which leads to a conclusion diametrically opposite from the first. Here, regionalization of this sort turns out to be good. The starting point is the observation that even without the formation of regional FTAs or preferential trading arrangements of any sort, countries trade more with their neighbors than with countries from which they are far removed because of transportation costs. We first documented this fact in chapter 3.

Imagine, in the limit, that transoceanic transportation costs were so high that all trade took place within continents. Then it must follow from standard trade theory that removal of trade barriers within each continent, that is, the formation of regional free trade areas, would be a good thing. This would represent the best solution of free trade within its own relevant world. Return to figure 8.1 and imagine that Columbus has not yet discovered the Americas. If the barriers between North America and South America are removed, the Aztecs can trade with the Incas, attaining the economists' bliss of free trade throughout the known world. The same applies to free trade within pre-Silk Route Asia or Europe. Producers gain from the opportunity to sell to whomever is willing to pay the highest price, wherever on the continent they are located, while consumers can buy from the most attractive supplier. Other continents are not relevant because locals cannot trade with them, regardless of the trade policy.

The example is an extreme one. One cannot be sure, without further investigation, whether the lesson from the *reductio ad absurdum* of infinite intercontinental transport costs also carries through to a more realistic setup. But Krugman guesses that it does. His conclusion is that, to the extent that trade follows the ''natural'' lines dictated by proximity, the formation of regional trading blocs is good. Such natural blocs are contrasted with ''unnatural blocs''—free trade agreements between individual countries on different continents. Examples are the US-Israel Free Trade Area and the old British Commonwealth preferences. He argues that these are less likely to be welfare-improving.

In what *The Economist* magazine called ''the shootout at Jackson Hole,'' Summers (1991) agreed with Krugman that natural blocs were likely to be beneficial, while Bergsten (1991) was on the other side. It should be

noted that the idea of proximity as a desideratum for successful FTAs, on the grounds that it would minimize the amount of trade diversion, was not entirely new with Krugman. Balassa (1987, 44) and Wonnacott and Lutz (1989) had mentioned the idea.[3] The leading opponent is Bhagwati, whose reaction to reports from Jackson Hole was: ''The prescription is sufficiently strange and hard to defend for me to wonder whether these distinguished economists truly expressed these views.''[4]

## The Intermediate Case

Each of these two arguments—Krugman's vision of three protectionist blocs and his idea of continents as natural FTAs—is valid within the terms of its own assumptions. One way to characterize them is as the limiting polar cases of zero intercontinental transportation costs and infinite intercontinental transportation costs, respectively. We know that the truth lies in between. The analysis, to be complete, cries out for a more general model that can handle the intermediate, realistic case in which transportation costs between continents are less than infinite but greater than zero (and greater than transportation costs *within* continents). This chapter supplies that analysis.[5]

We will examine a number of important policy questions. First, should departures from MFN in the form of preferential trade arrangements (PTAs) be encouraged or not allowed at all? Second, should free trade areas be restricted to geographical neighbors—that is, natural trading partners—as Krugman (1991b) suggests? This would mean that the European Union is good, but the Israel-US FTA is bad. It would mean NAFTA is good, but admitting Chile before Colombia is bad. Third, is the rule that technically requires 100 percent liberalization within a group—that is, that allows only FTAs—sensible? Or should the partial liberalization that de facto prevails in most FTAs be allowed? Fourth, does the logic regarding the desirability of individual countries combining to form local FTAs (e.g., Canada-US FTA) apply equally to the later stage of combining into continentwide FTAs (e.g., the Free Trade Area of the Americas, or FTAA)?

We shall attempt in chapter 8 to address welfare implications of different possible rules for the formation of preferential trade groups. At a theoretical level, we shall complete the Krugman model of the welfare implications

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3. Wonnacott and Wonnacott (1981, 708-09) discuss the relevance of transport costs being lower among members of a customs union than with outsiders in an article that shows that unilateral liberalization does not necessarily dominate the formation of a customs union.

4. This remark was found in footnote 8 of an early draft of Bhagwati (1993) and was tempered by the time it appeared as footnote 11 in the published version.

5. It draws very heavily on Stein and Frankel (1994) and Frankel, Stein, and Wei (1995).

of trading blocs for the realistic case in which transportation costs between continents are neither so high as to be prohibitive nor so low as to be the same as costs among neighbors. We consider three applications of the model in turn.

We start with continental FTAs. We shall see that it is not only unnatural FTAs that can leave everyone worse off than under MFN, but that under certain conditions FTAs that are formed along natural intracontinental lines can do so as well. We call such welfare-reducing blocs supernatural. We shall see in simulations that this possibility may obtain, in particular, when intercontinental transportation costs, while not necessarily as low as intracontinental costs, are as low as 10 or 20 percent.

Next we apply the model to the issue of partial preferential treatment within regional trade groups. In contrast to the thinking underlying the Article XXIV provision, we find that, under the assumptions of the model, partial liberalization within a regional trade group is better than 100 percent liberalization. The supernatural zone, where the regional trading arrangement reduces welfare, occurs for combinations of low intercontinental transport costs *and* high intrabloc preferences.

Finally, we apply the model to the question of subregional FTAs—that is, the formation of several FTAs on each continent. We have in mind, for example, the regionalization of trade within the Americas into four FTAs consisting of NAFTA, Central America, the Andean Community, and Mercosur. (The Caribbean countries might be included in Central America and Chile in the Andean group as it used to be, or perhaps all of them would join NAFTA.) We find that such an arrangement, like continental FTAs, would be worse than the status quo of MFN. If the constraint of Article XXIV is relaxed, however, and partial liberalization within each regional trading arrangement is allowed, then the formation of several PTAs within each continent is a good thing, although continent-wide PTAs are even better. Again, these conclusions hold within the terms of the model.

Chapter 9 tries to get a better idea of which of the theoretical welfare possibilities is actually most likely in practice by looking at data for trade among our basic data set of 63 countries. We offer a preview here. A preliminary estimate of intracontinental transport costs based on the ratio of cost-insurance-freight (c.i.f.) to free-on-board (f.o.b.) values (and trade shares) is 10 percent. Distance may generate costs beyond the freight and insurance required by physical transport of goods, however. A preferred alternative to the c.i.f./f.o.b. calculation is to adopt the estimates laid out in chapter 4 of the gravity model parameters for bilateral trade during 1965-92. As we saw there, these estimates can hold constant for membership in regional groups and other variables, unlike simple statistics drawn from trade shares. An estimate of the intracontinental parameter, based on the gravity model, is 16 percent. Such an estimate, combined with our

other simulation parameter values, would imply that negative returns to regionalization begin to set in when regional preferences reach about 10 percent. This suggests that supernatural blocs are a serious danger. But the goal of this chapter and the next is the more modest one of simply establishing the theoretical framework: the notion of the optimal degree of regionalization.

Most of our conclusions regarding economic welfare presume worldwide symmetry. In other words, we look at the consequences of a worldwide regime of allowing continental blocs or regional FTAs to form. The consequences of the formation of a single bloc or FTA in one part of the world is addressed only in the last section of chapter 8. It offers some justification for looking at the symmetric situation in which every region forms an FTA, by showing that this situation is the noncooperative equilibrium that will emerge from a structure of equal-sized regions.

It should be noted from the outset that many of the conclusions in these three chapters are approximate and that many possible considerations are omitted from the analysis. For example, we focus in these chapters only on the static economic effects. Chapter 10 will consider some political economy effects that make the level of a bloc's trade barriers against nonmembers endogenous.

## The Theory of Trade with Imperfect Substitutes and Transportation Costs

### The Differentiated Products Model

We work with a model of trade under monopolistic competition (Krugman 1980).[6] The innovation, after extending the model to many countries and many continents, is to allow for tariffs and transportation costs both within and between continents and to apply it to study the welfare implications of the formation of trading blocs.[7] As often is the case in this literature, the reference to ''tariffs'' is intended as shorthand for government-imposed trade barriers in general. In modern trade relations, nontariff barriers are often more important than tariffs per se.

Every firm has its own brand name; it produces a good that is an imperfect substitute for other goods. Despite the absence of perfect compe-

6. The basic model of industrial structure (monopolistic competition) and consumer preferences (love for variety) derives from Dixit and Stiglitz (1977).

7. Krugman (1980) introduced transport costs into his (two-country) model but applied it to a different purpose: to explore the ''home market effect'' on trade patterns. This is the idea that countries tend to specialize in goods for which the home market is relatively large. For the sake of comparability, both the notation and the description of the basic model in this book will closely follow his.

tition, the market structure has the property of ruling out strategic interaction among firms. That is, even though each firm has a bit of monopoly power in its product, it takes the actions of other firms as given. The reason is that there is free entry. An attempt to drive out one competitor and reap excess profits would soon be met by other firms entering. In equilibrium, no firm makes excess profits, even though each has monopoly power.

For simplicity's sake, we assume consumers treat all brands symmetrically. Goods enter symmetrically into the utility function, which is represented by the summation

$$U = \sum_i c_i^{\theta}; \qquad 0 < \theta < 1 \tag{7.1}$$

where $c_i$ is the consumption of the $i^{\text{th}}$ variety. There are a large number of goods being produced ($n$), but this number is much smaller than the potential number of goods or varieties.

This utility function implies a preference for variety on the part of consumers. The parameter $\theta$ indicates the degree of substitutability in their tastes. The higher the parameter, the lower the love for variety. In the limit of perfect substitutability, $\theta$ equals 1. This implies $U = \Sigma c_i$. In this limiting case, consumers do not care about brand names. Rather, they simply add up their consumption of all brands; the greater the total quantity, the better. In the limit of complete love for variety, consumers care *only* about the number of varieties consumed and not at all about the quantity: $\theta$ equals $0 \Rightarrow U$ equals $\Sigma_i 1$. A collector of baseball cards or butterflies, for example, wants one of each variety; after acquiring one specimen, he or she has no use for a second of the same variety and instead looks for a new one. Normally, consumers are in between the two extremes: $0 < \theta < 1$. They care about both quantity and variety.

Labor is the only factor of production. The total national supply of labor is $L$. The twin assumption to imperfect competition is declining average costs in production of each of the varieties, or increasing returns to scale. Increasing returns are introduced by assuming a fixed cost to setting up production followed by a constant marginal cost to producing each unit.

Individual households choose consumption so as to maximize their utility, given prices; individual firms maximize their profits; and free entry drives profits to zero in equilibrium. The zero-profit condition ensures that revenue minus cost is zero:

$$px_i - (\alpha + \beta x_i)w = 0$$

where $\alpha$ is a parameter representing the fixed costs of setting up production of a new variety and $\beta$ is the marginal cost of output (both expressed

in units of labor), and $w$ is the wage rate. The quantity of output of each good works out to

$$x_i = \frac{\alpha\theta}{\beta(1-\theta).}$$

Under these simple assumptions, the scale of output of each variety in equilibrium does not depend on the size of the economy. Rather, it is the number of varieties, $n$, that increases when the size of the population ($L$) increases:

$$n = \frac{L(1-\theta)}{\alpha} \tag{7.2}$$

Notice that, in the limiting case, as the substitution parameter ($\theta$) approaches zero, an infinitely small quantity of each of $L/\alpha$ varieties will be produced. Because consumers care only about the number of varieties available, there is no point in producing large quantities. In general, however, consumers are happy to give up some degree of variety in order to get a greater quantity of each. Industry can respond to higher levels of $\theta$, producing more of each variety by exploiting economies of scale. (Details of this derivation, and of others below, are given in Stein and Frankel [1994].)

Imagine that the size of a (closed) economy were to double. Equation (7.2) tells us that the number of varieties also doubles. There is no increase in the quantity of each good produced. Under this simple version of the imperfect substitutes model, consumers choose to take all their gains (gains that exist because of the advantages of economies to scale) in the form of greater variety. The experiment in which we are more interested is an opening up to international trade rather than an increase in the size of the domestic economy. The effects are analogous, however. The gains from international trade arise here from the opportunity to consume a greater variety of goods. To see these gains, we assume that countries have similar tastes and technologies. Also, there is a single factor of production. This rules out the classic gains of trade from comparative advantage. If we have two countries of equal size, allowing for unfettered trade will double the number of varieties available for consumption in each country and thus raise utility.

## Introduction of Transport Costs and Tariffs

We will think of the world as being divided into a number of continents ($C$), each of them equidistant from one another. Each of these continents comprises a number of nations ($N$). The transportation system we assume within each continent is a hub-and-spoke network. In each continent there

is a hub, through which all trade involving that continent must pass. Each hub has $N$ spokes, all assumed to be of equal length, connecting it to the countries in the continent. Transport costs will be assumed, following tradition, to be of Samuelson's ''iceberg'' type. This means that only a fraction of the good shipped arrives; the rest is lost along the way. The notion of transportation costs should be understood as transactions costs, encompassing not just physical transportation of goods but also costs of communications and the idea that countries tend to have a better understanding of their neighbors and their institutions than they do of countries further from them, as we have seen.

The cost of transport through two spokes will be represented as $a$, while that of transport from hub to hub (across the ocean), is given by $b$, where $a$ and $b$ are both between 0 and 1. Trade involving two countries on the same continent will have to be transported from the exporting country to the hub, and from the hub to the importing country. This involves two spokes, and so the fraction of a good shipped that arrives to the market is $1 - a$. Similarly, the fraction of a good that arrives in the case of trade between countries in different continents, which involves two spokes and a hub-to-hub section, is $(1 - a)(1 - b)$. This setup simply says that the cost of trading with another continent is higher than the cost of trading with neighbors, with the difference depending directly on $b$.

The tariffs will be treated in a standard way. When a consumer buys a foreign good, the government levies an ad valorem tariff $t$. We assume that governments distribute tariff revenue back to their citizens as lump-sum transfers $T$. Our basic theoretical model will assume that the tariff is levied as a percentage of the value of the good expressed in c.i.f. terms—that is, including transportation costs. For some purposes, the c.i.f. formulation may be more convenient, as well as more realistic, than to assume that the tariff is levied as a proportion of the value of the good in f.o.b. terms—that is, excluding transportation costs. The level of tariffs is exogenous and assumed to be uniform across countries, representing the MFN principle, except when we are ready to examine preferential trade arrangements.

For simplicity, we will assume that each of the countries is equal in size.[8] The symmetry of the model now ensures that the producers' prices are the same in every country, as well as the number of varieties and the quantity of each variety produced in every country. Prices of domestic and foreign goods that domestic consumers face differ due to transportation costs and tariffs. Prices in the producing country do not change in this model's equilibrium, however. If the producer prices in every country are $p$, then the price the domestic consumer will have to pay for every unit of foreign good consumed will be:

8. This assumption is relaxed by Stein (1994, 105-21).

$$p_{c,t} = \frac{p[1+t]}{1-a} \qquad p_{nc,t} = \frac{p[1+t]}{(1-a)(1-b)} \tag{7.3}$$

where the subscript $c$ refers to goods imported from within the continent and $nc$ to those from elsewhere (across continents). Notice that import prices depend positively on tariffs and transportation costs. In the absence of tariffs, the prices domestic consumers face will be $p_c = p/(1 - a)$ and $p_{nc} = p/(1 - a)(1 - b)$. In short, tariffs and transportation costs are each fully reflected in higher prices in the importing country.

Because the domestic consumer will pay different prices for consuming domestic and foreign products, he or she will consume them in different quantities. The next step is to derive, from the utility function, the consumption of each foreign variety relative to the consumption of each domestic variety. We need to do this both for imports from neighbor countries and for imports from countries in other continents. We begin by assuming that tariffs $t$ are levied.

From the maximization problem of the consumers, it is possible to derive the elasticity of demand for exports faced by the producers. It turns out to be $\epsilon_x = 1/(1 - \theta)$, the same as the elasticity of domestic demand. The convenient equality of these elasticities guarantees that the price that results from the firm's profit maximization is the same as in the case of the closed economy. So are the quantity produced of each variety and the number of varieties, $n$, produced in each country. Transport costs and tariffs, thus, introduce no changes in these variables. But the key point is the effect on consumption patterns.

The first-order conditions for the consumer's problem yield the relative consumption of each variety:

$$\frac{c_i^c}{c_i^h} = \left(\frac{p}{p_{c,t}}\right)^{\frac{1}{1-\theta}} \tag{7.4}$$

$$\frac{c_i^{nc}}{c_i^h} = \left(\frac{p}{p_{nc,t}}\right)^{\frac{1}{1-\theta}} \tag{7.5}$$

where $c_i^c$ and $c_i^{nc}$ are the domestic consumer's consumption of foreign varieties from countries within the continent and across the ocean and $c_i^h$ is the domestic consumer's consumption of domestic varieties.

Now we can derive the relative *demand* for varieties by the domestic consumer. The demand for the foreign varieties, as defined here (again, following Krugman), is larger than the consumption of those varieties because it includes what is lost through transportation. We know that in order to consume one unit of a foreign variety, a domestic consumer will have to demand $1/(1 - a)$ in the case of a neighbor country, $1/(1 - a)(1 - b)$ otherwise. Introducing these terms, as well as the prices given

by equation (7.3) into equations (7.4) and (7.5), we obtain the demand for each of the foreign varieties relative to the demand for the domestic varieties:

$$\sigma_{c,t} = \frac{(1-a)^{\theta/1-\theta}}{[1+t]^{1/1-\theta}}$$

$$\sigma_{nc,t} = \frac{[(1-a)(1-b)]^{\theta/1-\theta}}{[1+t]^{1/1-\theta}} \tag{7.6}$$

We can see that the relative demand for all foreign varieties depends negatively on tariffs and transportation.

From equation (7.6), it is simple to obtain the share of demand of the domestic consumer for the three types of varieties, given the number of continents ($C$) and the number of countries per continent ($N$). If we normalize the demand for each domestic variety to be equal to 1, the share of domestic goods in total domestic demand is

$$S_h = \frac{n}{n+n\sigma_{c,t}(N-1)+n\sigma_{nc,t}(C-1)N} = \frac{1}{1+\sigma_{c,t}(N-1)+\sigma_{nc,t}(C-1)N} \tag{7.7}$$

This share depends positively on tariffs and transportation costs, as one would expect.

The share of each neighbor country will be

$$S_c = \frac{\sigma_{c,t}}{1 + \sigma_{c,t}(N-1) + \sigma_{nc,t}(C-1)N} \tag{7.8}$$

and that of countries in other continents is

$$S_{nc} = \frac{\sigma_{nc,t}}{1 + \sigma_{c,t}(N-1) + \sigma_{nc,t}(C-1)N} \tag{7.9}$$

These shares depend negatively on tariffs and negatively on transportation costs $a$ and $b$.

## The Bilateral Volume of Trade

The bilateral volume of trade is easily identifiable in this model. To derive it is a bit of a diversion from our main task, which is to see the relationship between economic welfare and alternative regional trading arrangements. It is worth solving explicitly for the bilateral volume of trade, however, as this was the variable that was explained in the gravity equations of chapters 4 through 6. The gravity model can always use verification for its theoretical foundations.

Since we are dealing with a symmetric situation (with balanced trade), the bilateral volume of trade between two countries, A and B, will be equal to twice the volume of trade in one direction. This, in turn, is equal to the share of country B on country A's demand, multiplied by total demand. Total demand is equal to total income, which is in turn given by $L(w + T)$, the product of the labor force and the wage, augmented by the lump-sum transfer of revenue raised by the tariff. As an example, the bilateral volume of trade between two countries that belong to the same continent, with uniform tariffs, will be

$$BVT_c = 2\left[\frac{\sigma_{c,t}}{1 + \sigma_{c,t}(N - 1) + \sigma_{nc,t}(C - 1)N}\right]L(w+T) \tag{7.10}$$

Likewise, the bilateral volume of trade between countries across the ocean will be

$$BVT_{nc} = 2\left[\frac{\sigma_{nc,t}}{1 + \sigma_{c,t}(N - 1) + \sigma_{nc,t}(C - 1)N}\right]L(w+T) \tag{7.11}$$

Now we can look at the consequences of free trade areas, both of the natural and unnatural type, on the bilateral volume of trade. Let us assume, for example, that countries eliminate tariffs on their neighbors, in such a way that $C$ regional FTAs are created, each of them formed by $N$ neighboring nations. This would be an example of natural trading blocs.

In Stein and Frankel (1994), we also examine implications of FTAs for trade diversion and trade creation, which contribute some intuition to the welfare results.[9] Here we proceed directly to derive the bilateral volume of trade (BVT). The new equation for the bilateral volume of trade between countries belonging to the same continent is

$$BVT_c^f = 2\left[\frac{\sigma_c}{1 + \sigma_c(N - 1) + \sigma_{nc,t}(C - 1)N}\right]L(w+T) \tag{7.12}$$

where the $f$ superscript denotes that the trade takes place under a FTA. Comparing this equation with (7.11), we see that there is an increase in the bilateral volume of trade within the continent. (This increase is somewhat smaller than the change in the share—the expression inside the large bracket—suggests, as the formation of the bloc reduces the size of the transfer $T$.) This is trade creation.

In the case of countries across the ocean, the new bilateral volume of trade will be

9. A simulation comparison of the magnitudes of trade creation and trade diversion provides the right answer to the question of whether FTAs raise the welfare of the representative consumer under many plausible parameter values, though not all.

$$BVT_{nc}^{f} = 2\left[\frac{\sigma_{nc,t}}{1 + \sigma_c(N - 1) + \sigma_{nc,t}(C - 1)N}\right]L(w+T) \tag{7.13}$$

Comparing this with equation (7.12), we see that the bilateral volume of trade is reduced between countries that are not part of the same bloc. This is trade diversion. (The reduction is larger than the change in the share of trade, due to the decrease in $T$.)

The same analysis can be done for any symmetrical arrangements between countries. We could, for example, analyze changes in the bilateral volume of trade that would result if each country struck an agreement with one other country on another continent. This would be an example of unnatural trading blocs. By assigning values to the parameters $a$, $b$, $t$, $\theta$, $N$, and $C$, we can obtain the exact effect on BVT of any symmetrical arrangement.

In order to explore the desirability of potential trading blocs, we now need to introduce a measure of welfare.

## How Economic Welfare Depends on Tariffs and Transportation Costs

All people in this model are treated symmetrically. To gauge world welfare, we derive the utility of a representative individual in any country. To determine the utility of the consumer, we need to know how much he or she is consuming of each good and to introduce these values into the utility function. Equations (7.4) and (7.5) above give us the relative consumption of each domestic and foreign variety, so we need only to determine the consumption of each domestic variety, $c_i^h$. We do this by expressing the budget constraint in terms of $c_i^h$, taking into account the redistribution of the tariff revenue to consumers.

If we normalize $p$ to be 1, we can obtain, after some algebra:

$$c_i^h = \frac{K}{1 + (N-1)\left(\frac{1}{p_{c,t}}\right)^{\frac{1}{1-\theta}}(p_{c,t}-t) + (C-1)N\left(\frac{1}{p_{nc,t}}\right)^{\frac{1}{1-\theta}}(p_{nc,t}-t)} \tag{7.14}$$

where

$$K = \frac{w}{n} = \frac{\theta\alpha}{\beta L(1 - \theta)}$$

Once we have the consumption of domestic varieties, the consumption of foreign varieties can be obtained from the relative consumption equations (7.4) and (7.5):

$$c_i^c = c_i^h\left(\frac{1}{p_{c,t}}\right)^{\frac{1}{1-\theta}}; \qquad c_i^{nc} = c_i^h\left(\frac{1}{p_{nc,t}}\right)^{\frac{1}{1-\theta}} \tag{7.15}$$

Inserting these into the utility function, we obtain the value of the utility of the representative individual:

$$U = c_i^{h^\theta}\left[1 + (N-1)\left(\frac{1}{p_{c,t}}\right)^{\frac{\theta}{1-\theta}} + (C-1)N\left(\frac{1}{p_{nc,t}}\right)^{\frac{\theta}{1-\theta}}\right] \tag{7.16}$$

Given the values of the parameters $a$, $b$, $t$, $\theta$, $N$, and $C$, we can first obtain the value of $c_i^h$ by plugging the price equation (7.3) into (7.16). This gives the value of the utility of the representative individual, which is used as a measure of world welfare. Intuitively, we can see from equation (7.3) that tariffs and transportation costs raise the price in the consuming country proportionately. We can see from equation (7.15) that the higher prices reduce consumption of the foreign varieties, which in turn lowers utility.

Equation (7.16) is the expression for utility in the absence of free trade areas. All tariffs are set at the MFN level, $t$. It is straightforward to calculate utility under other arrangements in the same manner. When trading blocs are formed, whatever the pattern of tariffs, we just introduce the new set of relative prices faced by the domestic consumers into the model, and we can obtain new results for utility in a similar way.