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INTRA-INDUSTRY TRADE AND TRADE POLICY

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THREE ESSAYS OF INTERNATIONAL TRADE IN DIFFERENTIATED PRODUCTS: INTRA-INDUSTRY TRADE AND TRADE POLICY

By

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ABSTRACT

THREE ESSAYS OF INTERNATIONAL TRADE IN DIFFERENTIATED PRODUCTS: INTRA-INDUSTRY TRADE AND TRADE POLICY

By

Sangho Kim

(1) International Trade in Vertically Differentiated Products under Perfect Competition

This paper presents a theory of international trade in a two-sector, one-factor economy in which one sector is vertically differentiated. The paper shows that trade arises from the cost differences in goods in this sector between countries. Furthermore, this trade is characterized as inter-industry trade when cost differences are uniform and intra-industry trade when cost differences are biased. In both cases, an economy with either of these types of trade is more efficient than an autarkic economy because production is increased.

(2) The Effects of International Trade Policy on Vertically Differentiated Products: A General Equilibrium Analysis

This paper presents a general equilibrium model of two-country, two-factor and two-commodity in which one commodity is vertically differentiated. The policy analysis of the

model shows that quantitative restrictions (quotas and VERs) are elusive as restrictions on imports due to quality upgrading. Social welfare comparison between tariffs and quantitative restrictions reveals that the former instruments dominate the latter. Quantitative restrictions are shown to have the same equilibrium independent of their specific forms (quotas or VERs). Minimum quality standards can be used either to restrict imports or improve terms of trade. Quality standards also cause the factor market distortion in which one factor is under-utilized.

(3) <u>Intra-Industry Trade in Horizontally Differentiated Products: A One-Sector Model with Lancaster's Ideal Variety Approach</u>

The paper presents a one-sector, Chamberlinian monopolistic competitive model of intra-industry trade based on Lancaster's ideal variety approach. In specifying the utility function, two different cases of consumer demand are distinguished by the value of the parameter related to price elasticity: the "arbitrary" case and the "general" case. This paper is concerned with the general case, and shows that intra-industry trade occurs in order to take advantage of the internal diversity of preferences within each country.

Dedicated to my parents:

Samsoo Kim and Youngnam Choe

ACKNOWLEDGEMENTS

I am deeply appreciative of my dissertation committee chairperson Steven Matusz. He took me in his arm as a student when my former adviser departed and showed patience in reading through my mistake laden initial proposals. Without his time consuming guidance, encouragement and help, this dissertation could never have been started and completed. Through numerous discussions in which I inevitably found that I had been wrong in the ends, I came to see his integrity and excellence as a teacher and person. He taught me that a dissertation should have originality, no mistakes in logic and be able to make contributions to the field.

The other two members of the dissertation committee, Mordechai Kreinin and Carl Davidson, have been helpful. Actually, the second essay of this dissertation started out from the idea I got from Dr. Kreinin's paper about VERs on Auto industry, and his comments made the dissertation a better one.

Despite all of their guidance, needless to say, any remaining defects of the dissertation are mine.

My parents, Samsoo Kim and Youngnam Choe, have always greatly supported me making my studies much easier. For their

endless love and devotion, I dedicate this dissertation to them as a small token of my gratitude. I would like to thank all the members of my family, Sanghee, Kwangyong, Hangsook, Kyungsook, and Jeongsook. In particular, my elder brother, Sanghee, loved me enough to put off starting his own business for five years. All my sisters have always believed in me and given me their warmest encouragement. I love you all.

Choona Lee, my wife, has always encouraged me throughout the many hard times. She is the one I can count on day in and day out. Geesoo, my daughter, has endured the transitions of living in two countries. It has helped her to have grandparents like Inkyu Lee, who has since departed, and Jeongsook Kim to take good care of her during her stay in Korea. I would like to thank them for supporting us.

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Chapter 1

Introduction and Review of Literature

1.1. The Nature of Product Differentiation in International Trade

Goods traded internationally are grouped in the same atistical class for reporting because they are close ostitutes in either production or consumption, or both. oduct differentiation of goods of the same class can be nsidered as being of two types, quality and variety. In real world these analytical classes tend to overlap, but ically quality differentiation is based on measurable formance characteristics of products while variety ferentiation is based on product appearance and marginal formance characteristics.

The former type of differentiation, known as vertical ferentiation, arises from variations in the quality of a modity and is an important determinant of the pattern of modity trade. The first theoretical paper on this subject presented by Armington (1969). He assumed that consumers w otherwise identical goods produced in different countries different. Therefore, consumer uncertainty about fferences in quality among producers might lead consumers look at origin of products as a signal of average quality.

This view of products as vertically differentiated by untry of origin also prevails in international trade actice. For example, there is a grading system for coffee ans based on source of origin, nature and quality of the oduct [see Marshall (1983)]. Location of cocoa beans ays a critical role in the determination of quality, both cause of climatic and soil conditions and because of the erent characteristics of beans within countries [see tis et al. (1987)]. Similarly, grains are divided into sses and subclasses according to shape, texture, color of kernel, and their source of origin [see CBT (1982)].

Besides agricultural products and raw materials, which graded and differentiated by quality, manufactured ducts can be vertically differentiated, too. Automobiles, example, which differ in size, weight, engine power, ability of finish, etc., are considered to be quality ferentiated.

A theoretical explanation for this type of vertical ferentiation was presented by Linder (1961). Linder argued t a country tends to specialize in the production and ort of that quality of products which is demanded by the ority of its population, while it imports the qualities anded by both the richest and the poorest segments of its opulation.

The other type of product differentiation, called orizontal differentiation, is based on variety and can result rom the geographic origin of goods in an international trade ontext. Commodities become horizontally differentiated when nporters differ in their choice of the geographic origin of ne good as a result of attributes related to the export of product, despite the possible absence of quality variations rom country to country.

The pattern of international trade in products ifferentiated by variety takes the form of countries porting styles most popular in their own population while ey importing styles appealing to the minority. Empirical udies by Dreze (1960, 1961) supported these hypotheses using lgium trade data.

1.2. Intra-Industry Trade in Vertically Differentiated Products

A careful observation of differentiated products in ternational trade reveals that vertically differentiated ods are at least as popular as horizontally differentiated ods. Grubel and Lloyd (1975, ch. 6), for example, showed at there is significant intra-industry trade in both rtically and horizontally differentiated products. erefore, intra-industry trade theory in horizontally

ferentiated goods can be a partial explanation of the total
unt of trade in differentiated products.

The above recognition has largely been ignored in nomics literature which concentrates on horizontally ferentiated products in intra-industry trade theory. The k of literature on vertically differentiated products in ernational trade results from the fact that there has not n any micro economic theory for vertically differentiated ducts. This contrasts with the extensive research on ra-industry trade theory in horizontally differentiated ducts following the development of monopolistic competition ory by Dixit and Stiglitz (1977) and Lancaster (1979).

Theoretical attempts to explain patterns of trade in tically differentiated products date back to Linder (1961). envisioned trade in quality differentiated products on the umption that income is the dominant determinant of tastes. refore, the quality of products which are well developed hin a country is the quality that is demanded by the ulation of average income level of that country. From this umption, Linder's hypothesis says that a country tends to cialize in the production and export of that quality of ucts which is demanded by the majority of its population, e it imports the qualities demanded by both the richest the poorest segments of its population.

Linder supported his hypothesis with trade data from his ve country, Sweden. However, detailed empirical support the theory has not been found, and tests of propositions ıght to reflect Linder's hypothesis have had only mixed ılts.

Donnenfeld and Ethier (1984) combined the demand ıcture of Linder with the factor endowment model of trade explain inter-industry trade as well as intra-industry de in vertically differentiated products.

They showed that if trade in commodities does not lead factor price equalization, then a country will export the ge of qualities which are relatively intensive in its ndant factor and import the range of qualities which are ensive in its relatively scarce factor.

Donnenfeld (1986) extended Donnenfeld and Ethier's model .nclude imperfect information about quality and explain the tern of trade.

In a separate development, Grubel and Lloyd (1975) gested the life-cycle theory of Vernon (1966) as a possible .anation of intra-industry trade in vertically erentiated products. They showed that trade resulting the life-cycle theory is intra-industry trade if goods differentiated by quality. In such trade, a country at igher technological state produces and exports higher ity goods and imports lower quality goods from a country lagging technological state.

They used the pharmaceutical industry in which there is ge amount of trade in European- and U.S.-developed drugs d medicines to support their theory.

This theory emphasizes the dynamic nature of chnological development as in the life-cycle theory but ils to provide the basic reason why certain goods are tially developed by certain countries in the first place.

1.3.Trade Policy on Vertically Differentiated Products

The current literature on international trade policy in tically differentiated products has been stimulated by the irical findings that quantitative trade restrictions lead a shift in the composition of trade toward higher valued, her quality products. This hypothesis of quality upgrading been confirmed in all cases of quantitative restrictions various industries.

Patterson (1966) and Meier (1973) showed that quality rading exists in the textile industry. Their study ealed that higher quality textile imports resulted from a restriction measured in yardage of textile imports. hee (1974) reported that the voluntary tonnage restriction teel exports to the U.S. lead to the increase of price per age of imported steel. Mintz (1973) has noticed quality ading in dairy products, sugar and meat resulting from the quotas on these imports. Recent examples reporting ity upgrading include Anderson (1985) for cheese products, nd Roberts (1986) for footwear, Boorstein (1987) for steel imports, and Feenstra (1988) for auto imports.

These empirical findings have stimulated studies on trade policy in vertically differentiated goods. The first theoretical models were presented by Rodriguez (1979) and antoni and Van Cott (1979). These models assumed that uality can be varied continuously by recognizing multi-imensional characteristics of goods (quality and quantity). iven utility generating multi characteristics of goods, the arket response to a quota will encompass the complete set of haracteristics, not just the characteristic which is formally imited by a quota. Thus, market participating profit aximizing individuals will exploit potential gains by ubstituting the product's unregulated characteristics for the egulated characteristic.

Santoni and Van Cott used the shoe industry as an example show that when the unit of shoe imports is restricted, the restricted characteristic of shoe quality (durability) is creased as a rent maximizing behavior of imports.

Rodriguez presented a profit maximizing supplier who ooses the quality level to minimize cost per unit of rvices provided. Under this circumstance, he compared nsumer welfare between tariffs and quotas.

In both models quality level is denoted by total amount services provided by goods and becomes an explicit variable ntrolled by economic agents. This approach has provided a rtial equilibrium analysis of competitive foreign producers

which foreign producers regard price of services as given.

These models have been extended to the case of a foreign nopolist instead of perfect competitive foreign producers Das and Donnenfeld (1987) and Krishna (1987). Das and nnenfeld showed that both quotas and minimum quality andards dominate tariffs as policy instruments. Krishna monstrated that the effects and desirability of various ade restrictions depend on the valuation of quality crements by the marginal consumer relative to the average luation of quality increments by all consumers.

The initial models have been further extended by Mayer 982) who presented a simple general equilibrium model and owed the possibility of replacing tariffs with equivalent nimum quality standards. In Mayer's model quality is cluded in the production function, and raising quality duces output at an increasing rate. In other models quality ters into the cost function, and raising quality increases e unit production cost at an increasing rate. In another tension of the initial models, Donnenfeld and Mayer (1987) owed that voluntary export restraints can be used as policy truments to increase social welfare under the existence of ormational externalities. In general there is no incentive individual firms to increase quality because their quality perceived as an average quality of industry. VERs luntary Export Restraints), however, force firms to improve lity, thus increasing social welfare.

One common assumption prevailing in the above literature is associated with Swan (1970). In the Swan model demand is essentially for services produced by goods, and higher quality goods provide more services. The profit maximizing quality choice under monopoly or competition can be shown to be that which minimizes cost per unit of services and to be independent of the level of services produced.

All the above models ranked quotas, tariffs, and minimum quality standards in terms of consumer welfare. Contrary to traditional assumptions, quotas are shown to be preferred to tariffs because of the greater welfare induced by quality adjustment under quotas. However, the partial equilibrium or ad hoc nature of the literature prevents the studies from investigating various policy instruments from a social welfare standpoint.

1.4. Intra-Industry Trade in Horizontally Differentiated Products

The interest in intra-industry has arisen from the empirical studies by Balassa (1966), Kravis (1971) and Grubel and Lloyd (1975). These studies revealed a strikingly new characteristic of world trade which is that a trade among the DCs features a large and growing volume of intra-industry trade, both absolutely and relative to inter-industry trade.

Intra-industry trade - the simultaneous presence of imports and exports of the products of a given industry, presents a substantial challenge to traditional trade theories. Two-way trade flows of similar products between countries with nearly identical factor endowments can not be explained with the standard H-O-S framework.

Earlier theoretical attempts to explain intra-industry trade in differentiated products were provided by Grubel (1970), Gray (1973) and Barker (1977). They had tried to model firm level product differentiation with monopolistic competition. But only since 1980 have models appeared that successfully incorporate monopolistic competition with the general equilibrium requirements of trade theory.

In fact, a new wave of theoretical developments began with two studies of 1979 - Krugman (1979) and Lancaster (1979, ch. 10), which presented one sector model in which all international trade is intra-industry trade. These studies provided first formalized models explaining the effects of product differentiation, monopolistic competition, and conomies of scale on problems of international trade. mmediately, these simple models were extended to two sector odels in order to integrate the H-O-S approach to nternational trade with the theory of intra-industry trade see Lancaster (1980), Dixit & Norman (1980, ch. 9), Helpman 1981) and Krugman (1981)]. Integrated models try to explain rade within an industry consisting of close substitute with

.milar technologies, as well as trade of the products of the ıdustry for outputs of other industries. They relate the eterminants of the two kinds of trade to the underlying easons for trade, and show how intra-industry trade can be cplained by product differentiation while conventional H-O- explanations apply to inter-industry trade.

One difference that can be observed among the many udies of this topic is the specification of consumer eferences for differentiation. One approach following ence (1976) and Dixit & Stiglitz (1977) assumes that a presentative consumer likes to consume a large number of rieties [for example, Dixit & Norman (1980, ch. 8), Krugman 981), Helpman & Razin (1980) and Lawrence & Spiller (1983) In these models, every variety is assumed to command the ne value from consumers and be produced by the same oduction function. Therefore, all varieties of a given oduct are equally priced at equilibrium.

The alternative approach is derived from Lancaster's 979) characteristic approach to consumer's demand [see ıcaster (1979, 1980) and Helpman (1981)]. It is assumed ıt products are differentiated by the combination of some ;ic characteristics. Every consumer has an ideal product, :. his most desired combination of characteristics. If a 'iety is represented by a point on a line or the cumference of a circle, the variety closest to ideal iety will be chosen by consumers if ideal variety is not a

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available. In this approach, every available variety produced by firms of the same production function is equally priced and spaced in a symmetric equilibrium.

Despite the fact that both approaches used a different specification of preferences, they reached the same broad conclusions regarding the nature of intra-industry trade and gains from specialization which are obtained by taking advantage of economies of scale.

Another difference that distinguishes the various studies is whether the model deals with the trade in final products (consumer's good) or middle products (producer's good). All of the papers mentioned so far confined attention to final products only. The theory can be modified in order to deal with trade in middle products, without altering its main results [see Ethier (1982) and Helpman (1983)].

1.5. Purpose and Basic Features of the Study

In the following chapters, three different international trade models in differentiated products are presented. Each model is associated with one of the three pieces of literature discussed above. The first model presents a theory of intra-industry trade in vertically differentiated products in a Ricardian economy. The second model investigates the effects of commercial policy on vertically differentiated products in H-O-S economy. The third model develops a monopolistic com

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ompetition model of intra-industry trade in horizontally ifferentiated products.

In the first essay, patterns of trade in vertically ifferentiated products are studied in a two-sector, one-actor, Ricardian economy in which there are differences in oth technological factors and consumer types between ountries. The model emphasizes technological factors in the etermination of patterns of trade. The emphasis on echnological factors in international trade originated from ne life-cycle theory of Vernon (1966). Grubel and Lloyd 1975) suggested the life-cycle theory in international trade s a possible explanation of vertically differentiated roducts in intra-industry trade.

In the second essay, a two-sector, two-factor, two-ommodity model in which one commodity is vertically fferentiated is presented. This general equilibrium model nnects partial equilibrium or ad hoc models of the terature to the standard H-O-S model.

In the model vertically differentiated goods are measured total services, and total services are determined by a oduct of unit quality and physical quantity. Firms are sumed to choose an optimal quality to minimize their total t in providing services of differentiated goods according Swan (1970).

The general equilibrium nature of the model enables us t

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to compare the desirability of tariffs, quotas, voluntary export restraints and minimum quality standards from a social welfare standpoint instead of the consumer welfare standpoint of partial equilibrium models.

In the third essay, a one-sector, Chamberlinian monopolistic competitive model of intra-industry trade based on Lancaster's ideal variety approach is developed. This model is an attempt to formalize a general idea suggested by Lancaster (1979).

He suggested that gains from intra-industry trade could result from internal diversity of preferences within each country between identical countries. He specifies the utility function for differentiated products based on his characteristic approach, and it is called the ideal variety approach in the literature. This approach contrasts with the love of variety approach of Dixit and Stiglitz (1977). In presenting the model in this essay, the different features of the two approaches are clarified.

1.6. Overview of the results

The first essay shows that trade arises from the cost differences in vertically differentiated goods between countries.

Furthermore, this trade is characterized as inter-industry trade when cost differences are uniform and intra-industry

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trade when cost differences are biased. Uniform cost differences occur when there is a difference in labor productivity in the homogenous goods or a difference in the fixed cost required for the differentiated goods between countries. Biased cost differences result from changes in the parameter of the cost function representing the rate of change in cost in relation to quality. In both cases, an economy with either of these types of trade is more efficient than an autarkic economy because production is increased.

The second essay shows that quantitative trade restrictions (quotas and VERs) are elusive as restrictions on imports due to quality upgrading. Tariffs dominate quantitative restrictions because the former increases social welfare more than the latter. Quantitative restrictions are shown to have the same economic result independent of their specific forms (quotas or VERs). Minimum quality standards can be used either to restrict imports or improve terms of trade, but ambiguous results of these quality standards require careful consideration in their imposition. Quality standards also cause factor market distortion in which one factor is under-utilized.

This essay also investigates inter-relations of factor market abundance and factor intensity in association to the quality of differentiated goods.

The third essay shows that intra-industry trade occurs in order to take advantage of the internal diversity of pref

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preference within each country. Free trade provides more varieties than in a closed economy, and the welfare of the economy arises. The essay also shows that there are two different ways of specifying the utility function of Lancaster's ideal variety approach. In the "arbitrary" case, the consumer either specializes in one variety or consumes a mixture of varieties which offer the lowest effective price. In the "general" case, the consumer chooses a positive amount of every variety.

Each essay is presented separately in the next three chapters.

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CHAPTER 2

(ESSAY 1)

International Trade in Vertically Differentiated Products Under Perfect Competition

2.1. Introduction

A careful observation of differentiated products in international trade reveals that vertically differentiated goods are at least as popular as horizontally differentiated goods. However, contrary to abundance of a well developed body of literature on intra-industry trade in horizontally differentiated products, literature on that of vertically differentiated products is scarce.

This paper attempts to fill this vacuum by presenting a model which can explain causes and results of intra-industry trade of vertically differentiated products.

This paper emphasizes technological factors in the determination of patterns of trade along with the demand structure of the Hedonic price model. The emphasis on technological factors in international trade originated from the life-cycle theory of Vernon (1966), and Grubel and Lloyd

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(1975) suggested the life-cycle theory in international trade as a possible explanation of vertically differentiated products in intra-industry trade. This paper presents an explicit model based on the idea of Grubel and Lloyd. The paper studies causes of trade and the resulting gains when there are differences in technological factors and consumer types between countries.

This paper shows that intra-trade arises from the cost differences in goods in the vertically differentiated sector between countries. This paper also shows that the gains from intra-industry trade of vertically differentiated products more closely resemble the gains resulting from inter-industry trade rather than those based on intra-industry trade of horizontally differentiated products.

The present paper uses a utility function of Rosen (1974), and assumes there is a competitive market in the differentiated sector with free entry with the usual U-shaped cost function.

In every quality, there is perfect competition and free entry which reduces each firm's profits to zero. It is assumed that there exists a sufficiently large number of firms producing the same quality in every quality.

The situation described in this paper is an economy in which (1) no firm ever has any market power, and (2) no horizontal differentiation (varieties) exists within qualities.

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In the next section, the model is presented. In Section 2.3, autarkic equilibrium is derived, and its nature is explained. In Section 2.4, implications of the model on international trade are presented. This section is concerned with an open economy compared to the autarkic equilibrium discussed in Section 2.3. In the final section, summaries and brief conclusions will be stated.

2.2. The Model

Consider an economy made up of two sectors, one consisting of vertically (quality) differentiated goods, and the other of composite (outside) goods. Labor is the only factor in the production of both goods. Outside goods will be used as a numeraire. In the market for differentiated products, there are many qualities of goods available. The quality level of these differentiated products is represented by a one-dimensional hedonic attribute q, which is referred to as "product quality". A larger value in the subscript of q indicates higher quality products.

A. Production

The production function for the outside goods (composite goods) is:

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.1) $M = a_m L_m$

ere M represents the outside goods, and L_m is the labor
ployed in the outside sector. Each worker produces a_m units
M. Thus, the wage rate simply equals a_m if the outside
ods are produced, because M is the numeraire.

The cost function in the differentiated goods sector is sumed to be similar to the cost function of the one-factor del of Krugman (1979)[1] modified to give a U-shaped AC curve. rthermore, quality is added to both fixed and variable sts[2]. Because labor is the only factor of production, total sts are always equal to wage costs. The labor used in oducing each quality is:

.2) $l\ (Q,\ q) = h(q)\ [\ Q^2 + F\ ]$

ere Q represents the total quantity of quality goods oduced, and Q^2 and F are variable and fixed costs spectively. l is the labor used in producing Q goods of ality q. Total costs are the product of labor requirement .2) multiplied by wage rate, w:

The cost function used in Krugman (1979) could be written

$$C = w\ [\ Q + F\ ]$$

Other formulas regarding how quality enters the cost
are discussed in Appendix A.

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2.3) $C(Q, q) = w\ h(q)\ [\ Q^2 + F\ ]$

his cost function has the same minimum point of average osts, AC for every quality produced at $Q^* = \sqrt{F}$. This curve s illustrated in Figure 2.1.[3]

In the short run, the supply of goods of quality q by he competitive firm i, is determined by:

2.4) $p = C'(Q, q)$ if $p \geq w\ h(q)\ Q\ (= AVC)$

$Q = 0$ $p < w\ h(q)\ Q$

e non-negative profit condition can be written as $p \geq$ $C(Q_i)$.

Thus, the firm will operate at a positive level of output long as it can cover variable costs. The supply curve is e portion of the marginal cost curve which is above average riable cost. In the long run, with free entry and a mpetitive market for each quality, each firm will earn zero ofit and produce at a minimum average cost level:

.5) $C^* = C(Q_i^*)/\ Q_i^*$

the demand for the output of this industry is some integral

For detailed discussion and calculation, see Appendix A.

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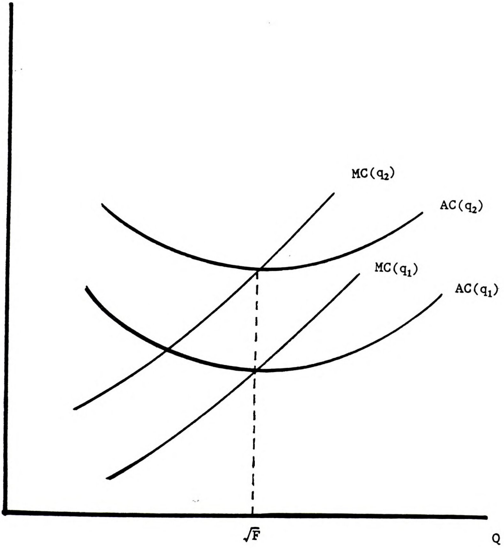

Figure 2.1

Cost Curves in the Differentiated Sector multipl

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ultiple of Q_i^*, then each firm will produce at Q_i^*, and the quilibrium price will be $p^* = C^*$. Thus, profit will be zero.

By substituting $\sqrt{F}$ for Q^* in AC derived from eq. (2.3), ne prices of qualities are derived as:

$$(2.6) \quad p_i = \text{min. of AC} = 2wh(q)\sqrt{F} = 2a_m h(q)\sqrt{F}$$

For the unique solution for the quality demanded by onsumers, A condition on the price schedule (2.6) is ecessary as follows:

$$(.7) \quad p(q) \geq 0 \quad p'(q) > 0 \quad p''(q) > 0$$

tuitively, condition (2.7) implies that price should crease at an increasing rate as quality level rises. If ice increases at a constant rate with the rate of increase quality (dp = dq; a case of $p''(q) = 0$), any consumer who ooses to buy a quality product will be indifferent to the vel of quality, because every quality yields the same nsumer surplus (= utility - price) for consumers. erefore, an infinite number of consumer quality choices ists (indeterminate solution). If price increases at a creasing rate as quality level rises (dp < dq; a case of (q) < 0), any consumer who chooses to buy quality goods l be better off by upgrading quality, because higher ality will provide him with more quality for the money spen

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B. Consumers

(B-1). Utility Function

Consumers are assumed to differ in their preferences for qualities, each buying either one unit of a differentiated product or none. A particularly useful form of the utility function, $U(M,q,\theta,X)$, originated by Mussa & Rosen (1978), can be represented by:

$$U(M,q,X,\theta) = M + \theta qX \tag{2.8}$$

$$X = 1 \text{ if buy quality, } X = 0 \text{ if not.}$$

where M is the composite goods. X denotes the total units of quality goods bought by consumers, (X takes binary values of 0, 1 because each consumer either buys zero or one unit), and θ indexes consumer types. θ is proportional to the amount of money that each consumer is willing to pay for one unit of output of quality q of the differentiated products. Thus, consumers valuations of quality vary in proportion to θ, so that

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that the taste patterns of consumers are characterized by a distribution of parameter θ among consumers. θ is assumed to be a distribution on the interval of real numbers [0,R] with the density $f(\theta)$.

The utility function (2.8) has convenient properties useful for the study of quality differentiated goods. First, it ignores the income effects because it is defined only by price, quality and parameter θ, space. Second, it assumes a strong separability between the composite goods and the differentiated products in question. Third, each consumer has a constant marginal utility with regard to quality which depends on his preference θ. This is drawn in Figure 2.2.

(B-2). Indifference Curve

The demand for quality is derived from the utility maximization subjected to the budget constraints of consumers. From the utility function (2.8), we can draw the indifference curves on (M, q) space. By total differentiation of (2.8) for the given value of U, the indifference curves have slopes equal to $-\theta$.

(2.9) $\quad$ if $X = 1, \quad dM/dq = -\theta$

This indifference map is drawn in Figure 2.3 for a given value of θ.

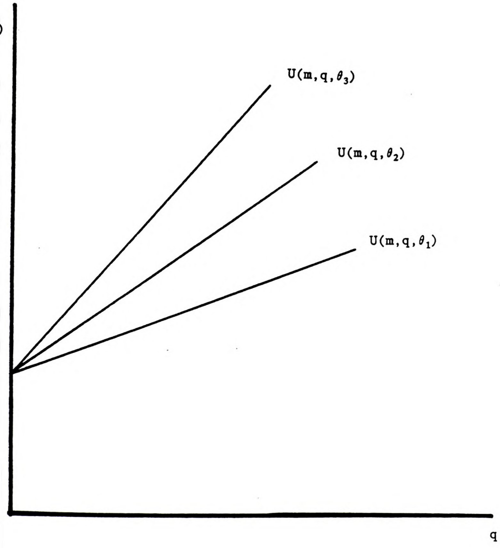

Figure 2.2

Utility Functions

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The property of the curve can be explained by considering two different individuals represented by θ_1 and θ_2. Two indifference curves representing consumers θ_1 and θ_2 are drawn in Figure 2.4.

At point A, both consumers have the same utility, so consumer 1's indifference curve guarantees the same utility as consumer 2's indifference curve guarantees. All utilities of consumers are from the consumption of composite goods at point A. Therefore, the difference in θ does not affect the utility level of individuals.

Notice that bundle B, lies below consumer 1's indifference curve, so consumer 2 gets greater utility from bundle B than does consumer 1. In general, consumer 2 values quality more than consumer 1; i.e. given both m and q are the same for both consumers, utility is higher for the person with the higher θ.

(B-3). Budget Constraint

Consumer income is only from labor with the wage rate w in this one-factor economy. The budget constraint is:

(2.10) $M + p(q) = Tw$

where T and p are the total amount of labor time supplied by consumers/workers and the price of the quality differentiated

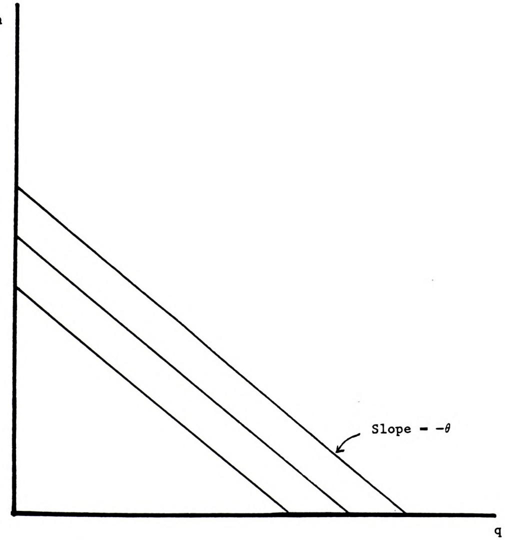

Figure 2.3

Indifference Map of a Consumer

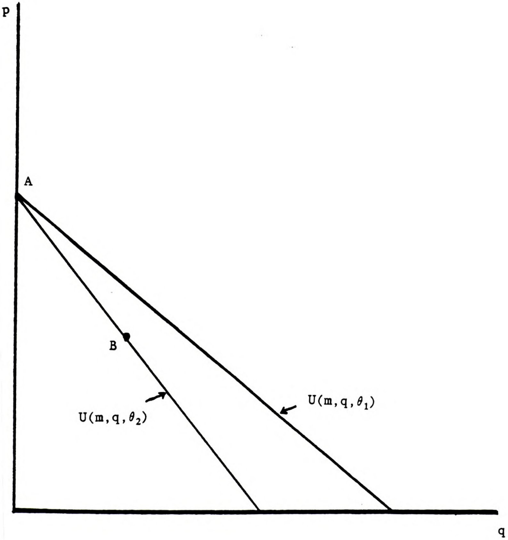

Figure 2.4

Indifference Curves of Two Different Consumer Types goo

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ood respectively, and p is dependent on q.

From the total differentiation of (2.10), the slope of ne budget constraint is:

$$\left.\frac{dM}{dq}\right|_{\substack{\text{budget}\\ \text{const.}}} = -p'(q) \qquad \text{(2.11)}$$

resumably, $p'(q) > 0$.[4]

3-4). Demand for Qualities: Utility Maximization

The utility maximization of consumers requires that the ope of the indifference curve equals that of the budget nstraint at optimum consumption bundle (M, q). This is the rst-order-condition of utility maximization.

It is intuitively right to assume that higher qualities ond to higher prices. But the proof of this is as follows. e competition with free entry requires that profit must be r all q, yielding a zero-profit condition in the long-run.

q) = minimum of AC(q) (1)

om the assumptions of the cost function, which was discussed ion A, the cost function is an increasing function of , that is,

$(q) > 0$, $C''(q) > 0$ for all qualities q (2)

and (2), $p'(q) > 0$ is implied.
te that the quantity differences between qualities does not the proof because the min. AC of lower qualities is always han that of higher qualities.

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12) $p'(q) = \theta$

generate the interior solution to (2.12), the following triction on the p(q) which is discussed intuitively in the t section is required.

13) $p(0) = 0 \quad p'(q) > 0 \quad p''(q) > 0$

n the above restriction,[5] the unique choice of q by sumers of θ is illustrated in Figure 2.5. The concavity p(q) is guaranteed by the positiveness of the second-order ivatives, $p''(q) > 0$. This critical condition is required the unique tangent solution between the budget constraint the indifference curve. The solution in Figure 2.5 also ws not only that the utility maximization solution is que but also that consumers with high θ maximize utility choosing higher q than consumers with low θ. Also note if θ is low enough, the consumer specializes in M, and

---

he restriction of eq. (13) is, in fact, a second-order- of utility maximization. The maximization of utility, $q = (w - p(q)) + \theta q$, results in a first-order-condition:

$q) + \theta = 0$

differentiation of a first-order-condition, results in order-condition:

$q) < 0$

this is the same as eq.(13).

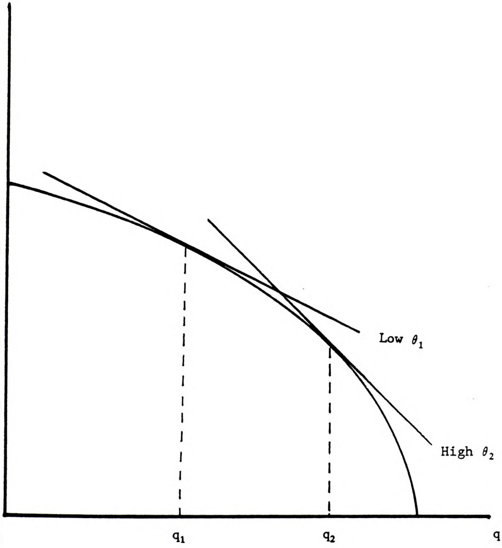

Figure 2.5

Utility Maximization

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θ is high enough, the consumer specializes in q.

The restriction (2.13) corresponding to a unique solution be expressed as a restriction of the cost function. By riting the cost function as:

14) $C(Q, q) = h(q) [V(Q) + F]$

re, Q represents the quantity of the differentiated goods, V(Q) and F are variable and fixed costs respectively. lity is added to both variable and fixed costs portionately. A detailed discussion was offered in Section The price schedule with respect to the change in quality t equal the marginal change of cost as quantity changes, t is:

15) $\partial C(Q^*, q)/ \partial Q = h(q) V'(Q^*)$

$p(q) = h(q) [\partial V(Q^*)/ \partial Q]$

re Q^* represents the optimum level of production of the petitive firm. Therefore, p(q) > 0, p'(q) > 0, and p"(q) will require the following restrictions:

.6) $h(q) > 0 \quad h'(q) > 0 \quad \text{and} \quad h''(q) > 0$

: will be satisfied for the specific functional form h(q) 1(q) = q^r, if r>1. This restriction will be used in the specif

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ecification of the cost function in later sections.

2.3. Autarkic Equilibrium

Now consider an economy consisting of L workers/consumers th the same type of preferences θ. For the solution of the del, we will use a specific functional form for h(q):

17) $h(q) = q^r, \quad r > 1$

rewriting the price schedule (eq. (2.6)), and F-O-C of utility maximization (eq. (2.12)):

18) Price schedule: $p(q) = 2a_m q^r \sqrt{F}$

F - O - C: $\theta = p'(q)$

s, the quality produced at equilibrium can be solved as:

19). $q = (\theta / 2ra_m\sqrt{F})^{1/(r-1)})$

The equilibrium price of the quality produced in the nomy can be obtained by substituting equilibrium quality q. (2.19)) into the price schedule:

20) $p = 2a_m\sqrt{F} (\theta / 2ra_m\sqrt{F})^{r/(r-1)}$

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The equilibrium quantity of the differentiated good oduced with L workers/consumers is equal to the total number consumers L. This is because each consumer demands one it of the group goods according to his utility function. r this model, the utility attainable from the consumption quality goods q ($=\theta q$) is always larger than that from nsuming composite goods ($=p$), because $\theta q - p > 0$ is tisfied at equilibrium for any $\theta > 0$, i.e.:

21) $$\theta q - p = (1/r)^{1/(r-1)} > (1/r)^{r/(r-1)}, \text{ for any } \theta > 0$$

Given prices of quality goods, wage rate and total labor e, the demand for the composite goods from the budget straints of the economy can be derived:

22) $$TwL = p(q)L + M$$

substituting the equilibrium price into the budget straint, the income spent for the composite goods M is:

23) $$M = TwL - 2a_m q^r \sqrt{F}L = Ta_m L - 2a_m q^r \sqrt{F}L$$
$$= a_m L(T - 2q^r \sqrt{F})$$

he composite goods consumed is positive, assume $T \geq 2q_r\sqrt{F}$.

The total number of firms existing in the differentiated ls sector can be derived by dividing the total number of mar

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rket demand L by the optimum production of each firm $Q^* = \sqrt{F}$ ich corresponds to the minimum AC in a perfect competitive onomy. The number of firms in the differentiated sector is:

.24) $L/Q^* = L/\sqrt{F}$

Equilibrium values of the quality goods and their prices e depicted graphically in Figure 2.6 for the differentiated ods sector. From the F-O-C of the market demand, and the uilibrium price of quality goods, the following equilibrium ndition for quality and price is derived:

.25) F-O-C: $2ra_m\sqrt{F}q^{r-1} = \theta$

e LHS of eq. (2.25) is derived from $p(q) = 2a_m\sqrt{F}q^r$, $r>1$, ch in turn depends on the cost conditions. Therefore, it called the "supply factors". The RHS of eq. (2.25) is rived from the utility function, $U = M + \theta q = (Tw - p) +$ Thus, call this the "demand factors" from now on.

For a given utility level U, the "demand factors" is ived by substituting M in the budget constraint, $M + P =$ into the utility function, $U = M + \theta q$. Therefore, the mand factors" in the graph is the same as in the ifference curve, and utility rises as one moves in a theast direction. This implies a tangency solution of the sumers' choice given the "supply factors", the price

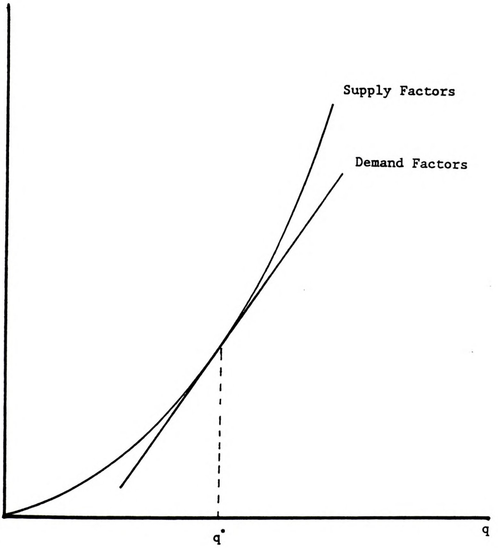

Figure 2.6

Autarkic Equilibrium with Single Consumer type equ

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The closed economy equilibrium is represented by L production of q by a tangent solution of (q, p) for each worker/consumer.

2.4. Technological Differences and International Trade

. Uniform Cost Differences

Suppose changes are introduced in the parameters of the rice schedule shifting the "supply factors" of the economy. y innovating the production processes of its quality roducts, through R&D investments for example, a country can educe its production costs, which may be expressed in lowered ixed cost F, or it can maintain a higher wage rate because f its higher productivity in the outside goods sector. These nanges in the parameters a_m and F shift the price schedule niformly. This is depicted in Figure 2.7.

In Figure 2.7, the shift-out of the price schedule from ne original state (p, the home country) to the starred state p^*, the foreign country) corresponds to a lowering of either ne value a_m or F. The shift-out occurs because each quality roduct can be supplied at a lower price with the new state. nerefore, the consumer's tangency solution for each quality ood will force the consumer to choose higher quality at a new quilibrium ($q < q^*$). This can be shown by the partial der

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derivatives of eq. (2.19) with regard to a_m and F, keeping other exogenous variables (θ, r) constant:

$$(2.26) \quad \partial q/\partial a_m = \{ 1/(r-1) \} \{ \theta/2ra_m\sqrt{F} \}^{(2-r)/(r-1)} \{- \theta/2r\sqrt{F}a_m^2 \} < 0$$

$$(2.27) \quad \partial q/\partial F = \{ 1/(r-1) \} \{ \theta/2ra_m\sqrt{F} \}^{(2-r)/(r-1)} \{ [(-F^{-3/2})]/2 \} \{\theta/2ra_m\} < 0$$

From the partial derivatives of the equilibrium price eq. (2.20), the effects of change of a_m and F on equilibrium price can be derived. The result is:

$$(2.28) \quad \partial p/\partial a_m = 2\sqrt{F}q^r [1 - r/(r-1)] < 0$$

$$(2.29) \quad \partial p/\partial F = (2/\sqrt{F})q^r [1 - r/(r-1)] < 0$$

The effects of changes in a_m and F on the equilibrium values of q and p, can be restated as:

$$(2.30) \quad \partial q/\partial a_m < 0 \quad \partial q/\partial F < 0 \quad \partial p/\partial a_m < 0 \quad \partial p/\partial F < 0$$

This result shows that when there are uniform changes in price schedule (shift-out) resulting from the lowered values of a_m and F, the equilibrium quality consumed is raised, and its price is raised in both cases. Thus, consumers can get higher


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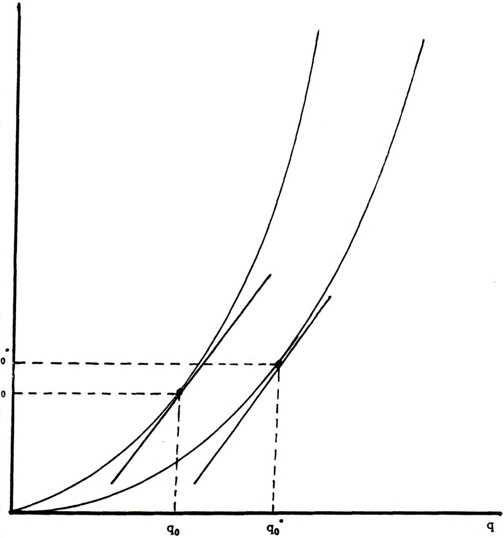

Figure 2.7

Uniform Cost Differences

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quality at higher prices in this new equilibrium.

Now consider two countries, one with the original "supply factors" and the other with new "supply factors" in the differentiated products represented by the shifted-out "supply factor" in Figure 2.7. In this one factor economy, the country with a shifted-out price schedule has a comparative advantage over the other in the production of the differentiated products. In addition, the country with lower technology in the production of quality goods will have a relative comparative advantage in the production of composite goods which are assumed to require the same labor per unit of production in both countries. Once trade opens between the two countries, each country will specializes in the products of its relative comparative advantage. This specialization of production after trade will increase total world wide production to the benefit of both countries.

The trade resulting from the technological innovations in the production of the differentiated products is characterized as <u>inter-industry trade</u> between countries in which one country specializes in differentiated products and the other in composite products.

In fact, at free trade equilibrium there exists at least one country completely specializing in the production of either composite or differentiated goods in this two-sector, one-factor Ricardian economy. The exact determination of the specialization depends on the parameter values of the model.

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The total world demand for q_0^* (* = the foreign country) with free trade is:

(2.31) $D = 2L$

The total labor required (L) to produce the amount of quality goods demanded can be derived by dividing the total income spent on quality goods by income Tw ($=Ta_m$), because every worker/consumer earns the same income.[6]

(2.32) $L = 2Lp^*/Ta_m = 4L\sqrt{F}q^{r*}/T$

Assuming the total labor force of the two countries is the same, if the labor required for quality goods demanded by both countries is matched by the exact labor force of the foreign country, both countries will completely specialize in the sector of their relative advantage. The home (foreign) country will produce only composite (differentiated) goods if:

(2.33) $4\sqrt{F}\ Lq^{r*}/T = L\ (=L^*)$

Incomplete specialization in one country occurs if the total

This is true in a closed economy of diversified production, necessarily true in an open economy. Generally, wage (w) a_m (productivity in the outside sector) as discussed before. ialization exists, wage rate used in this discussion refers of the foreign country.

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labor demand for quality goods production is not equal to the labor force of one country. If the former is greater than the latter, the foreign country will specialize in quality goods, but the home country will diversify by producing both quality goods and composite goods.[7] The condition for this is:

(2.34) $2\sqrt{F}\ Lq^{r^*}/T > L$

Foreign country diversification and home country specialization in composite goods also occurs if inequality is reversed in the above equation.

For either of the above situations, free trade can be shown to be Pareto efficient than an autarkic economy, because total world wide production increases.

Total production gain from the trade between the two countries can be shown in terms of composite goods. To calculate production gain the production of quality is held constant at autarkic level ($L = q_0$, $L = q^*$) rather than allowing it to change as expected under trade ($2L = q^*$). In this case, the production in the trade between the two countries decreases the price of q_0.

. Even though this is possible, there remains a question how the home country can be competitive in the quality entiated products. A pricing scheme will be required for If less efficient home quality goods are still preferred by ers over the outside goods, then consumers will buy them. r, if foreign quality goods are preferred over those of the consumers are willing to pay a premium for foreign quality A pricing scheme must solve this questions.

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The price of q can be lowered from p_0 to p^W by the reallocation of the production between the two countries. [See Figure 2.7]

Now, the total production of composite goods after trade (M^W), keeping the qualities produced constant at autarkic level, can be derived from eq. (2.22), and M^W is greater than ($M + M^*$)

(2.35) $$M^W = (wTL - p^W L) + (wTL - p^* L)$$
$$> (wTL - p_0 L) + (wTL - p^* L)$$
$$= M + M^* \quad (* = \text{Foreign})$$
because $p^W < p$

Furthermore, the increase of production with free trade is:

(2.36) $$dM = M^W - (M + M^*) = (p_0 - p^W) L$$

Thus, the increase of production or gains from trade depend on the price differentials of the two countries resulting from the difference in "supply factors."

. Biased Cost Differences

Now consider the effects of changes of parameter "r" on the p(q) schedule. An increase in r raises the production cost of the differentiated products if q > 1, but lowers the cost

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cost if $q < 1$. This is clearly seen by looking at the cost function.

(2.37) $$C(Q, q) = q^r \{ Q^2 + F \} w$$

If $q < 1$, q^r falls as r increases

If $q = 1$, q^r unchanged as r increases

If $q > 1$, q^r increases as r increases

Thus, changes in "r" cause the twist in the p(q) schedule which is drawn in Figure 2.8.

The effects of changes in r on the equilibrium values of quality and price can be derived by the partial differentiation of eq. (2.19) and eq. (2.20) with respect to r keeping all other exogenous variables (a_m, F, and θ) constant. Since r appears in the exponents of q and p, the derivatives can be found by logarithmic differentiation.

(2.38) $$\ln q = [1/(r-1)] \ln(\theta/2ra_m\sqrt{F})$$
$$= [1/(r-1)] [\ln(\theta/2ra_m\sqrt{F}) - \ln r]$$

(2.39) $$(1/q)(dq/dr) = -[1/(r-1)^2] [\ln (\theta/2a_m\sqrt{F}) - \ln r]$$
$$+ [1/(r-1)](-1/r) = -[1/(r-1)] [\ln q + 1/r]$$

(2.40) $$\text{Sign } (dq/dr) = - \text{Sign } (\ln q + 1/r)$$

(2.41) $$dq/dr \gtrless 0 \text{ iff } q \lessgtr q^1 < 1$$

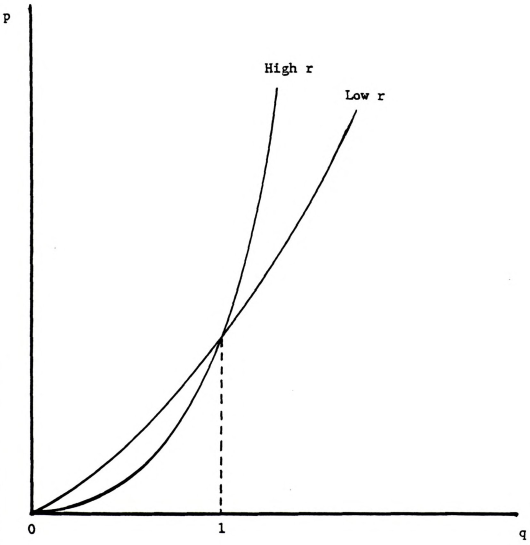

Figure 2.8

Biased Cost Differences

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for $q^1 = e^{-1/r}$ (from $\ln q + 1/r = 0$)

Similar derivatives can be attained for the equilibrium price.

(2.42) $\ln p = \ln(2a_m\sqrt{F}) + r\ln q$

(2.43) $(1/p)(dp/dr) = \ln q + r\,(1/q)(dq/dr)$

$= \ln q + (r/q)\ [\,-[q/(r-1)]\,]\ [\,\ln q + 1/r]$

by substituting $(1/q)(dq/dr)$ from eq. (2.39)

$= -1/(r-1)\ [\,\ln q + 1\,]$

(2.44) Sign dp/dr = - Sign [$\ln q + 1$]

(2.45) $dp/dr \gtrless 0$ iff $q \lessgtr q^2 < q^1 < 1$

for $q^2 = e^{-1}$ (from $\ln q + 1 = 0$)

From eq. (2.41) and (2.45), we can divide the p(q) schedule into three zones according to the signs of dq/dr and dp/dr:

(2.46) Zone I (for $q \leq q^2$); $dq/dr > 0$, $dp/dr \geq 0$

Zone II (for $q^2 < q \leq q^1$); $dq/dr \geq 0$, $dp/dr < 0$

Zone III (for $q < q^1$); $dq/dr < 0$, $dp/dr < 0$

This is drawn in Figure 2.9. In zone I, the increase in r causes both quantity and its price to rise. Therefore, the quality consumed rises, and the price paid for this higher

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quality also rises. for lower quality with low r. In zone II, the increase in r causes the quality consumed to rise but its price falls. Therefore, consumers pay less for higher quality than lower quality. In zone III, the increase in r causes both the quality consumed and its price to fall. Therefore, consumers buy lower quality and pay a lower price.

Even though consumers' choice of quality and price is affected differently depending on the zone, they are better off as they move to the outer frontier of the price schedule. Let's call this outer envelop of the price schedule the "technological frontier." It is represented by a thick line in Figure 2.9. In Figure 2.9, "marginal consumers" who can be satisfied by the qualities produced in both countries, q_0 and q_{00} are represented. These consumers are equally well off with high quality-high price (q_{00}) or low quality-low price (q_0). People with θ's which are greater than those of marginal consumers buy higher quality goods from the country with low r, and people with lower θ's than those of marginal consumers buy lower quality from the country with high r.

Therefore, the pattern of trade depends on the labor type which is assumed to be the same between countries. If the labor type θ is lower than that of marginal consumers, then the country with high r will export differentiated goods in exchange for outside goods imported from the country with low r. On the other hand, if the labor type θ is greater than that of marginal consumers, the country with low r will export

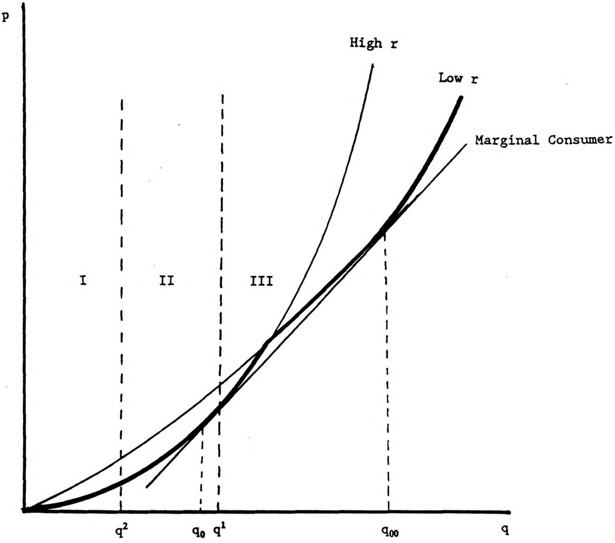

Figure 2.9

Quality Zones, Technological Frontier and Marginal Consumer di

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differentiated goods in exchange for imports of outside goods from the country with high r. If labor type θ is equal to that of marginal consumers, there will be no trade between the two countries. Thus, if consumers buy higher quality goods, the country with low r has a relative comparative advantage in the production of differentiated goods and the other country has a relative comparative advantage in the outside goods. Similarly, if lower quality is consumed by consumers, the country with high r has a relative comparative advantage in differentiated goods with the other country having a comparative advantage in outside goods.

For each case, once trade opens, the two countries will engage in <u>inter-industry trade</u> in which one country exports the goods of its relative comparative advantage. The exact pattern of specialization is dependent upon the parameter values by the same reasoning as in the last section, and it can be shown that trade is better than no trade because total world wide production is increased.[8]

C. Intra-Industry trade

Now suppose the economy of the home country consists of L workers/consumers with three different types of preferences

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[8]. For the gains from the trade, see the proof of the next ion. The same method of proof can be used with slight fication.

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θ_i denoted by numeric subscripts on labor L:

$$(2.47) \qquad L = L_0 + L_1 + L_2$$

where L_i represents workers/consumers with preferences θ_i, and assume that:

$$(2.48) \qquad 0 = \theta_0 < \theta_1 < \theta_2$$

The equilibrium in the closed economy will produce L_1 and L_2 units of quality q_1 and q_2 respectively because each consumer of type 1 and 2 will demand one unit of quality goods of type of 1 and 2 respectively. Given prices of quality goods and the total income Tw, we can derive the demand for composite goods from the budget constraint of the economy.

$$(2.49) \qquad TwL_0 + TwL_1 + TwL_2 = p(q_1)L_1 + p(q_2)L_2 + M$$

By substituting $p_i = 2w\sqrt{F}q_i^r$ into the budget constraint, we get the income spent for the demand of the composite goods M:

$$\begin{aligned}(2.50) \qquad M &= wTL_0 + (wTL_1 - p_1L_1) + (wTL_2 - p_2L_2) \\ &= wTL_0 + wL_1\ (T - 2\sqrt{F}q_1^r) + wL_2\ (T - 2\sqrt{F}q_2^r) \\ &= \Sigma_i\ a_mL_i\ (T - 2\sqrt{F}q_i^r),\ q_0 = 0 \\ &= \Sigma_i\ a_mL_i\ (T-2\sqrt{F}q_i^r),\quad q_0 = 0\end{aligned}$$

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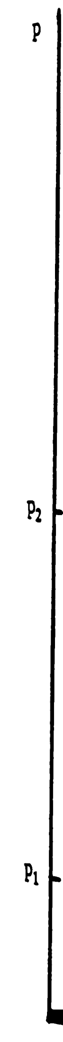
This autarkic equilibrium is depicted graphically in Figure 2.10.

Suppose the foreign country has a higher "r" than the home country with the same labor types. The price schedules for the two countries are drawn in Figure 2.11.

In Figure 2.11, q_1^* and q_2 are tangency solutions of the "technological frontier" of the two countries of consumers with labor types of θ_1 and θ_2 respectively. Consumers with θ_1 (θ_2) will be better off consuming q_1^* (q_2) from the foreign (home) country after trade, assuming $\theta_1 < \theta^m < \theta_2$. The exact changes in (q, p) with trade will depend on the initial position of q (zone I, II, and III) as we discussed in the last section.

The trade resulting from biased cost differences (differences in r) between countries is <u>intra-industry trade</u> in which each country specializes in one part of the differentiated products and then trades with the other country. The home country has a relative comparative advantage in high quality goods and the foreign country has a relative comparative advantage in low quality goods. Both countries will gain from the trade because they can consume quality products at lower prices after trade.

In fact, the total production gain from the trade between the two countries can be shown in terms of composite goods. To calculate production gain the production of quality is held constant at autarkic level ($L_1 = Q_1$, $L_2 = Q_2$, $L_1 = Q_1^*$, and L_2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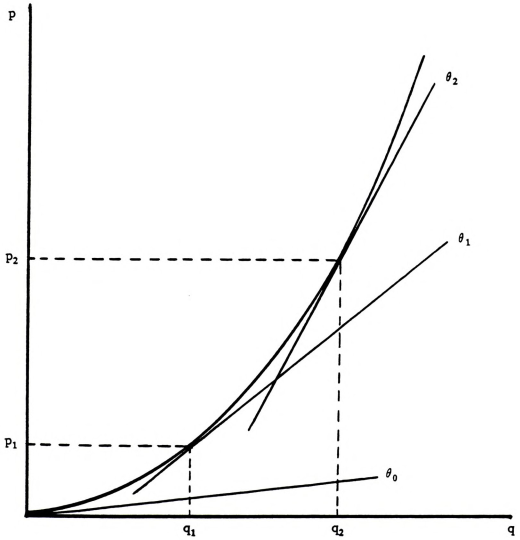

Figure 2.10

Autarkic Equilibrium with Multiple Consumer Types

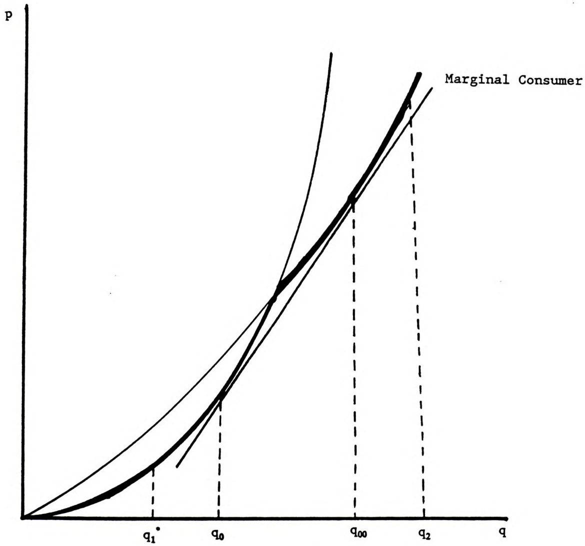

Figure 2.11

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$= Q_2^*$) rather than allowing it to change as expected under trade ($Q_1^* = 2L_1$, and $Q_2 = 2L_2$). In this case, the "technological frontier" in the trade between the two countries decreases the prices of q_1 and q_2^*. This is drawn in Figure 2.12.

The price of q_1 (q_2^*) can be lowered from p_1 (p_2^*) to p_1^W (p_2^W) by the reallocation of the production between the two countries.

Now, the total production of composite goods after trade (M^W), keeping the qualities produced constant at autarkic level, can be derived from eq. (2.22), and M^W is greater than ($M + M^*$).

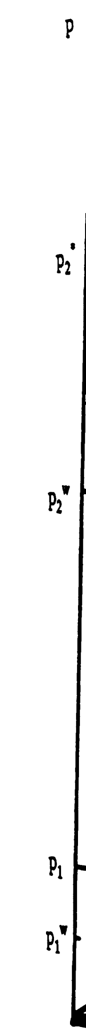
(2.51) $$M^W = 2wTL_0 + L_1(2wT - p_1^* - p_1^W) + L_2(2wT - p_2 - p_2^W)$$
$$> 2wTL_0 + L_1(2wT - p_1 - p_1^*) + L_2(2wT - p_2 - p_2^*)$$
$$= M + M^*$$

because $p_1 > p_1^W$, and $p_2^* > p_2w$

In addition, the production expansion in terms of composite goods (dM) depends on the differentials of (p_1 and p_1^W) and (p_2^* and p_2^W) which in turn depend on the technological differences between the two countries.

(2.52) $$dM = M^W - (M + M^*) = L_1(p_1 - p_1^W) + L_2(p_2^* - p_2^W)$$

Thus, We have shown that free trade is better than no trade.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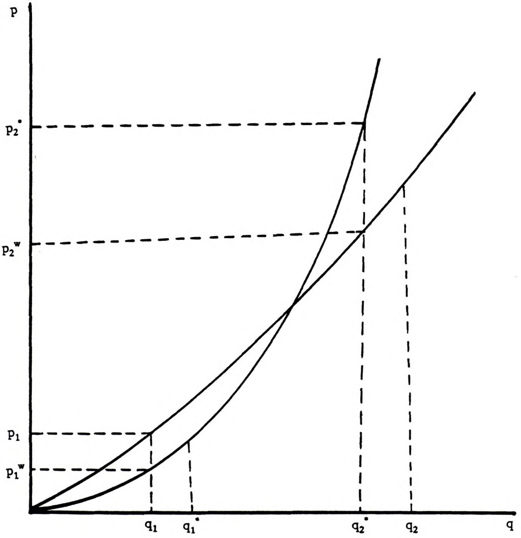

Figure 2.12

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This also shows that the gains from intra-industry trade of vertically differentiated products more closely resemble the gains resulting from inter-industry trade rather than those based on intra-industry trade of horizontally differentiated products.

2.5. Summary and Conclusions

This paper presents a model for a two-sector one-factor Ricardian economy in which one sector is vertically differentiated. Perfect competition along with free entry with a U-shaped cost function is assumed in the differentiated sector.

The discussion of the cost function with quality, shows that the quantity level of differentiated goods at the minimum average cost depends on how quality is factored into the cost function. There are three ways quality may be factored in. It may be multiplied with the variable cost, the fixed cost, or both. The minimum AC is the same in the first two ways, and only depends on the fixed cost and the quality. However, the minimum AC of the third way is different from that of the first two ways and only depends on the quality. Therefore, since the cost function is not affected by quantity in any of the three ways, the utility maximization can be used to determine optimum quality. The optimum quantity for each firm

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is determined irrespective of the quality goods produced in the market. Therefore, the results of this paper, which proceeds on the assumption that quality enters both variable and fixed cost, would remain the same if the cost function were defined using the first two methods.

The closed economy equilibrium of the model shows the quality produced and its price given labor type. The equilibrium quantity of outside goods demanded is derived from the budget constraint of the economy. In the equilibrium, "supply factors" representing cost conditions and "demand factors" representing the consumers' problem played major roles.

Changes in parameters a_m and F lead to shifts in the price schedule of the differentiated products. Unbiased cost differences resulting from decreases in a_m and F raise the equilibrium level of quality and cause its price to fall. Thus, two countries which have a difference in productivity in the outside goods sector (a_m) or a difference fixed costs in the differentiated goods sector (F) engage in inter-industry trade in which one country with high values of a_m and F has a relative comparative advantage in the production of composite goods, and the other country with low values has a relative comparative advantage in the production of differentiated goods.

The change in value of parameter r leads to "twist" in the price schedule. This biased cost difference changes the

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equilibrium quality and its price depending on the initial value of quality. Thus, countries with different values of "r" engage in intra-industry trade when the two countries have more than one type of labor. In this trade, the country with higher r has a relative comparative advantage in the production of low quality goods, and the country with low r has a relative comparative advantage in high quality goods.

Furthermore, it is shown that if either of the above types of trade happens, total production efficiency is increased. This paper also shows that the gains from intra-industry trade of vertically differentiated products more closely resemble the gains resulting from inter-industry trade rather than those based on intra-industry trade of horizontally differentiated products.

The extension of the paper can be pursued by assuming increasing costs in the outside goods. For example, suppose capital is another factor of production that is specific to the production of outside goods. Extending this model to a two-factor economy may give us the basis for a trade model based on factor endowments and distribution of preference types.

Another interesting question may be inquiring what if preference for quality depends on income which may be related to factor endowments in some way.

As a direct application, this model could be used to examine commercial policy. Tariffs, and minimum quality stand

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standards could be analyzed conveniently with same type of analysis used in this model.

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CHAPTER 3

(ESSAY 2)

The Effects of International Trade Policy on Vertically Differentiated Products: A General Equilibrium Analysis

3.1. Introduction

The current literature on international trade policy in vertically differentiated goods has been stimulated by the empirical finding that quantitative trade restrictions lead to a shift in the composition of trade toward higher valued, higher quality products.

The resulting theoretical models are limited by their partial equilibrium and ad hoc nature because they concentrate on explaining the reason behind the hypothesis. Thus, they fail to analyze it thoroughly in a standard H-O-S economy.

The partial equilibrium models of the literature only emphasize consumer welfare effects of policy instruments thus failing to consider social welfare effects resulting from terms of trade effects.

Another defect of the literature of ad hoc and partial

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equilibrium models is that they can not investigate trade policy within a whole economy, interaction between goods and factors and that between countries.

The present paper presents a two-country, two-factor, two-commodity model in which one commodity is vertically differentiated. Vertically differentiated goods are measured in the total services they generate, and total services are determined by a product of unit quality and physical quantity. Firms are assumed to choose an optimal quality to minimize their total cost in providing services of differentiated goods according to Swan (1970).

The economic situation of the model is similar to that of the standard H-O-S economy. In the production, Leontief technology is used as a specific example of constant returns to scale technology. Leontief technology is chosen for simplicity, but the basic results are not dependent on this specific functional form. The general equilibrium nature of the model enables us to investigate inter-relations of factor abundance and factor intensity in association to the quality of differentiated goods.

The model also reveals the desirability of tariffs, quotas, voluntary export restraints and minimum quality standards from a social welfare standpoint instead of the consumer welfare standpoint of partial equilibrium models. Quotas and voluntary export restraints are shown to be equivalent in their final result and inferior to tariffs.

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Minimum quality standards can be used to restrict total import services or improve social welfare but with underemployment of factor endowment.

In the next section, the basic model of Leontief technology is set up. The production possibility frontier of the economy is derived based on the technology.

In Section 3.3, autarkic equilibrium and comparative statics of the equilibrium are presented. This section proves the standard theorems of the H-O-S model in the context of the model.

In Section 3.4 and 3.5, commercial policies are discussed. Section 3.4 is devoted to tariffs and quantitative trade policies, and Section 3.5 is devoted to qualitative trade policies.

In the final section, brief summaries and conclusions are presented.

3.2. the Model[9]

Consider an economy made up of two sectors, one consisting of vertically (quality) differentiated goods, and the other of homogenous goods. Leontief (fixed coefficient)

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[9]. The model of Chapter 1 can be used for analysis of minimum ity standards and tariffs but is not suitable for the study of as and VERs because of fixed optimum quality assumption. efore, the new model will be developed for a comprehensive stigation of both quantitative (quotas, VERs) and qualitative e policy (minimum quality standards) within the same context.

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technology is used in the production as a specific example of constant return to scale (CRS) technology. The economic situation of the model is similar to that of the standard H-O-S economy.

A. Production

The production function for the homogenous goods y, and the differentiated goods x are:

(3.1-1) $y = \text{Min}\ \{\ k_y/a_{ky},\ \ L_y/a_{Ly}\ \}$

(3.1-2) $x = \text{Min}\ \{\ k_x/a_{Kx},\ \ L_x/a_{Lx}\ \}$

$= \text{Min}\ \{\ k_x/(\alpha_{kx}/q),\ \ L_x/\alpha_{Lx}q\ \}$

with $a_{kx} = \alpha_{kx}/q$, and $a_{Lx} = \alpha_{Lx}q$

where k_i and L_i represent the capital and labor used in sector i respectively, and a_{ij} is the factor i required to produce one unit of goods j. The production function for goods y is usual Leontief technology, but that for goods x includes quality variables in the fixed coefficients which require an explanation.

In sector x, each good is measured by the total services it generates because goods are differentiated by quality, and total services are determined by quality level and physical units of output as:

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(3.2) $x = q\ Q$

where x and q are services and the quality of a unit of goods x respectively, and Q represents physical units of output that can vary by quality. Thus, this equation captures the fact that higher quality grains (q), for example, yield more calories (x) than lower quality grains for given amount (Q). Q has the following production function:

(3.3) $Q = \text{Min}\ \{\ k_x/\alpha_{kx},\ \ L_x/(\alpha_{Lx}\ q^2)\ \}$

where α_{kx} and $\alpha_{Lx}q^2$ are the capital and labor required to produce one physical unit of Q respectively. Thus, the physical units of output producible from given factors depend on quality q inversely. The way quality enters into a fixed coefficient of labor ($\alpha_{Lx}q^2$) specifies that higher quality requires more labor for a unit production of Q. This amounts to assuming that upgrading quality requires R&D investment of hiring more scientists and engineers. The production for x (3.1-2) is derived from the combination of (3.2) and (3.3).

The cost functions for sector x and y can be derived from the production functions as:

(3.4-1) $C_x = (\alpha_L x\ q)\ w + (\alpha_{kx}/q)\ r$

(3.4-2) $C_y = a_{Ly}\ w + a_{ky}\ r$

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where C_i is the unit (or average) cost function for sector i, and w and r are the wages and rents respectively.

Firms in sector x choose an optimal quality to minimize their total costs in providing services of x according to an idea originated by Swan (1970). From the cost function (3.4-1), the optimal quality can be derived by partial differentiation with regard to q, and it is a negative function of the wage-rental ratio.

$$(3.5) \qquad q = \sqrt{(r\ \alpha_{kx})/(w\ \alpha_{Lx})}$$

Intuitively, increase in quality requires more labor such as scientists and engineers, and excess demand for labor raises wage-rental ratio. Therefore, optimal quality is inverslely related to wage-rental ratio.

The cost function with an optimal quality can be derived from the substitution of (3.5) into (3.4-1).

$$(3.6) \qquad C_x^* = 2\sqrt{\alpha_{Lx}\alpha_{kx}wr}$$

The zero-profit curves in sector x and y can be written as:

$$(3.7\text{-}1) \qquad 1 = w\ a_{Ly} + r\ a_{ky}$$

$$(3.7\text{-}2) \qquad p = w\ \alpha_{Lx}q + r\ \alpha_{kx}/q$$

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where goods y is used as a numeraire, and p is the relative price of x in terms of y. The slopes of the zero-profit curves which are equal to negative factor intensity ratios can be derived from the differentiation as:

(3.8-1) $dw/dr|\pi_{x=0} = - a_{Ly}/a_{Ly} = - k_y$

(3.8-2) $dw/dr|\pi_{y=0} = - \alpha_{kx}/q^2\alpha_{Lx} = - (w/r) = - k_x$

For the derivation of (3.8-2), the envelope theorem is used, and q_* is substitued into q. The zero-profit curves are depicted in Figure 3.1. The figure shows that there exists a factor intensity reversal in the model because two zero-profit curves intersect twice at E_1 and E_2.

At E_1 the slope of π_x is steeper than that of π_y, and goods x are relatively capital intensive. At E_2 goods x are relatively labor intensive.

The price p can be solved explicitly as a function of w/r from (3.7) after the substitution of q_* into q as:

(3.9) $p = \{ 2\sqrt{\alpha_{Lx}\alpha_{kx}}/[a_{Ly}(w/r) + a_{ky]} \} \sqrt{(w/r)}$

Note that

(3.10) $(w/r) = 0 \rightarrow p = 0$ and $\lim_{(w/r)\to\infty} p = 0$

also, from the differentiation of p

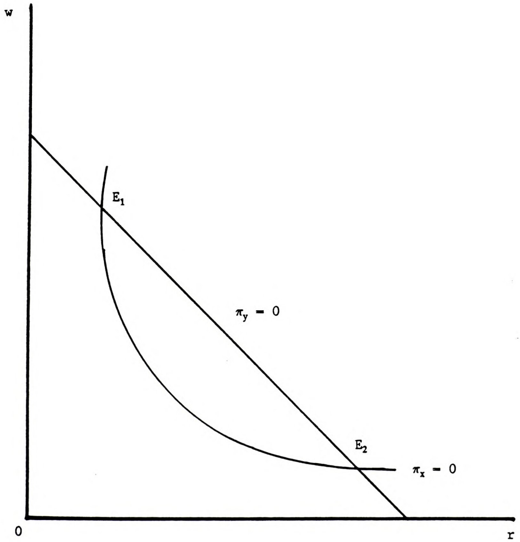

Figure 3.1

Zero Profit Curves

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(3.11) $dp/d(w/r) =$

$$\{\sqrt{\alpha_{Lx}\alpha_{kx}}/[a_{Ly}(w/r) + a_{ky}]^2\}\{ a_{ky}(w/r)^{-1/2} - a_{Ly}(w/r)^{1/2}$$

Therefore,

(3.12) $dp/d(w/r) > 0 \rightarrow a_{ky}/a_{Ly} > w/r$

Note that the critical point a_{ky}/a_{Ly} $(=k_y)$ $= w/r$ $(=k_x)$ is the point of factor intensity reversal.

The following relationship between the output price and optimal quality can be derived from the combination of (3.5) and (3.12) as:

(3.13) $q = q(p) \quad q' > 0 \rightarrow k_x > k_y$

The relationships can be illustrated in the 4-quadrant diagram in Figure 3.2. Intuitively, increase in the output price of vertically differentiated products which is capital intensive will lower wage-rental ratio (the Stolper-Samuelson Theorem), and this lowered wage-rental ratio will make possible for firms to hire more labor which is required to upgrading quality (optimal quality relationship).

The value of p at the factor intensity reversal is obtained by subtituting $w/r = a_{ky}/a_{Ly}$ into (3.13):

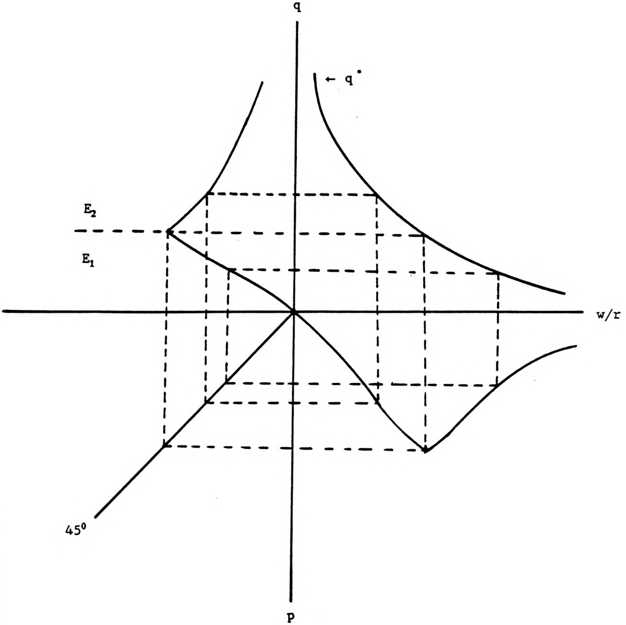

Figure 3.2

Four Quadrant Diagram of the Model

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(3.14) $p^m = \sqrt{\alpha_{Lx}\alpha_{kx}/\alpha_{Ly}a_{ky}}$

Whether the useful equilibrium for the economy is E_1 or E_2 is decided by the relative factor abundancy of the economy. Once the factor endowment is given, the wage-rental ratio of the economy is determined, along with the equilibrium. This can be illustrated by the Harrod-Johnson diagram in Figure 3.3.

If the endowment ratio of the economy (=k) is greater than k_y, k_x is greater than k_y. The economy, in this case, will has an E_1 type equilibrium. If k is smaller than k_y, the economy will has an E_2 type equilibrium. Therefore, both types of equilibrium are not possible at the same time. The following relationships represents the above discussion.

(3.15) $k > k_y \rightarrow k_x > k_y \rightarrow E_1$

$k < k_y \rightarrow k_x < k_y \rightarrow E_2$

The model will proceed on the assumption that the economy is relatively capital abundant, thus goods x are relatively capital intensive. In this case, (3.13) can be written as:

(3.16) $q = q(p), \quad q' > 0$

This fits well with the fact that quality and the output price has a positive relationship. Appendix C shows the way of specifying the production function when goods x are relatively

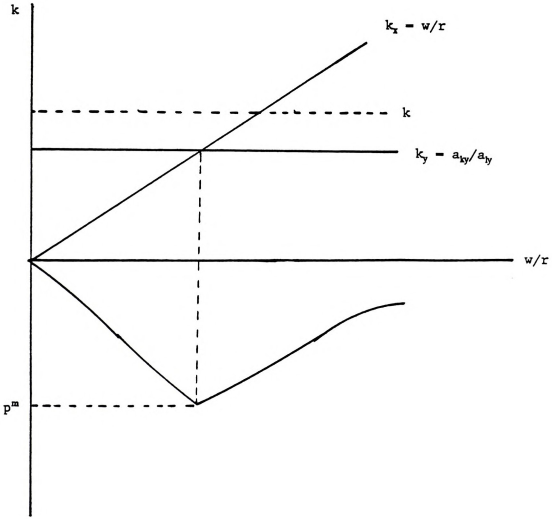

Figure 3.3

Harrod-Johnson Diagram

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labor intensive with the same result as (3.16). Thus, the proceeding discussions will apply equally to both case irrespectively of the capital intensity of goods x.

B. The Production Possibility Frontier

The production possibility frontier (PPF) can be derived from the productions (1) for a given endowment of (K, L) of the economy. The sum of the factors used in both sectors must be equal to the endowment, and this creates the following restrictions:

(3.17-1) $a_{ky}\ y + (\alpha_{kx}/q)\ x = k$ (KK)

(3.17-2) $a_{Ly}\ y + (\alpha_{Lx}q)\ x = L$ (LL)

By re-arranging (3.17), we have:

(3.18-1) $y = k/a_{ky} - (\alpha_{kx}/qa_{ky})\ x$ (KK)

(3.18-2) $y = L/a_{Ly} - (\alpha_{Lx}q/a_{Ly})\ x$ (LL)

KK curve (18-1) is steeper than LL curve (3.18-2), since goods x are relatively capital intensive. These two curves are depicted in Figure 3.4.

The two intercepts Kq/α_{kx}, $L/\alpha_{Lx}q$ change in opposite directions as the price changes in the same direction [see (3.16)]. For example, as the price increases from the


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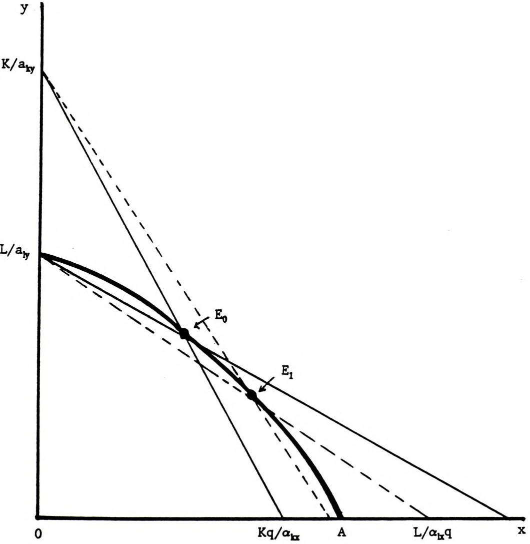

Figure 3.4

Production Possibility Frontier

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original price, which yields the intersection point E_0, kq/α_{kx} moves further from the origin O, and $L/\alpha_{Lx}q$ moves closer to the origin. The restrictions (3.18) change to the dashed line in Figure 3.4, yielding a new intersection point E_1. Repeating this operation on all prices and connecting the resulting intersection points such as E1, the PPF of the thick line in Figure 3.3 can be derived. At these intersection points, the factors are fully employed because two conditions of KK and LL are satisfied at the same time.

Note that as the production of x increases, so does the quality. This relationship can be written as:

(3.19) $dq/dx > 0$

The slope of the PPF can be derived from the total differentiation of (3.17), which is:

(3.20-1) $0 = a_{ky}dy + a_{kx}dx - (a_{kx}x/q)dq$

(3.20-2) $0 = a_{Ly}dy + a_{Lx}dx + (a_{Lx}x/q)dq$

Re-arranging (3.20) into a matrix form, we have:

(3.21) $$\begin{bmatrix} a_{ky} & a_{ky} \\ a_{Ly} & a_{Lx} \end{bmatrix} \begin{bmatrix} dy/dq \\ dx/dq \end{bmatrix} = \begin{bmatrix} a_{kx}x/q \\ -a_{Lx}x/q \end{bmatrix}$$

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(3.22) $$m = \begin{vmatrix} a_{ky} & a_{kx} \\ a_{Ly} & a_{Lx} \end{vmatrix}$$

$$m_y = \begin{vmatrix} q_{kx}x/q & a_{kx} \\ -a_{Lx}x/q & a_{Lx} \end{vmatrix} = 2a_{kx}a_{Lx}x/q$$

$$m_x = \begin{vmatrix} a_{ky} & a_{kx}x/q \\ a_{Ly} & -a_{Lx}x/q \end{vmatrix} = -(a_{ky}a_{Lx} + a_{kx}a_{Ly})x/q$$

Using Cramer's rule, we have:

(3.23) $$dy/dq = m_y/m \qquad dx/dq = m_x/m$$

Therefore, the slope of the PPF can be derived from (3.23) as:

(3.24) $$dy/dx|ppf = m_y/m_x = -\ 2a_{kx}a_{Lx}/(a_{ky}a_{Lx} + a_{kx}a_{Ly})$$
$$= -\ 2\alpha_{kx}\alpha_{Lx}/(a_{ky}\alpha_{Lx}q + a_{Ly}\alpha_{kx}/q)$$

The total differentiation of (3.24) with regard to q gives:

(3.25) $$(\partial/\partial q)(dy/dx)|ppf$$
$$= 2\alpha_{kx}\alpha_{Lx}\ [a_{ky}\alpha_{Lx} - a_{kx}a_{Ly}/q]/[a_{ky}\alpha_{Lx}q + a_{Ly}\alpha_{kx}/q]^2$$

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(3.26) $(d/dq)(dy/dx)|ppf < 0$ if $k_x > k_y$

The concavity of the PPF is derived from the combination of (3.26) and (3.19).

3.3. Equilibrium and Comparative Statics

A. Autarkic Equilibrium

The indifference curves of the economy are assumed to be downward sloped and convex to the origin. The homotheticity of the consumer's preference is sufficient for this. An autarkic equilibrium can be illustrated with indifference curves, the PPF and a price line as in Figure 3.5.

The production/consumption point A in Figure 3.5 yields the highest level of utility in the economy assuming no trade. Not only is A the "optimal" production point, it also represents the "autarkic" equilibrium. The marginal rate of transformation and the marginal rate of substitution at point A are equal to the price ratio p^*. The existence of tangency between the price line and indifference curve is assumed from the well behaving indifference curves, but the existence of tangency between the price line and the PPF must be proven because of the specific production function used in the model. It is proven by showing that the price is equal to the negative of the slope of the PPF. The price (3.9) after the su

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substitution (w/r) from (3.5) is:

$$(3.27)\qquad p = \{\ 2\sqrt{\alpha_{Lx}\alpha_{kx}}\ /\ [a_{Ly}(w/r)+a_{ky}]\ \}\sqrt{w/r} \qquad \text{eq. } (3.9)$$

$$= \{\ 2\sqrt{a_{Lx}a_{kx}}\ /\ [a_{Ly}(a_{kx}/a_{Lx})\ +a_{ky}]\}\sqrt{a_{kx}/a_{Lx}}$$

substituting (w/r) from (3.5)

$$= 2a_{kx}a_{Lx}\ /\ (a_{Ly}a_{kx} + a_{ky}a_{Lx})$$

$$= -\ dy/dx|ppf \qquad \text{eq. } (3.24)$$

Now suppose that the economy depicted in Figure 3.5 is allowed to engage in international trade. The excess demand or supply of products can be derived at each price. For example, at p_1 and the corresponding production-cum-consumption combination (for example, E-cum-C) in Figure 3.5, there is an offer of exports (FE of y) for an equal market value of imports (FC of x), and this offer is represented by trade triangle of EFC. Placing all such triangles in Figure 3.6 (where triangle TBO represents the equal triangle of EFC) generates the offer curve OH.

Note that as we moves along the OH further from the origin the price of x decreases, as does the quality of x.

B. The Comparative Statics of the Equilibrium

Now consider the effects of changing the relative factor endowment on the PPF and offer curve. These effects can be analysed by the Rybczynski theorem. In the following the

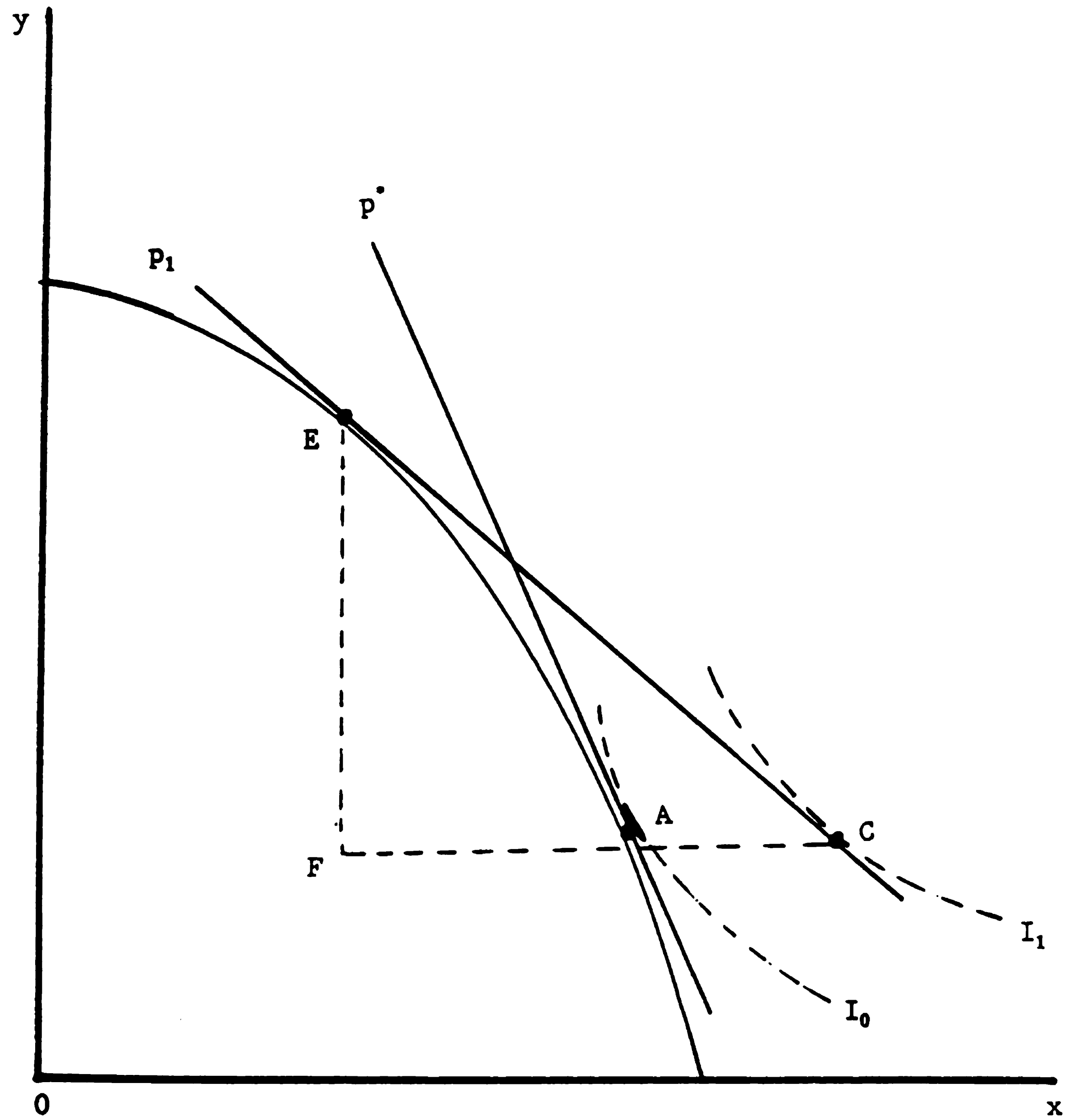

Figure 3.5

Trade Triangle

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Rybczynski theorem can be proven in this specific production model.

Proposition 1: (The Rybczynski theorem)

At constant prices, an increase in capital will increase by a greater amount the output of the differentiated goods which is intensive in capital and will reduce the output of the homogenous goods.

Proof:

From the total differentiation of (3.17), we have:

(3.28-1) $a_{ky}dy + a_{kx}dx = dk$ (kk)

(3.28-2) $a_{Ly}dy + a_{Lx}dx = dL$ (LL)

Note that a_{kx} and $a_{L}x$ are constant, since q is constant at constant prices. Re-arranging (3.28) in a matrix form after dividing it by dk and letting dL = 0, we have:

(3.29) $$\begin{bmatrix} a_{ky} & a_{Lx} \\ a_{Ly} & a_{Lx} \end{bmatrix} \begin{bmatrix} dy/dk \\ dx/dk \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

let,

(3.30) $$m = \begin{vmatrix} a_{ky} & a_{kx} \\ a_{Ly} & a_{Lx} \end{vmatrix} = a_{ky}a_{Lx} - a_{Ly}a_{kx}$$

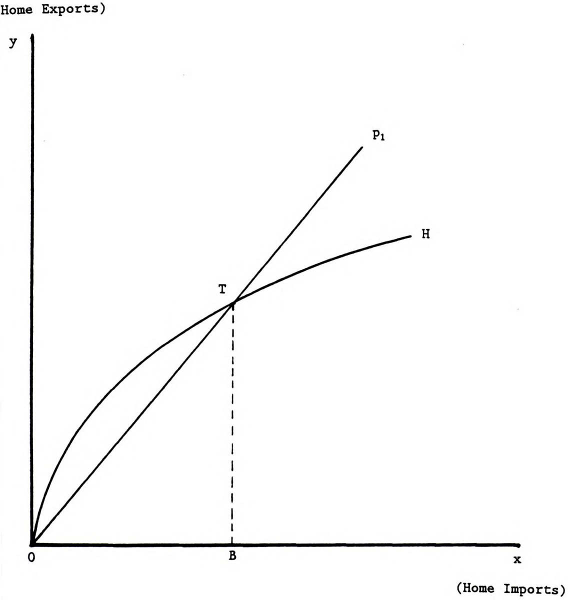

Figure 3.6

Offer Curve

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$$m_y = \begin{vmatrix} 1 & a_{kx} \\ 0 & a_{Lx} \end{vmatrix} = a_{L}x$$

$$m_x = \begin{vmatrix} a_{ky} & 1 \\ a_{Ly} & 0 \end{vmatrix} = -a_{Ly}$$

Therefore, using Cramer's rule we have:

(3.31) $$dy/dk = m_y/m = a_{Lx} \ / \ \{a_{ky}a_{Lx} - a_{kx}a_{Ly}\}$$

$$dx/dk = m_x/m = -a_{Ly} \ / \ \{a_{ky}a_{Lx} - a_{kx}a_{Ly}\}$$

Note that:

(3.32) $dy/dk < 0$ and $dx/dk > 0$ since $k_x > k_y$

Q.E.D.

Proposition 1 is depicted in Figure 3.7. The increase of one factor (capital) shifts the PPF outward from T_0T_1 to $T_0'T_1'$. Suppose the economy is at E before a factor increase. The Rybczynski theorem asserts that point E' on the new PPF, which has the same slope as E (= -p) on the old PPF, lies to the southeast of E, as illustrated.

Now consider the effects of increased capital on the offer curve. The same diagram of the capital increase is used to illustrate the effects in Figure 3.8. As capital increases in

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in a relatively labor abundant country, the economy will produce relatively more capital intensive differentiated goods as explained by the Rybczynski theorem, and thus reduce the trade. The increase in capital will neutralize the difference of relative factor endowment between this country and the capital abundant country. Therefore, trade will be reduced. This is illustrated in Figure 3.8.

An increase in capital shifts the PPF outward from T_0T_1 to $T_0'T_1'$, and production will change to the point E_1 which lies southeast of the old production point E at given price p. Consumption will change to C_1 which lies on the ray passing through C. Thus, trade will shrink from EFC to $E_1F_1C_1$. This reduction in trade is represented as an inward shift of the offer curve from OH to OH' in Figure 3.8-B. Note that the trade triangles EFC and $E_1F_1C_1$ in Figure 3.8-A are equal to the offer triangles BKO and B'K'O in Figure 3.8-B respectively.

By the same reasoning, we can analyse the case of increased capital in a capital abundant country. This will accentuate the relative factor endowment of the country. As a result, trade will expand, and the offer curve of the country will shift out.

The following theorem on the pattern of the trade can be easily derived from proposition 1.

<u>Proposition 2</u>: (The Heckscher Ohlin theorem)

A relatively capital abundant country has a comparative


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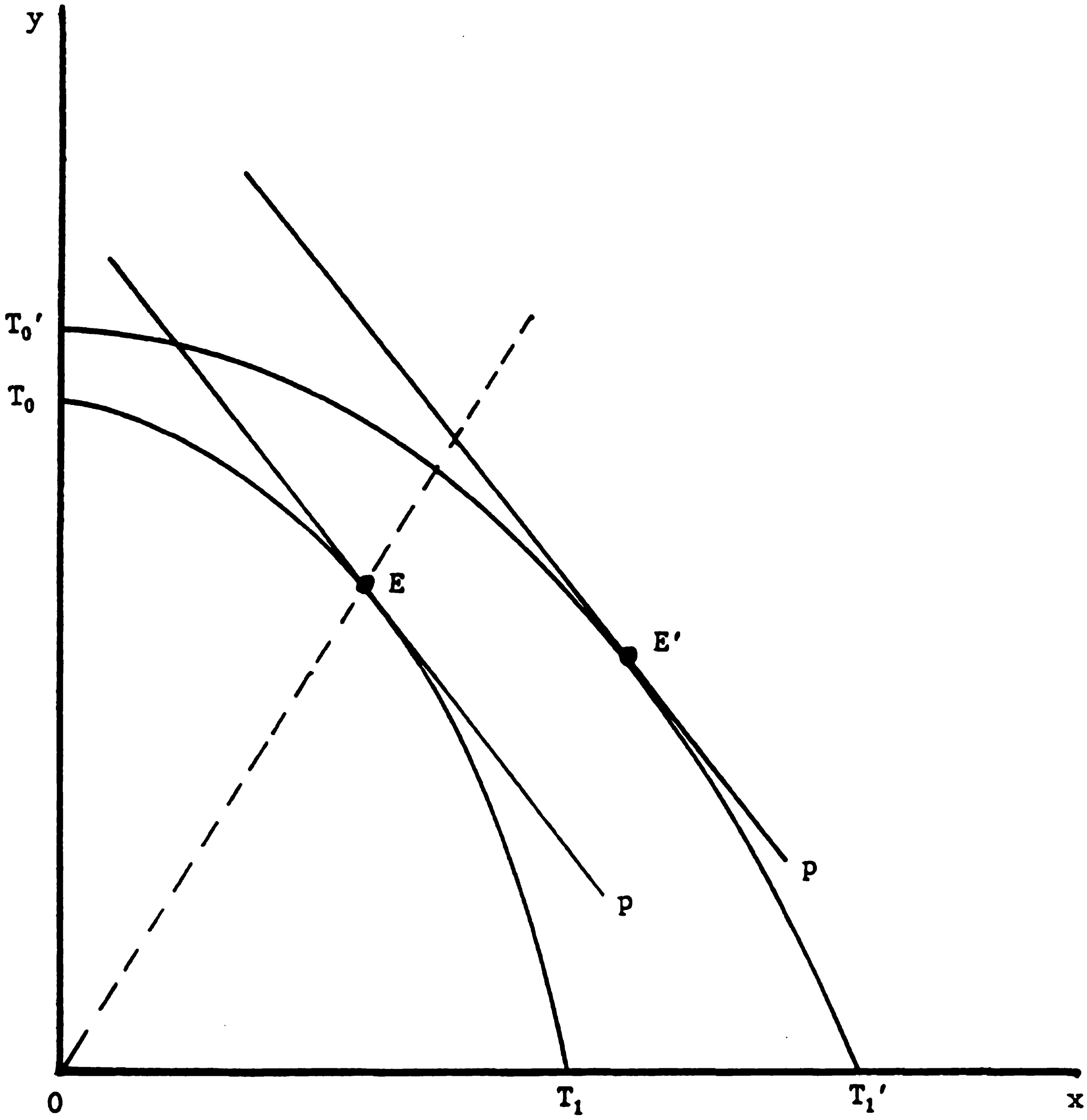

Figure 3.7

Rybczynski Theorem

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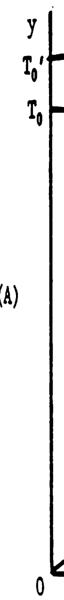

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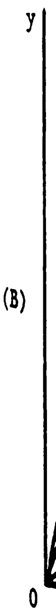

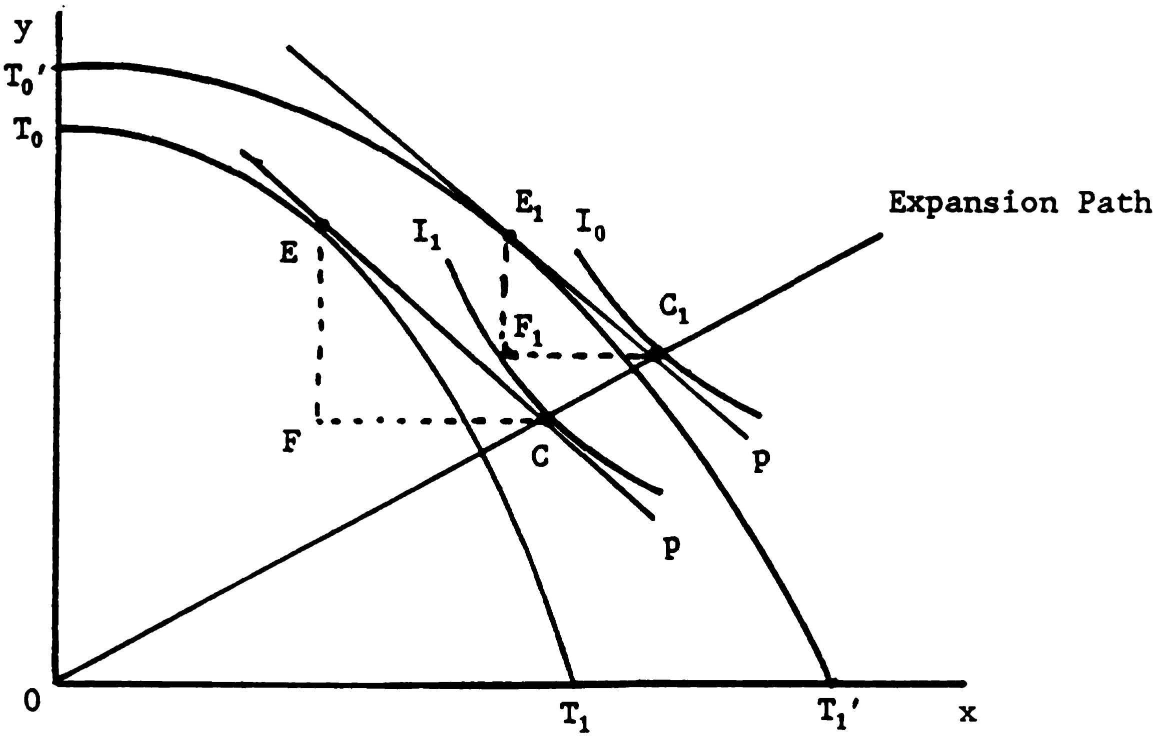

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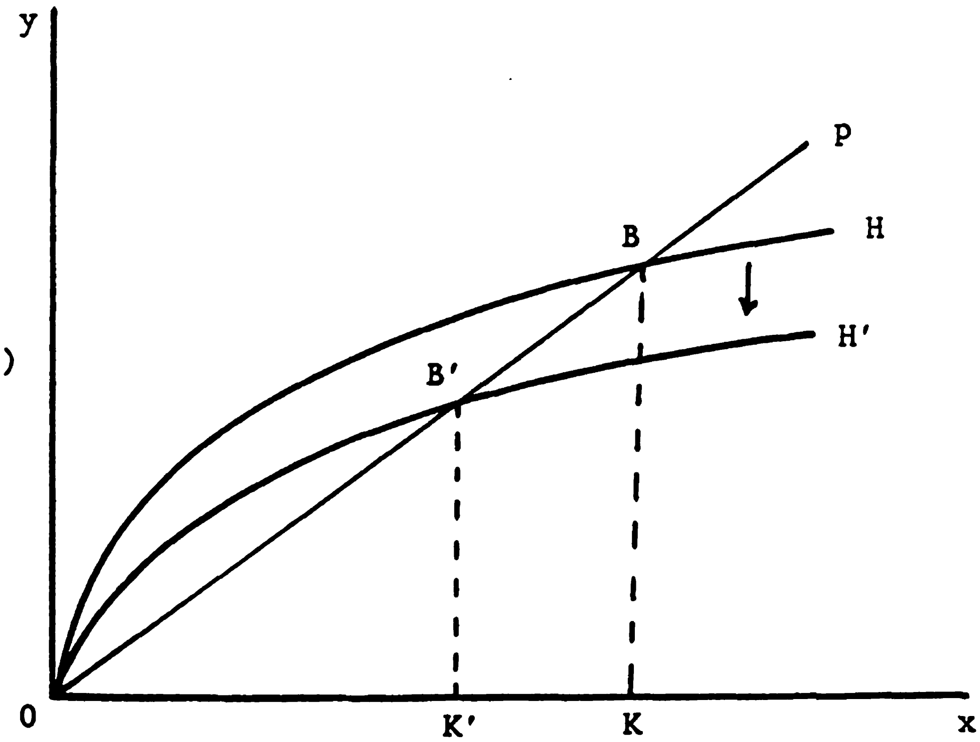

Figure 3.8

Effects of Capital Increase

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advantage in relatively capital intensive differentiated products.

Proof

If a country is relatively capital abundant, proposition 1 tells us that:

(3.33) $S_x/S_x > S_x^*/S_y^*$

where S_i and S_i^* are the supply of goods i by the capital abundant and the labor abundant country respectively.

Assuming that two countries have the same tastes:

(3.34) $D_x/D_y = D_x^*/D_y^*$

where D_i and D_i^* are the demand for good i by the capital and labor abundant country respectively. The world consumption of each good equals the world supply. Thus:

(3.35) $$S_x/S_y > D_x/D_y = (S_x + S_x^*)/(S_y + S_y^*) = D_x^*/D_y^* > S_x^*/S_y^*$$

The first inequality says that the capital abundant country exports x and imports y, and the last inequality says the opposite about the labor abundant country.

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The next proposition relating quality of differentiated goods with autarkic equilibrium prices can be derived easily from the patterns of trade.

Proposition 3: (Quality in Autarky Economy)
In autarkic equilibrium, the capital abundant country produces lower quality differentiated goods than the labor abundant country.

Proof

Proposition 2, which states the physical version of the Heckscher-Ohlin theorem, can be transformed into the price version of the Heckscher-Ohlin theorem assuming no factor market distortions as:

$$(3.36) \qquad p_A < p_A^*$$

where p_A and p_A^* are the autarkic prices of capital and labor abundant country respectively. This with (3.16) proves proposition 3.

Q.E.D.

Once trade opens, the capital abundant country will export differentiated products which will be imported by the labor abundant country. At free trade the equilibrium price of

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of the differentiated goods is determined by the intersection of the offer curves of the two countries. The international equilibrium is depicted in Figure 3.9.

In Figure 3.9 OH and OF represent the offer curves of the home and the foreign country respectively. The home country is assumed to be relatively labor abundant. Op^* is the equilibrium price at free trade. The law of one price at free trade gives the following proposition.

Proposition 4: (Quality Equalization at Free Trade)
At free trade the quality of the differentiated goods becomes equal between countries, and determined at world trade prices.

3.4. Policy Issues (1): Tariff, Quota and Voluntary Export Restraint

A. Tariff

In policy analysis trade indifference curves (TIC), which were originated by Meade (1952), are used to study the welfare effects of various trade polices. Trade indifference curves represent the locus of imports and exports which brings equal welfare to the economy. TICs are depicted in Figure 10 for the country which imports goods x for exports of goods y.

TICs have the following properties which give rise to the concave shape: (1) An increase of imports (dx) is required to co

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compensate for an increase of exports (dy), and (2) the more the country imports x on any TIC the greater is the increment of imports x which is required in order to compensate for a given increment of exports of y.

As a country moves toward the southeast direction of the trade indifference map following the arrow in Figure 3.10, the country has more imports for less exports, and the welfare of the country increases.

Every point of the offer curve is a tangency between the price line and TIC, since the offer curve is derived to maximize welfare.

For the country which imports goods y in exchange for goods x, the TIC is concave to the axis Y which is the mirror shape of TICs of Figure 3.10. The welfare of the country increases as the country moves to the northwest direction.

Suppose there are two countries, say home and foreign. The home country is assumed to be relatively labor intensive and imports differentiated products x. The international equilibrium is represented by the offer curve of the two countries in Figure 3.11. The offer curve of the home country OH intersects the foreign offer curve OF at point A generating the international equilibrium price p^*.

At autarkic equilibrium, the two countries do not engage in trade and remain at point O where the autarkic prices are p_A^H and p_A^F for the home and the foreign country respectively.

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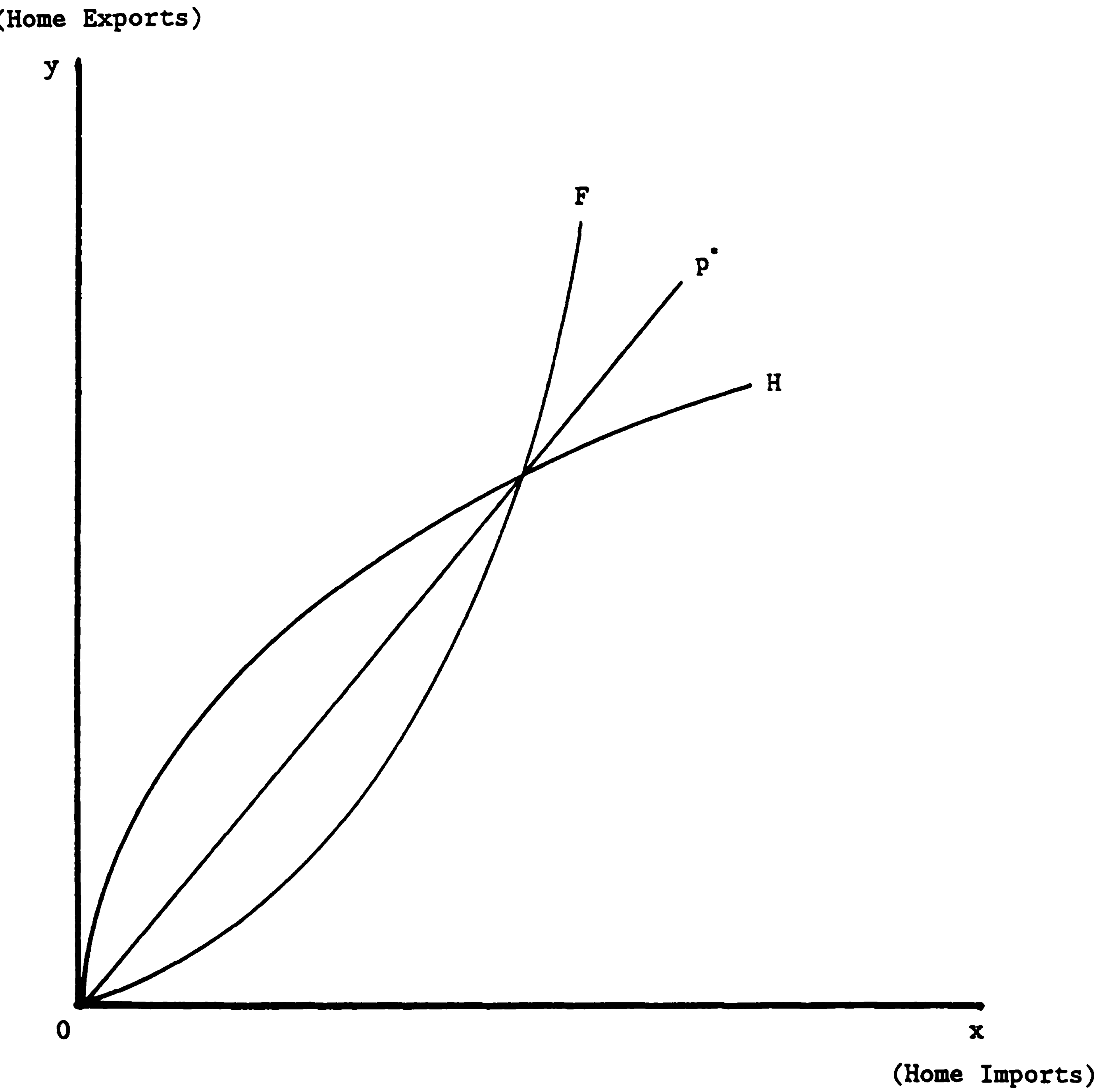

Figure 3.9

International Equilibrium

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(3.37) $p_{AF} < p^{*} < p_{AH}$

This is a graphical exposition of proposition 3 which states that the capital abundant foreign country has a lower quality differentiated goods than the labor abundant home country.

At international trade, goods x will have the same quality for both countries corresponding to p^{*}. This requires a decrease of quality for the home country and a increase of it for the foreign country.

The pattern of trade between the countries is typical Heckscher-Ohlin type and determined by the relative factor endowments. The services, not quality, of the differentiated goods matters for consumers, and quality is determined by an optimal behavior of firms given price in this model.

Now consider the effects of tariffs imposed by the home country. A tariff will shift the home offer curve from OH to OH' as in Figure 3.12.

A shift in of the offer curve is due to the difference between the offer of consumers and that actually presented to trade after tariff. For example, at point B on the free trade offer curve, it indicates that in order to obtain the quantity OK of imports, consumers of the home country are willing to pay BK of exports at a price p^{t}. But if there is a tariff, part of the total payment BK must be paid as a tariff, and only a portion will be left for the foreign country. Point A' in Figure 3.12 is drawn so that BK'/A'K equals the tariff

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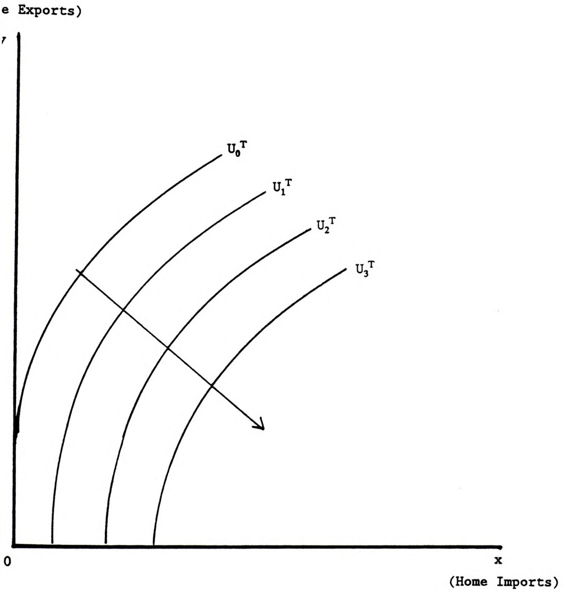
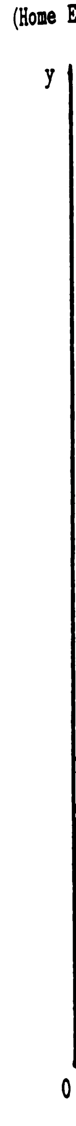


Figure 3.10

Trade Indifference Curves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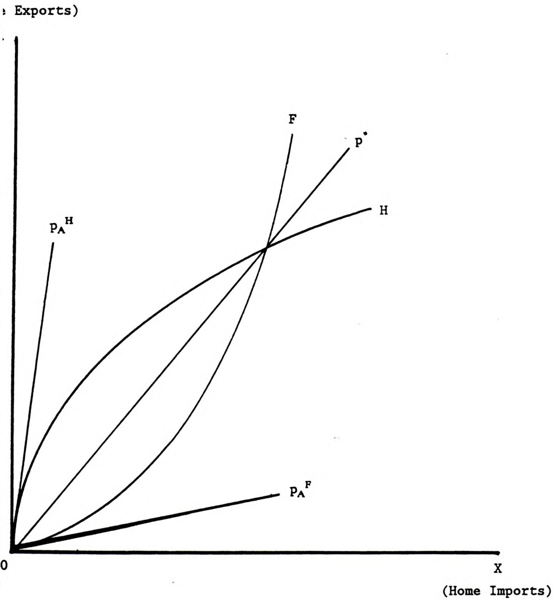

Figure 3.11

International Equilibrium and Autarkic Prices rat

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At the new equilibrium A', the tariff-ridden price p^t creases from the free trade price p^*, and the international ice becomes p'.

$$.38) \quad p^t = p'(1+t) > p^* > p'$$

erefore, tariffs will destroy the equality of quality tween the two countries. The home country will produce the ality corresponding to p^t, and consume a part of the lower ality corresponding to p' which is produced by the foreign untry.

Considering the TICs for these two countries, the welfare the home country can only be improved at the expense of the reign country.

Quota

A quota limits the physical units of goods that can be ought into the country. For homogenous goods a quota stricts total imports quantity since the goods are measured one-dimensional physical quantity. For vertically ferentiated goods, the goods are measured in two-nensional total services which is a product of unit quality physical quantity. In this case, quota which restricts sical quantity leaves quality to change freely. Thus, the


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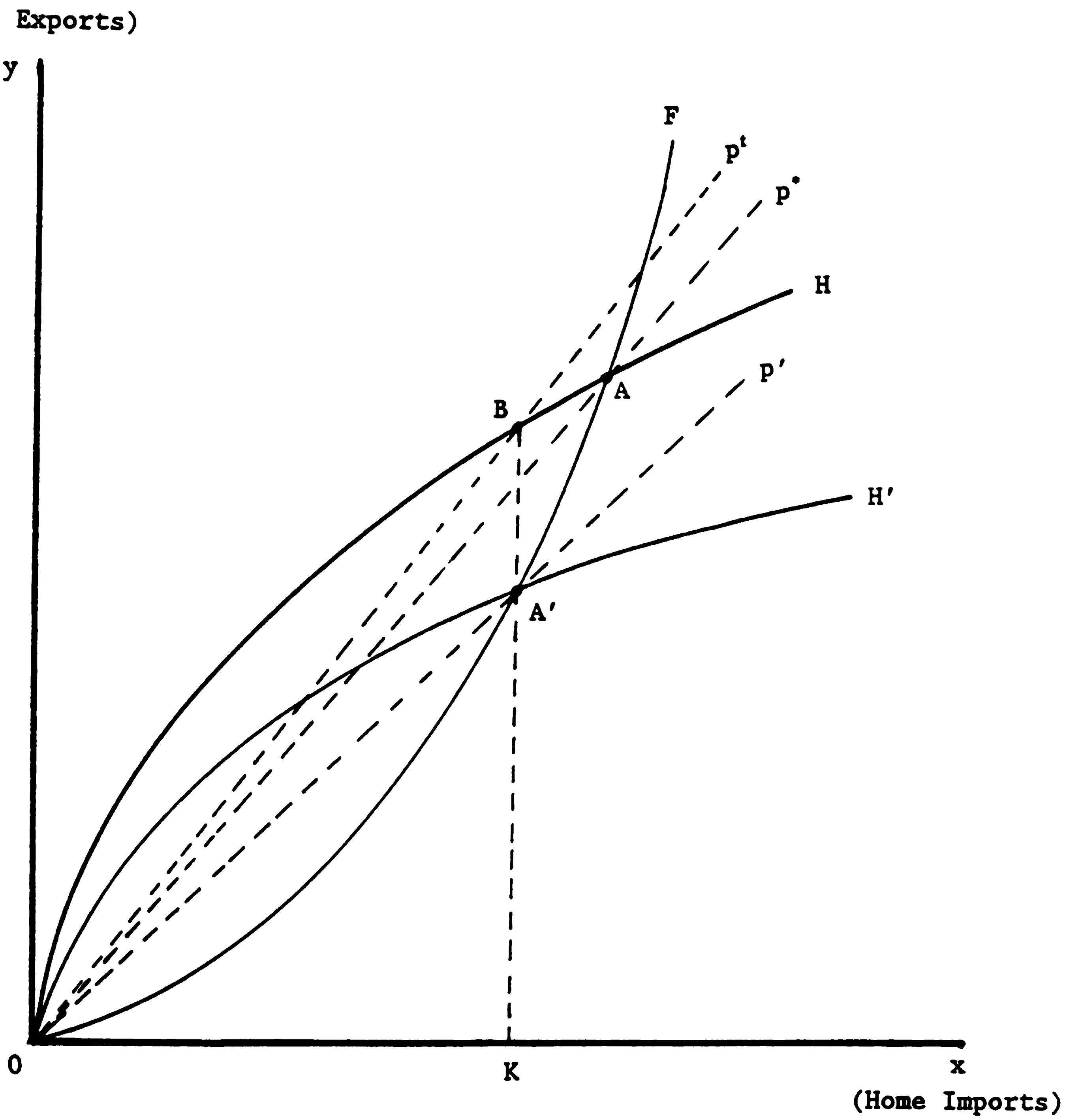

Figure 3.12

Effects of a Tariff

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effects of quantitative restrictive policy are different between the two types of goods.

If a quota is imposed by the home country, exports of the foreign country are subject to limits on the specific physical units but can be increased by providing higher qualities. Consider the PPF in terms of Q and y to understand how it is related with the PPF of x and y. The production function of Q is given in (3.3). From the production functions (3.1-1) and (3.3), the following factor endowment restrictions are derived:

(3.39-1) $a_{ky}\, y + \alpha_{kx}\, Q = K$ (KK)

(3.39-2) $a_{Ly}\, y + (\alpha_{Lx} q^2)\, q = L$ (LL)

By re-arranging (3.39), we have:

(3.40-1) $y = K/a_{ky} - \alpha_{kx}\, Q/a_{ky}$ (KK)

(3.40-2) $y = L/a_{Ly} - \alpha_{Lx} q^2/a_{Ly} Q$ (LL)

KK is steeper than LL, since goods x are relatively capital intensive. These two curves are depicted in Figure 3.13.

The PPF of Q and y can be derived by connecting the intersection points between KK and LL as quality changes corresponding to the change of the price. The intersection points of the two restrictions lie on the KK line below the dotted horizontal LL line for zero price because only the LL cur

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rve is a function of quality. The resulting PPF is depicted the thick line in Figure 3.13.

The slope of the PPF is simply the slope of the KK line $_x/a_{ky}$. This can also be shown by the differentiation of KK d LL.

.41-1) $$a_{ky}\, dy + \alpha_{kx}\, dQ = 0$$

.41-2) $$a_{Ly}\, dy + \alpha_{Lx} q^2\, dQ + 2\alpha_{Lx} qQ\, dq = 0$$

ranging (3.41) in a matrix form after dividing it by dq, we ve:

.42) $$\begin{bmatrix} a_{ky} & \alpha_{kx} \\ a_{Ly} & \alpha_{Lx} q^2 \end{bmatrix} \begin{bmatrix} dy/dq \\ dQ/dq \end{bmatrix} = \begin{bmatrix} 0 \\ -2\alpha_{Lx} qQ \end{bmatrix}$$

Cramer's rule, we get:

.43) $$dy/dq = 2\alpha_{Lx} qQ\alpha_{kx} \,/\, (a_{ky}\alpha_{Lx} q^2 - a_{Ly}\alpha_{kx})$$

$$dQ/dq = -2a_{ky}\alpha_{Lx} qQ \,/\, (a_{ky}\alpha_{Lx} q^2 - a_{Ly}\alpha_{kx})$$

erefore, we get:

.44) $$dy/dQ|ppf = (dy/dq)/(dQ/dq) = -\alpha_{kx}/a_{ky}$$

The transformation of the quantity version PPF into the rvice version PPF can be done by multiplying Q by q, since x =

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x = qQ. Notice that the PPFs of both the service version in Figure 3.4 and the quantity version have the same vertical intercepts of KK and LL. The horizontal intercepts are also equal if q = 1. In this case x = Q. This comparison can be depicted in the same graph in Figure 3.14.

The quantity version PPF is transformed into the service version in Figure 3.14. The following relationship is observed because quality q is an index number greater than zero:

$$(3.45) \quad \begin{aligned} 0 < q < 1 &\rightarrow x < Q \\ q = 1 &\rightarrow x = Q \\ q > 1 &\rightarrow x > Q \end{aligned}$$

Now suppose there is a restriction in the physical quantity produced in the foreign country. This cause a direct restriction in the quantity version PPF changing it to a vertical line for quantities greater than specified quantity Q^*. For the service version PPF, this quantity restriction will not be represented in the same simple way as in the quantity version PPF since services can change as quality changes. Thus, the restricted portion of the PPF is concave because x increases as quality increases for high prices. This is depicted in Figure 3.15.

The PPF under a physical quantity restriction can be derived specifically as follows. The substitution of dx = Qdq


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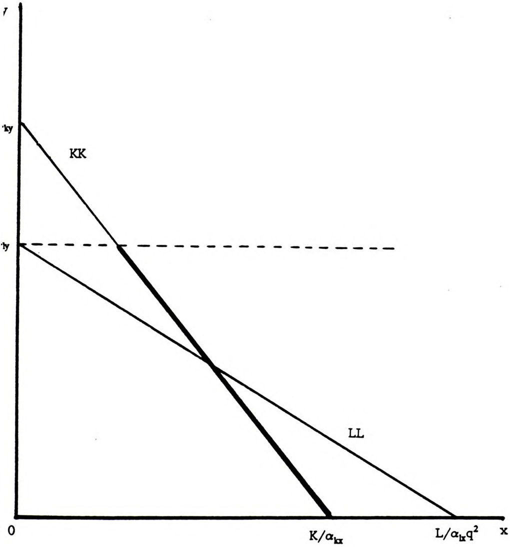

Figure 3.13

Quantity Version of the Production Possibility Frontier

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+ qdQ into (3.20) gives the following total differentiation of the factor endowment restrictions:

(3.46-1) $a_{ky}\ dy + a_{kx}\ (\ Qdq + qdQ\ ) - (a_{kx}/q)xdq = 0$

(3.46-2) $a_{Ly}\ dy + a_{Lx}\ (\ Qdq + qdQ\ ) + (a_{Lx}/q)xdq = 0$

By re-arranging (3.46), we have:

(3.47-1) $a_{ky}\ dy + a_{kx}q\ dQ = 0$

(3.47-2) $a_{Ly}\ dy + 2a_{Lx}Q\ dq + a_{Lx}q\ dQ = 0$

Writting (3.47) in a matrix form after dividing it by dQ, we have:

(3.48) $$\begin{bmatrix} a_{ky} & o \\ a_{L}y & 2a_{Lx} \end{bmatrix} \begin{bmatrix} dy/dQ \\ Qdq/dQ \end{bmatrix} = \begin{bmatrix} -a_{kx}q \\ -a_{Lx}q \end{bmatrix}$$

From Cramer's rule, we get:

(3.49) $dy/dQ = -2a_{Lx}a_{kx}q/2a_{ky}a_{Lx}$

$Qdq/dQ = (-a_{ky}a_{Lx}q + a_{Ly}a_{kx}a_{kx}q)/2a_{ky}a_{Lx}$

Therefore:

(3.50) $dy/Qdq = -\ 2a_{Lx}a_{kx}/(a_{kx}a_{Ly} - a_{ky}a_{Lx})$

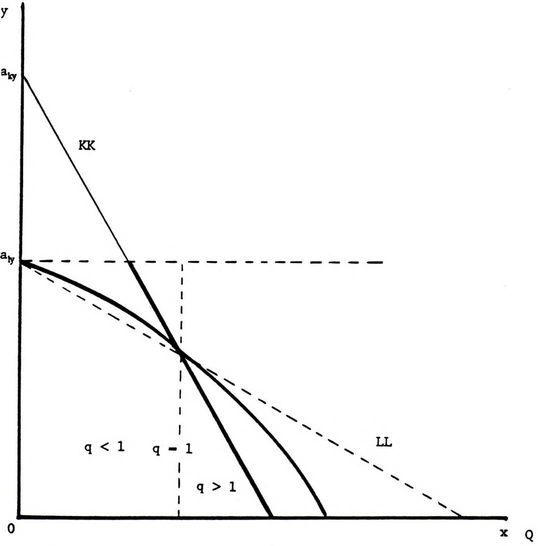

Figure 3.14

Two Versions of the Production Possibility Frontier

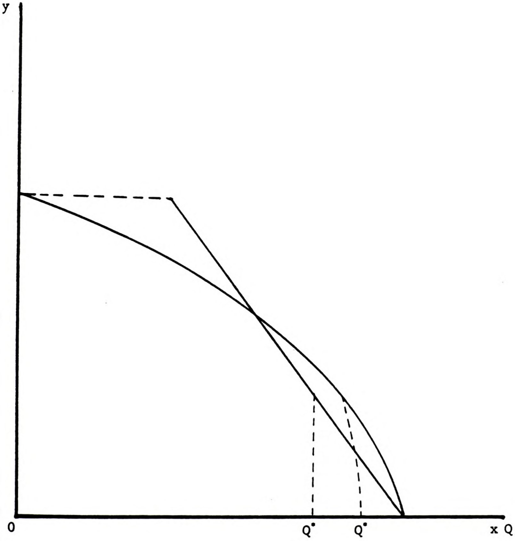

Figure 3.15

Effects of Quantity Restriction on PPFs

Noticing that $dx = Qdq$ if $dQ = 0$, the slope of the PPF when there is a restriction in Q ($dQ = 0$) is:

(3.51) $$dy/dx|Q=Q^* = dy/Qdq|Q=Q^* = -2a_{Lx}a_{kx}/(a_{kx}a_{Ly} - a_{ky}a_{Lx})$$

The concavity of the restricted PPF can be proven by the differentiation of the slope with regard to q.

(3.52) $$\partial/\partial q(dy/Qdq)$$
$$= -2a_{Lx}a_{kx}(a_{Ly}\alpha_{Lx}/q^2 + a_{ky}\alpha_{Lx})/(a_{Ly}\alpha_{Lx}/q - a_{ky}\alpha_{Lx}q)^2 < 0$$

The slope of the restricted PPF is smaller than that of the unrestricted PPF (3.24).

(3.53) $$dy/Qdq|Q=Q* = - 2a_{Lx}a_{kx}/(a_{kx}a_{Ly} - a_{ky}a_{Lx}$$
$$< dy/dx|ppf = - 2a_{lx}a_{kx}/(a_{kx}a_{ly} + a_{ky}a_{lx})$$

The restricted PPF is steeper than the unrestricted PPF. The price which is equal to the negative of the slope of the unrestricted PPF is smaller than that of the restricted PPF. Note also that $q = q(p)$ (3.20) is true irrespective of quantity in this CRS economy since quantity is indeterminate for zero-profit firms. Therefore, goods are not produced at tangent points of the restricted PPF, since the economy is distorted by the restriction. This is depicted in Figure 3.16.

In Figure 3.16 p_0 is the price in which the economy produces quality q_0 at E which is also true for the restricted economy at E'.

The shift of the PPF with quantity restriction can be tranformed into the shift of the offer curve. At point A in Figure 3.16, the exports of the foreign country are assumed to be equal to the amount compatible with point A in the offer curve in Figure 3.17. In Figure 3.16, once the price increases higher than the slope at A, and the offer of exports by the foreign country decreases if the country is subject to physical quantity restriction. For example, for the price p_0 the offer of the country can be derived by connecting the consumption points C and C' which lie on the expansion path. The offer of exports ED is reduced to E'D' under the restriction. This change of offer results in the foreign offer curve after the price p which is compatible with the production at A. The shift-in of the offer curve represents the reduction of the offer. This is depicted in Figure 3.17. For example, at price p_0 the offer of exports is reduced from DB to D'B'. DBO and D'B'O' in Figure 3.17 are equal triangles with EDC and E'D'C' in Figure 3.16 respectively.

Now consider the effects of a quota imposed by the home country. Figure 3.18 shows how such a quota works.

A quota of physical quantity Q' is imposed to obtain the results of the optimum tariff with the rate of B"C/CA". If the quality of the imports stays at q_0 which is compatible

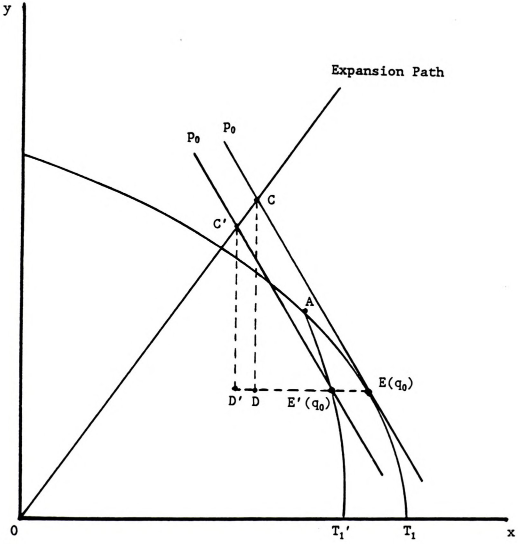

Figure 3.16

Trade Triangle under Quantity Restriction with Q', then the economy will reach the new equilibrium C with total imports q_0Q'. In this case OB"A will be the effective offer curve of the home country. This is the equilibrium attainable by the optimal tariff and its offer curve OH'.

At q_0Q' there exists an excess demand for services by the home country. The excess demand can be filled only by importing higher quality given restriction on physical quantity. However, foreign firms will not produce higher quality without a price increase as implied by the offer curve OCF'. Thus, world excess demand pushes the price up, foreign quality produced rises, and home demand falls. This process continues until equilibrium B' is attained. At the new equilibrium B' the home country's terms of trade is deteriorated. The new equilibrium price becomes A'B'/OA' which is higher than the free trade equilibrium price AE/OA. Therefore, the welfare of the foreign country rises from U^t_0 to U_t^1 as depicted in Figure 3.18.

A quota on vertically differentiated goods reduces total import services from A to A' at the expense of the terms of trade of the home country. A quota on vertically differentiated goods lowers the national welfare of the home country. In contrast, a quota on homogenous goods improves the quota imposing country's terms of trade to A"C/OA", and therefore its welfare.

At point B" the quantity exported by the foreign country

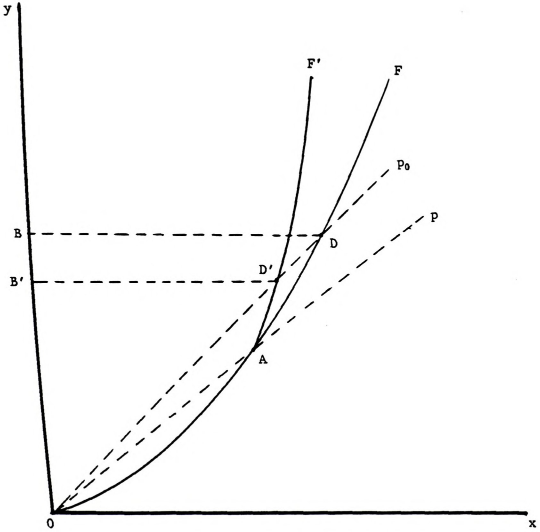

Figure 3.17

Shift of the Offer Curve under Quantity Restriction

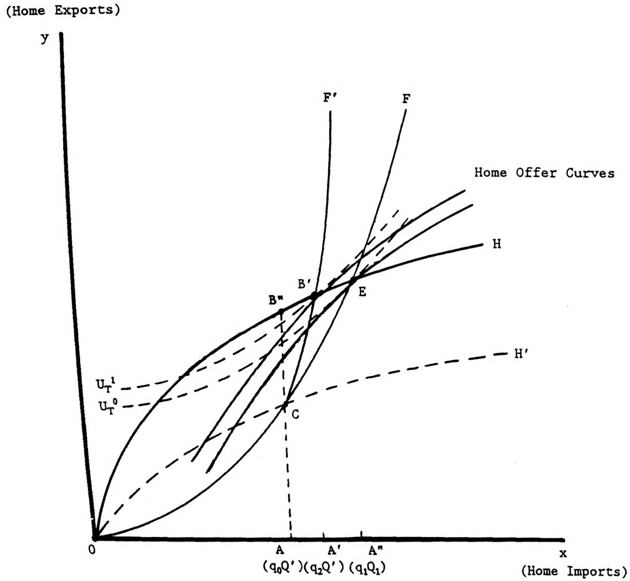

Figure 3.18

Effects of the Quota

commands a higher price than that of the initial equilibrium E. This implies that the quality with quota restriction is higher than that in free trade.

C. Voluntary Export Restraint

Another quantitative restriction on trade can be practiced by voluntary export restraint (VER) under which the foreign country is coerced into restricting exports instead of the home country invoking tariffs or quotas.

VER on vertically differentiated goods should be analysed as a quantity restriction which leaves quality to adjust. Therefore, VERs work the same as quotas. Figure 3.19 shows how VER works.

The VER of physical quantity Q' is imposed by the foreign country. If there is no quality change as in homogenous goods, the VER shifts the effective foreign offer curve to OCF" generating a new equilibrium B". At B" the foreign terms of trade increase to B"A"/OA" from free trade level EA/OA. Therefore, the welfare of the foreign country rises from U_t^0 to U_t^2.

Now consider a quality adjustment under this VER. There is an excess demand at A" in the home country. This excess demand can be filled only by importing high quality goods under quantity restriction. However, foreign firms require an increase of the price to increase the quality produced.

The excess demand forces the price up, and the foreign quality produced increases as the price rises. The price increase will dampen the excess demand. This process continues until the new equilibrium B' lying on the foreign offer curve under the restriction CF' is attained.

At B' the terms of trade of the foreign country becomes B'A'/OA' which is lower than that without quality change. Therefore, the welfare of the foreign country decreases from U_t^2 to U_t^1. The total amount of exports increases from OA" to OA' with quality adjustment.

VER on vertically differentiated goods reduce total export services from A to A', which is greater than A", the amount implied without quality increase. This evasion of restrictive policy of VER (=A'-A") partially offsets the improvements of both terms of trade and welfare of the foreign country.

The equivalence between quota and VER is observed when VERs are compared with the same quantity quotas. Two quantitative trade policies will have the same final equilibrium (B' at Q'). Therefore, quantitative restrictions on vertically differentiated goods have identical effects irrespective of their specific forms because the goods have an additional aspect (quality) which moves freely under quantitative restrictions. Quality changes to meet the excess demand created by the policies. The terms of trade of an imposing country deteriorates.

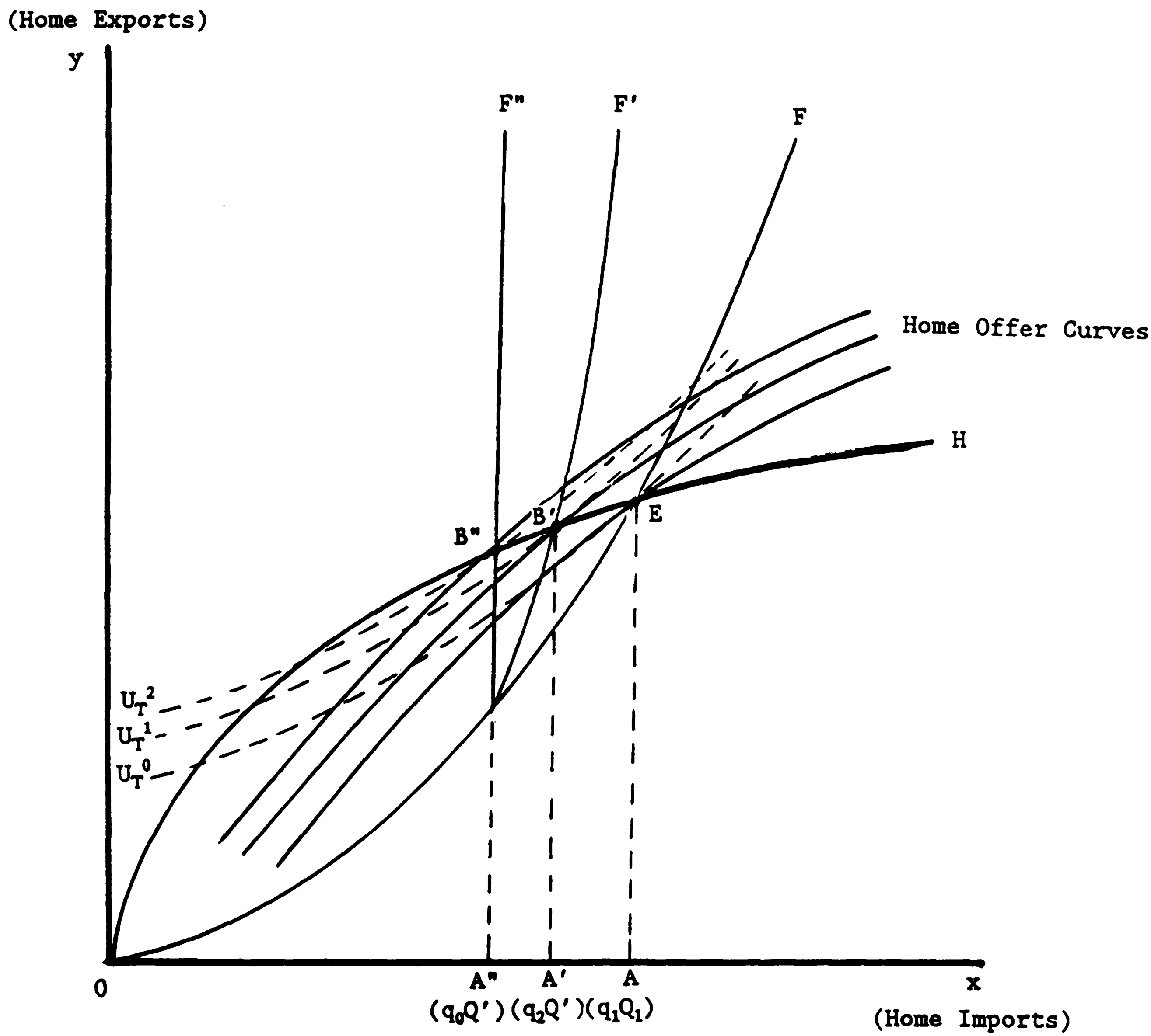

Figure 3.19

Effects of The Voluntary Export Restraint

For the home country, tariffs definitely bring restrictions on imports; however, quantitative policies (quotas and VERs) are elusive in their restrictions. Furthermore, tariffs are superior to VERs and quotas from a welfare standpoint.

3.5. Policy Issues (2): Minimum Quality Standard

The minimum quality standard (MQS) is a restriction imposed by governments to prevent home firms from producing lower quality goods than a minimum quality (q^m) in sector x. The MQS is also used to restrict imports. In this case quality exported by foreign firms should conform to it. Contrary to quantitative trade policy (quota, VER) which restricts physical units of goods, the MQS is a quality restriction policy. Thus, physical units of goods are free to adjust once the quality of each unit is greater than the minimum quality (MQ) under a MQS.

A. Production

The production functions for y and x are defined by (1-1) and (1-2) with additional restriction on (1-2) under the MQS

(3.54) $$q \geq q^m$$

where q^m is the MQ imposed by the government. From the relationship between optimal quality and wage-rental ratio (3.5), the MQS is binding when the wage-rental ratio increases from the level (w/r)' compatible with q^m because optimal quality is a nagative function of the wage-rental ratio.

If the MQS is binding, firms can not adjust their quality to the optimum, and q is fixed at q^m. The slope of the zero-profit curve restricted by the MQS can be derived from the differentiation of (3.7-2) as:

$$(3.55) \qquad dw/dr|_{q=q^m} = -\alpha_{kx}/\alpha_{Lx}q^2 \quad (\text{ =constant })$$

The slope is constant because q is fixed at q^m. Therefore, the zero-profit curve of x becomes a straight line with a negative slope. With the presence of the MQS, the zero-profit curve (3.7-2) can be written as:

$$(3.56) \qquad w = p/\alpha_{Lx}q^m - \alpha_{kx}r/\alpha_{Lx}q^{m2}$$

The restricted zero-profit curve (3.56) is tangent to the unrestricted zero-profit curve (3.7-2) at (w/r)', since the slope of the restricted zero-profit curve is equal to that of the unrestricted zero-profit curve at the critical wage-rental ratio (w/r)': The substitution of $q^m = \sqrt{(w/r)'(\alpha_{kx}/\alpha_{Lx})}$ into (3.56) generates -(w/r)' which is the slope of the zero-profit curve at (w/r)'. This is illustrated in Figure 3.20.

The MQ is restricted at the level compatible with (w/r)' which is represented by the ray from the origin, and the MQS is binding when (w/r)' lies left of the ray. The zero-profit curve when the MQS is binding is AE_0. For wage-rental ratios lower than (w/r), the MQS is not binding, and the zero-profit curve is $E_0\pi_x$. Thus, the effective zero-profit curve becomes $AE_0\pi_x$ depicted by the thick line in Figure 3.20. As MQ increases from the level E_0 to En, the vertical intercept A of the zero-profit curve moves toward A', and the curve becomes flattened.

The effects of the MQS on economic equilibrium can be illustrated with a factor price frontier diagram. This is depicted in Figure 3.21.

In Figure 3.21, factor price frontiers of goods x and y are drawn with an initial equilibrium E. $AE_0\pi_x$ and π_y are the zero-profit curves of x and y respectively, and the MQS is imposed at (w/r)'.

Suppose there is a decrease in the price of goods x from p to p' shifting the zero-profit curve to $A'B\pi_x'$. The new equilibrium of the economy is at A' which is the intersection point of the two zero-profit curves. Further decreases of the price p below p_k cause the zero-profit curve of y to lie above that of x at every wage-rental ratio. Thus, the economy will specialize in the production of y which brings higher profit than x. Furthermore, this specialization in y leaves the

capital endowments of the economy unemployed because y is relatively labor intensive, and the rents of capital becomes zero as in A' in Figure 3.21.

The critical price for specialized production (p_k) can be solved from the zero-profit conditions (3.7) as:

$$(3.57\text{-}1) \qquad 1 = wa_{Ly} + ra_{ky}$$

$$(3.57\text{-}2) \qquad p = w\alpha_{Lx}q^m + r\alpha_{kx}/q^m$$

Substituting $q^m = \sqrt{(w/r)'(\alpha_{kx}/\alpha_{Lx})}$ and $r = 0$ (as in point A') into (3.57), the critical price is get

$$(3.58) \qquad p_k = \alpha_{Lx}q/a_{Ly} = (\alpha_{Lx}/a_{Ly})\sqrt{(w/r)'(a_{kx}/a_{Lx})}$$

This shows that p_k increases as $(w/r)'$ falls, i.e. the MQS is imposed at higher quality.

B. The Production Possibility Frontier

The production possibility frontier with the MQS can be derived from (3.17) and (3.54). This is written as:

$$(3.59\text{-}1) \qquad a_{ky}\, y + (\alpha_{kx}/q)\, x \le K \qquad \text{(KK)}$$

$$(3.59\text{-}2) \qquad a_{Ly}\, y + (\alpha_{Lx}q)\, x \le L \qquad \text{(LL)}$$

$$(3.59\text{-}3) \qquad q \ge q^m$$

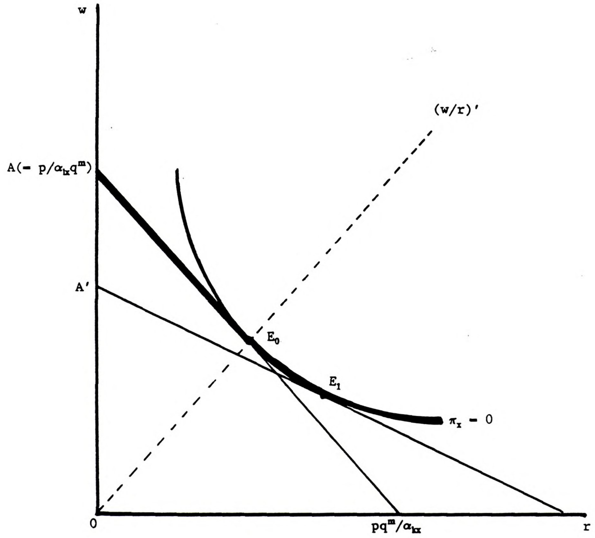

Figure 3.20

Effective Zero Profit Curve

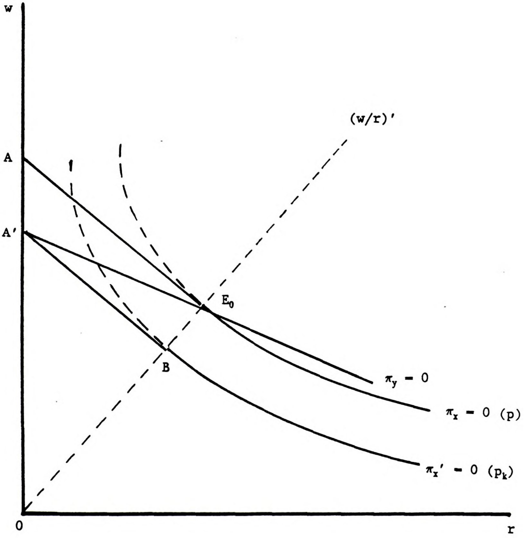

Figure 3.21

Effects of the MQS on Factor Price Frontier

The factor endowment restrictions are depicted in Figure 3.22. The horizontal intercept of KK moves outward from the origin as quality increases following a rise in the price, but that of LL moves toward the origin. The PPF when the MQS is not binding ($q \geq q^m$) gives rise to E_0A which is the line drawn by connecting the intercepts of KK and LL. If the price falls below the level compatible with q^m, the MQS is binding. In this case, KK and LL are fixed lines as in Figure 3.22. Therefore, the economy will produce at LL which satisfies (3.59), and the PPF for this price range is CE. The PPF under the restriction of the MQS is CE_0A depicted by the thick line in Figure 3.22. As MQ increases, point E_0 moves toward A.

The PPF CE_0A shows that an under-utilization of capital exists when the MQS is binding (at CE_0), since KK is not satisfied by equality. The slope of the PPF with the MQS is equal to that of the labor restriction.

(3.60) $$y = L/a_{Ly} - (\alpha_{Lx}q^m/a_{Ly})\ x \qquad \text{(LL)}$$

Therefore, from the differentiation (3.60), the slope of the restricted PPF is:

(3.61) $$dy/dx|_{q=q^m} = - \alpha_{Lx}q/a_{Ly}$$

This is equal to the negative of the price with the specialization of (3.58). Thus, the economy still produces

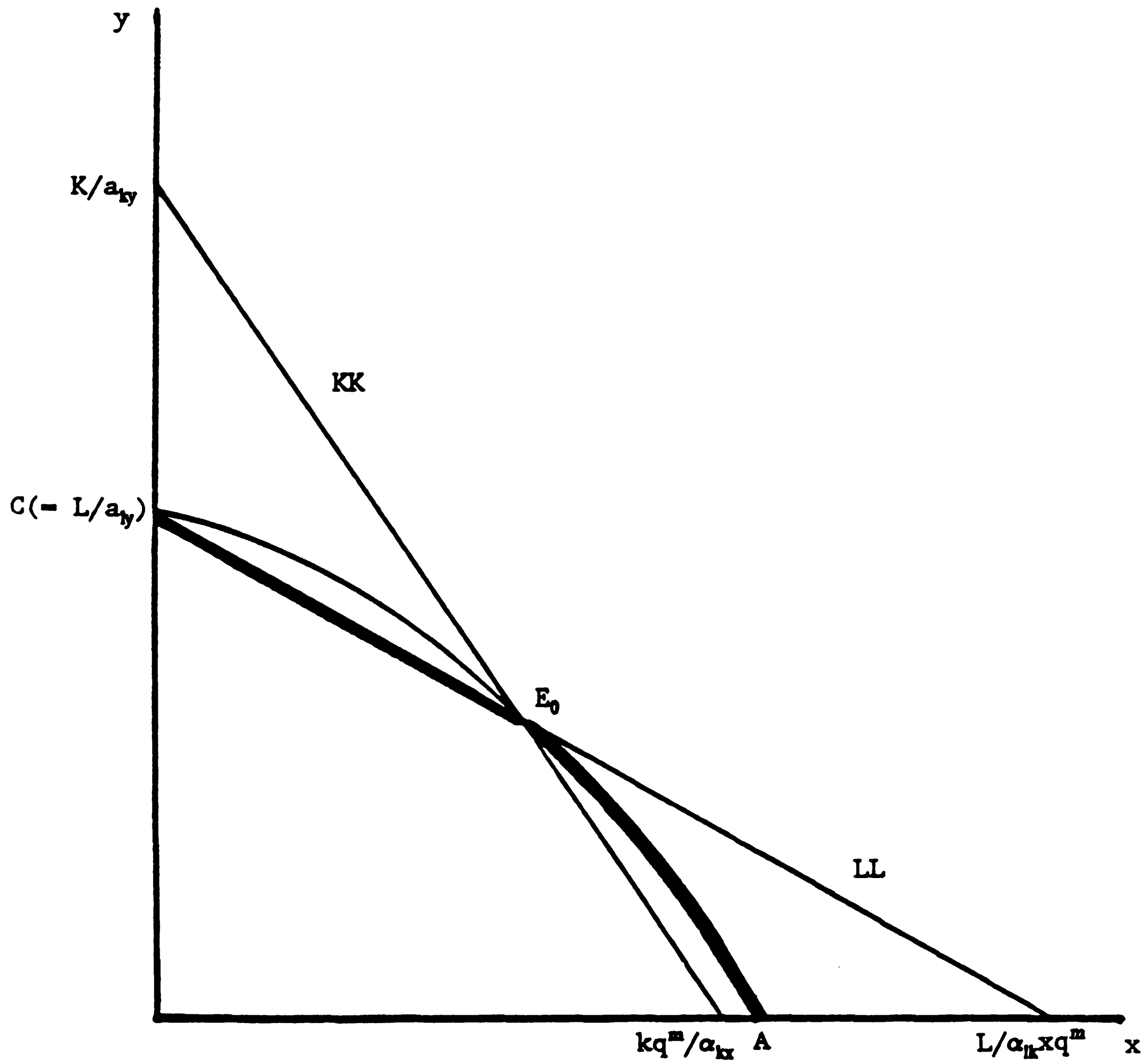

Figure 3.22

Production Possibility Frontier under MQS at tangent points (actually a LL line) between the price and the PPF when MQS is binding. The MQS distorts the economy with under-utilization of the capital endowment of the economy.

C. The Offer Curve

(C-1). The Home Country

The offer curve of the economy under the MQS defined in (3.54) can be derived from the PPF of the last section. Figure 3.23 shows how the home offer curve shifts when the MQS is on its own goods x. The unrestricted offer curve of OH in Figure 3.23-B represents excess demand (imports) and excess supply (exports) of the home country at each price ratio. For example, at price p_0 the home country produce at A and consumes at C_0 exchanging AB units of y for the same value of B_0C_0 services of x, and at price p_1 the home country exchanges A'B' units of y for B'C' services of x at free trade. These combinations of exports and imports give rise to the offer curve of OH.

Now suppose the MQS discussed exists in the economy. The PPF will become T_0AT_1 assuming MQ is imposed at the price p_0. At price ratio p_1 which is lower than p_0, the production of the economy remains at A due to the MQS generating a trade triangle AB_1C_1. Therefore, at price p_1 trade is reduced from

(A)

(B)

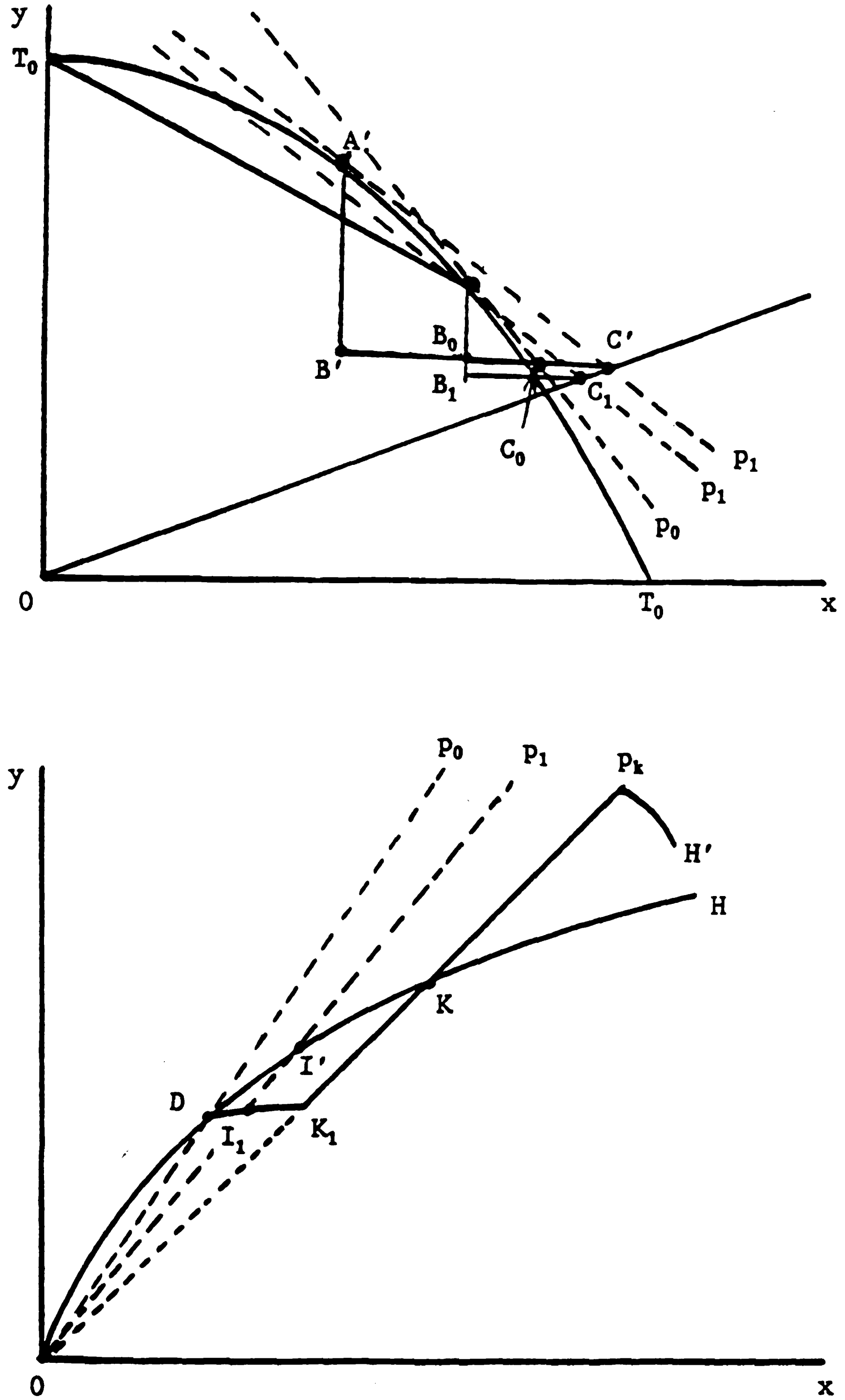

Figure 3.23

Shift of the Home Offer Curve under MQS

A'B'C' to AB_1C_1 with the MQS. This reduction of trade at price p_1 is depicted as an inward shift of the offer curve from I' to I_1 in Figure 3.23-B.

At price p_k the production of the economy can occur at any point of T_0A, and the trade triangle increases uniformly as the production moves from A to T given the same consumption point. This generates the K_1p_k portion of the offer curve in Figure 3.23-B. As the price becomes lower than that represented by the restricted PPF, the p_k line which equals (3.58), the economy will specialize in the production of goods y. The trade offer increases as the price falls, and this is represented by p_kH' in Figure 3.23-B.

The effective offer curve of the home country becomes ODK_1p_kH' under the restriction of the MQS. The greater the price decrease from p_0, the greater the trade is reduced, because the production distortion becomes bigger.

(C-2). The Foreign Country

The offer curve of the foreign country which exports differentiated goods x shifts in a symmetric way to the shift of the home country. Figure 3.24 illustrates the shift of the foreign offer curve under the MQS.

The MQS is imposed at quality compatible with p_0 at A. If there is a decrease of the price from p_0, the MQS is binding. At price p_1, which is lower than p_0, the unrestricted economy produces at A', and consumes at C'. Thus, the trade triangle of the economy is C'B'A'. At the same price p_1 the production under the restriction of the MQS will be at A, and the trade triangle will be CBA which is greater than that without the restriction.

This expansion of trade with the MQS is depicted as shift-out of the foreign offer curve in Figure 3.24-B. For example, at price p_1 the offer curve shifts out from I' to I.

As the price falls to p_k which is equal to the negative of the restricted PPF, consumption will be at one point on that PPF, and as the production moves from A to t_0 exports of goods x decrease uniformly, and the foreign country eventually becomes an importer of these goods. As the price falls further below p_k, the economy specializes in the production of goods y and imports goods x. This portion of the offer curve is not shown in Figure 3.24-B because it represents the part of the offer curve of the foreign country as an exporter of the differentiated goods x.

The greater the degree which the price decreases below p_0, the greater trade expands because the production distortion becomes bigger. The effective offer curve of the foreign country becomes OK_1KF under the MQS.

D. International Trade and the MQS

The effects of the MQS on international trade will be

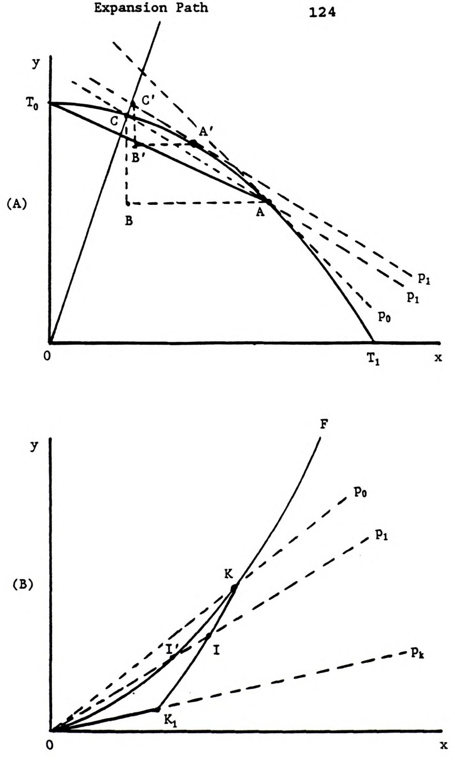

Figure 3.24

Shift of the Foreign Offer Curve under MQS

analyzed in this section using the offer curve of the last section. The equilibrium of trade with the MQS is compared with free trade equilibrium in three situations which depend on whether the MQS restricts only differentiated goods produced by the home country or all the goods sold in the home country.

(D-1). The MQS on the Home Goods

Suppose the home country imposes the MQS on its own products. The international trade equilibrium is depicted in Figure 3.25. The home offer curve will shift to ODK'p_k' or ODK"p_k" depending on the p_k which is equal to the slope of LL at MQ if the MQS is imposed on the level at D which is higher than that of free trade equilibrium E. Trade equilibrium becomes E' or E" with the home country's terms of trade p_k' or p_k".

At E" the welfare of the home country improves through the improved terms of trade, but at E' its welfare deteriorates through the worsened terms of trade. p_k is critical in determining its welfare because it is the terms of trade.

Intuitively, p_k is the equilibrium price for the wide range of the restricted PPF (T_0A in Figure 3.23-A), and home firms are indifferent to any point on the PPF with zero-profit assumption. This flexibility in production results in the

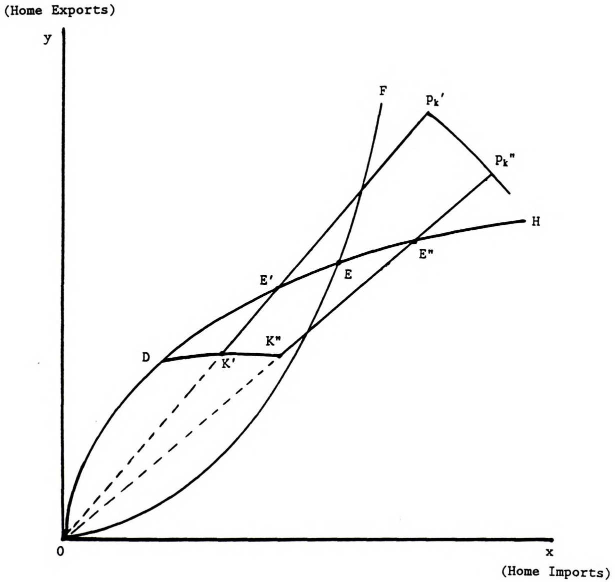

Figure 3.25

MQS on Home Goods

$K'p_k'$ (or $K''p_k''$) portion of the offer curve which decides terms of trade under the MQS.

The home country can improve its welfare with an appropriate MQS, but if the production of the home country is on the restricted PPF, the MQS causes an under-utilization of the capital endowment of the economy.

(D-2). The MQS on Foreign Imports

Suppose the home country imposes the MQS on foreign imports. International equilibrium is depicted in Figure 3.26. The foreign offer curve will shift to OK'F or OK"F depending on p_k, which is equal to the slope of LL at the MQ imposed on the level at K, at which the quality is higher than at free trade equilibrium E.

Trade equilibrium becomes E' or E" with home country's terms of trade p_k' or p_k''.

At E" the welfare of the home country improves through the improved terms of trade, but at E' the welfare deteriorates through the worsened terms of trade. p_k is again shown to be critical in determining its welfare because it becomes the terms of trade.

The home country can either improve its welfare (at E") or restrict total imports (at E'). At these new equilibriums, the foreign country will produce at the restricted PPF, and the capital endowment will be under-utilized.

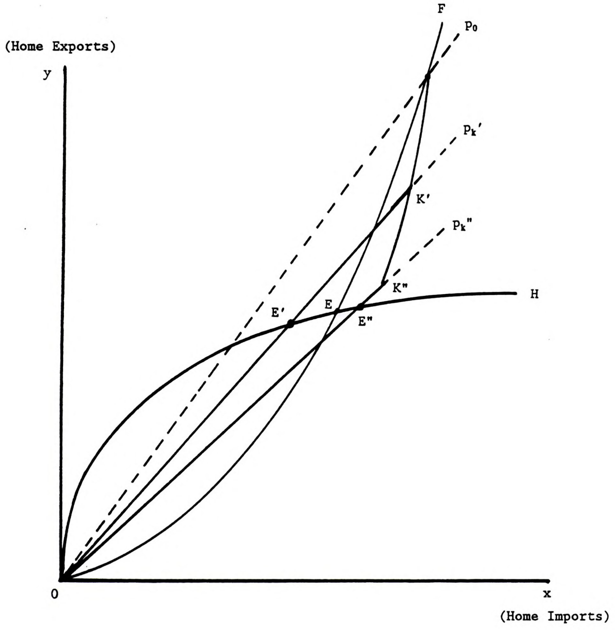

Figure 3.26

MQS on Foreign Imports

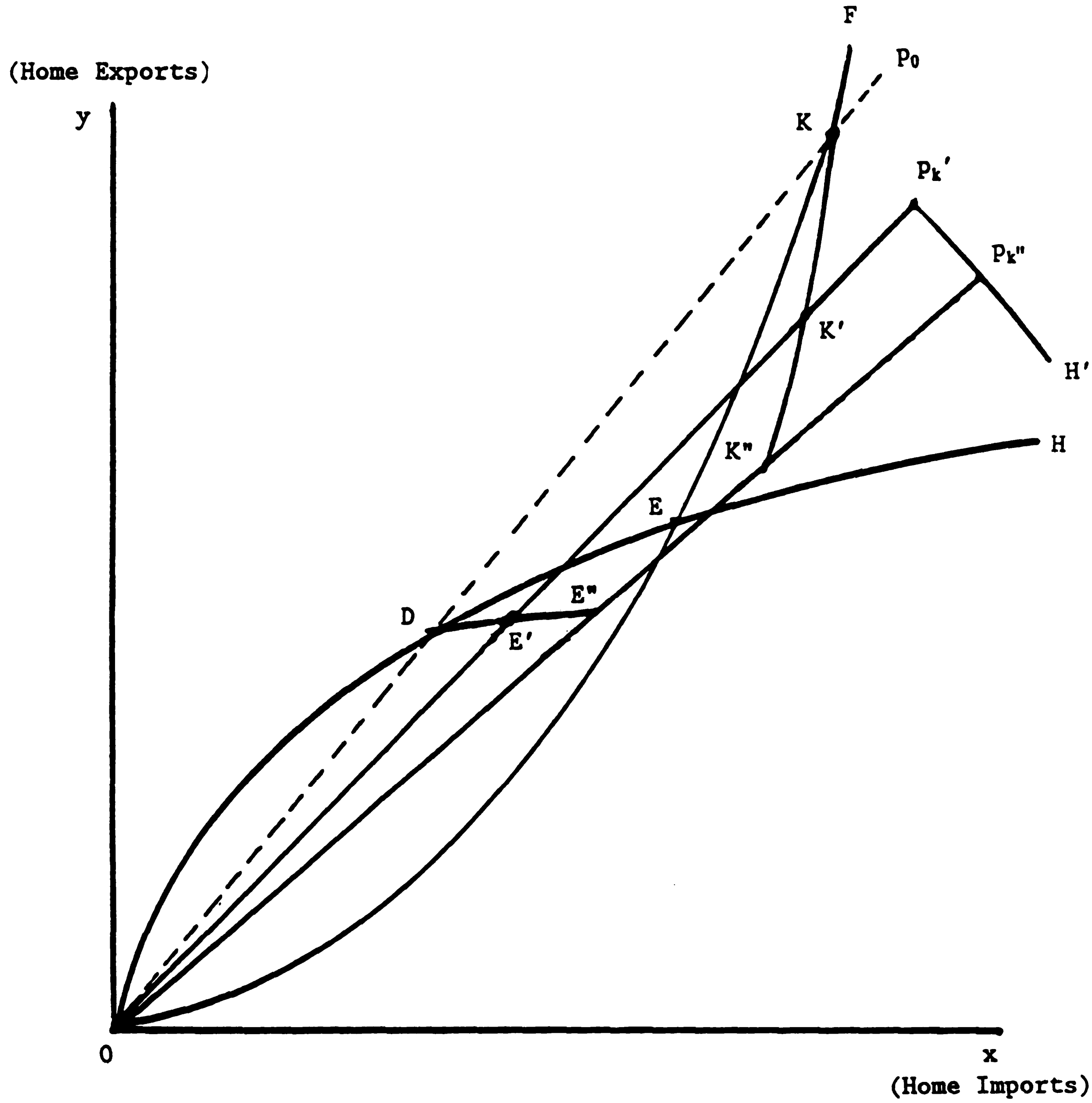

Figure 3.27

MQS on both Domestic and Foreign Goods

(D-3). The MQS on Both Domestic Products and Foreign Imports

The offer curves of both countries are affected when the MQS is on all differentiated products sold in the home country. This is depicted in Figure 3.27.

Home and foreign offer curves shift to ODE'p_k'H' and OK'KF if p_k is p_k', and they shift to ODE"p_k"H' and OK"KF if p_k is p_k". In any case, total imports are restricted by the MQS at p_0, but the resulting social welfare depends on p_k. The social welfare of the home country will increase if p_k is lower than free trade terms of trade, and otherwise decreases because p_k is the terms of trade under the MQS.

Both countries will under-utilize the capital endowment under the MQS, since each country produces at the restricted PPF.

3.6. Conclusion

This paper presents a general equilibrium model of two-country, two-factor and two-commodity in which one commodity is vertically differentiated. In the model Leontief technology is used in the production as a specific example of constant returns to scale technology.

The analysis of the paper based on capital intensive vertically differentiated goods is equally appropriate to

labor intensive differentiated goods requiring only minor changes in specification. Quality enters into a fixed coefficient of only one factor of the production, and the physical units of output producible from the endowment of the economy depend on quality inversely.

Firms choose an optimal quality to minimize their total cost in providing services of the differentiated goods which are measured by a product of a unit quality and physical quality.

In the model, the PPF is derived in association to quality, and the increase of the price and services of the differentiated goods corresponds to higher quality.

The Rybczynski theorem and the Heckscher-Ohlin theorem are proven in the context of the model. At equilibrium, the capital abundant country produces lower quality differentiated goods than the labor abundant country assuming that the differentiated goods are capital intensive. Furthermore, at free trade the quality of the differentiated goods becomes equal between countries and determined at world trade price.

The policy analysis of the model shows that quantitative restrictions (quotas and VERs) are elusive as restrictions on imports due to quality adjustment. Social welfare comparison between tariffs and quantitative restrictions reveal that the former instruments dominate the latter. Quantitative restrictions are shown to have the same equilibrium independent of their specific forms (quotas or VERs).

MQSs are analyzed as policy instruments of governments to achieve various goals. Due to its ambiguous results, MQSs on a country's own products should be used carefully. MQSs can improve terms of trade, but they deteriorate the domestic market resulting in under-employment of one factor. MQSs on imports can either reduce total imports, thus deteriorating terms of trade, or increase social welfare depending on the critical price which is determined by the slope of the restricted PPF. MQSs on both countries' products will have the same ambiguous effect on terms of trade.

The policy analysis in this paper shows that in the specified economy tariffs are preferrable to other policy instruments because they improve the terms of trade of the imposing country. This is in contrast with partial equilibrium models which rank quantitative restrictions preferable to tariffs. These models only considere the change of the consumer's welfare resulting from quality adjustment, but fail to consider the terms of trade effects of each policy. Therefore, this model shows a strategic implication of trade policy instruments.

This model is an attempt to connect partial equilibrium or ad hoc models of the literature to the standard H-O-S economy. Further development of the paper can be pursued by replacing the specific Leontief technology with a generalized CRS technology.

CHAPTER 4

(ESSAY 3)

Intra-Industry Trade in Horizontally Differentiated Products: A One-sector Model with Lancaster's Ideal Variety Approach

4.1. Introduction

The development of theories to explain intra-industry trade in differentiated products began with Krugman (1979) and Lancaster (1979, ch.10), who presented one-sector models in which all international trade is intra-industry trade. These models explain intra-industry trade by monopolistic competition theory.

One difference that can be observed between Krugman's and Lancaster's models is the specification of consumer preferences for differentiated products. Krugman assumes that a representative consumer likes to consume a large number of varieties according to Dixit & Stiglitz (1977). In this approach, every variety is assumed to command the same value from consumers. Lancaster (1979) utilizes his own characteristic approach in specifying consumer preferences. In his approach, products are assumed to be differentiated by

the combination of some basic characteristics, and every consumer has an ideal variety, i.e. his most desired combination of characteristics. All available varieties can be converted into the ideal variety equivalent by using the compensation function.

In one-sector models, Krugman (1979) shows that intra-industry trade occurs between countries with identical tastes, technologies, and factor endowments. Lancaster (1979, ch.10) suggested that gains from intra-industry trade could result from internal diversity of preferences within each country between identical countries. His suggestion is presented as a broad idea for further exploration without an explicit model.

This paper attempts to formalize a one-sector monopolistic competitive model in differentiated products based on Lancaster's idea. In presenting this model, the different features of the two approaches are clarified. This paper shows that intra-industry trade occurs to exploit preferences of consumers for variety. It further shows that the output of each variety after trade is constant, rather than increased as in Krugman's (1979) paper. This difference results from the assumptions made about the elasticity of demand, which decreases in Krugman's and is constant in this paper.

In specifying the utility function, this paper also shows that there exist two different cases of consumer demand

resulting from Lancaster's ideal variety approach. In the "arbitrary" case, the consumer either specializes in one variety or consumes a mixture of varieties which offer the lowest effective price. In the "general" case, the consumer chooses a positive amount of every variety. Therefore, the paper presents a form of the utility function which can solve the arbitrary problem and obtains specific results from the ideal variety approach.

In the next section, the model with Lancaster's ideal variety approach is presented in a monopolistic competitive market structure. In section 4.3, trade implied by the model is discussed. In the final section, brief summaries and conclusions are presented.

4.2. The Model

Consider an economy which produces a differentiated product (x) under monopolistic competition. The number of available varieties of x is n, and n is assumed to be a large number. Consumers are assumed to spend their income on this differentiated product based on utility maximization. The utility function is defined as a variant of the ideal variety approach of Helpman & Krugman (1985). The market structure is one of Chamberlinian monopolistic competition in which each firm in the market earns zero profit at profit maximization.

A. Demand Side

(A-1). Utility Function

Preferences for varieties are characterized by the assumption that an individual prefers a particular variety of product x, which is called his "ideal variety." This follows the approach originated by Lancaster (1979). "Ideal variety" means that when the consumer is offered the same quantity for all varieties, he will choose the ideal variety. Furthermore, when comparing a given quantity of two different varieties, it is assumed that the individual prefers the variety that is closest to his ideal variety.

Lancaster devises the compensation function with which a certain quantity of available varieties can be transformed into an equivalent quantity of the ideal variety. This function represents the additional quantity (compensation) required for consumers to demand varieties other than an ideal variety. Thus, the compensation function [h(v)] depends on the distance (v) between the available variety and an ideal variety. The compensation function has the following properties: First, the compensation ratio h increases the more the specification of the available goods differs from the specification of the most preferred good. Secondly, the rate of increase of the compensation ratio with respect to a change in specification of the available good increases as the

difference in specification between the available good and the most preferred good increases.

The properties of this function can be stated more formally as:

(4.1) (a) $h(0) = 1$

(b) $h'(0) = 0$

(c) $h'(v) > 0$, for $v > 0$

(d) $h''(v) > 0$

Property (a) follows directly from the definition of the compensation ratio. Property (b) is required for the consumer's tangency solution at the most preferred specification, implying that this is indeed an optimal specification. Property (c) means that every variety other than the ideal one requires positive compensation. Finally, property (d) assumes the convexity of the compensation function. A typical compensation function is drawn in Figure 4.1.

Using the compensation function, the utility function can be defined as:

(4.2) $$u(c_1, \ldots, c_i, \ldots, c_n) = \Sigma_i\ u[c_i/h(v_i)]$$

where c_i is the consumption of the available variety, v_i is the distance between variety i and the ideal variety, and $h(v_i)$ is

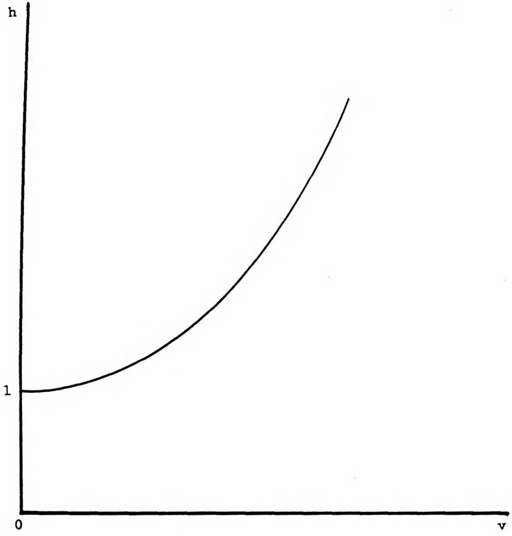

Figure 4.1

Compensation Function

the compensation function which converts c_i into the equivalent quantity of the ideal variety. Therefore, all of the available n varieties enter the utility function additively, and are measured in units of ideal variety.

This utility function is assumed to have the following more specific function form for further analysis:

$$(4.3) \qquad u(c_1,\ldots,c_i,\ldots,c_n) = \Sigma_i\ [c_i/h(v_i)]^b \qquad 0 < b \leq 1$$

where b is a parameter related to the price elasticity.

Consumer demand for variety can be derived from (4.3) by utility maximization subject to the budget constraint of:

$$(4.4) \qquad \Sigma_i\ p_i c_i = I$$

where I is total income of a consumer. Depending on the value of the parameter b, the consumer's problem can be separated into two different cases.

Case 1: b = 1

This case corresponds to the example presented by Helpman & Krugman (1985, ch. 6). The consumer's choice depends both on prices of available varieties and the distance of the available varieties from his ideal variety. A consumer either specializes in one variety or consumes a mixture of varieties which offer the lowest effective price, the price which

satisfies the first-order-condition.

Forming the Lagrangian, we have:

$$(4.5) \qquad L = \Sigma_i \, [c_i/h(v_i)] + \mu \, [\, I - \Sigma \, p_i c_i \,]$$

where μ is a Lagrangian multiplier. First order conditions are:

$$(4.6) \qquad \partial L/\partial c_i = 1/h(v_i) - \mu \, p_i \leq 0, \quad \text{strict equality if } c_i > 0$$

Re-arranging terms:

$$(4.7) \qquad 1/\mu \leq p_i \, h(v_i), \quad \text{strict equality if } c_i > 0$$

Suppose we numbered goods in such a way that the following ordering was true:

$$(4.8) \qquad p_1 \, h(v_1) \leq p_2 \, h(v_2) \leq \ldots \leq p_n \, h(v_n)$$

μ is adjusted so that:

$$(4.9) \qquad 1/\mu = p_1 \, h(v_1) \leq p_2 \, h(v_2) \leq \ldots \leq p_n \, h(v_n)$$

If $p_1 \, h(v_1) < p_2 \, h(v_2)$, the consumer specializes in variety 1. If $p_1 \, h(v_1) = p_2 \, h(v_2) < p_3 \, h(v_3)$, etc, the consumer divides his income between goods 1 and 2 but consumes none of the other varieties.

Case 2: $0 < b < 1$

This is a more general case and the concern of this paper. This case eliminates the "arbitrary" problem in the choice decision of a consumer. A consumer chooses a positive amount of every variety.

The Lagrangian is:

$$(4.10) \qquad L = \Sigma_i \ [c_i/h(v_i)]^b + \mu \ [\ I - \Sigma \ p_i c_i \ ]$$

First order conditions are:

$$(4.11) \qquad b[c_i/h(v_i)]^{b-1}[1/h(v_i)] - \mu p_i \leq 0,$$

a strict equality if $c_i > 0$

Re-writing the above equation, we have:

$$(4.12) \qquad b[1/h(v_i)]^b \ c_i^{b-1} \leq \mu p_i, \text{ strict equality if } c_i > 0$$

$$\rightarrow \ 1/\mu \leq \{p_i/b\}[h(v_i)]^b \ c_i^{1-b}, \text{ strict equality if } c_i > 0$$

Notice that if we set $b = 1$, this is the exact same conditions as we had earlier in equation (4.7). In this case of $b = 1$, the right hand side of the above relationship is independent of c_i.

However, if $0 < b < 1$, the right hand side of the above relationship increases in c_i. For given values of μ, p_i, v_i and b, there exists a solution entailing positive c_i for all i (i.e. consumers diversify their consumption.) [see Figure 4.2]

To solve for μ and get a complete demand specification, arbitrarily choose one of the varieties to be numeraire, e.g. variety 1. In this case., $p_1 = 1$ and we have:

$$(4.13) \qquad (p_1/b)\ [h(v_1)]^b\ c_1^{1-b} = 1/\ \mu = (p_i/b)[h(v_i)]^b\ c_i^{1-b}$$

Let $p_1 = 1$, and re-arrange to:

$$(4.14) \qquad [h(v_1)/h(v_i)]^{b/(1-b)}[1/p_i]^{1/(1-b)}c_1 = c_i$$

The expression $p_i c_i$ can now be stated as:

$$(4.15) \qquad p_i c_i = [h(v_1)/h(v_i)]^{b/(1-b)}[1/p_i]^{1/(1-b)}\ p_i c_1$$
$$= [h(v_1)/h(v_i)]^{b/(1-b)} p_i^{b/(b-1)} c_1$$

so:

$$(4.16) \qquad \Sigma_i\ p_i c_i = \Sigma_i\ [h(v_1)/h(v_i)]^{b/(1-b)} p_i^{b/(b-1)} c_1$$
$$= c_1\ \Sigma_i\ [h(v_1)/h(v_i)]^{b/(1-b)} p_i^{b/(b-1)}$$
$$= I$$

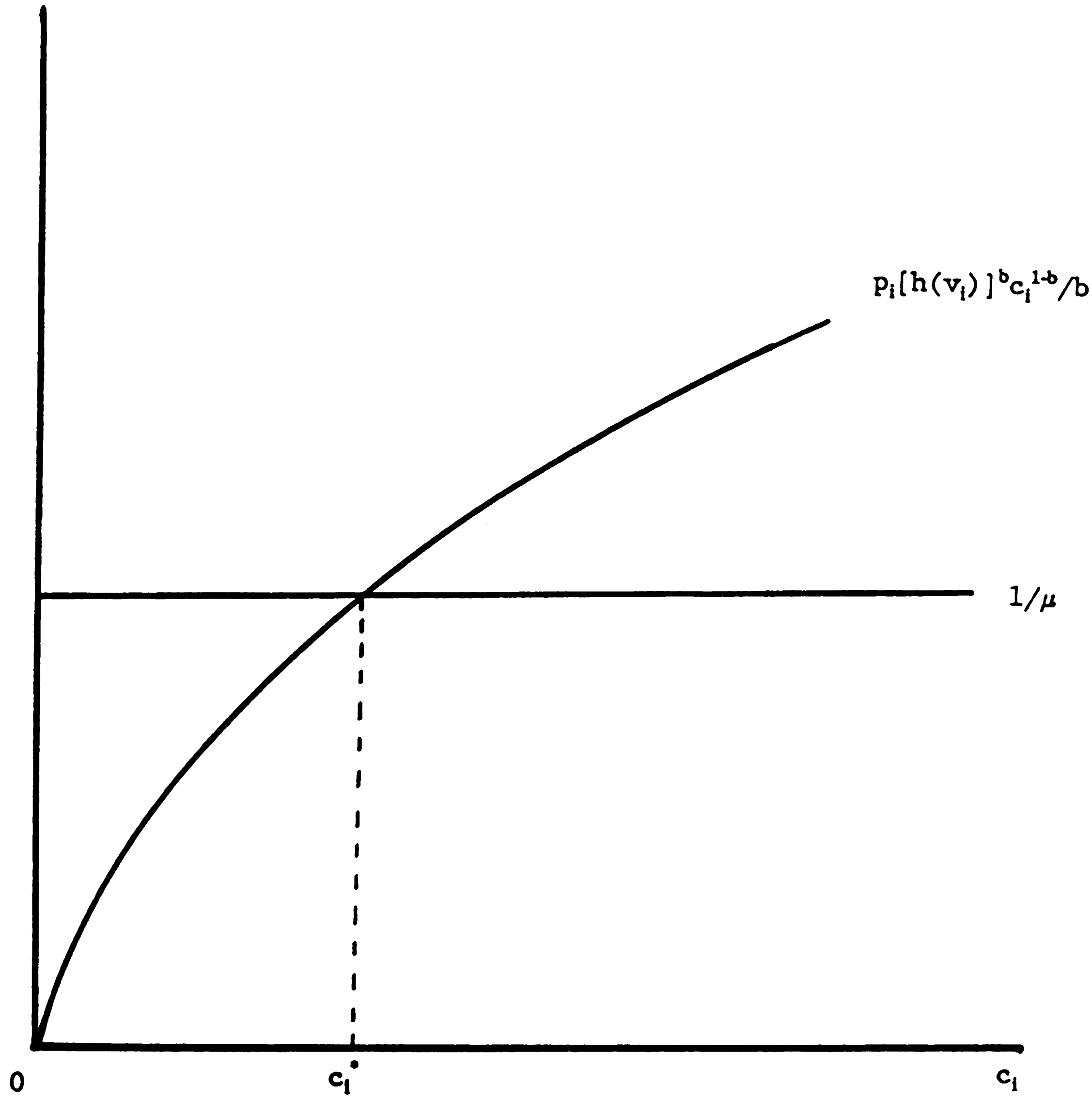

Figure 4.2

Consumer Demand

Therefore;

$$(4.17) \qquad c_1 = I / \Sigma_j \; [h(v_1)/h(v_j)]^{b/(1-b)} p_i^{b/(b-1)}$$

Substituting back to eq. (4.14) for the values of c_1 yields:

$$(4.18) \qquad c_i = \frac{\{h(v_1)/h(v_i)\}^{b/(1-b)} \; I}{[\Sigma_j \; \{h(v_1)/h(v_j)\}^{b/(1-b)} p_j^{b/(b-1)}]} \qquad (1/p_i)^{1/(1-b)}$$

$$= (I/p_i) \; \Sigma_j \; [p_j h(v_j)/p_i h(v_i)]^{b/(1-b)}$$

From the partial differentiation, we can get $\partial c_i/\partial p_i$, $\partial c_i/\partial v_i$ and $\partial c_i/\partial I$ as:

$$(4.19) \qquad \partial c_i/\partial p_i = \underset{(-)}{[\cdot/[\cdot]](1/(1-b))(1/p_i)^{b(1-b)}(-1/p_i^2)} + \underset{(+)}{[\cdot/-[\cdot]^2]\{\cdot\}^{b/(1-b)}(b/(b-1))p_i^{1/(b-1)}(\cdot)^{1/(1-b)}}$$

$$(4.20) \qquad \partial c_i/\partial v_i = \underset{(-)}{[I/[\cdot]](\cdot)^{1/(1-b)}(b/(1-b))\{\cdot\}^{(2b-1)/(1-b)} h(v_1)h'(v_i)/-[h(v_i)]^2} + [\cdot/-[\cdot]^2]p_i^{b/(b-1)}$$

$$\underset{(+)}{(b/(1-b))\{\cdot\}^{(2b-1)/(1-b)}h(v_1)h'(v_i)(\cdot)^{1/(1-b)}/\{h(v_i)\}^2}$$

$$(4.21) \qquad \partial c_i/\partial I = \overset{(+)}{\{\cdot\}^{b/(1-b)}(\cdot)^{1/(1-b)}/[\cdot]}$$

The partial derivatives with respect to p_i and v_i have two

parts which have opposite signs. Thus, $\partial c_i/\partial p_i$ and $\partial c_i/\partial v_i$ seem to have indeterminate signs. For a large number of varieties (n is large), $[\cdot]^2$ dominates the second part making it close to zero, and the first part dominates total effects. Notice that n is assumed to be a large number. Therefore, we have the following properties of consumer demand:

(4.22) $\partial c_i/\partial p_i < 0 \qquad \partial c_i/\partial v_i < 0 \qquad \partial c_i/\partial I > 0$

(A-2). Market Demand

Market demand can be derived from the individual demand (4.18), i.e. market demand is a total sum of (4.18) over all consumers. For an actual calculation, we need both a distribution of consumers and varieties along the circumference on which the varieties can be represented by points.

It is assumed that preferences for ideal products are uniformly distributed over the unit length circumference of the circle and the population density on the circumference is equal to L. Notice that L is both the density and the size of the population.

From the unit length circumference, the demand for c_i by a consumer whose ideal variety is i is represented by point c in Figure 4.3. The minimum demand is from a consumer at point A with $v_i = 1/2$, and the average demand is from a

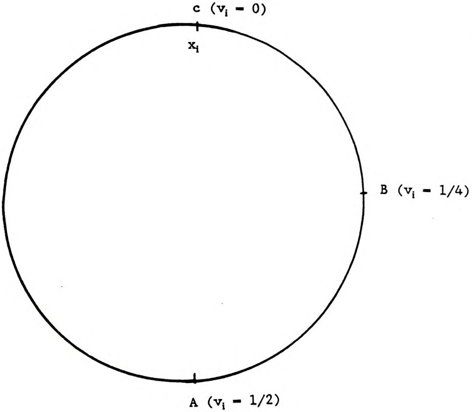

Figure 4.3

Consumer Distribution

consumer at point B with $v_j = 1/4$. We will approximate a market demand by multiplying the average demand (demand by a consumer with $v_j = 1/4$) by the total number of population L.

The above approximation becomes an actual market demand if the second derivative $\partial^2 c_i/\partial v_i^2$ becomes zero. This is depicted in Figure 4.4-A. If $\partial^2 c_i/\partial v_i^2$ is less (greater) than zero, an approximation exaggerates (decreases) the actual demand. These two situations are illustrated in Figure 4.4-B and 4.4-C. An approximated demand x_i can be written as:

$$(4.23) \qquad x_i = L\ c_{i''} = L\ c_i(v_{i''} = 1/4)$$
$$= L\ [\ \{h(v_1)/h(v'')\}^{b/(1-b)}\ I/[\Sigma_j\{h(v_1)/h(v_j)\}^{b/(1-b)}\ p_i^{b/(b-1)}]\ ]\ (1/p_i)^{1/(1-b)}$$

The denominator of (4.23) can be simplified if we denote:

$$(4.24) \qquad \{h(v_1)/h(v'')\}^{b/(1-b)}\ p''^{b/(b-1)}$$
$$= (1/n)[\ \Sigma_j\ \{h(v_1)/h(v_j)\}^{b/(1-b)} p_i^{b/(b-1)}]$$

Then:

$$(4.25) \qquad x_i = L\ [\ \{\ [h(v_1)/h(v'')]^{b/(1-b)}\ I\ \}/\{\ n\ p''^{b/(b-1)}\ [h(v_1)/h(v'')]^{b/(1-b)}\ \}\ ]\ (1/p_i)^{1/(1-b)}$$
$$= (L\ I/n)\ (1/p'')^{b/(b-1)}\ (1/p_i)^{1/(1-b)}$$

The market demand (4.25) is shown as a function of a share of

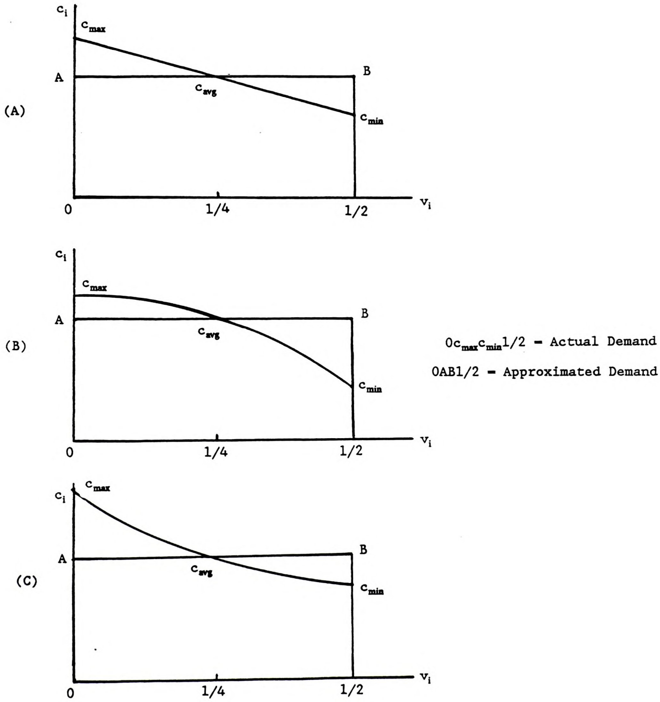

Figure 4.4

Approximation of the Actual Demand

variety (S) from total GDP (LI):

$$S = L\ I/n \tag{4.26}$$

and its own price (p_i) and an average price of all other varieties (p). The price elasticity of the demand can be easily calculated as:

$$\epsilon_p = 1/(1-b) \tag{4.27}$$

B. Supply Side

All goods are assumed to be produced with the identical cost function. The labor used in producing each good is a linear function of output x_i:

$$l_i = \alpha + \beta\ x_i \tag{4.28}$$

where l_i is the labor used in the production of good i, x_i is the output of good i, and α is the fixed cost. This input requirement function specifies economies of scale with decreasing cost and constant marginal cost as output increases.

Monopolistic competition of the Chamberlinian type is assumed in the differentiated goods market. Each firm chooses its price given cost conditions which are known to everyone.

The cost conditions of all the different types are assumed to be the same as (4.28). Thus, firm i's problem is to maximize its profit:

$$(4.29) \qquad \pi_i = p_i x_i - (\alpha + \beta\ x)\ w$$

where w is wage rate.

In its maximization solution, a firm earns a positive profit if its price lies above the AC curve. This situation is termed a short-run equilibrium of monopolistic competition. In the long-run, the entry of firms into the industry will drive profit to zero. Therefore, in the long-run, each firm must charge a price p_i and produce at output x_i with zero profit:

$$(4.30) \qquad \pi = p_i x_i - (\alpha + \beta\ x_i)\ w = 0$$

This means that price must equal average cost for each firm in the long-run equilibrium. In addition, each firm must be at the maximal profit point on its demand curve; any inefficient firm will be driven out of business by the entry of other firms. Thus, the demand curve facing firm i must be tangent to its average cost curve, see Figure 4.5.

From profit maximization of (4.29), firm i chooses its price given the market demand for its products (4.25). The profit maximization price depends on marginal cost (β) and on

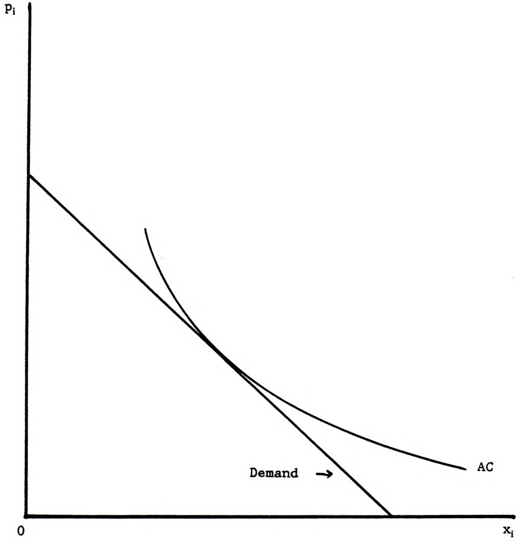

Figure 4.5

Monopolistic Competitive Equilibrium

the elasticity of demand (4.27):

$$(4.31) \qquad p_i\ (1 - 1/\epsilon_p) = \beta\ w \qquad \text{or} \qquad p_i/w = \beta/b$$

Since elasticity of demand and marginal cost are constant in this model, the profit maximization prices of firm i are proportional to wage rates as in (4.31).

From the zero-profit condition (4.30), the price of the firms in the market equals AC:

$$(4.32) \qquad p_i = (\alpha/x + \beta)\ w$$
$$\text{or} \quad p_i/w = \beta + \alpha/x$$

In addition to the two conditions of (4.31) and (4.32), we have a factor market equilibrium condition with full employment. Full employment implies a sum of factor employments of n firms equals total labor L:

$$(4.33) \qquad L = \Sigma_i\ l_i = \Sigma\ [\ \alpha + \beta\ x_i\ ]$$

Notice that there are three endogenous variables: p_i/w, the price of each good relative to the wage; x, the output of each good; and the number of goods produced, n. To make the analysis simple, we assume a symmetry in every good produced which requires every variety having the same price and quantity of production. Thus, from now on, we can use variables without subscript i:

(4.34) $p = p_i$, $x = x_i$, $c = c_i$ and $l = l_i$, for all i

We can re-write (4.33) with symmetry.

(4.35) $L = n\ (\alpha + \beta\ x)$ or

$n = L/(\alpha + \beta\ x)$

The number of goods produced is determined by the total labor force divided by the labor requirements of each firm. This is shown in (4.35). By re-writing (4.23) in a shorthand notation, we have:

(4.36) $x = L\ c''$

Therefore, the consumption of an average consumer (c'') can determine the output of each firm (x). Once p/w and c'' are solved from (4.31) and (4.32), n can be determined from (4.35). The graphical solution of (4.31) and (4.32) is shown in Figure 4.6. The profit maximization condition is line PP and is horizontal because the elasticity of consumers is constant. The zero profit condition line ZZ is negatively sloped because it decreases as average consumer demand increases.

Notice that β/b is above β, since $0 < b < 1$. If $b = 1$,

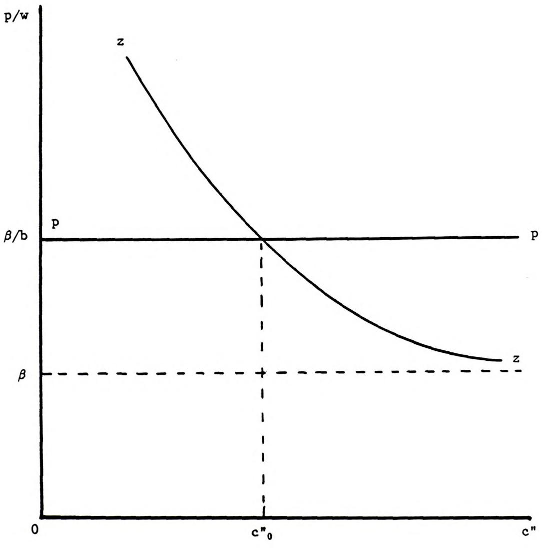

Figure 4.6

Graphical Solution of the Model

then ß/b equals ß, and there is no solution in this economy, since there is no intersection between ZZ and PP schedules. This fact shows that the "arbitrary" case of consumer decision is not compatible with the monopolistic competitive model of this paper. In the next chapter, we use the model to analyze the effects of trade.

4.3. International Trade

Suppose there are two countries which are identical in every respect. In standard H-O-S models, there is no reason for trade because trade results from the difference of factor endowments between countries. In this model, there will be both trade and gains from it.

Two countries with identical technology and tastes can be integrated as one country as trade opens. Thus, the effects of trade are identical to the effects of labor growth in the economy. Furthermore, the effects of trade can be analyzed as a change of the parameter, labor, of the model. The effects of labor growth are depicted in Figure 4.7.

As labor grows, PP is constant because the profit maximization condition (4.31) does not depend on labor, but the ZZ schedule shifts to the left because p/w is negatively related to labor in the zero profit condition (4.32). Therefore, the equilibrium of the model changes from A to B, which is the new intersection point of PP and Z'Z'.

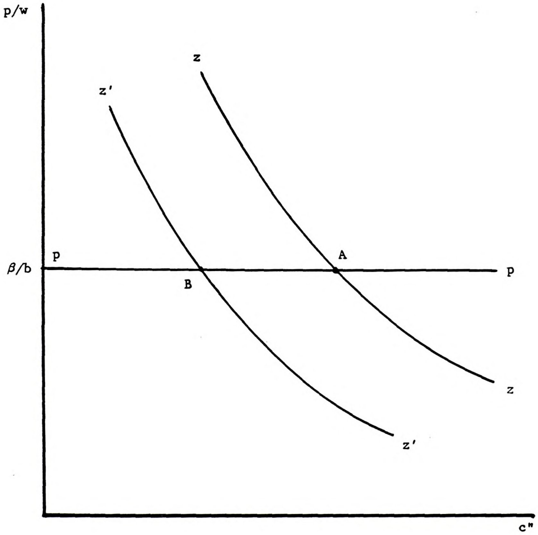

Figure 4.7

Effects of International Trade

At B consumer's demand (c) falls and p/w remains unchanged. Thus, the output of each firm will not change because there is no change in equilibrium price. The output of each firm can be derived explicitly from (4.32) as:

$$(4.37) \qquad x = \alpha/(p/w - \beta)$$

There is an increase in total number of firms in the economy, which can be derived from (4.36) as:

$$(4.38) \qquad n = L/(\alpha + \beta Lc)$$

In (4.38), n increases as L increases and c decreases.

Intuitively, this result implies that an increase in labor requires each consumer to spend less on each variety for the firm to stay at zero-profit because each firm's output remains constant. The consumer's budget now spreads out over the increased variety given constant income.

As a result of trade, the number of varieties will increase, and each variety will be produced in the same amount irrespective of trade. Notice that the firms' output is independent of the labor force because of the constant equilibrium price, which in turn is based on the constant elasticity of demand. Note that ϵ_p is assumed to be a parameter defined in (4.27), and this assumption is fundamental to a Lancaster type specification of the

preferences in the model. Therefore, free trade and resulting market integration increases the total number of varieties available in the economy,

Krugman (1979) presented a similar model with Dixit-stiglitz type preferences in which both the output of firms and the total number of varieties in the market increase in free trade. His conclusion is based on the assumption that elasticity of demand decreases as consumer demand increases. Therefore, the elasticity with regard to demand is critical in determination of the change of each firm's output. In this model of Lancaster type preference, the output of each variety does not change.

Consumers of the economy will gain from trade because of the increased variety. Gains from trade can be seen from the utility function of consumers (4.3); it increases with the new increased number of varieties. From (4.3) an increase in welfare results from an increased number of varieties because variety is valued in itself: An increase in variety will increase utility.

4.4. Conclusions

This paper presents a monopolistic competitive model with Lancaster type preferences, in which each consumer has an ideal variety and compensation function. It shows that intra-industry trade occurs in order to take advantage of the

preferences between symmetric countries which have the same technology and tastes. Free trade and the resulting extension of market will provide more varieties than a closed economy, and the welfare of the economy increases.

Contrary to Krugman's (1979) model which is based on Dixit-Stighitz type preference with a variable elasticity assumption, this paper shows that individual firms' output is unchanged with trade. Firms have no incentive to increase their output if demand elasticity is fixed as in this model. Therefore, the extent of the utilization of scale economies by each firm depends on the elasticity of demand.

However, the limitation of this model is its use of the approximated demand for the market demand. The market demand should be solved for more explicit analysis of the model.

APPENDICES

A: Quality Dimension in the Cost Function

The structure of the cost function with a quality dimension can be developed from the general form of the cost function used in economics. Without considering the quality dimension, the cost function can be expressed as the sum of variable costs plus fixed costs:

$$(A.1) \qquad C(Q) = V(Q) + F$$

where Q represents the total number of quality goods produced. For a U-shaped AC curve, V(Q) will take a quadratic form such as, $V(Q) = Q^2$.

Now there are three different ways in which the quality dimension (quality) can be entered into the cost function of (A.1). Each of the cost functions depends upon the different assumptions on how the change of quality level affects the costs of production. First, if the quality level produced only affects the fixed cost, the cost function looks like this:

(A.2) $C(Q, q) = V(Q) + h(q)\ F$

Second, if the quality levels are assumed to affect only the variable cost, the cost function can be written as:

(A.3) $C(Q, q) = h(q)\ V(Q) + F$

Third, if the quality level produced affects not only the fixed cost but also the variable cost, condition which are more true of reality, the cost function can be written as:

(A.4) $C(Q, q) = h(q)\ [\ V(Q) + F\ ]$

The above three cost functions have different curvatures depending on how the quantity corresponding to the minimum AC changes with respect to the quality levels. When the quality only affects fixed cost, the cost function has the following properties. From (A.2), AC and MC are as follows:

(A.5) $AC = C(Q, q)/Q = V(Q)/Q + h(q)\ F/Q$

$MC = \partial C(Q, q)/\partial Q = V'(Q)$

The minimum point of AC can be determined by equating AC to MC. Using the example of $V(Q) = Q^2$ for the U-shaped curve, the output level compatible to the point of minimum AC, denoted by Q^*, can be determined as:

(A.6) $Q^* = \sqrt{h(q)\ F}$

Thus, as quality level q increases, Q^* increases too. This is because a higher quantity of goods must be produced to absorb the higher fixed cost required for higher quality goods. Therefore, as quality increases, the AC curve reaches the minimum point at a greater quantity. This is illustrated in Figure A.1.

By substituting Q^* and $h(q) = q^r$ into AC, we can derive the minimum of the AC as:

(A.7) $\text{min. AC} = 2\sqrt{F}\ q^{r/2}$

When the quality level is assumed to be added only to variable costs, we can derive AC and MC from eq. (A.3). Using the specific functional form, $V(Q) = Q^2$, we get the following minimum point of AC:

(A.8) $AC = h(q)\ V(Q)/Q + F/Q$

$MC = h(q)\ V'(Q)$

$Q^* = \sqrt{F/h(q)}$

Therefore, for higher quality goods, Q^* has a lower value. This is because the higher variable costs corresponding to higher quality goods increase AC at an earlier stage compared

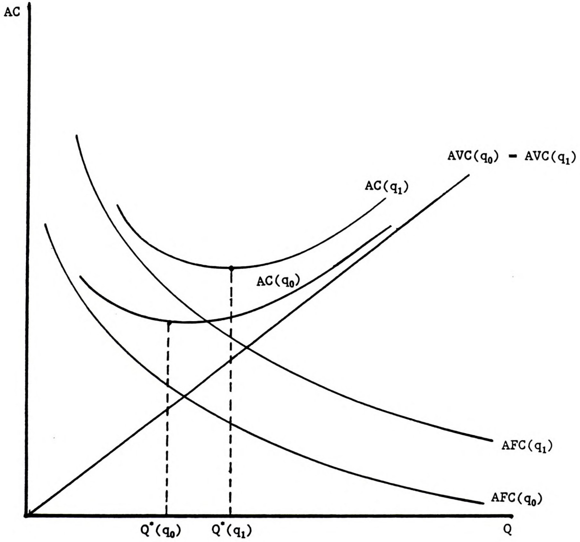

Figure A.1

Cost Function with Quality Factored into Fixed Cost Only with that of lower quality goods. This is illustrated in Figure A.2.

Again, by substituting Q^* and $h(q) = q^r$ into AC, we get the minimum of AC as:

$$\text{(A.9)} \qquad \text{min. } AC = 2\sqrt{F}\, q^{r/2}$$

Note that the two cases when h(q) enters either V(Q) or F(compare (A.6) and (A.7) with (A.8) and (A.9)), generate the same min. AC with differences only in Q^*. It is $\sqrt{h(q)}$ that determines min. AC in both cases.

If it is assumed that the quality levels affect both variable cost and fixed cost, which actually fits reality in which quality upgrading requires not only new facility investment but higher quality labor, AC, MC, and Q^* are derived from eq. (A.4) as:

$$\text{(A.10)} \qquad AC = h(q)/Q\, [\ V(Q) + F\ ]$$

$$MC = h(q)\ V'(Q)$$

The minimum point of AC can be solved by equating AC to MC:

$$\text{(A.11)} \qquad 1/Q\, [\ V(Q) + F\ ] = V'(Q)$$

$$Q^* = \sqrt{F} \quad \text{and} \quad \text{min } AC = 2\sqrt{F}\, q^r$$

Because of the equal elimination of q from both sides of

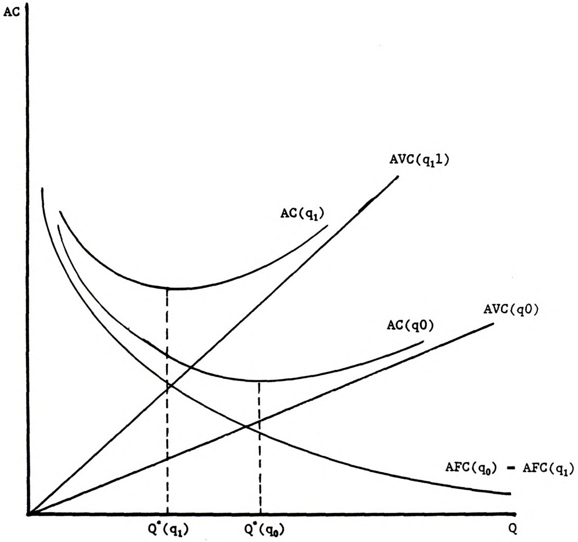

Figure A.2

Cost Function with Quality Factored into Variable Cost Only

(A.11), (A.11) is not a function of quality q. This shows that the minimum point of AC is not affected by quality levels. Intuitively, the proportional increase of both variable and fixed costs only shifts AC upward not affecting its curvature. This is illustrated in Figure A.3.

From the discussion above, we show that factoring in quality to fixed cost, variable cost, or both has different implications on the curvature of the cost function with quality. Furthermore, it is $\sqrt{h(q)}$ that determines the min. AC when h(q) is multiplied by either V(Q) or F. However, it is h(q) that determines the min. AC, when h(q) is multiplied by both V(Q) and F.

In any case, since min. AC (= p) depends only on quality (and fixed cost), we can use the consumers' problem to solve for q irrespective of which of the three ways quality is factored into the cost function. Once we know q, we can obtain Q for each firm. Therefore, this paper, developed under the assumption that both V(Q) and F are multiplied by h(q), can be easily extended to other cases without any qualitative changes.

B: Other Restrictions on the Price Schedule

Restrictions other than (5) on p(q) generate corner solutions. Two cases of restrictions for corner solutions are explained. First, suppose:

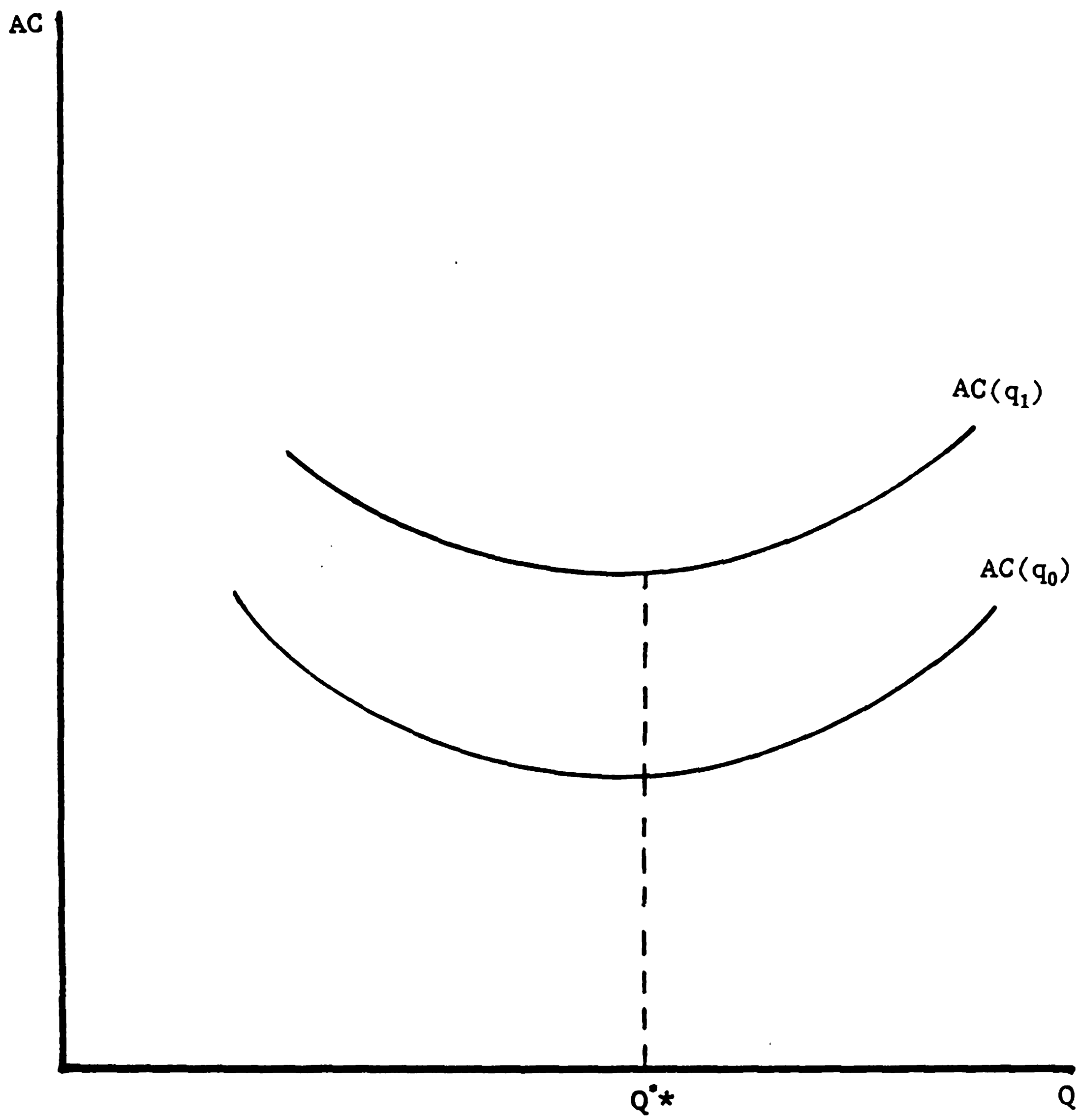

Figure A.3

Cost Function with Quality Factored into Both Variable and Fixed Cost

(B.1) $p(0) = 0 \quad p'(q) > 0 \quad p''(q) = 0$

In this case, the budget constraint, which is a straight line (by $p'' = 0$), and the indifference curves are drawn in Figure B.1.

Three possible cases of the consumer's maximization are as follows:

(1) $\theta < p'(q)$: Consumers purchase $q = 0$ (equivalent to $X = 0$)

(2) $\theta > p'(q)$: Consumers purchase the highest quality available, might entail $m = 0$ if the highest quality available is high enough.

(3) $\theta = p'(q)$: There are an infinite number of solutions to the consumer problem.

The other restriction is stated as follows:

(B.2) $p(0) = 0 \quad p'(q) > 0 \quad p''(q) < 0$

The consumers' maximization problem is drawn in Figure B.2 with the budget constraint which is convex to the origin ($p'' < 0$).

Except in the indeterminate case (3) from the first restriction, consumer maximization yields corner solutions (1) and (2) above.

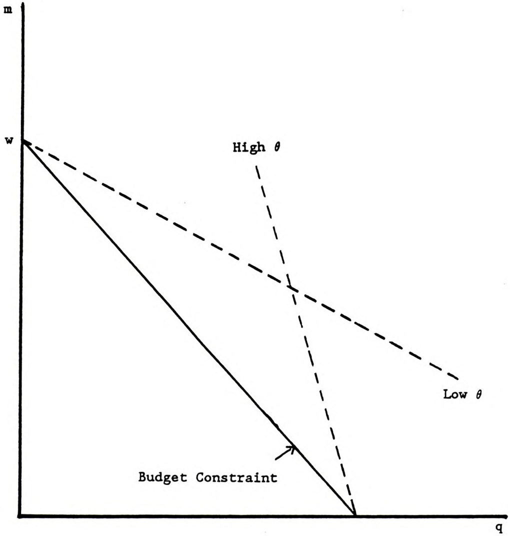

Figure B.1

Corner Solution: A Case of $p''(q) = 0$

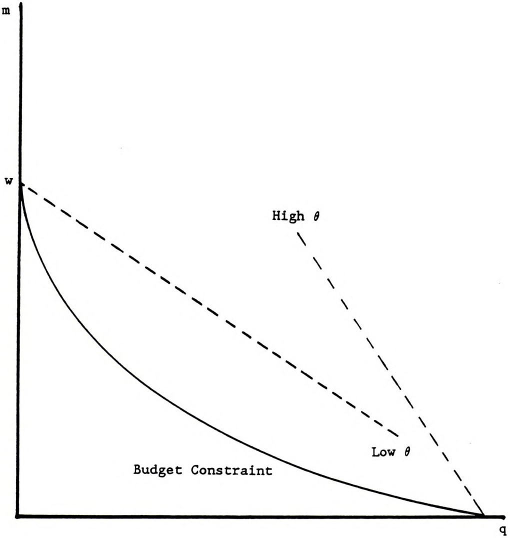

Figure B.2

Corner Solution: A Case of $p''(q) < 0$

C: The Production Function When x is Labor Intensive

The production functions for the homogenous goods y, and the differentiated goods x are:

(C.1-1) $y = \text{Min} \{ k_y/a_{ky},\ L_y/a_{Ly} \}$

(C.1-2) $x = \text{Min} \{ k_x/a_{kx},\ L_x/a_{Lx} \} = \text{Min} \{ k_x/\alpha_{kx}q,\ L_x/(\alpha_{Lx}/q) \}$

with $a_{kx} = \alpha_{kx}$ $a_{Lx} = \alpha_{Lx}/q$

The production function of (C.1) is derived from the combination of (2) and the following production function of Q:

(C.2) $Q = \text{Min} \{ k_x/\alpha_{kx}q^2,\ L_x/\alpha_{Lx} \}$

The cost function for sector x and y can be derived from (C. 1) as:

(C.3-1) $c_x = (\alpha_{Lx}/q)\ w + (\alpha_{kx}q)\ r$

(C.3-2) $c_y = a_{Ly}\ w + a_{ky}\ r$

The optimal quality is derived from the partial differentiation of (C.3-1) with regard to q:

(C.4) $q^* = \sqrt{w\alpha_{kx}/r\alpha_{Lx}}$

The cost function with an optimal quality can be derived from the substitution of (C.4) into (C.3-1) as:

(C.5) $c_x^* = 2\sqrt{\alpha_{Lx}\alpha_{kx}wr}$

The zero-profit curves in sector x and y are:

(C.6-1) $1 = w\ a_{Ly} + r\ a_{ky}$

(C.6-2) $p = w\alpha_{Lx}/q + r\alpha_{kx}$

where goods y are used as a numeraire.

The slopes of the zero-profit curves are:

(C.7-1) $dw/dr|\pi_{y=0} = -\ a_k/a_{Ly} = -\ k_y$

(C.7-2) $dw/dr|\pi_{x=0} = -\ \alpha_{kx}q^2/\alpha_{Lx} = -\ w/r = -\ k_x$

Note that these are the same as (8) of the text.

The price p can be solved as a function of w/r from (C.6) with the substitution of q^* into q as:

(C.8) $p = \{\ 2\sqrt{\alpha_{Lx}\alpha_{kx}}/(a_{Ly}(w/r) + a_{ky})\ \}\ \sqrt{w/r}$

(C.8) also equals p of the text, (9).

From the differentiation of (C.8) which is done in the text (12), we know:

(C.9) $\partial p/\partial(w/r) > 0$ if $k_y > k_x$

The following positive relationship between quality and price can be derived from the combination of (C.4) and (C.9):

(C.10) $q = q(p)$, $q' > 0$

The above relationship is derived from the production function by changing the way quality enters into the fixed coefficient ($\alpha_{kx}q^2$ instead of $\alpha_{Lx}q^2$ of the text) of the production function Q. This case is compatible with an economy that is relatively labor abundant as explained with the Harrod-Johnson diagram of the text.

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