Trade Policy, Scale Economies, and Imperfect Competition in Applied Models

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Joseph F. Francois
World Trade Organization and CEPR

David W. Roland-Holst
Mills College, OECD Development Centre, and CEPR

I. 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 multilateral 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 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.

In this paper, 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. Following this, 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 Korea-focused multi-region general equilibrium model.

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 my 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*.

Consider the relatively simple example of procompetitive effects for a small country in which one sector is monopolistic. This is represented in Figure 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 for any trade to actually occur. Rather, it is the potential for entry by foreign suppliers that leads to this effect. 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 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 between 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 will 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 (1989), Grossman (1992), Helpman and Krugman (1989), and Markusen at 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 (1984) and Reinert, Shiells and Roland-Holst (1994) examine economic integration in North America, while Venables and Smith (1986, 1988) examine economic integration in Europe. For multilateral 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 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, owing to 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 declining 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 on the part of a domestic monopolist. We may therefore expect liberalization of non-tariff barriers 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 modelling 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 modelling 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 industry-wide 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, its empirical veracity is open to question. In the real world, factors are heterogeneous in quality and mobility, and changes in the level of output often involves changes in average cost, even for relatively simple production processes. 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) 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 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

$$AC = \frac{FC}{X} + MC \tag{1}$$

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

$$AC = X^{\theta-1} f(\omega) \qquad where \;\; 0<\theta<1 \tag{2}$$

where f(ω) represents the cost function for a homogenous bundle of primary and intermediate inputs. 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 industry-wide basis of intermediate inputs, resulting in industry-wide scale effects. (Markusen 1990).

With scale economies as in equation (1) (i.e. with fixed costs), the CDR (cost disadvantage ratio), as defined below, will vary with the scale of output. Alternatively, with a cost function like (2), the CDR remains fixed. The properties of the two cost functions are illustrated in Figure 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

$$CDR = \frac{AC - MC}{AC} \tag{3}$$

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

In practice, calibration of either (1) or (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 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 suspiciously circular. It 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 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 homgeneous goods

A. 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:

$$P = AC \tag{4}$$

Under increasing returns to scale at the firm level, equation (4) can be motivated by contestability, with real or threatened entry forcing economic profits to zero. Demand for primary and intermediate inputs will then depend on the specific cost structure that is assumed. If we assume constant instead of increasing returns, average cost pricing then also implies pricing at marginal cost.

$$P = MC \tag{5}$$

B. 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 (4) and (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 (5) is then replaced by the following equation:

$$\frac{P-MC}{P} = \frac{1}{\epsilon} \tag{6}$$

where the market elasticity of demand is given by

$$\epsilon = -\frac{\partial Q}{\partial P}\frac{P}{Q} \tag{7}$$

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

(6) and (4). This is the approach taken in models with monopolistic competition. Alternatively, we may instead have price determined by equation (6) in isolation from (4), such that demand quantities at the monopoly price also then determine average cost. Equation (4) is then replaced by a definition of economic profits.

$$\pi = (P - AC)Q \tag{8}$$

C. 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, following Frisch (1933), 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

$$\Omega_i = \frac{dQ}{dQ_i} \tag{9}$$

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

$$\Pi_i = PQ_i - TC_i \tag{10}$$

this yields the first-order condition,

$$\frac{d\Pi_i}{dQ_i} = P + Q_i \frac{dP}{dQ}\frac{dQ}{dQ_i} - \frac{dTC_i}{dQ_i} = P^D - \frac{Q_i}{n\epsilon}\frac{P}{Q_i}\Omega - MC = 0 \tag{11}$$

and also the oligopoly pricing rule

$$\frac{P - MC}{P} = \frac{\Omega}{n\epsilon} \tag{12}$$

The above expression encompasses a variety of relevant cases. The classic Cournot specification corresponds to (Ω/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 Ω=0 corresponds to perfectly competitive, average cost pricing, while Ω=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.

D. 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 (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 things 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

$$\Omega = \frac{\Omega_o n_o}{n} \tag{13}$$

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

E. *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 modelling 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 modelled 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 modelling 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. The second specification is based on firm-level product differentiation.

A. 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, we assume that demand goods from different regions are aggregated into a composite good according to the following CES function:

$$q_{j,r} = \left[\sum_{i=1}^{R} \alpha_{j,i,r} \; X_{j,i,r}^{\rho_j} \right]^{1/\rho_j} \tag{14}$$

In equation (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 σ_j , where $\sigma_j = 1/(1-\rho_j)$. For tractability, we focus here on the non-nested case, where σ_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 (14):

$$P_{j,r} = \left[\sum_{i=1}^{R} \alpha_{i,r}^{\sigma_j} \, P_{i,r}^{1-\sigma_j} \right]^{1-1/\rho_j} \tag{15}$$

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

$$\begin{aligned} X_{j,i,r} &= [\alpha_{j,i,r}/P_{j,i,r}]^{\sigma_j} \, [\sum_{i=1}^{R} \alpha_{j,i,r}^{\sigma_j} \, P_{j,i,r}^{1-\sigma_j}]^{-1} \, E_{j,r} \\ &= [\alpha_{j,i,r}/P_{j,i,r}]^{\sigma_j} \, P_{j,r}^{\sigma_j - 1} \, E_{j,r} \end{aligned} \tag{16}$$

$$\epsilon_{j,i,r} = \sigma_j + (1-\sigma_j) \left[\sum_{k=1}^{R} \left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}} \right)^{\sigma_j} \left(\frac{P_{j,kr}}{P_{j,i,r}} \right)^{1-\sigma_j} \right]^{-1} \tag{17}$$

where E_j represents economywide expenditures in region r on the sector j Armington composite. From equation (16), the elasticity of demand for a given variety of good X_j, produced in region i and sold in region r, will then equal:

The last term measures market share.

<u>monopoly</u>

At this stage, there are a number of ways to introduce imperfectly competitive behaviour. For example, for a monopolists 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 (17). This implies, potentially, $n \times R^2$ sets of elasticity and price mark-up equations for an R region, n sector 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 $(n+k) \times n \times R^2$ elasticity and mark-up equations, where k is the number of final demand sources in each region. Hence, in large multiregion 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 mark-up. From equation (17), the aggregate elasticity of demand will then be determined by a combination of σ_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 ζ.[6] If each firm assumes that $\zeta_{j,i}$ is fixed, this means it forms a conjecture about the elasticity of demand based on $\zeta_{j,i}$ and σ_j. For a monopolist in region i producing j, we then have:

$$\epsilon_{j,i} = \sigma + (1-\sigma)\ \zeta_{j,i} \tag{18}$$

Instead of assuming that ζ is fixed (at least for relevant equilibria), we can also specify an explicit definition based on equation (17). For each sector, we must then add the equations necessary to endogenize ζ.

$$\zeta_{j,i} = \sum_{r=1}^{R} \frac{X_{j,i,r}}{X_{j,i}} \left(\sum_{k=1}^{R} \left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}} \right)^{\sigma_j} \left(\frac{P_{j,kr}}{P_{j,i,r}} \right)^{1-\sigma_j} \right)^{-1} \tag{19}$$

There are trade-offs between the complexity of the model, and the degree of discriminatory power allowed for monopolists. If we expect significant pro-competitive effects related to changes in perceived market power in particular markets, through changes in either $\epsilon_{j,i}$ 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.

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 (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

$$\frac{P - MC}{P} = \frac{\Omega}{n\epsilon} = \frac{\Omega}{n}\left[\sigma + (1-\sigma)\zeta\right]^{-1} \tag{20}$$

B. Firm-level product differentiation

Next, we turn to firm-level product differentiation. This approach builds on the theoretical foundations laid by Ethier (1979, 1982), Helpman (1981), 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

$$q_{j,r} = \left[\sum_{i=1}^{n} \alpha_{j,i,r} \; X_{j,i,r}^{\rho_j} \right]^{1/\rho_j} \tag{21}$$

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 (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 towards the former interpretation. While we have technically dropped the Armington assumption by allowing firms to differentiate products, the vector of α 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 (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:

$$\frac{P_{f,\,i} - MC_{f,\,i}}{P_{f,\,i}} = \frac{1}{\epsilon_{f,\,i}} \tag{22}$$

$$P_{f,\,i} = AC_{f,\,i} \tag{23}$$

The elasticity of demand <u>for each firm f_i</u> will be defined by the following conditions.

$$\epsilon_{j,\,f,\,i} = \sigma_j + (1-\sigma_j)\ \zeta_{j,\,f,\,i} \tag{24}$$

$$\zeta_{j,\,f_i} = \sum_{r=1}^{R} \frac{X_{j,\,f_i,r}}{X_{j,\,f_i}} \left(\sum_{k=1}^{n} \left(\frac{\alpha_{j,\,k,\,r}}{\alpha_{j,\,f_i,r}} \right)^{\sigma_j} \left(\frac{P_{j,k,\,r}}{P_{j,\,f,r}} \right)^{1-\sigma_j} \right)^{-1} \tag{25}$$

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 by the resource index Z. Full employment of resources hired by firms in the sector j in region i then implies the following condition.

$$Z_{j,i} = \sum_{f=1}^{n_i} TC_{j,i,f} \tag{26}$$

In models with regionally symmetric firms (so that $Z_{j,i} = n_{j,i} \times TC_{j,i}$), equations (22) - (26), together with the definition of AC=AC(x), define a subsystem that determines six sets of variables: x, ϵ, ζ, P, n, and the cost disadvantage ratio CDR= (1- MC/AC).

These equilibrium conditions are represented graphically in Figure 4. The full employment of resources at level Z in the regional sector implies, from equation (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 (22) and (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 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.

<u>some simplifications: variety scaling</u>

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 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 (8) as follows.

$$q_{j,r} \;=\; [\; \sum_{i=1}^{R} n_{j,i}\, \alpha_{j,i,r} \;\; \overline{x}_{j,i,r}{}^{\rho_j} \;]^{\frac{1}{\rho_j}} \qquad (27)$$

Where x is the identical consumption in region r of each variety produced in region i. Upon inspection of equations (27) and (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 (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 (27). Noting that total quantities are $X_{j,i,r}=n_{j,r}\times x$, we then have:

where $\tilde{x}_{j,i}$ is variety-scale output, and where $n_{j,i\,0}$ is the benchmark number of firms. Note that $\tilde{x}_{j,i} = X_{j,i}$ in the benchmark.

When we specify the system of equations for monopolistic competition using a variation of equation (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 $\tilde{x}_{j,i}$, as defined by equation (28). In fully symmetric equilibria, the reader should be able to verify that complete firm exit from particular

$$\begin{aligned} q_{j,r} &= \Big[\sum_{i=1}^{R} \gamma_{j,i,r} \, \tilde{x}_{j,i,r}^{\rho_j} \Big]^{\frac{1}{\rho_j}} \\ \gamma_{j,i,r} &= \alpha_{j,i,r} \, n_{j,i\,0}^{1-\rho_j} \\ \tilde{x}_{j,i,r} &= \left(\frac{n_{j,i}}{n_{j,i\,0}} \right)^{(1-\rho_j)/\rho_j} X_{j,i,r} \end{aligned} \tag{28}$$

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 below, the combination of output and variety scaling can then specified as part of the regional production function for $\tilde{x}_{j,i}$.

<u>scale economies from fixed costs</u>

We will focus on two particular specifications of increasing returns. The first is a variation of equation (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:

$$C(x_{j,i}) = (\alpha_{j,i} + \beta_{j,i}\, x_{j,i})\, P_{Z_{j,i}} \tag{29}$$

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

Substituting equation (29) into (22), (23), and (26), the system of equations (22) through (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 (22) and (23), the elasticity of demand can be related directly to the cost disadvantage ratio.

$$\frac{AC - MC}{AC} = \frac{\alpha_{j,i}}{\alpha_{j,i} + \beta_{j,i}\, x_{j,i}} = \frac{1}{\epsilon_{j,i}} \tag{30}$$

The remainder of the system is as follows:

$$\epsilon_{j,i} = \sigma_j + (1 - \sigma_j)\, \zeta_{j,i} \tag{31}$$

$$\zeta_{j,i} = \sum_{r=1}^{R} \frac{\tilde{x}_{j,i,r}}{\tilde{x}_{j,i}} \left(\sum_{k=1}^{R} n_{j,k} \left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}} \right)^{\sigma_j} \left(\frac{P_{j,k,r}}{P_{j,i,r}} \right)^{1-\sigma_j} \right)^{-1} \tag{32}$$

$$Z_{j,i} = n_{j,i} \, (\alpha_{j,i} + \beta_{j,i} \, x_{j,i}) \tag{33}$$

Given the resources allocated to sector j in region i, as measured by the index $Z_{j,i}$, equations (30) through (33) define a subsystem of 4 equations and 4 unknowns: $n_{j,i}$, $x_{j,i}$, $\zeta_{j,i}$, and $\epsilon_{j,i}$. In addition, the value of $\tilde{x}_{j,i}$ is then determined by equation (28), while producer price is set at average cost. Note that the price terms in equation (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 $\zeta_{j,i}$ is effectively zero, and hence, through equations (30) and (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:

$$\tilde{X}_{j,i} = \left(\frac{Z_{j,i \quad 1}}{Z_{j,i \quad 0}} \right)^{(1-\rho_j)/\rho_j} X_{j,i} \tag{34}$$

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

It can be shown that proportional changes in $\tilde{x}_{j,i}$ relate to proportional changes in $Z_{j,i}$:

$$\hat{\tilde{X}}_{j,i} = (\sigma_j /(\sigma_j - 1)) \, \hat{Z}_{j,i} + \left(\frac{(\sigma_j - \epsilon_{j,i})\zeta_{j,i}}{(\sigma_j - 1)(1 - \zeta_{j,i})} \right) CDR \, \hat{\zeta}_{j,i} \tag{35}$$

What does equation (35) 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 $\zeta_{j,i}$ 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 as the sector expands. In particular, as the sector expands, the value $(\sigma\text{-}\epsilon)$ converges on zero, as does $\zeta_{j,i}$,so that this last term becomes less important. This follows from the procompetitive effects of sector expansion. As the sector expands, new entrants intensify the conditions of competition, forcing existing firms down their cost curves and hence 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, where $(\sigma=\epsilon)$, such that the second term vanishes.

<u>scale economies with fixed scale effects</u>

We close this section with an alternative specification of monopolistic competition, in which cost functions for individual firms take the form of equation (2):

$$C(x_{j,i}) = x_{(j,i)}^{\theta_{j,i}} P_{Z_{j,i}}$$
$$where\ \ 0 < \theta_{j,i} < 1 \tag{36}$$

With costs described by equation (36), the cost disadvantage ratio is constant. From equations (22) through (25), this requires entry and exit such that the parameter $\zeta_{j,i}$ 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 (28):

$$(1 - \theta_{j,i})^{-1} = \sigma_j + (1 - \sigma_j)\ \bar{\zeta}_{j,i} \tag{37}$$

$$\bar{\zeta}_{j,i} = \sum_{r=1}^{R} \frac{\tilde{X}_{j,i,r}}{\tilde{X}_{j,i}} \left(\sum_{k=1}^{R} n_k \left(\frac{\alpha_{j,k,r}}{\alpha_{j,i,r}} \right)^{\sigma_j} \left(\frac{P_{j,k,r}}{P_{j,i,r}} \right)^{1-\sigma_j} \right)^{-1} \tag{38}$$

$$Z_{j,i} = n_{j,i}\ x_{(j,i)}^{\theta_{j,i}} \tag{39}$$

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 ζ=(1/n). Given estimated cost disadvantage ratios, equation (37) can therefore be used to calibrate the value of σ.

We can again show that changes in $\tilde{x}_{j,i}$ relate to proportional changes in $Z_{j,i}$:

$$\hat{\tilde{X}}_{j,i} = (\sigma_j / (\sigma_j - 1))\ \hat{Z}_{j,i} - \left(\frac{(\sigma_j - \epsilon_{j,i})}{(\sigma_j - 1)(\epsilon_{j,i} - 1)} \right) \hat{n}_{j,i} \tag{40}$$

Equation (40) is quite similar to equation (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. In symmetric equilibria or under the large group assumption, the second term is zero.

In the large group case, equations (35) and (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 samel reduced functional form. In both cases, the output elasticity of variety-scale output is 1/(1-CDR). In terms of figure 4, these two cases correspond to curves $Z_1Z_1$and Z_2Z_2.

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 a Korea-focused multi-region general equilibrium. We will limit ourselves to a Uruguay Round scenario, involving multilateral liberalization. While the model is basically the same as standard CRTS Armington models, some important features should be highlighted. First, the current account balance is held constant in all simulations. In addition, the Armington structure is a non-nested structure. Finally, as described below, 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 1 presents the trade and scale elasticities employed in the numeric assessments. 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 paper, assuming two values for (Ω/n), (Ω/n)

= 0.2 and 0.5. These values are consistent with classic Cournot competition with 5 firms and 2 firms, respectively. In general, with Cournot competition and identical firms, the markup of price over average cost is be defined as follows:

$$P_{j,i} = AC_{j,i}\left(1 - CDR_{j,i}\right)\left(1 - \left(\Omega_{j,i} / (n_{j,i}\epsilon_{j,i})\right)\right)^{-1} \tag{41}$$

Upon inspection of equation (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 2 presents estimated oligopoly markups for Korean industry, based on equation (41), and derived from the benchmark 1992 dataset. These markups are a function of market shares, and of the substitution elasticities presented in Table 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 trade liberalization, which exhibit significant procompetitive features for these same sectors.

Table 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. This is one of our first indications of the potential importance of scale effects when evaluating trade liberalization.

We next turn to Cournot behaviour, as reported in columns 4,5, and 6 of Table 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 2 that some sectors, like processed food and chemicals, had particularly high estimates of markups of price over average cost. 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 4 correspond to the same specifications employed in Table 3. Recall that we only introduce Cournot behaviour in Korea, so that, 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 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 vs. 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 pro-competitive benefits then those estimated under Armington preferences.

VII. Summary and Closing Ruminations

This paper has been concerned with relationships between 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 the 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 conclusion 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 other ones. In addition, as Helpman and Krugman (1989, Chapter 8) have noted, while there may be small gains from <u>unilateral</u> protection, the apparent costs of <u>mutual</u> protection are magnified when scale economies and imperfect competition enter the picture. A corollary of this last point is that bilateral and multilateral trade liberalization tend to imply much greater welfare gains, once we allow for imperfect competition and scale economies, than analyses based on perfect competition and constant returns to scale would otherwise imply.[9]

As an illustration, we have offered a set of Korea-focused Uruguay Round simulation results. These results highlight rather starkly the significant role that imperfect competition can play in assessments of trade liberalization. Not surprisingly, our estimates prove sensitive to the assumptions we make. However, taken as a whole, the pattern of results demonstrate 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, particularly for developing countries. 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.

Endnotes

1. See Roberts and Tybout (1990) and Devarajan and Rodrik (1989ab), Rodrik (1988), and de Melo (1988) for more on the perspective from development studies.

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

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

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

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. In the present context, this would involve another set of equations for each region, though the discussion would be qualitatively similar.

6. Clearly, this raises the question of how to calibrate ζ, and the relative advantages and disadvantages of endogenizing ξ. In the numeric examples in this paper, we could have employed estimates of the reduced form elasticity of demand in general equilibrium, based on perturbations of price, to calibrate $\epsilon_{j,R}$, based on 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 directly calculate these share parameters.

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). Rather, trade is then based on the Armington assumption regarding regional composite goods. 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 (35) and (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. Otherwise, we would need to adopt a specific-factor specification, or in some other way ensure 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, "Problems of generalization," in Theory of International Trade, pp. 56-59). In general, the introduction of scale economies raises the likelihood of multiple equilibria.

9. 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 reason we have institutions such as the GATT is to discourgae 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, 1988, p 660).

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Table 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	*

Table 2
Estimated oligopoly markups in Korea
(percent 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	*	*

Table 3

Scale economies, Cournot competition, and output effects in Korea

	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

Table 4

Welfare effects with regionally homogenous goods, scale economies, and Cournot competition

	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
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 5

Welfare effects with scale economies and average cost pricing --
regional vs. 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

Figure 1

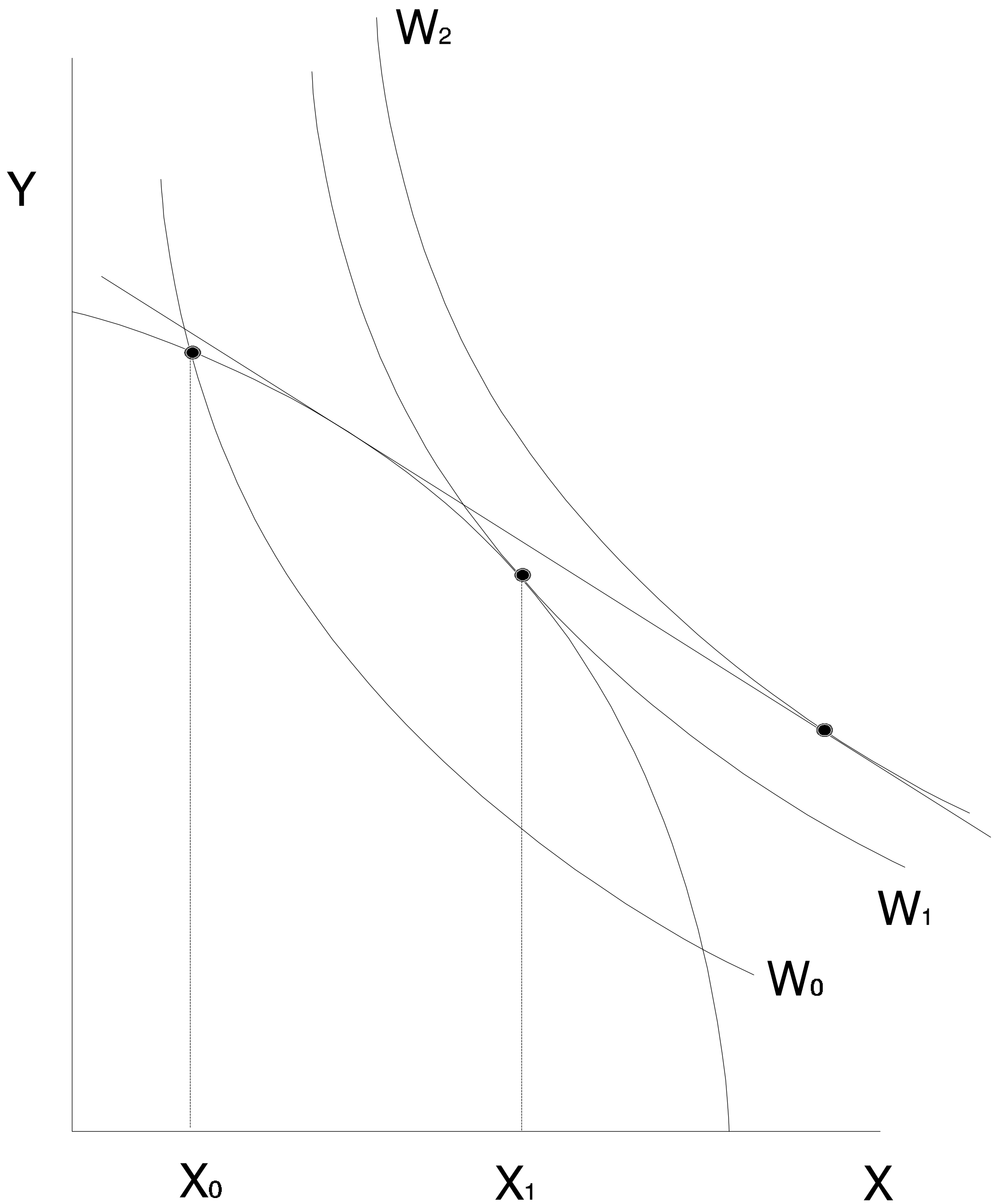

Figure 2

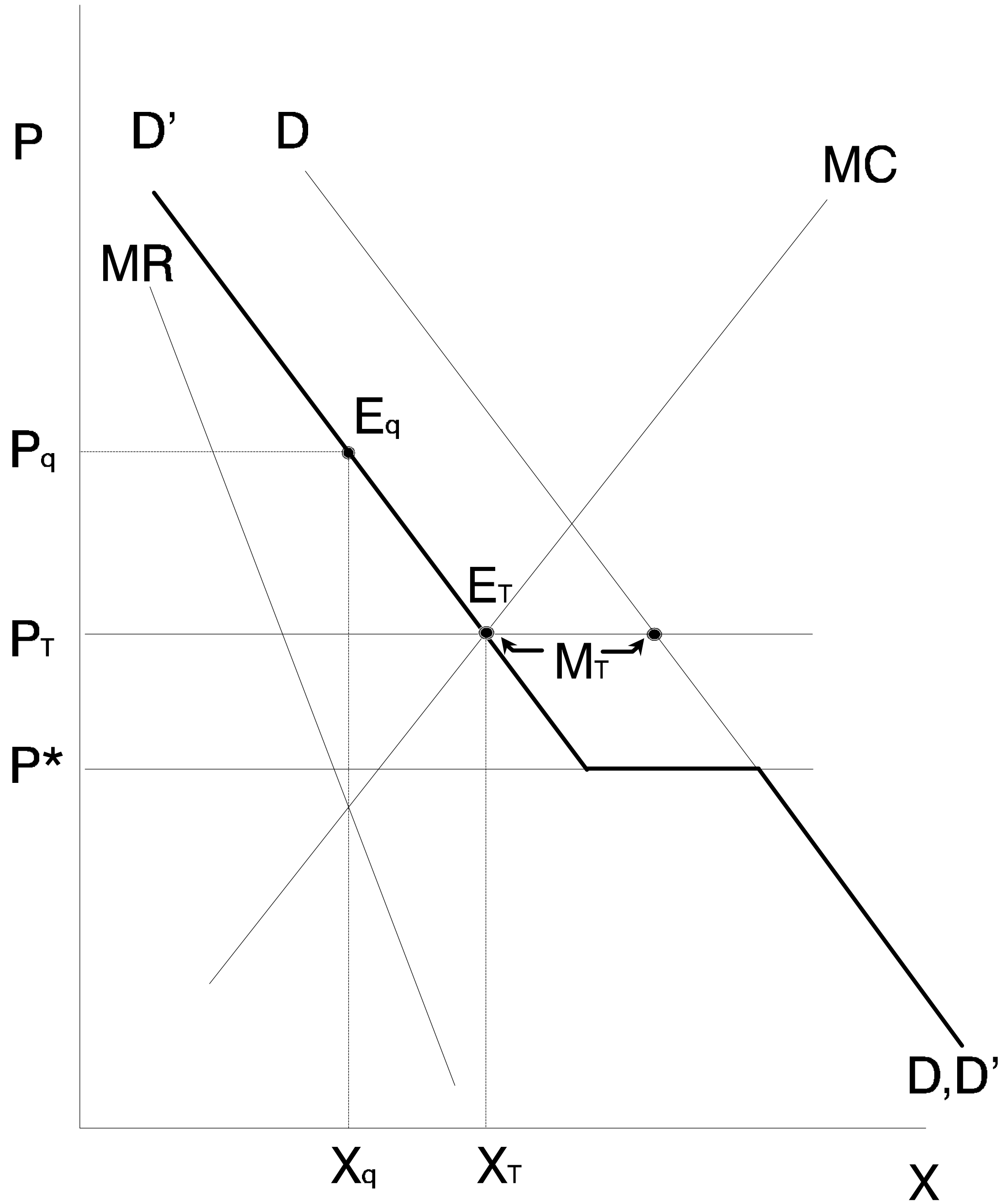

Figure 3

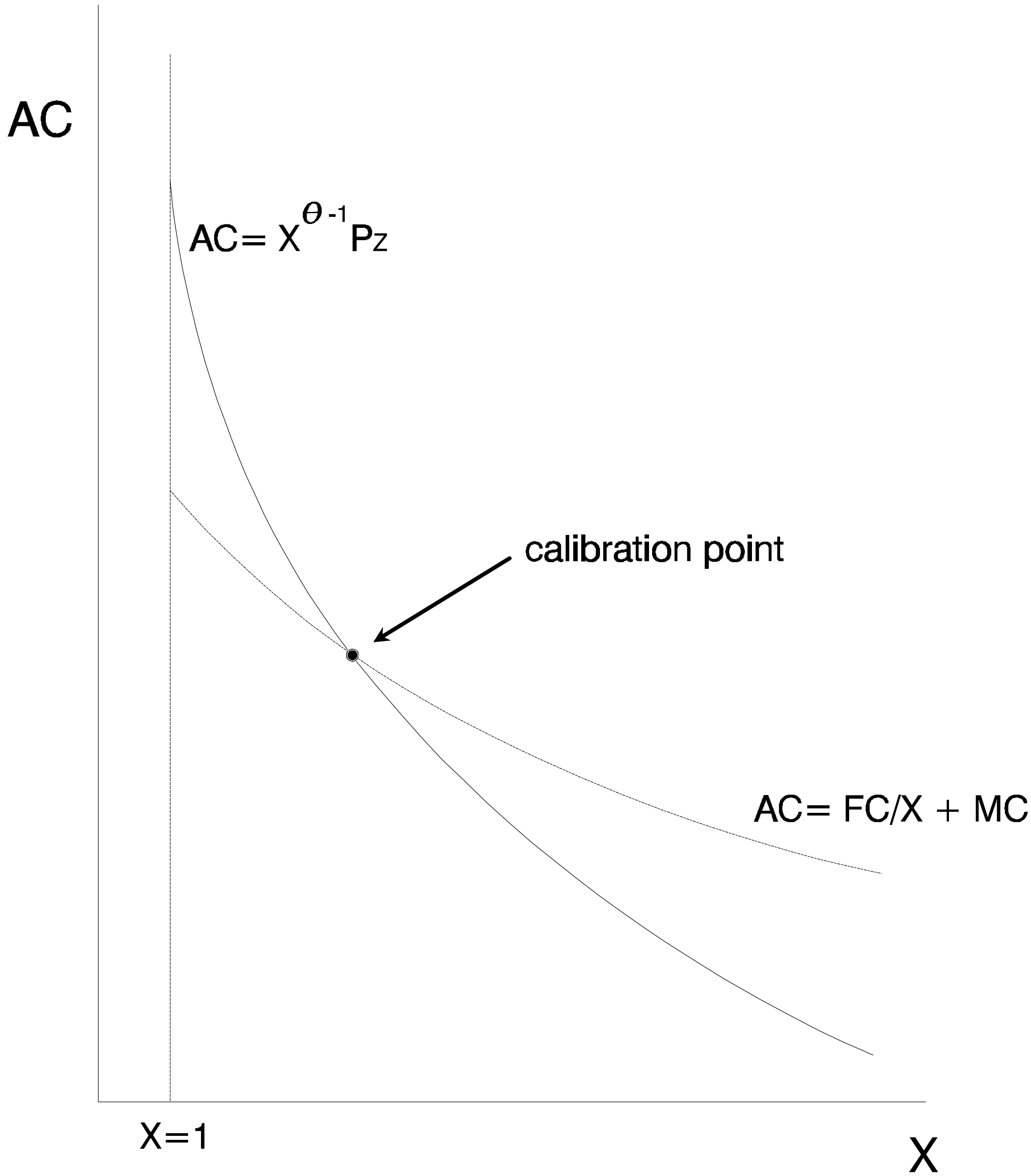

Figure 4

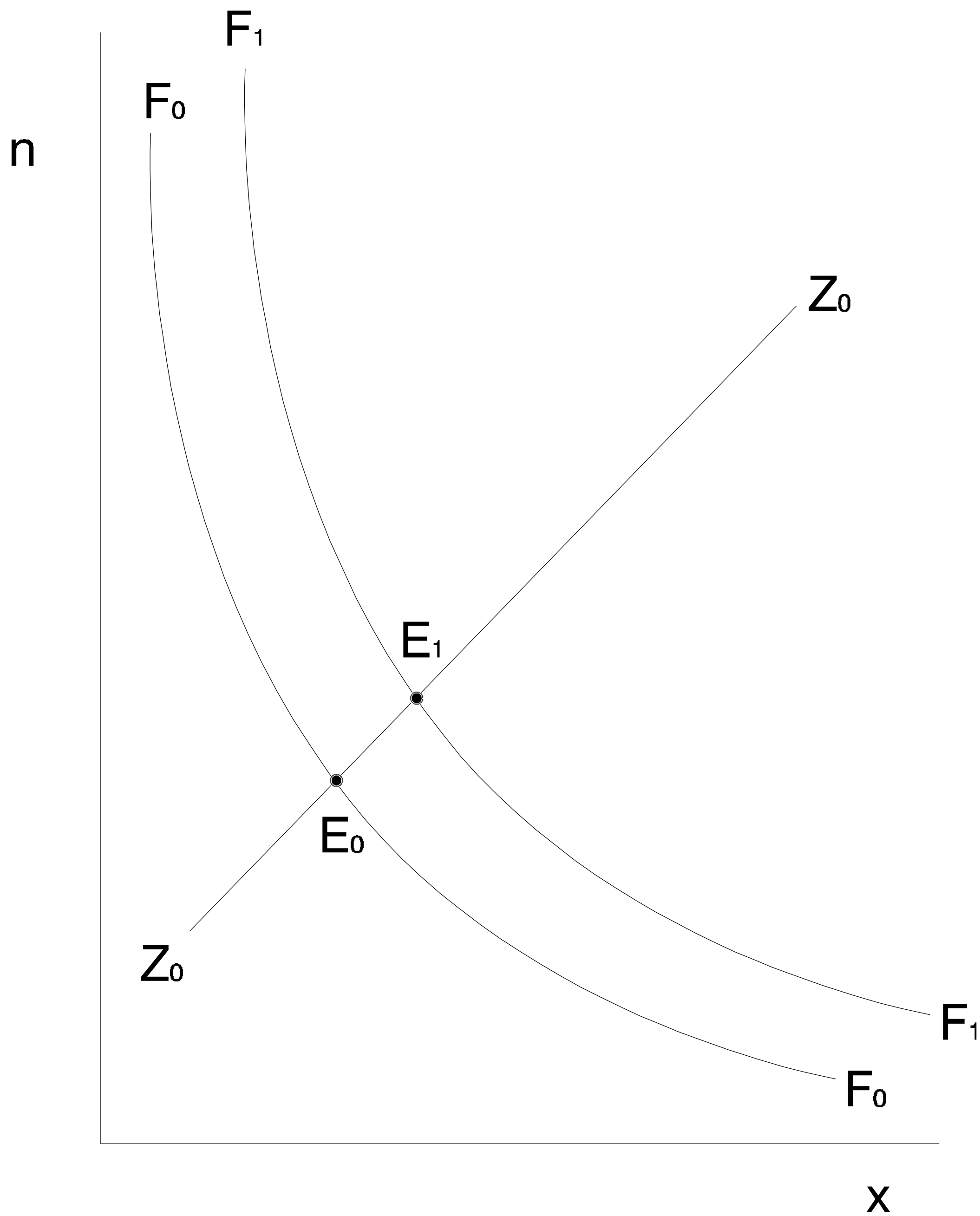

Figure 5