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# 11

# Scale Economies and Imperfect Competition

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## 1 Introduction

The links between trade policy and competition have received intense scrutiny in recent years. Current interest in the policy community follows a long period during which many of the basic tenets of modern industrial organization theory were integrated into the core of mainstream trade theory. A number of empirical studies of commercial policy have attempted to incorporate theoretical insights from this literature into numerical assessments of commercial policy. These include studies of regional integration in North America and Europe (Venables and Smith, 1986, 1989; Cox and Harris, 1985; Francois and Shiells, 1994), studies of national trade policies (de Melo and Tarr, 1992), studies of multi-lateral liberalization (Francois et al., 1994; Haaland and Tollefson, 1994), and sector-focused commercial policy studies (Dixit, 1988; Baldwin and Krugman, 1988a,b).

Over roughly the same period during which trade and industrial organization theory were being integrated, developing countries were grappling with the very real consequences of dramatic changes in their trade orientation and domestic economic structure. Since 1980, developing countries have passed through stabilization and adjustment experiences which rival those of the Organization for Economic Cooperation and Development (OECD) countries at any time since the Second World War. For the most part, closer examination of the vivid and diverse lessons of this experience by mainstream trade economists has just begun.[1] It is therefore somewhat ironic that the new school of trade theorists has until recently focused its attention on developed countries, since nowhere has the link between trade and industry structure and conduct been more apparent in recent times than in developing countries.

[1] See Roberts and Tybout (1990), Devarajan and Rodrik (1988a,b), Rodrik (1988), and de Melo (1988) for more on the perspective from development studies.

In this chapter, we examine a variety of alternative specifications of market structure in applied trade models. After a brief discourse on the concept of procompetitive effects of trade, we turn to an overview of conventions for specifying scale economies. We then set out a menu of specifications for market structure and conduct. While these approaches can be, and have been, employed in both partial and general equilibrium models, we limit ourselves here to general equilibrium examples. These examples are drawn from numerical assessments of the Uruguay Round, under alternative specifications of market structure. For the numerical examples, we work with a modified version of the same Korea-focused multi-region general equilibrium model employed in Chapters 9 and 12.

## II The Procompetitive Effects of Trade Policy

When we depart from the perfect competition paradigm, variations in industry structure and market structure greatly complicate formal analysis of the gains from trade. These complications relate to potential shifts in the cost of production, rising and falling profit margins, new product introduction, increased competitive pressure on domestic producers, and changes in the parameters underlying strategic decisions. The interaction of these effects with trade and trade policy can be quite complex, though the minimum conditions for welfare gains are generally linked to changes in industry output (see Markusen et al., 1995). While the specifics vary by model type, the gains from trade that are directly linked to conditions of scale economies and/or imperfect competition are grouped under a common label - *procompetitive effects*.

Markusen et al. offer the relatively simple example of procompetitive effects for a small country in which one sector is monopolistic. This is represented in Figure 11.1, where sector $X$ is assumed to be monopolized. Under autarky, the monopolist sets prices that do not reflect the social rate of transformation. Introduction of trade will have two sets of effects. First, the threat of imports may be sufficient to force the monopolist to price competitively. This is the procompetitive effect in this example, and it is reflected in expanded output from $X_0$ to $X_1$. It moves the economy from welfare $W_0$ to $W_1$. Note that it is not necessary that any trade actually occur. Rather, it is the potential for entry by foreign suppliers that leads to this effect. Second, traditional gains from trade imply a further welfare shift to $W_2$. Under more complex specifications of market power and industry structure, procompetitive effects may relate to increased scale economies and




Figure 11.1. *Procompetitive effects with a domestic monopoly*

falling costs, increased product variety, or increased total profits (measured as the gap between social cost and price).

In addition to complicating the welfare calculus underlying the gains from trade relative to autarky, imperfect competition also complicates the interaction of production incentives, welfare, and commercial policy. At the most basic level, tariffs alter the competitive position of domestic firms relative to foreign firms, as reflected in the demand conditions they face. Just as important, different types of protection have different effects on the competitive position of domestic firms (Bhagwati, 1965). In other words, instruments that are "equivalent" under perfect competition can lead to disparate effects under imperfect competition. An important direction for research relates to the interaction between the types of trade policy instrument surveyed in Chapter 2, and the mechanics of scale economies and competitive market structures explored in this chapter. While the literature on quotas is relatively extensive (see Anderson 1988), our understanding of the more exotic instruments, like domestic content requirements, product standards, and contingent protection triggered by threshold market shares, is limited at best. This is made even more difficult by the almost infinite scope for creating derivative commercial policy instruments out of combinations of these individual instruments. At a general level, we refer the reader to Markusen and Venables (1988), Grossman (1991), Helpman and Krugman (1989), and Markusen et al. (1995) as good starting points on abstract treatment of commercial policy under these conditions. For more concrete examples involving applied studies of specific industries, see Baldwin and Krugman (1988a,b), Dixit (1988), Feenstra (1988), and de Melo and Tarr (1992). On a regional basis, Cox and Harris (1985) and Francois and Shiells (1994) focus on economic integration in North America, Venables and Smith (1986, 1991) and Haaland and Wooton (1991) examine economic integration in Europe, and Lee and Roland-Holst (1995) examine economic integration in the Pacific Basin. For multi-lateral liberalization, recent studies include Haaland and Tollefson (1994) and Francois et al. (1994, 1995).

To highlight how important the interactions between imperfect competition and choice of commercial policy instruments can be, we close this section with a simple example involving tariffs and quotas. Consider a small country, with a monopolist producing good $X$, subject to the cost schedule $MC$ in Figure 11.2. This good is also available on the world market at price $P^*$. If we introduce a tariff at $t$ which is less than the prohibitive tariff, the domestic monopolist then faces the marginal revenue schedule $P_t=P^*(1+t)$ and will produce at point $E_t$. Imports will be at level $M_t$, and price will be at $P_t$. Next, assume the government replaces the import tariff with a quota allowing for the same level of imports as under the tariff. The relevant demand schedule for the domestic firm is then represented by the heavy line in the figure, which maps residual demand. Under the quota, the monopolist then faces the marginal revenue schedule $MR$. The result is that he will restrict output to $Xq$, charging price $Pq$. Basically, with the quota, the domestic monopolist has more market power, as a result of a less elastic demand curve than under the "equivalent" tariff. Helpman and Krugman (1989) offer a generalization of this point, showing that the basic insight is relatively robust and follows even within frameworks incorporating declin-



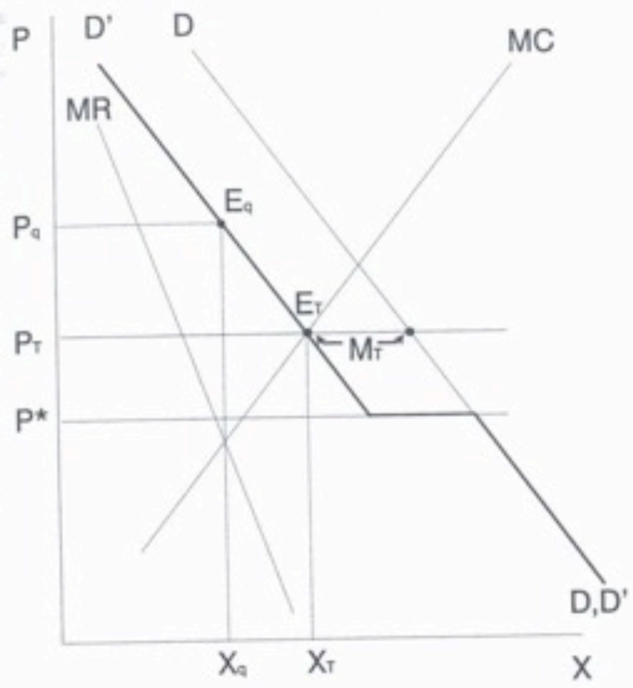


Figure 11.2. *Tariffs versus quotas with a domestic monopoly*

ing marginal costs, imports that are imperfect substitutes for domestic goods, non-cooperative oligopoly, and collusive oligopoly. In the extreme, quotas even at the full free trade level of imports can induce anti-competitive behaviour and reductions in output by a domestic monopolist. We may therefore expect liberalization of quantitative restrictions to induce greater procompetitive effects than tariff liberalization.

### III Firm-Level Costs

In empirical models, the cost structure of firms, and hence of industry, follows from the choice of modeling technique and the observed data to which it is calibrated. One aspect which has received intense scrutiny in recent years is returns to scale. Beginning with a study by Harris (1984), a large literature on empirical modeling arose to evaluate trade liberalization under various specifications of returns to scale.[2] This new empirical research initiative was abetted by the intense parallel interest among trade theorists in applying concepts from industrial organization to trade theory.[3] Both strains of work on firm-level scale economies confirm a basic conclusion of the earlier literature on trade with industrywide scale economies – the results of empirical and theoretical work grounded in classical trade theory can be contradicted, in magnitude and/or direction, when scale economies or diseconomies play a significant role in the adjustment process.

Constant returns to scale (CRTS) is an attractive property in terms of flexibility and parsimony. It facilitates practical data gathering, calibration, and interpretation of results. However, there is strong empirical evidence against this assumption. In the real world, factors are heterogeneous in quality and mobility, and changes in the level of output often involve changes in average cost, even for relatively simple production processes (Westerbrook and Tybout, 1990). While there may be uncertainty about the precise magnitude, scale economies are a fact of life and appear to be pervasive even in mature industries with diverse firm populations. For these reasons, a re-appraisal of insights drawn from CRTS-based empirical results is probably justified.

The most common departure from CRTS incorporates unrealized economies of scale in production. Increasing returns to scale (IRTS), where average cost falls as output rises, often takes the form of a monotonically decreasingly average cost function, calibrated to some simple notion of a fixed cost intercept. In other words, one assumes that marginal costs are governed by the preferred CRTS production function (usually constant elasticity of substitution [CES]), but that some subset of inputs are committed *a priori* to production and their costs must be covered regardless of the output level. The total cost function may be homothetic (i.e., fixed costs involve the same mix of inputs as marginal costs), or alternatively fixed costs may be assumed to involve a different set of inputs. In either case, average costs are given by a reciprocal function of the form

$$AC = \frac{FC}{X} + MC \tag{11.1}$$

2 See de Melo and Tarr (1992) for methodological discussion, Roland-Holst, Reinert, and Shiells (1994) and Francois et al. (1995) for more recent applications.

3 See, e.g., Helpman and Krugman (1985) for examples from this literature.



As an alternative, scale economies can also be specified as deriving from costs that enter multiplicatively, with an average cost function like the following:

$$AC = X^{\theta-1} f(\omega) \qquad where\ 0 < \theta < 1 \tag{11.2}$$

where $\omega$ is the input price vector, and $f(\omega)$ represents the cost function for a homogenous bundle of primary and intermediate inputs. In later discussion, we shall index the bundle of inputs by the variable $Z$. This type of reduced form structure can be derived, for example, from scale economies due to returns from specialization (i.e., an increased division of labour) inside firms (Francois, 1990). In reduced form, it can also represent returns to specialization on an industrywide basis of intermediate inputs, resulting in industrywide scale effects (Markusen, 1990).

With scale economies as in equation (11.1) (i.e., with fixed costs), the cost disadvantage ratio (CDR), as defined later, will vary with the scale of output. Alternatively, with a cost function like (11.2), the CDR remains fixed. The properties of the two cost functions are illustrated in Figure 11.3.

Under either approach, one "only" needs to calibrate the cost function from engineering estimates of the distance between average and marginal cost. With fixed costs, this also requires some idea about how to impute fixed cost to initial factor and/or intermediate use. In practice, it has become customary to appeal to the concept of a cost disadvantage ratio. This measure of unrealized scale economies is generally defined as

$$CDR = \frac{AC - MC}{AC} \tag{11.3}$$

At the margin, output elasticities are equal to $(1/(1-CDR))$.

In practice, calibration of either (11.1) or (11.2) can be problematic. At a conceptual level, estimated CDRs may be based on one level of "typical" production, while the benchmark dataset we are working with corresponds to another. If we model scale economies with fixed costs and variable CDRs (i.e., equation [11.1]), then the CDR estimates can be inappropriate and even misleading. At a more basic level, the pattern of citations in the empirical literature employing scale economies is circular and converges on a set of engineering studies on scale elasticities, many of which are surveyed by Pratten (1988), and many of which date from the 1950s, 1960s, and early 1970s. Given technical change over this period, including the introduction of numerically controlled machinery, computerization of central offices, and

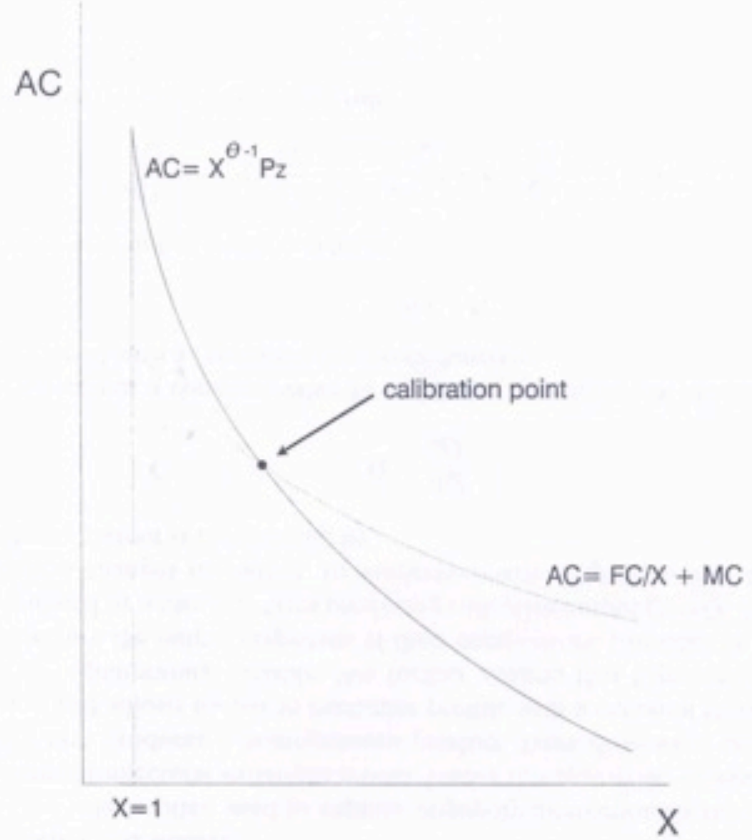


Figure 11.3. *Increasing returns with fixed costs and fixed CDRs*

the shift toward white-collar workers and away from production workers in the OECD countries, these estimates appear somewhat stale. Clearly, this is an important area for future research.

## IV Market Power and Homogeneous Goods

### *IV.1 Perfect Competition*

The standard starting point for market structure in applied trade models, and our reference point for the discussion in this section, is a competitive industry that can be described in terms of a representative firm facing perfectly competitive factor markets and behaving competitively in its relevant output markets. Under these assumptions, the representative firm takes price as given, and the cost structure of the industry then determines output at a given price. Formally, we have

$$P = MC \tag{11.4}$$

With competitive markets, real or threatened entry forces economic profits to zero. Demand for primary and intermediate inputs then depends on the specific cost structure that is assumed:

$$P = AC \tag{11.5}$$

If we assume constant instead of increasing returns, then equation (11.5) holds by definition. Otherwise, we can motivate equation (11.5) by contestability.

### *IV.2 Monopoly*

Our first departure from the competitive paradigm is the case of monopoly. The monopoly specification is a straightforward extension of perfect competition. In terms of equations (11.4) and (11.5), we still have a representative firm in the sector under consideration. The difference lies in the firm's pricing behaviour. In particular, the monopolist does not take price as given, but rather takes advantage of her ability to manipulate price by limiting supply. This means that the pricing equation (11.4) is then replaced by the following equation:

$$\frac{P - MC}{P} = \frac{1}{\varepsilon} \tag{11.6}$$

where the market elasticity of demand is given by

$$\varepsilon = -\frac{\partial Q}{\partial P}\frac{P}{Q} \tag{11.7}$$

The relationship of price to average cost depends on our assumptions about the cost and competitive structure of the industry. For example, with contestability and scale economies, entry may still force economic profits to zero, such that the monopolist prices according to equations (11.6) and (11.5). This is the approach taken in models with monopolistic competition. Alternatively, we may instead have price determined by equation (11.6) in isolation from (11.5), such that demand quantities at the monopoly price also then determine average cost. Equation (11.5) is then replaced by a definition of economic profits:

$$\pi = (P - AC)Q \tag{11.8}$$

### IV.3 Homogeneous Products and Oligopoly

Between the perfect competition and monopoly paradigms lies a continuum of possible firm distributions. When the number of firms is small enough for them to influence one another, complex strategies can arise. We will not pretend to cover the full spectrum of oligopoly theory in this chapter. Instead, we offer a set of representative specifications which indicate the decisive role that firm interactions can play in determining price, quantity, efficiency and welfare.

One vehicle often used to explore oligopoly interactions is the so-called Cournot conjectural variations model. Under this approach, we assume that each firm produces a homogeneous product, faces downward sloping demand and adjusts output to maximize profits, with a common market price as the equilibrating variable. We further assume that firms anticipate or conjecture the output responses of their competitors. Consider an industry populated by $n$ identical firms producing collective output $Q=nQ_i$. When the $i$th firm changes its output, its conjecture with respect to the change in industry output is represented by

$$\Omega_i = \frac{dQ}{dQ_i} \tag{11.9}$$

which equals a common value $\Omega$ under the assumption of identical firms. Combined with a representative profit function

$$\Pi_i = PQ_i - TC_i \tag{11.10}$$

this yields the first-order condition

$$\frac{d\Pi_i}{dQ_i} = P + Q_i \frac{dP}{dQ}\frac{dQ}{dQ_i} - \frac{dTC_i}{dQ_i} = P - \frac{Q_i}{n\varepsilon}\frac{P}{Q_i}\Omega - MC = 0 \tag{11.11}$$

and also the oligopoly pricing rule

$$\frac{P - MC}{P} = \frac{\Omega}{n\varepsilon} \tag{11.12}$$

The preceding expression encompasses a variety of relevant cases. The classic Cournot specification corresponds to $(\Omega/n)=(1/n)$, where each firm



believes that the others will not change their output, and industry output changes coincide with its own. Price–cost margins vary inversely with the number of firms and the market elasticity of demand, as logic would dictate. In the extreme cases, a value of $\Omega=0$ corresponds to perfectly competitive, average cost pricing, while $\Omega=n$ is equivalent to a perfectly collusive or monopolistic market. The range of outcomes between these extremes, as measured by $1 \geq (\Omega/n) \geq 0$, can provide some insight into the significance of varying degrees of market power.

### IV.4 Market Entry and Exit

In the previous section, we defined Cournot interactions with respect to a fixed number of incumbent firms, implying barriers to entry (and exit). When we allow for the possibility of market entry and exit, then the number of firms ($n$) becomes endogenous, and the competitive climate in the industry under consideration varies accordingly.

Note that the price–cost margins in equation (11.12) vary with the number of firms. In particular, margins shrink with an increase in the number of firms. This is the first effect of entry. In addition, a major effect of entry and exit relates, under increasing returns, to firm-level scale economies. Entry and exit can alter the average scale of firm operations, other factors equal, and in the increasing and decreasing returns cases this can have aggregate efficiency effects.

The ultimate scope for entry, exit, or realization of scale economies in particular industries is an empirical question. In the present context, entry and exit are basically model closure problems, taking the form of limiting rules for incumbent profits, prices, or some other indicator of the return on existing operations. In general, these rules should provide an explicit link between profits and entry. We will briefly discuss two illustrative cases. One stylized approach involves assuming that there is no actual entry or exit, but that the threat of entry forces incumbent firms to limit profits. In this case, the scale of individual (representative) firm operations varies proportionately with industry output, and changes in scale economies are easy to predict. An alternative is to allow firm numbers to be endogenous and linked to profitability, while also specifying a secondary rule linking incumbent pricing to the number of firms. It is then actual entry and exit that acts as an explicit constraint on profitability. For example, endogenous Cournot conjectures of the form

$$\Omega = \frac{\Omega_0 n_0}{n} \tag{11.13}$$

imply that firms perceive their markets as becoming more competitive when the number of firms increases.

### IV.5 Dynamic Interactions

While the conjectural variation approach to Cournot competition allows us to specify a set of equilibria ranging from competition to monopoly, it has been criticized by a number of authors as being an unrealistic and rather naive approach to dynamic market interactions.[4] In recent years, significant advances have been made in the theory of repeated games. It may be that, when incorporated into applied models, these theoretical approaches yield more realistic approaches to simulating market dynamics. The repeated game approach can be appealing not only because it explicitly considers the sequential and historical aspects of competition, but also because it opens up a richer universe of strategic opportunities and solution concepts. At the same time, depending on the context of the modeling exercise, one must be careful not to hang too much significance on the benefits of such methods. It is not always clear what is gained when complex, firm-level interactions are explicitly modeled for a heterogeneous sector such as "other machinery" or "transport equipment" that is clearly a collection of firms and industries (such as bicycles, automobiles, and airplanes) that are only related directly through statistical aggregation. Even at the level of only a few firms (like automobiles or mid-sized aircraft), lack of data may mean that we have replaced conjectural variations with conjectural data manufacturing.

Repeated games can yield tacit collusion (Tirole, 1988; Shapiro, 1989). The simple Cournot strategy, for example, emerges as the Nash equilibrium for a repeated game. However, this strategy does not maximize profits for the industry as a whole or for individual firms. The same is true of Bertrand competition. Under both price and quantity competition, we can construct repeated games that yield sustained collusion with higher profits. Use of repeated game frameworks may therefore allow for modeling of cases where trade liberalization, through its effect on relevant variables, can induce changes in the incentives for collusion (with reversion from collusion to Cournot equilibria, for example).

## V Heterogeneous Goods

We turn next to market power in models that explicitly incorporate heterogeneous goods, emphasizing specifications involving two or more regions. In the first case, a class of heterogeneous goods is assumed to be differentiated by country of origin. This is the Armington assumption, which was first introduced in Chapter 5. The second specification is based on firm-level product differentiation.

4 See, e.g., Shapiro (1989).



### V.1 Market Power in Armington Models

In Armington models, goods are differentiated by country of origin, and the similarity of goods from different regions is measured by the elasticity of substitution. Formally, within a particular region $r$, we assume that demand goods $j$ from different regions are aggregated into a composite good $Q_{j,r}$ according to the following CES function:

$$Q_{j,r} = \left[ \sum_{i=1}^{R} \alpha_{j,i,r} X_{j,i,r}^{\rho_j} \right]^{1/\rho_j} \tag{11.14}$$

In equation (11.14), $X_{j,i,R}$ is the quantity of $X_j$ from region $i$ consumed in region $r$. The elasticity of substitution between varieties from different regions is then equal to $\sigma_j$, where $\sigma_j = 1/(1 - \rho_j)$. For tractability, we focus here on the non-nested case, where $\sigma_j$ is identical across regions, and is equal to the degree of substitution between imports, as a class of goods, and domestic goods.[5] Within a region, the price index for the composite good $q_{j,r}$ can be derived from equation (11.14):

$$P_{j,r} = \left[ \sum_{i=1}^{R} \alpha_{i,r}^{\sigma_j} P_{i,r}^{1-\sigma_j} \right]^{1-1/\rho_j} \tag{11.15}$$

At the same time, from the first-order conditions, the demand for good $X_{j,i,r}$ can then be shown to equal

$$\begin{aligned} X_{j,i,r} &= \left[ \frac{\alpha_{j,i,r}}{P_{j,i,r}} \right]^{\sigma_j} \left[ \sum_{i=1}^{R} \alpha_{j,i,r}^{\sigma_j} P_{j,i,r}^{1-\sigma_j} \right]^{-1} E_{j,r} \\ &= \left[ \frac{\alpha_{j,i,r}}{P_{j,i,r}} \right]^{\sigma_j} P_{j,r}^{\sigma_j - 1} E_{j,r} \end{aligned} \tag{11.16}$$

5 A variation on this approach involves nesting the Armington structure, so that imports from different sources are first aggregated, and the composite good then competes with domestic goods in a second Armington aggregation function. This is discussed in Chapter 9. In the present context, this would involve another set of equations for each region, though the discussion would be qualitatively similar.

where $E_j$ represents economywide expenditures in region $r$ on the sector $j$ Armington composite. From equation (11.16) (and fixing cross-prices), the elasticity of demand for a given variety of good $X_j$, produced in region $i$ and sold in region $r$, will then equal

$$\varepsilon_{j,i,r} = \sigma_j + (1-\sigma_j)\left[\sum_{k=1}^{R}\left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}}\right)^{\sigma_j}\left(\frac{P_{j,k,r}}{P_{j,i,r}}\right)^{1-\sigma_j}\right]^{-1} \tag{11.17}$$

The last term in square brackets measures market share.

*Monopoly* At this stage, there are a number of ways to introduce imperfectly competitive behaviour. For example, for a monopolist in each region that can price discriminate between regional markets, the regional elasticity of demand (and hence the relevant mark-up of price over marginal cost) is determined in each market by equation (11.17). This implies, potentially, $n \cdot R^2$ sets of elasticity and price markup equations for an $n$ sector, $R$ region model. In models where different sources of demand can potentially source imported inputs in different proportions (like the SALTER and GTAP models), we then have a potential for $(n+k)\cdot n \cdot R^2$ elasticity and markup equations, where $k$ is the number of final demand sources in each region. Hence, in large multi-region models, full regional price discrimination for each product in each region can add a great deal of numerical complexity to the model.

A greatly simplifying assumption involves assuming a monopolist that does not price discriminate, but instead charges a single markup. From equation (11.17), the aggregate elasticity of demand for a given variety will then be determined by a combination of $\sigma_j$ and a weighting of $(1-\sigma_j)$ determined by regional market shares. One option is to assume that each firm forms a conjecture about the value of this weighting parameter, represented by $\zeta$.[6] If each firm assumes that $\zeta_{ji}$ is fixed, this means it forms a conjecture about the elasticity of demand based on $\zeta_{ji}$ and $\sigma_j$. For a monopolist in region $i$ producing $j$, we then have

$$\varepsilon_{j,i} = \sigma + (1-\sigma)\zeta_{j,i} \tag{11.18}$$

6 Clearly, this raises the question of how to calibrate $\zeta$, and the relative advantages and disadvantages of endogenizing $\xi$. In the numeric examples in this chapter, we could have employed estimates of the reduced form elasticity of demand in general equilibrium, based on perturbations of price and as reported in Chapter 9, to calibrate $\varepsilon_{i,x}$, on the basis of the assumption that firms correctly know the marginal elasticity of demand, and assuming that this value is constant in counterfactual simulations. We have chosen instead to simplify the demand structure slightly, and to calculate these share parameters directly.



Instead of assuming that $\zeta$ is fixed (at least for relevant equilibria), we can also specify an explicit definition based on equation (11.17). For each sector, we must then add the equations necessary to endogenize $\zeta$.

$$\zeta_{j,i} = \sum_{r=1}^{R}\frac{X_{j,i,r}}{X_{j,i}}\left(\sum_{k=1}^{R}\left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}}\right)^{\sigma_j}\left(\frac{P_{j,k,r}}{P_{j,i,r}}\right)^{1-\sigma_j}\right)^{-1} \tag{11.19}$$

This is less complex in implementation than it appears, as equation (11.19) is simply a quantity weighting of regional market shares.

There are trade-offs between the complexity of the model and the degree of discriminatory power allowed for monopolists. If we expect significant procompetitive effects related to changes in perceived market power in particular markets, through changes in either $\varepsilon_{j,i,r}$ or $\zeta_{j,i}$, then we should explicitly specify relative market power in those markets that are at least partially segmented through tariffs, transport costs, or other trade barriers.

Equations (11.17), (11.18), and (11.19) are based on a non-nested CES structure for aggregation of imports and domestic production. A common alternative Armington specification involves nested CES functions, where the lower tier is defined over all imports, and the upper tier is then defined over a composite import and the competing domestic good. In this case, equation (11.17) is replaced by the following:

$$\begin{aligned}\varepsilon_{j,i,r}\big|_{i\neq r} = &\left[\sigma_j^M\left(\theta_{j,r}^D\left(\frac{\sigma_j^D}{\sigma_j^M}\right)+\sum_{k=1}^{R}\theta_{j,k,r}^M\right)+\left(1-\sigma_j^M\right)\theta_{j,i,r}^M\right] \\ &\cdot\left[\theta_{j,r}^D\left(\frac{\sigma_j^D}{\sigma_j^M}\right)+\sum_{k=1}^{R}\theta_{j,k,r}^M+\left[\theta_{j,r}^D\phi_{j,i,r}^M\left(\left(\frac{\sigma_j^D}{\sigma_j^M}\right)-1\right)\right]\right]^{-1} \\ \text{and}\quad \varepsilon_{j,i,r}\big|_{i=r} = &\ \sigma_j^D+\left(1-\sigma_j^D\right)\theta_{j,r}^D\end{aligned} \tag{11.17'}$$

where $\sigma^D$ and $\sigma^M$ are the upper- and lower-tier substitution elasticities, $\theta^M$ measures market shares for imports by source at the upper tier, $\theta^D$ measures market share for the domestic good at the upper tier, and $\phi^M$ measures the market share of imports at the lower tier. The reader can verify that, with a non-nested specification, where $\sigma^D=\sigma^M$, this collapses to equation (11.17). With a non-discriminating monopolist, equation (11.18) will still involve a quantity weighting of regional demand elasticities.

*Oligopoly* If we start with the non-discriminatory case of market power, then extending our model from monopoly to oligopoly is relatively straightforward. We keep the simplifying assumption, introduced earlier, that under oligopoly firms are identical. The key difference is that they now produce a regionally homogeneous product. Demand for a regional product is downward sloping, as defined by equation (11.17). We further assume that firms adjust output to maximize profits, with a common market price as the equilibrating variable, and that firms anticipate or conjecture the output responses of their competitors. This leaves us with a variation of the basic oligopoly pricing rule

$$\frac{P-MC}{P}=\frac{\Omega}{n\varepsilon}=\frac{\Omega}{n}\left[\sigma+(1-\sigma)\zeta\right]^{-1} \tag{11.20}$$

### *V.2 Firm-Level Product Differentiation*

Next, we turn to firm-level product differentiation. This approach builds on the theoretical foundations laid by Ethier (1982) and Krugman (1979, 1980). Arguments for following this approach, where differentiation occurs at the firm level, have been offered by Norman (1990) and Brown (1987). The numeric properties of this type of model have been explored in a highly stylized model by Brown (1994). Theoretical properties of the type of model developed here, which explicitly allows for firms having different market shares in the various markets in which they operate, have been examined by Venables (1987).

*General Specification of Monopolistic Competition* Formally, within a region $r$, we assume that demand for differentiated intermediate products belonging to sector $j$ can be derived from the following CES function, which is now indexed over firms or varieties instead of over regions. We have

$$Q_{j,r}=\left[\sum_{i=1}^{n}\alpha_{j,i,r}x_{j,i,r}^{\rho_j}\right]^{1/\rho_j} \tag{11.21}$$

where $\alpha_{j,i,r}$ is the demand share preference parameter, $x_{j,i,r}$ is demand for variety $i$ of product $j$ in region $r$, and $\sigma_j=1/(1-\rho_j)$ is the elasticity of substitution between any two varieties of the good. Note that we can interpret $Q$ as the output of a constant returns assembly process, where the resulting composite product enters consumption and/or production.[7] Equation (11.21) could therefore be interpreted as representing an assembly function embedded in the production technology of firms that use intermediates in production of final goods, and alternatively as representing a CES aggregator implicit in consumer utility functions. In the literature, both cases are specified with the same functional form. Because most industrial trade involves intermediates, we lean toward the former interpretation. While we have technically dropped the Armington assumption by allowing firms to differentiate products, the vector of $\alpha$ parameters still provides a partial geographic anchor for production.[8]



In each region, industry $j$ is assumed to be monopolistically competitive. This means that individual firms produce unique varieties of good $j$, and hence are monopolists within their chosen market niche. Given the demand for variety, reflected in equation (11.21), the demand for each variety is less than perfectly elastic. However, while firms are thus able to price as monopolists, free entry drives their economic profits to zero, so that pricing is at average cost. The joint assumptions of average cost pricing and monopoly pricing imply the following conditions for each firm $f_i$ in region $i$:

$$P_{f_i}=AC_{f_i} \tag{11.22}$$

$$\frac{P_{f_i}-MC_{f_i}}{P_{f_i}}=\frac{1}{\varepsilon_{f_i}} \tag{11.23}$$

7 An approach sometimes followed involves monopolistic competition within regions, with trade only involving composite goods. Trade then is not based on firm-level differentiation (i.e., monopolistic competition), and firms in different regions do not "compete" directly in the sense emphasized by Ethier (1982), Krugman (1980), and Helpman and Krugman (1985). Rather, trade is then based on the Armington assumption regarding regional composite goods, as discussed in Chapter 9. The basic difference between this approach and the one developed in the text is the relaxation of the linkage between upper tier substitution elasticities and measures of market power for regional firms. We leave it to the reader to verify, from equations (11.35) and (11.40), that this implies a model exhibiting, in reduced form, external scale economies at the regional level.

8 The Armington assumption, or more generally allowing for region-specific differentiation, ensures uniqueness of production equilibria with $v$ factors and $n>v$ goods. Numerically, such models exhibit properties of models with sector-specific factors of production. Otherwise, we would need explicitly to adopt a specific-factor specification, or in some other way ensure that the number of goods did not exceed the number of factors, in order to solve for unique production and trade patterns for a given set of prices. With inter-sectoral mobility of capital and labour, and more than two goods, if we assumed differentiation was only at the firm level, and that all firm output entered the CES aggregator identically regardless of origin (i.e., with identical weights), free trade production patterns with two-way trade, at least in an integrated equilibrium, would be indeterminate. See Dixit and Norman (1980, pp. 56–59). In general, the introduction of scale economies raises the likelihood of multiple equilibria.

We assume firms treat the prices of other firms or varieties as given (i.e., Bertrand behaviour). The elasticity of demand *for each firm* $f_i$ will then be defined by the following conditions:

$$\varepsilon_{j,f,i} = \sigma_j + (1-\sigma_j)\zeta_{j,f,i} \tag{11.25}$$

$$\zeta_{j,f_i} = \sum_{r=1}^{R} \frac{x_{j,f,r}}{x_{j,f_i}} \left( \sum_{k=1}^{n} \left( \frac{\alpha_{j,k,r}}{\alpha_{j,f_i,r}} \right)^{\sigma_j} \left( \frac{P_{j,k,r}}{P_{j,f,r}} \right)^{1-\sigma_j} \right)^{-1} \tag{11.24}$$

In a fully symmetric equilibrium, $\zeta=n^{-1}$. Under more general conditions, it is a quantity weighted measure of market share. To close the system for regional production, we index total resource costs for sector $j$ in region $i$ with a resource index, designated $Z$. In a Ricardian framework, $Z$ is simply labour employed in production. In multiple input models, $Z$ indexes the overall level of activity, measured on the input side. Because we have assumed homothetic cost functions, $Z$ will move in proportion to changes in all inputs. Full employment of resources hired by firms in the sector $j$ in region $i$ then implies the following condition:

$$Z_{j,i} = \sum_{f=1}^{n_i} TC_{j,i,f} \tag{11.26}$$

In models with regionally symmetric firms (so that $Z_{j,i}=n_{j,i}\times TC_{j,i}$), equations (11.22)–(11.26), together with the definition of $AC=AC(x)$, define a subsystem that determines six sets of variables: $x$, $\varepsilon$, $\zeta$, $P$, $n$, and the cost disadvantage ratio $CDR=(1-MC/AC)$.

These equilibrium conditions are represented graphically in Figure 11.4. The full employment of resources at level $Z$ in the regional sector implies, from equation (11.26), possible combinations of $n$ and $x$ mapped as the curve $FF$. At the same time, demand for variety, combined with zero profit pricing (equations [11.22] and [11.23]), imply demand-side preference for scale and variety mapped as the curve $ZZ$. Equilibrium is at point $E_0$. Holding the rest of the economy-wide system constant, expansion of the sector means the $FF$ curve shifts out, yielding a new combination of scale and variety and point $E_1$. The exact pattern of shifts in $n$ and $x$ depends on the assumptions we make about the cost structure of firms, and about the competitive conditions of the sector. It may also be affected by general equilibrium effects.

*Some Simplifications: Variety Scaling* To simplify the system of equations somewhat, symmetry can be imposed on the cost structure of firms within a region. Regional symmetry means that, in equilibrium, regional firms will



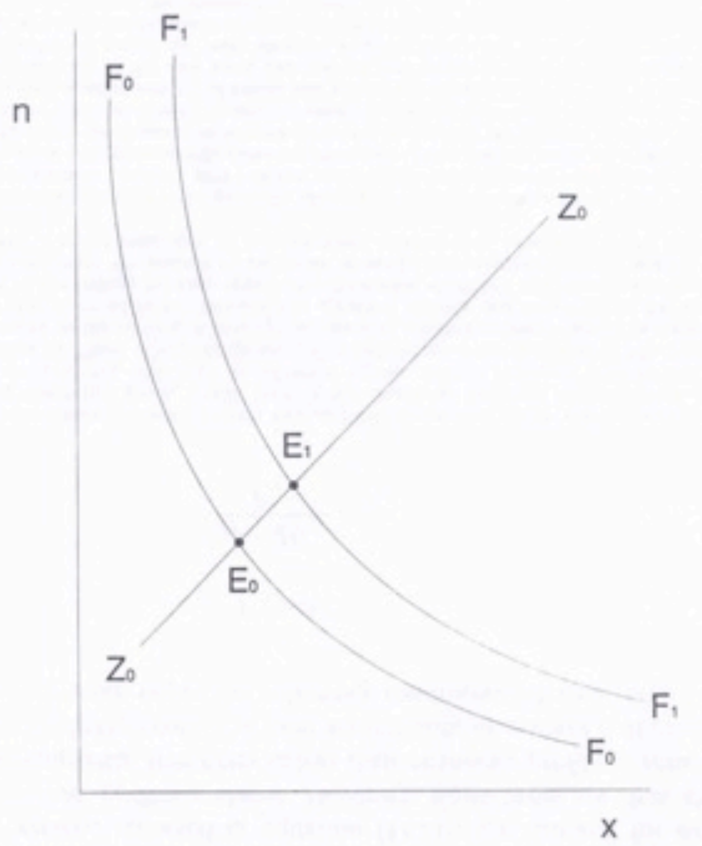


Figure 11.4. *Variety and scale effects with monopolistic competition*

produce the same quantity of output and charge the same price. Under variety scaling, we further assume that the CES weights applied to goods produced by sector $j$ firms from region $i$, when consumed in a particular region $r$, are equal. This means we can rewrite equation (11.8) as follows:

$$Q_{j,r} = \left[ \sum_{i=1}^{R} n_{j,i} \alpha_{j,i,r} \bar{x}_{j,i,r}^{\rho_j} \right]^{1/\rho_j} \tag{11.27}$$

where $\bar{x}$ is the identical consumption in region $r$ of each variety produced in region $i$. Upon inspection of equations (11.27) and (11.14), it should be evident that the Armington assumption and firm-level product differentiation, in practice, bear a number of similarities. The primary difference is that, in equation (11.27), the CES weights are now endogenous, as they include both variety scaling effects and the base CES weights. We can make a further modification to equation (11.27). Noting that total quantities are $X_{ijr}=n_{jr}\times\bar{x}$, we then have

$$Q_{jr}=\left[\sum_{i=1}^{R}\gamma_{ijr}\tilde{x}_{ijr}^{\rho_j}\right]^{1/\rho_j}$$

$$\gamma_{ijr}=\alpha_{ijr}n_{ij0}^{1-\rho_j}$$

$$\tilde{x}_{ijr}=\left(\frac{n_{ij}}{n_{ij0}}\right)^{(1-\rho_j)/\rho_j}X_{ijr} \tag{11.28}$$

where $\tilde{x}_{ij}$ is variety-scale output, and where $n_{ij0}$ is the benchmark number of firms. Note that $\tilde{x}_{ij}=X_{ij}$ in the benchmark.

When we specify the system of equations for monopolistic competition using a variation of equation (11.22), the final set of equations for producing sector $j$ composite commodities is then almost identical to that employed in standard, non-nested Armington models. The key difference is that the relevant CES weights are endogenized through $\tilde{x}_{ij}$, as defined by equation (11.28). In fully symmetric equilibria, the reader should be able to verify that complete firm exit from particular regions is possible, since the regional CES weights are simply equal to the number of firms, which collapse to zero with full exit. Depending on the specification of the structure of monopolistically competitive markets, as detailed later, the combination of output and variety scaling can then be specified as part of the regional production function for $\tilde{x}_{ij}$.

*Scale Economies from Fixed Costs* We will focus on two particular specifications of increasing returns. The first is a variation of equation (11.1), in which we assume that the cost function, while exhibiting increasing returns due to fixed costs, is still homothetic. In particular, for a firm in region $i$, we have

$$C(x_{ij})=(\alpha_{ij}+\beta_{ij}x_{ij})P_{z_{ij}} \tag{11.29}$$

where $\alpha_{ij}$ and $\beta_{ij}$ represent fixed and marginal costs, and $P_{zij}$ represents the price for a bundle of primary and intermediate inputs $Z_{ij}$, where the production technology for $Z_{ij}$ is assumed to exhibit constant returns to scale.

Substituting equation (11.29) into (11.22), (11.23), and (11.26), the system of equations (11.22) through (11.26), along with the definition of average cost, can be used to define general conditions for equilibrium in a monopolistically competitive industry. Starting from equations (11.22) and (11.23), the elasticity of demand can be related directly to the cost disadvantage ratio:

$$\frac{AC-MC}{AC}=\frac{\alpha_{ij}}{\alpha_{ij}+\beta_{ij}x_{ij}}=\frac{1}{\varepsilon_{ij}} \tag{11.30}$$

The remainder of the system is as follows:

$$\varepsilon_{ij}=\sigma_j+(1-\sigma_j)\zeta_{ij} \tag{11.31}$$

$$\zeta_{ij}=\sum_{r=1}^{R}\frac{\tilde{x}_{ijr}}{\tilde{x}_{ij}}\left(\sum_{k=1}^{R}n_{jk}\left(\frac{\alpha_{jkr}}{\alpha_{ijr}}\right)^{\sigma_j}\left(\frac{P_{jkr}}{P_{ijr}}\right)^{1-\sigma_j}\right)^{-1} \tag{11.32}$$

$$Z_{ij}=n_{ij}(\alpha_{ij}+\beta_{ij}x_{ij}) \tag{11.33}$$

Given the resources allocated to sector $j$ in region $i$, as measured by the index $Z_{ij}$, equations (11.30) through (11.33) define a subsystem of four equations and four unknowns: $n_{ij}$, $x_{ij}$, $\zeta_{ij}$, and $\varepsilon_{ij}$. In addition, the value of $\tilde{x}_{ij}$ is then determined by equation (11.28), while producer price is set at average cost. Note that the price terms in equation (11.32) are internal prices and will hence reflect trade barriers and other policy and trade cost aspects of the general equilibrium system, implying still more equations linking producer and consumer prices.

A special case of this specification involves "large group" monopolistic competition. In large group specifications, we assume that $n$ is arbitrarily large, such that $\zeta_{ij}$ is effectively zero, and hence, through equations (11.30) and (11.31), the elasticity of demand and the scale of individual firms are also fixed. In this case, changes in the size of an industry involve entry and exit of identically sized firms. The full set of equations then collapses to the following single equation:

$$\tilde{x}_{ij}=\left(\frac{Z_{ij1}}{Z_{ij0}}\right)^{(1-\rho_j)/\rho_j}X_{ij} \tag{11.34}$$

Here, $X_{ij}$ is produced subject to constant returns to scale, given entry and exit of identical firms of fixed size, which follows from our assumption about the cost function for $Z_{ij}$. At the same time, changes in variety are directly proportional to changes in $Z_{ij}$.

It can be shown that proportional changes in $\tilde{x}_{ij}$ as defined by equation (11.28) relate to proportional changes in $Z_{ij}$:

$$\hat{\bar{x}}_{ji} = \left(\frac{\sigma_i}{(\sigma_i - 1)}\right)\hat{Z}_{ji} + \left(\frac{(\sigma_i - \varepsilon_{ji})\zeta_{ji}}{(\sigma_i - 1)(1 - \zeta_{ji})}\right) CDR\,\hat{\zeta}_{ji} \qquad (11.35)$$

In equation (11.35), a ˆ denotes a percentage change. What does this equation tell us? The first term is clearly positive and relates to the impact of increased resources on the general activity level of the sector, given its structure. The second term relates to changes in the condition of competition. Controlling for changes in market share for the entire regional industry, changes in $\zeta_{ji}$ are proportional to changes in the inverse number of firms in the industry. Hence, we expect the last term to have a negative sign, but also to become smaller in absolute value as the sector expands. In particular, as the sector expands, the value $(\sigma-\varepsilon)$ converges on zero, as does $\zeta_{ji}$, so that this last term becomes less important. This follows from the procompetitive effects of sector expansion. As the sector expands, new entrants intensify competition, forcing existing firms down their cost curves and squeezing the markup of price over marginal cost. As the sector becomes increasingly competitive, the marginal benefits of devoting more resources to the sector are greater, until at the limit the output elasticity for variety-scaled output converges on $(1/\rho)$. This is the large group case identified in equation (11.39), where $(\sigma=\varepsilon)$, such that the second term vanishes.

*Scale Economies with Fixed Scale Effects* We close this section with an alternative specification of monopolistic competition, in which cost functions for individual firms take the form of equation (11.2):

$$C(x_{ji}) = (x_{ji})^{\theta_{ji}} P_{z_{ji}} \qquad \text{where } 0 < \theta_{ji} < 1 \qquad (11.36)$$

With costs described by equation (11.36), the cost disadvantage ratio is constant. From equations (11.22) through (11.25), this requires entry and exit such that the parameter $\zeta_{ji}$ remains constant. This ensures that monopoly pricing is consistent with zero profits. Hence, the relevant subsystem of equations will be the following, along with equation (11.28):

$$(1-\theta_{ji})^{-1} = \sigma_i + (1-\sigma_i)\bar{\zeta}_{ji} \qquad (11.37)$$

$$\bar{\zeta}_{ji} = \sum_{r=1}^{R} \frac{\bar{X}_{jir}}{\bar{X}_{ji}} \left( \sum_{k=1}^{R} n_k \left(\frac{\alpha_{jkr}}{\alpha_{jir}}\right)^{\sigma_i} \left(\frac{P_{jkr}}{P_{jir}}\right)^{1-\sigma_i} \right)^{-1} \qquad (11.38)$$

$$Z_{ji} = n_{ji}(x_{ji})^{\theta_{ji}} \qquad (11.39)$$

In purely symmetric equilibria, where firms are identical across regions, this specification yields a fixed number of firms, with sector expansion



characterized strictly by expansion of existing firms. In this case, we have $\zeta=(1/n)$. Given estimated cost disadvantage ratios, equation (11.37) can therefore be used to calibrate the value of $\sigma$.

We can again show that changes in $\bar{x}_{ji}$ relate to proportional changes in $Z_{ji}$:

$$\hat{\bar{x}}_{ji} = \left(\frac{\sigma_i}{(\sigma_i - 1)}\right)\hat{Z}_{ji} - \left(\frac{(\sigma_i - \varepsilon_{ji})}{(\sigma_i - 1)(\varepsilon_{ji} - 1)}\right)\hat{n}_{ji} \qquad (11.40)$$

Equation (11.40) is quite similar to equation (11.35). The difference is that the second term, which is again negative, now relates to the entry of additional firms. In a framework that now emphasizes output scaling, entry reduces the cost benefits of increased scale somewhat (the first term), though this is moderated by the varietal benefits of entry, which are incorporated in the first term. In symmetric equilibria or under the large group assumption, the second term is zero.

In the large group case, equations (11.35) and (11.40) are identical. Hence, while the large group specification, with fixed costs, yields pure variety scaling, the fixed CDR specification yields output scaling. These two mechanisms both imply the same reduced functional form, though the underlying story is different. In both cases, the output elasticity of variety-scale output is $1/(1-CDR)$. In terms of Figure 11.5, these two cases correspond to curves $Z_A$ and $Z_B$.

## VI An Application to Korea

We now turn to a specific application involving scale economies and imperfect competition. The basic model we work with is the Korea-focused multi-region general equilibrium introduced in Chapter 9. We will limit ourselves to the Uruguay Round scenario, involving multilateral liberalization. While the model is basically the same, some modifications have been introduced for the present application. First, the current account balance is held constant in all simulations. In addition, the nested Armington structure employed in Chapter 9 has been changed to a non-nested structure. Finally, as described later, the assumption of constant returns to scale (CRTS) and perfect competition is replaced by various specifications of increasing returns to scale (IRTS) and imperfect competition.

Table 11.1 presents the trade and scale elasticities employed in the numerical assessments. The trade substitution elasticities are identical to the upper tier substitution elasticities employed earlier, in Chapter 9, in the

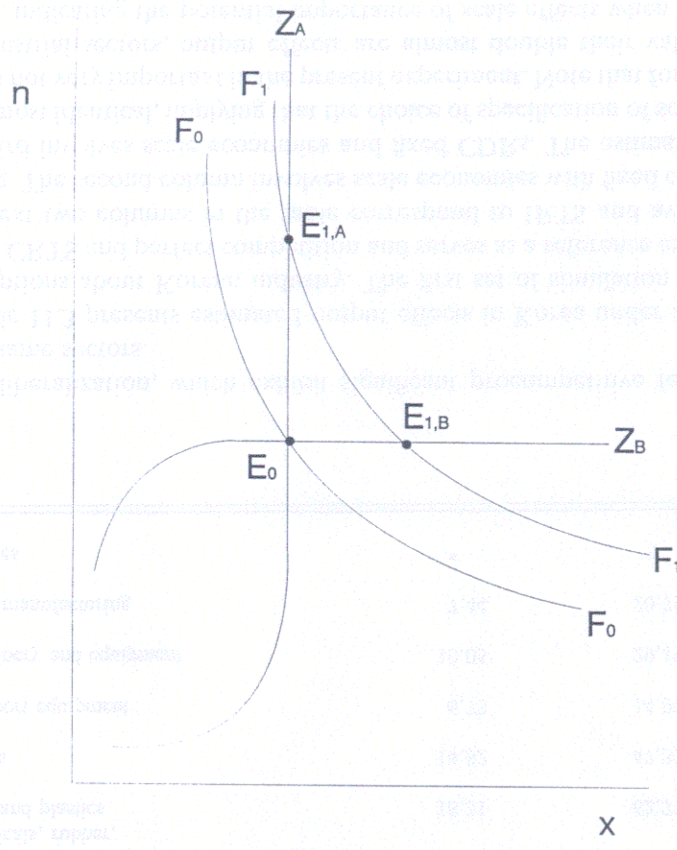


Figure 11.5. *Pure variety and pure output scaling under "large group" monopolistic competition*

nested specification. The CDR estimates are taken from various sources (primarily Pratten, 1988).

When specifying oligopolistic competition, we limit ourselves to the Korean manufacturing sector. In this case, we work with Cournot conjectural variations, as defined earlier in the chapter, assuming two values for $(\Omega/n)$, $(\Omega/n)=0.2$ and 0.5. These values are consistent with classic Cournot competition with five firms and two firms, respectively. In general, with Cournot competition and identical firms, the markup of price over average cost is defined as follows:

Table 11.1. *Trade and scale elasticities*

| | trade substitution elasticity | CDR |
|---|---|---|
| crops | 2.20 | * |
| other agriculture | 2.79 | * |
| extraction | 2.37 | .05 |
| processed food | 2.38 | .15 |
| textiles | 2.20 | .14 |
| apparel | 4.40 | .00 |
| chemicals, rubber, and plastics | 1.90 | .14 |
| metals | 2.80 | .14 |
| transport equipment | 5.20 | .15 |
| machinery and equipment | 2.80 | .12 |
| other manufacturing | 3.41 | .15 |
| services | 1.94 | * |

$$P_{j,i} = AC_{j,i}\left(1-CDR_{j,i}\right)\left(1-\left(\frac{\Omega_{ji}}{\left(n_{j,i}\varepsilon_{j,i}\right)}\right)\right)^{-1} \tag{11.41}$$

Upon inspection of equation (11.41), it should be clear that, with scale economies, Cournot behaviour can be inconsistent with positive profits. In particular, with a large enough CDR or highly elastic demand, pricing such that $MR=MC$ will imply setting $P<AC$.

Table 11.2 presents estimated oligopoly markups for Korean industry, based on equation (11.41), and derived from the benchmark 1992 dataset. These markups are a function of market shares, and of the substitution elasticities presented in Table 11.1. In some cases, like processed food, home market shares, and hence the implicit markups, are a direct result of import protection. This becomes evident when we examine the output effects of

Table 11.2. *Estimated oligopoly markups in Korea (percentage over average cost)*

| | Ω/n=.2 | Ω/n=.5 |
|---|---|---|
| crops | * | * |
| other agriculture | * | * |
| extractions | * | * |
| processed food | 21.69 | 81.20 |
| textiles | 15.17 | 48.77 |
| apparel | 7.79 | 24.33 |
| chemicals, rubber, and plastics | 18.31 | 62.77 |
| metals | 14.82 | 47.32 |
| transport equipment | 6.73 | 14.97 |
| machinery and equipment | 10.05 | 29.19 |
| other manufacturing | 7.44 | 20.79 |
| services | * | * |

trade liberalization, which exhibit significant procompetitive features for these same sectors.

Table 11.3 presents estimated output effects in Korea under alternative assumptions about Korean industry. The first set of simulation results involves CRTS and perfect competition and serves as a reference experiment. The next two columns in the table correspond to IRTS and average cost pricing. The second column involves scale economies with fixed costs, while the third involves scale economies and fixed CDRs. The estimated effects are almost identical, implying that the choice of specification of scale economies is not very important in the present experiment. Note that for a number of industrial sectors, output effects are almost double their values under CRTS, indicating the potential importance of scale effects when evaluating trade liberalization.

Table 11.3. *Scale economies, Cournot competition, and output effects in Korea (percentage changes)*

| | CRTS perfect competition | IRTS AC pricing fixed costs | IRTS AC pricing fixed CDRs | CRTS Cournot Ω/n=0.2 | CRTS Cournot Ω/n=0.5 | IRTS Cournot Ω/n=0.5 |
|---|---|---|---|---|---|---|
| crops | -7.2 | -7.5 | -7.5 | -6.9 | -7.2 | -7.5 |
| other agriculture | -1.8 | -1.8 | -1.8 | -0.4 | -1.5 | -0.5 |
| extractions | -0.3 | -0.9 | -0.9 | -0.1 | -0.8 | -1.4 |
| processed food | 2.8 | 3.7 | 3.8 | 4.4 | 3.5 | 5.9 |
| textiles | 25.2 | 39.8 | 40.4 | 32.6 | 33.2 | 48.5 |
| apparel | 33.8 | 72.5 | 74.9 | 41.5 | 41.4 | 64.3 |
| chemicals, rubber, and plastics | 2.4 | 3.5 | 3.5 | 5.0 | 7.0 | 9.1 |
| metals | -2.5 | -6.7 | -6.7 | -0.1 | 4.3 | 2.1 |
| transport equipment | -0.8 | -4.2 | -4.7 | 1.4 | 7.1 | -2.4 |
| machinery and equipment | -1.7 | -5.9 | -5.9 | -0.3 | 5.5 | 2.1 |
| other manufacturing | 10.8 | 19.7 | 21.4 | 13.6 | 17.6 | 26.0 |
| services | 0.1 | -0.1 | -0.1 | 0.4 | 1.2 | 0.8 |

We next turn to Cournot behaviour, as reported in columns 4, 5, and 6 of Table 11.3. The first two of these sets of results involve CRTS. Evidence of the procompetitive effects of trade liberalization can be seen if we compare these results with those in the first column. Recall from Table 11.2 that some sectors, like processed food and chemicals, had particularly high estimates of price over average cost markups. Because trade liberalization erodes the market power derived from protection, these markups are reduced and output increased in Cournot sectors. The result in some sectors, like chemicals and processed foods, is output effects roughly twice as great as those estimated under CRTS and perfect competition. Finally, the last column of the table combines Cournot behaviour with increasing returns. The result, across a broad range of sectors, is substantially greater output effects than those reported in the other columns. This follows from the effects of reduced market power, combined with the output boost that follows from falling average costs. Taken together, the result of IRTS and Cournot is that several manufacturing sectors expand by roughly twice the amount estimated in the benchmark experiment.

The welfare effects reported in Table 11.4 correspond to the same specifications employed in Table 11.3. Recall that we only introduce Cournot behaviour in Korea, and not surprisingly, the greatest variation in welfare results relates to Korea. In particular, the introduction of Cournot behaviour in isolation from scale economies, or IRTS in isolation from imperfectly competitive behaviour, implies a significant magnification of the estimated welfare gains for Korea. In particular, while our benchmark case involves a 0.6 percent increase in welfare, this is basically increased by a factor of 3 in columns 2 through 5. Column 6 presents estimates where we have introduced both scale economies and Cournot behaviour. Here, welfare increases by 3.2 percent, as compared to 0.6 percent in the benchmark and 1.5 to 1.9 percent in columns 2 through 5.

Finally, Table 11.5 contrasts the implications of scale economies under national product differentiation (the Armington assumption) with scale economies under firm-level product differentiation (large group monopolistic competition). While the result is a magnification of estimated benefits for Korea (4.6 percent versus 1.9 percent in columns 3 and 2), this is not true for all regions. For the region "Other Asia," welfare gains are greater with national product differentiation. For all other regions excluding ROW, firm-level product differentiation clearly implies greater procompetitive benefits than those estimated under Armington preferences.

Table 11.4. *Welfare effects (percentage) with regionally homogeneous goods, scale economies, and Cournot competition*

| | CRTS perfect competition | IRTS AC pricing fixed costs | IRTS AC pricing fixed CDRs | CRTS Cournot $\Omega/n=0.2$ | CRTS Cournot $\Omega/n=0.5$ | IRTS Cournot $\Omega/n=0.5$ |
|---|---|---|---|---|---|---|
| Korea | 0.6 | 1.7 | 1.9 | 1.6 | 1.5 | 3.2 |
| Japan | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 |
| Other Asia | 0.9 | 1.6 | 1.7 | 1.0 | 1.1 | 0.9 |
| North America | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| Europe and Australasia | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| ROW | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 |

Table 11.5. *Welfare effects (percentage) with scale economies and average cost pricing – regional versus firm-level differentiation*

| | CRTS perfect competition | IRTS regional differentiation | IRTS firm-level differentiation |
|---|---|---|---|
| Korea | 0.6 | 1.9 | 4.6 |
| Japan | 0.4 | 0.4 | 0.8 |
| Other Asia | 0.9 | 1.7 | 1.0 |
| North America | 0.2 | 0.2 | 0.3 |
| Europe and Australasia | 0.2 | 0.1 | 0.2 |
| ROW | -0.1 | -0.1 | -0.1 |

## VII Summary and Closing Remarks

This chapter has been concerned with relationships among trade policy, imperfect competition, and industry performance. Our basic goal has been to provide an overview of linkages between trade policy and competitive behaviour, including the presentation of a menu of relatively standard specifications of imperfect competition and scale economies. As a now extensive body of applied research demonstrates, these linkages can easily dominate, in sign and/or magnitude, the production and welfare effects estimated under the perfect competition paradigm.

The empirical literature confirms a basic finding of the new trade theories, suggesting that there may be small potential gains from mild unilateral protection. However, these numerically estimated gains, like their theoretical counterparts, are often the product of single-market or partial equilibrium modeling exercises. Dixit and Grossman (1984) have rightly objected to drawing policy conclusions from this type of single-market framework for a simple reason. In general equilibrium, it is impossible to subsidize or effectively protect the entire economy. Targeting expansion of some increasing returns sectors implies targeting contraction of others. In addition, as Helpman and Krugman (1989, Chapter 8) have noted, while there may be small gains from *unilateral* protection, the apparent costs of *mutual* protection are magnified when scale economies and imperfect competition enter the picture.[9] A corollary of this last point is that bilateral and multi-lateral

9 This follows, in part, from effects related to market segmentation. To the extent that trade liberalization reduces market fragmentation, we can expect a reduction in firm markups (Baldwin and Venables, 1995).



trade liberalization tend to imply much greater welfare gains, once allowance is made for imperfect competition and scale economies, than analyses based on perfect competition and constant returns to scale would otherwise imply.[10]

As an illustration, we have offered a set of Korea-focused Uruguay Round simulation results. These results highlight rather starkly the role that imperfect competition can play in assessments of trade liberalization. While our estimates are of course sensitive to the assumptions we make, the pattern of the results demonstrates that the procompetitive effects of trade liberalization, including falling market power and expanded output in imperfectly competitive sectors, may be some of the most substantial effects following from trade liberalization. At a minimum, it is clear that the constant returns, perfect competition paradigm suppresses a number of potentially powerful mechanisms linking trade policy with industry performance.

## References

Anderson, J.E. 1988. *The Relative Inefficiency of Quotas*. Cambridge, Massachusetts: MIT Press.

Baldwin, R.E. and P. Krugman. 1988a. "Industrial policy and international competition in wide-bodied jet aircraft." In *Trade Policy Issues and Empirical Analysis*, edited by R.E. Baldwin. Chicago: University of Chicago Press.

Baldwin, R.E. and P. Krugman. 1988b. "Market access and international competition: A simulation study of 16K random access memories." In *Empirical Methods for International Trade*, edited by R.C. Feenstra. Cambridge: MIT Press.

Baldwin, R.E. and A.J. Venables 1995. "Regional economic integration." In *Handbook of International Economics*, Vol. III, edited by G.M. Grossman and K. Rogoff. Amsterdam: North-Holland/Elsevier.

Bhagwati, J.N. 1965. "On the equivalence of tariffs and quotas." In *Trade, Growth, and the Balance of Payments: Essays in Honor of Gottfried Haberler*, edited by R.E. Baldwin. Chicago: Rand McNally.

Brown, D. 1994. "Properties of applied general equilibrium trade models with monopolistic competition and foreign direct investment." In *Modelling Trade Policy: AGE Models of North American Free Trade*, edited by J.F. Francois and C.R. Shiells. Cambridge: Cambridge University Press.

Brown, D.K. 1987. "Tariffs, the terms of trade and national product differentiation." *Journal of Policy Modeling* 9:503–526.

10 To quote Venables and Smith, "It seems unlikely, to say the least, that in a world in which all countries pursue restrictive trade policies the potential benefits of scale economies will actually be realized. One of the reasons we have institutions such as the GATT is to discourage this type of beggar-thy-neighbour policies. The fact that our analysis indicates that there may be significant potential gains from policy intervention should not be taken as establishing a case for nationalistic trade restrictions but as providing a strong rationale for negotiated reductions in trade barriers" (Venables and Smith, 1986, p. 660).

Cox, D. and R. Harris. 1985. "Trade liberalization and industrial organization: Some estimates for Canada." *Journal of Political Economy* 93:115–145.
De Melo, J. and D. Tarr. 1992. *A General Equilibrium Analysis of U.S. Foreign Trade Policy*. Cambridge, Massachusetts: MIT Press.
Devarajan, S. and D. Rodrik. 1988a. "Trade liberalization in developing countries: Do imperfect competition and scale economies matter?" *American Economic Review* 78:283–287.
Devarajan, S. and D. Rodrik. 1988b. "Pro-competitive effects of trade reform: Results from a CGE model of Cameroon." Working Paper, Harvard University.
Dixit, A. 1988. "Optimal trade policy and industrial policies for the U.S. automobile industry." In *Empirical Methods for International Trade*, edited by R.C. Feenstra. Cambridge: MIT Press.
Dixit, A. and G. Grossman. 1984. "International Trade Policy with Several Oligopolistic Industries." Discussion Paper in Economics No. 71, Woodrow Wilson School, Princeton University.
Dixit, A. and V. Norman. 1980. *Theory of International Trade*. Cambridge: Cambridge University Press.
Eaton, J. and G.M. Grossman. 1986. "Optimal trade and industrial policy under oligopoly." *Quarterly Journal of Economics* 101:383–406.
Ethier, W. 1982. "National and international returns to scale in the modern theory of international trade." *American Economic Review* 72:950–959.
Feenstra, R.C. 1988. "Gains from trade in differentiated products: Japanese compact trucks." In *Empirical Methods for International Trade*, edited by R.C. Feenstra. Cambridge, Massachusetts: MIT Press.
Francois, J.F. 1990. "Trade in producer services and returns to specialization under monopolistic competition." *Canadian Journal of Economics* 21:100–109.
Francois, J.F. 1992. "Optimal commercial policy with international returns to scale." *Canadian Journal of Economics* 23:109–124.
Francois, J.F., B. McDonald, and H. Nordström. 1994. "The Uruguay round: A global general equilibrium assessment." Centre for Economic Policy Research Discussion Paper 1067.
Francois, J.F., B. McDonald, and H. Nordström. 1995. "Assessing the Uruguay Round." In *The Uruguay Round and the Developing Countries*, edited by W. Martin and A. Winters. World Bank Discussion Paper 201.
Francois, J.F. and C.R. Shiells, 1994. *Modelling Trade Policy: AGE Assessments of North American Free Trade*. Cambridge: Cambridge University Press.
Grossman, G.M. 1991. *Imperfect Competition and International Trade*. Cambridge, Massachusetts: MIT Press.
Haaland, J. and T.C. Tollefsen. 1994. "The Uruguay Round and trade in manufactures and services: General equilibrium simulations of production, trade and welfare effects of liberalization." Center for Economic Policy Research Discussion Paper 1008.
Haaland, J. and I. Wooton. 1991. "Market Integration, Competition, and Welfare." Center for Economic Policy Research Discussion Paper No. 547.
Harris, R. 1984. "Applied general equilibrium analysis of small open economies with scale economies and imperfect competition." *American Economic Review* 74:1016–1033.
Helpman, E. and P. Krugman. 1985. *Market Structure and Foreign Trade*. Cambridge, Massachusetts: MIT Press.
Helpman, E. and P. Krugman. 1989. *Trade Policy and Market Structure*. Cambridge, Massachusetts: MIT Press.
Krugman, P.R. 1979. "Increasing returns, monopolistic competition, and international trade." *Journal of International Economics* 9:469–480.
Krugman, P.R. 1980. "Scale economies, product differentiation, and the pattern of trade." *American Economic Review* 70:950–959.
Lee, H. and D.W. Roland-Holst. 1995. "Trade liberalization and employment linkages in the Pacific Basin." *Developing Economies* 33:155–184.
Markusen, J.R. 1990. "Micro-foundations of external scale economies." *Canadian Journal of Economics* 23:285–508.
Markusen, J.R., J.R. Melvin, W.H. Kaempfer, and K.E. Maskus. 1995. *International Trade: Theory and Evidence*. London: McGraw-Hill.
Markusen, J.R. and A.J. Venables. 1988. "Trade policy with increasing returns and imperfect competition: Contradictory results from competing assumptions." *Journal of International Economics* 24:299–316.
Norman, V.D. 1990. "Assessing trade and welfare effects of trade liberalization: A comparison of alternative approaches to CGE modelling with imperfect competition." *European Economic Review* 34:725–745.
Pratten. 1988. "A survey on the economies of scale." In *Studies on the Economics of Integration*. Luxembourg: Commission of the European Communities.
Roberts, M.J. and J.R. Tybout. 1990. "Size rationalization and trade exposure in developing countries." Working Paper, Department of Economics, Georgetown University.
Rodrik, D. 1988. "Imperfect competition, scale economies and trade policy in developing countries." In *Trade Policy Issues and Empirical Analysis*, edited by R. Baldwin. Chicago: University of Chicago Press.
Roland-Holst, D.W., Reinert, K.A., and C.R. Shiells. 1994. "A general equilibrium analysis of North American integration." In *Modelling Trade Policy: AGE Models of North American Free Trade*, edited by J.F. Francois and C.R. Shiells. Cambridge: Cambridge University Press.
Shapiro, C. 1989. "Theories of oligopoly behaviour." In *Handbook of Industrial Organization*, edited by R. Schmalansee and R. Willig. Amsterdam: North-Holland.
Smith, A. and A.J. Venables. 1988. "Completing the internal market in the European Community." *European Economic Review* 32:1501–1525.
Tirole, J. 1988. *The Theory of Industrial Organization*. Cambridge: MIT Press.
Venables, A. 1987. "Trade and trade policy with differentiated products: A Chamberlinian–Ricardian model." *Economic Journal* 97:700–717.
Venables, A. and Smith, A. 1986. "Trade and industrial policy under imperfect competition." *Economic Policy* 1:622–672.
Venables, A. and Smith, A. 1991. "Completing the internal market in the European Community: Some industry simulations." *European Economic Review* 32:1501–1525.
Westerbrook, M.D. and J.R. Tybout. 1990. "Using large imperfect panels to estimate returns to scale in LDC manufacturing." Working Paper, Department of Economics, Georgetown University.