"Complementarities and Cumulative Processes in Models of Monopolistic Competition"

Kiminori Matsuyama
Northwestern University

www.kellogg.nwu.edu/research/math

CMS-EMS
The Center for
Mathematical Studies
in Economics &
Management Sciences

Discussion Paper No. 1106

COMPLEMENTARITIES AND CUMULATIVE PROCESSES
IN MODELS OF MONOPOLISTIC COMPETITION

By Kiminori Matsuyama[*]

October 1994

Abstract

Monopolistic competition models have frequently been applied in macroeconomics, growth and development, and international and interregional economics. The three features of monopolistic competition, the monopoly power of producers, the lack of strategic interaction, and endogenous product variety, make it a useful framework to examine the aggregate implications of imperfect competition, increasing returns and incomplete markets. This paper presents a highly selective review in this area, with special emphasis on complementarity and its role in generating multiplier processes, business cycles, clustering, underdevelopment traps, regional disparities, and sustainable growth, or more generally, what Myrdal (1957) called the "principle of circular and cumulative causation."

TABLE OF CONTENTS

1.   Introduction

In recent years, the paradigm of monopolistic competition has been applied to model a variety of aggregate phenomena in macroeconomics, international and interregional economics, and economic growth and development. Monopolistic competition is typically defined as a situation of imperfect competition with the following features:

a)   The products are differentiated. Each firm, as the sole producer of its own brand, is aware of its monopoly power and sets the price of its product.

b)   The number of firms (and products) is so large that each firm ignores its strategic interactions with other firms; its action is negligible in the aggregate economy.

c)   Entry is unrestricted and takes place until the profits of incumbent firms are driven down to zero.

These features make the paradigm of monopolistic competition very useful for modelling aggregate phenomena. First, as a form of imperfect competition, it allows us to describe decentralized allocations in the presence of increasing returns. Second, unlike oligopoly models, it helps us to focus on the aggregate implications of increasing returns without worrying about strategic interactions among firms and the validity of profit maximization as the objective of firms. Third, the explicit analysis of entry-exit processes makes it suitable for capturing the role of net business formations across business cycles. Furthermore, in models of monopolistic competition, the range of products supplied in the market can be endogenized through entry and exit. This feature also makes monopolistic competition a useful apparatus within which to formalize growth and development processes, as economies grow and our standards of living rise not so much by producing or consuming more of the same products, but by adding new products to the list of those we already produce and consume.

In this paper, I present a highly selective review of recent developments in this area. Central to the discussion is the notion of complementarity. Broadly speaking, complementarities are said to

exist when two phenomena (or two actions, or two activities) reinforce each other. For example, if expansion of industry A leads to expansion of industry B, which in turn leads to further expansion of A, then the two industries are complementary to each other. Or, if the arrival of a new store makes the neighborhood a desirable location for other stores, then there are complementarities in the locational decisions. Such complementarity introduces some circularity in the economic system, which has profound implications for the stability of the system. If a change in a certain activity is initiated by an exogenous shock, this leads to a similar change in complementary activities and starts a cumulative process of mutual interaction in which the change in one activity is continuously supported by the reaction of the others in a circular manner. Many writers of the past, such as Hicks (1950), Kaldor (1985), Kalecki (1939), Myrdal (1957), and Nurkse (1953), among others, have stressed that cumulative processes of this kind should be an essential element in explaining business cycles, underdevelopment, economic growth, and regional inequalities.

On the other hand, the standard neoclassical paradigm, exemplified by Arrow and Hahn (1971), emphasizes the self-adjusting mechanisms of market forces with its efficient resource allocation. As different activities compete for scarce resources, expansion of one activity comes only at the expense of others, which tends to dampen any perturbation to the system. Imperfect competition and incomplete markets (through an endogenous change in the range of products offered in the market), as departures from the standard paradigm, leave more room for complementarities, and make the system more conducive to circular and cumulative causation, as complementarities help the system break away from the stabilizing forces of resource constraints.

Ever since the publication of Chamberlin (1933) and Robinson (1933), a large number of studies has applied the paradigm of monopolistic competition in a variety of contexts. Indeed, there are already many excellent surveys, such as Beath and Katsoulacos (1991), Eaton and Lipsey (1989), Stiglitz (1986), and Tirole (1988). These studies, however, are written from a different perspective.

They address questions like: "How do models of monopolistic competition differ from oligopoly models?" or "What is the most appropriate way of modelling product differentiation?" or "Does market equilibrium provide optimal product diversity and selection?" i.e., they are written from predominantly partial equilibrium or industrial organization perspectives. Some studies, such as Benassy (1991) and Hart (1985), discuss general equilibrium models of monopolistic competition, but their concerns remain largely theoretical, such as the existence of equilibrium, its uniqueness, and limit theorems. In contrast, this paper discusses how general equilibrium models of monopolistic competition can be applied to explain complementarities and cumulative phenomena and their implications in the context of macroeconomics, international and regional economics, as well as growth and development.[1] To put it differently, the main goal is to point out the commonality of ideas across a wide range of fields, using the notion of complementarity as an organizing principle.

The rest of this paper is hence organized according to different mechanisms behind complementarity. In each section, my strategy is first to develop a basic model to illustrate the underlying logic, and then to use variations of it for discussing the literature. Section 2 focuses on the role of price distortions in generating multiplier processes, by developing a class of models in which the range of products offered is fixed. Section 3 focuses on endogenous product variety and increasing returns, by developing a class of models in which all products are marked-up at the same

---

[1] I should emphasize that this paper surveys the literature in which complementarities arise as an outcome of equilibrium interaction in models of monopolistic competition. Many studies, both in industrial organization and in macroeconomics, analyze the performance of imperfect competitive markets in the presence of assumed technological complementarities. An extreme example would be the problems of two producers, each supplying a good to the customer that is a perfect complement to the other, such as "nuts and bolts." The most successful application of this framework is the literature on the organization of firms, exemplified by Milgrom and Roberts (1992). Many economists find the macroeconomic applications of this framework unconvincing, since there would be a strong incentive to internalize this kind of complementary activities, as rightly pointed out by Milgrom and Roberts, and hence the aggregate implications would be, at best, dubious. In the models discussed here, on the other hand, complementarities arise as an outcome of the internal mechanism of the market system: anything short of taking over the entire economy would not internalize them.

rate. Section 4 combines the two elements by developing models with both endogenous product variety and differential mark-ups. Section 5 discusses some methodological issues concerning the logic of coordination failures and multiple equilibria. The final section offers some concluding remarks.

2. Monopoly Pricing Distortions and Multiplier Processes

The departure from perfect competition means that the firm, faced with downward sloping demand, sets price above marginal cost. In the presence of such a distortion, aggregate demand management could be effective in stimulating aggregate economic activity, as well as in raising the welfare of the economy. To grasp the intuition behind the mechanism, suppose the government increases its demand for monopolistically competitive goods, financed by a lump-sum tax. Since prices exceed marginal costs, such a shift in demand would increase the level of monopoly profits in the economy and thus national income. This increased income would generate additional demand for monopolistically competitive goods, which further raises profits and income and so on. With monopoly price distortion, the equilibrium behavior of the economy resembles the multiplier process described in a simple textbook Keynesian model.

2.A. The Basic Model

The idea can be modelled as follows. To focus on monopoly pricing distortions, I will ignore the entry process and endogenous changes in product variety, i.e., it is assumed that the economy produces a fixed set of products, each of which is supplied by a sole monopolist. Let $z \in [0,1]$ be an index of a product, as well as of the monopolist producing it. The assumption of restricted entry may be defended simply by arguing that the model describes the short-run equilibrium.[2]

---

[2]Alternatively, one can assert that some specific factors, such as entrepreneurial capital, are required to operate firms, and their services can be purchased in the competitive market, but they are fixed in supply. According to this interpretation, no firm earns monopoly profits and all rents are captured by the owners of competitively supplied factors. Whether one should describe this situation as "free entry" or "restricted entry" is a matter of semantics.

The representative consumer is endowed with L units of labor, holds ownership shares of all profit-making firms, and maximizes the following preferences,

$$\alpha \int_0^1 \ln c(z)\,dz + (1-\alpha)\ln(N) \ ,$$

where c(z) denotes consumption of variety z, and N leisure, respectively; α represents the budget share of the product group, $z \in [0,1]$, and is assumed to be between zero and one. Taking leisure as a numeraire, the budget constraint is given by

$$\int_0^1 p(z)c(z)\,dz + N \le Y - T \ ,$$

where $Y = L + \Pi$, represents aggregate income, which is equal to the sum of labor income, L, and profit, Π, while T is the lump sum tax. As a solution to this consumption decision problem, one can obtain demand for each variety of good as,

$$c(z) \ = \ \frac{\alpha(Y-T)}{p(z)} \ .$$

Let us assume that the government spends G equally for all goods regardless of their prices. Then, the total demand for each good is given by $q(z) = \{\alpha(Y-T) + G\}/p(z)$. The government also hires N' units of labor; the budget constraint requires $T = G + N'$.

Each variety can be produced by two types of firms. First, there is a competitive fringe of firms that can convert one unit of labor input into one unit of output with constant returns to scale technology. (Alternatively, one may interpret it as the technology of home production.) Second, there is a unique monopolist firm with access to an increasing returns to scale technology. This firm alone knows how to produce q units of output by using $aq + F$ units of labor input, where $0 \le a < 1$, and F represents the fixed cost. This firm chooses p(z) to maximize its profit, $\pi(z) = p(z)q(z) - [aq(z)+F]$. In doing so, it treats Y as a fixed parameter; although this firm has some monopoly power

over its own variety, it is negligible relative to the aggregate economy. Because of the unit elasticity

of demand and the competitive fringe, the monopolist adopts the limit pricing rule, $p(z) = 1$, and thus

$\mu = 1 - a = \{p(z)-a\}/p(z)$ can be interpreted as the profit margin. Since all monopolists face the

same incentive, $c(z) = \alpha(Y-T)$ and $q(z) = \alpha(Y-T) + G$ for all $z \in [0,1]$. Aggregate profit is

therefore equal to $\Pi = \pi(z) = \mu[\alpha(Y - T) + G] - F$. Note that higher aggregate demand increases

aggregate profit because of the positive profit margin, μ.

The income identity implies $Y = L + \Pi = L + \mu[\alpha(Y - T) + G] - F$, or

$$Y = A + \mu \alpha Y, \tag{1}$$

where

$$A \equiv L - F + \mu (G - \alpha T)$$

is the "autonomous" component of aggregate income. Solving the income identity equation (1) for

equilibrium income yields

$$Y = \frac{A}{1-\mu\alpha} = \frac{L-F+\mu(G-\alpha T)}{1-\mu\alpha}. \tag{2}$$

Note that a one unit increase in government spending on the monopolistically competitive products

raises A by μ when unaccompanied by a tax increase, and by $\mu(1-\alpha)$ when financed by a lump-sum

tax. This autonomous increase in income generates an induced demand increase by α, hence further

increasing income by $\mu\alpha$. Through such a cumulative process, aggregate income increases by an

amount equal to the original increase in the "autonomous" component of aggregate income,

"multiplied" by $1 + \mu\alpha + (\mu\alpha)^2 + \ldots = 1/(1-\mu\alpha)$.

It is easy to show that an increase in G, when financed by a reduction in N', improves the

welfare of the representative consumer. This is because in equilibrium non-competitive goods are

consumed too little, due to the pricing distortions. Alternatively, this inefficiency can be understood

in terms of aggregate demand spillovers. To see this, suppose that all consumers simultaneously increase their demand for non-competitive goods; this leads to a more efficient allocation of resources, as the marginal benefit of consumption exceeds the social cost of production. Nevertheless, no individual consumer has any incentive to demand more in equilibrium. The discrepancy between the effects of coordinated versus unilateral demand increases arises, as the potential gains generated by a unilateral shift in demand, materialized as an increase in monopoly profit, will be widely dispersed in the economy. This spillover effect creates a kind of free-rider problem in consumption decisions. An increase in government spending improves welfare as it solves the free-rider problem.

Benassy (1978) and Negishi (1978, 1979) demonstrated underemployment and insufficient aggregate demand in monopolistically competitive economies, under the so-called "subjective demand" approach. For the "objective demand" approach, see Benassy (1987), Blanchard and Kiyotaki (1987), Hart (1982), Startz (1989), Weitzman (1982), as well as the surveys by Benassy (1994) and Silvestre (1993). Some of these studies emphasized aggregate demand management policies, both fiscal and monetary, as a way of solving the free-rider problems that arise from aggregate demand spillovers. To discuss the effectiveness of monetary policies, it would be necessary to introduce nominal price stickiness into the model, for which I refer to the surveys by Gordon (1990) and Rotemberg (1987) on the "New Keynesian Macroeconomics" literature.[3]

2.B. Vertical Complementarity

The magnitude of the multiplier can be large even when the profit margin enjoyed by a typical firm is small, if a shift in demand ignites a chain reaction across a large number of firms. To see this,

---

[3]It should be noted that the primary goal of this literature is to explain the rigidity of nominal prices. Monopolistically competitive market structures are adopted out of necessity of modelling price-setting firms. Complementarities due to aggregate demand spillovers are rather by-products in this literature.

let us extend the basic model to multi-stage production. Suppose that there are S stages in production and, in each stage, there is a continuum of varieties, $z_j \in [0, 1]$, ($j = 1, 2,..., S$). Here, j = 1 represents consumption goods, j = 2 represents inputs to the consumption goods, etc. As before, each product can be produced either by a competitive fringe of firms, or a single monopolist, which has unique access to the superior technology. For all $1 \le j \le S - 1$, the competitive fringe uses the constant returns to scale technology given by

$$q(z_j) = \exp\left[\int_0^1 \ln q(z_{j+1}) \, dz_{j+1}\right],$$

and the technology of the monopolist is given by

$$(1 - \mu_j) q(z_j) + F_j = \exp\left[\int_0^1 \ln q(z_{j+1}) \, dz_{j+1}\right].$$

For j = S, the competitive fringe converts one unit of labor to one unit of output, while the labor input function of the monopolist is $(1-\mu_S)q(z_S) + F_S$. Under this specification, each firm is negligibly small as a purchaser of its inputs, and hence takes input prices given. Then, each monopolist firm, as a producer, faces unit elastic demand, and hence sets its output price equal to the unit cost of the competitive fringe. This implies that $p(z_j) = 1$ for all products, and hence, the output level and profit in each stage can be solved as a function of Y, recursively from $q_1 = \alpha(Y - T) + G$, $q_{j+1} = (1-\mu_j)q_j + F_j$, $\Pi_j = \mu_j q_j - F_j$, for $1 \le j \le S$. Combining them with the income identity,

$$Y = L + \sum_{j=1}^{S} \Pi_j,$$

one can show that equilibrium income can be written in the following form:

$$Y = \frac{A_0 + \mu (G - \alpha T)}{1 - \mu \alpha} ,$$

where

$$A_0 = L - \sum_{j=1}^{S} \left[F_j \prod_{k=j+1}^{S} (1 - \mu_k) \right] , \qquad \mu \equiv 1 - \prod_{j=1}^{S} (1 - \mu_j) .$$

According to this formula, μ can be close to one for a long chain of production, as long as there are some price-distortions at each stage of production. For illustration, let us take a couple of numbers from the range estimated by Domowitz, Hubbard and Petersen (1988) and Hall (1988). If $\mu_j = 0.3$, $\mu = 0.76$ for S = 4 and $\mu = 0.94$ for S = 8. If $\mu_j = 0.4$, $\mu = 0.87$ for S = 4 and $\mu = 0.98$ for S = 8.

In this model, an exogenous rise in the final goods demand causes a chain reaction of output and profit increases through vertical complementarity, running from downstream to upstream industries. The multiplier can be large even with a small profit margin, since the double (multiple) marginalization generates a large inefficiency at the aggregate level. See Hart (1982) for another model of two-stage (producers and unions) monopolistic competition, although his main reason for introducing monopolistic labor unions was to generate unemployment.

2.C.   Horizontal Complementarity

In a perfectly competitive world, a sectoral shock helps to expand some sectors only at the expense of other sectors. In a monopolistically competitive world, on the other hand, a favorable sectoral shock can lead to an economy-wide boom, in which all producers benefit simultaneously. Aggregate demand spillovers create a horizontal complementarity across all sectors of the economy. To see this, let us now extend the basic model to have two product groups, i = 1 and 2, with n_i being the size of group i. Let α_i, μ_i and Π_i be the budget share, the profit margin, and the profit level of product group i. Then, $Y = L + \Pi_1 + \Pi_2$, and, if the government spends G_i on product group i, Π_i

$= \mu_i[\alpha_i(Y - T) + G_i] - n_iF$. The profits of the two groups thus satisfy

$$\Pi_1 = A_1 + \mu_1\alpha_1(\Pi_1 + \Pi_2) , \qquad (3)$$

$$\Pi_2 = A_2 + \mu_2\alpha_2(\Pi_1 + \Pi_2) , \qquad (4)$$

where

$$A_1 \equiv \mu_1[G_1 + \alpha_1(L-T)] - n_1F$$
$$A_2 \equiv \mu_2[G_2 + \alpha_2(L-T)] - n_2F$$

summarize the autonomous components of the profits in the two groups. The second terms in (3) and (4) represent the induced components; a unit increase in total income generates additional demand for sector i by α_i, which increases its profit by $\alpha_i\mu_i$. Solving these equations simultaneously yields

$$\begin{bmatrix} \Pi_1 \\ \Pi_2 \end{bmatrix} = \frac{1}{1-\mu_1\alpha_1-\mu_2\alpha_2} \begin{bmatrix} 1-\mu_2\alpha_2 & \mu_1\alpha_1 \\ \mu_2\alpha_2 & 1-\mu_1\alpha_1 \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} .$$

Note that an increase in government spending on one group increases not only the profit (and the output) of that group, but also the profit and the output of the other group. Thus, an expansion of one sector benefits the other sector; the two sectors now become complementary to each other through demand spillover effects.

This implication can be carried over into international contexts. An increase in the autonomous demand for domestic products leads to a higher level of monopoly profits in the economy and thus of national income. This increased income will generate additional demand for domestic products, leading to a multiplier process. To the extent that increased income in demand falls on foreign goods and raises aggregate profits abroad, it also creates similar chain reactions and lead to an increase in income abroad. Thus, under imperfect competition, there are positive transmissions of country specific demand shocks: see Matsuyama (1992a) for a formal demonstration.

2.D.   Economic Development

The profit multiplier process and aggregate spillover effects are also important in understanding some problems in economic development. To see this, let us modify the basic model in two ways. First, the monopolist in each industry, instead of being equipped with the increasing returns to scale technology, decides whether to adopt the technology or to stay with the competitive fringe. Second, the fixed cost involves the use of products, instead of labor, as follows:

$$F = \exp\left[\int_0^1 \ln f(z)dz\right],$$

where $f(z)$ represents the investment demand for variety z by a monopolist, who decides to use the increasing returns to scale technology. This specification implies that the investment demand, and hence the total demand curve, of each product are also unit elastic. Again, facing the unit elastic demand and the competitive fringe, the monopolist using the increasing returns to scale technology sets the price equal to one. Hence, the output is equal to $q = \alpha(Y - T) + G + sF$, where s is a fraction of the monopolists that invest. The monopoly profit is $\pi = \mu q - F = \mu[\alpha(Y - T) + G + sF] - F$. The income identity is now $Y = L + s\pi$, so that the aggregate income and the monopolist profit can be derived as functions of s,

$$Y(s) = \frac{L + s\mu(G - \alpha T) - (1 - \mu s)sF}{1 - \mu \alpha s},$$

$$\pi(s) = \frac{\mu\{G + \alpha(L - T)\} - (1 - \mu s)F}{1 - \mu \alpha s}.$$

Note that the multiplier is now equal to $1/(1 - \mu\alpha s)$, since an induced demand increase, α, caused by one unit increase in autonomous income, generates the profit, μ, only in a fraction s of the industries, in which the monopoly adopts the increasing returns to scale technology.

The incentive to adopt the increasing returns to scale technology, of course, depends on the profit, which in turn depends positively on s, i.e., on how widely the technology is used in the
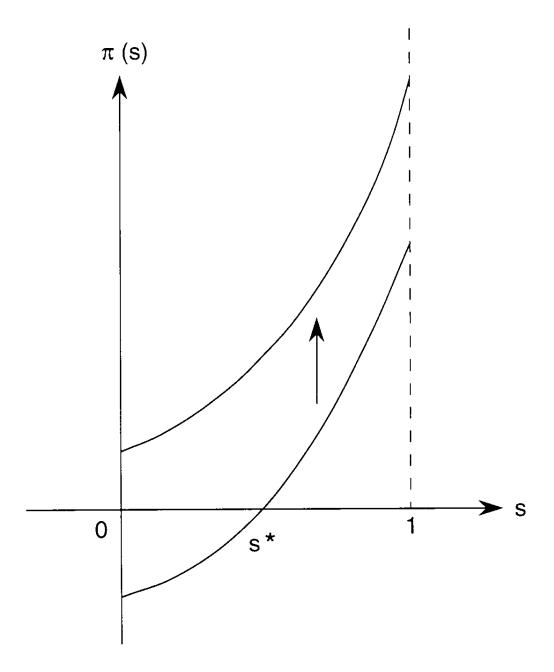
Fig. 1

economy. Furthermore, if

$$\frac{1}{\mu} F \;>\; G + \alpha \, (L - T) \;>\; \frac{1 - \mu}{\mu} F \;,$$

then $\pi(0) < 0$ and $\pi(1) > 0$, as depicted in Figure 1. Under this condition, the complementarity of investment decisions across industries leads to a co-existence of a good equilibrium (s = 1) and a bad equilibrium (s = 0). In the former, all industries invest and use the increasing returns to scale technologies; in the latter, no investment takes place and all industries stay with constant returns to scale technologies, which can be interpreted as an underdevelopment trap. It is also straightforward to show that $\pi(1) > 0$ ensures that the welfare level is higher at the good equilibrium than at the bad equilibrium. In this model, because of the fixed cost, the incentive to invest depends on the market size. But the market size depends on the investment demand. This circularity generates the complementarity and multiple equilibria.

With multiple equilibria, government spending may have a large impact on the economy. Suppose that the above condition is met and the economy is trapped in the bad equilibrium. A sufficiently large increase in G can shift the profit curve upward to eliminate the bad equilibrium, as depicted in Figure 1. In fact, even a small and "temporary" increase may be enough to lift the economy out of the state toward which it would otherwise gravitate.

Murphy, Shleifer and Vishny (1989a) argued, using models similar to one discussed above, that aggregate demand spillovers are crucial in understanding the problem of underdevelopment. In one of their models, it is assumed that workers suffer disutility from working in the factory (increasing returns to scale). In order to attract labor from villages, where cottage production is used (competitive fringe), monopolists have to pay a factory wage premium. In this model, the market size depends on the purchasing power of workers, which in turn depends on the extent of industrialization in the economy (through the factory wage premium), which generates the complementarity of

investment across industries and multiple equilibria.

Arguably, these models capture the old idea, which dates back to Rosenstein-Rodan (1943), Nurkse (1953), and Hirschman (1958), that the complementarity of modernization efforts across industries is the main obstacle to economic development. Rosenstein-Rodan, in particular, uses this idea to advocate for a large-scale development planning as a way of breaking away from underdevelopment traps. It should be stressed, however, that the complementarity of investment across industries does not necessarily provide the rationale for comprehensive central planning, as coordinated investment could be achieved through "the infectious influence of business psychology (Nurkse 1962, p.249)," which may be orchestrated by no more than some form of indicative planning: see Matsuyama (1992b) for more on this issue.

2.E.   Business Cycles: The First Approach.

As the analysis above suggests, a small modification of the basic model can easily generate Pareto-rankable multiple equilibria. For example, incorporating non-homothetic preferences (Heller 1986), decreasing marginal costs (Kiyotaki 1988), or endogenizing the mark-up (Galí 1994), could magnify the multiplier to such an extent that the modified models have both good and bad equilibria. The so-called "coordination failure" literature, surveyed by Cooper and John (1988), argues that such models with Pareto-rankable multiple equilibria describe the essence of business cycles with the interpretation of a good equilibrium as a boom and a bad one as a recession. Unfortunately, the static nature of most models in this literature leaves many skeptical of its usefulness as a foundation of business cycle theories. In this section, I will sketch one approach of converting a static model of complementarities into a dynamic model of business cycles, inspired by Shleifer (1986), Hall (1991) and Murphy, Shleifer and Vishny (1989b), among others. (An alternative approach, based on "sunspots," will be discussed in Section 4.D.)

Consider the following static game. There is a continuum of identical players with unit mass,

$z \in [0, 1]$, where "a player" can be interpreted as a firm or an industry. (In general equilibrium models of monopolistic competition, the distinction between a firm and an industry is not important.) Each player can be either "active" or "inactive." Let s be the fraction of active players. The payoff of a player is zero if inactive and $\pi(s)$ if active, where π is increasing in s. Assume that $\pi(1) > 0$. If $\pi(0) > 0$, then this game has a unique equilibrium, $s = 1$. If $\pi(0) < 0$, define s^* by $\pi(s^*) = 0$. In this case, the game has three equilibria: the good equilibrium $(s = 1)$, in which all players are active, the bad equilibrium $(s = 0)$, in which no player is active, and the middle equilibrium $(s = s^*)$, where the players are indifferent between "active" and "inactive". The model in the previous section is an example of this type of a game. Now let us produce a dynamic game by replicating the static game over time. Time is discrete $(t = 0, 1, ...,)$ and each player discounts future payoffs by the factor $\beta < 1$. The dynamic trajectory is described by a sequence, s_t.

The key for generating cyclical behavior is to introduce intertemporal substitution in this dynamic game, so that the players are also concerned with the timing of their actions as well. When combined with intratemporal complementarities, the intertemporal substitution restrictions provide an incentive for temporal agglomeration.[4] The following, though an admittedly crude way of modelling intertemporal substitution, would suffice to illustrate the basic idea. Instead of allowing each player to choose between "active" and "inactive" in every period, let us assume that no player can be active for two consecutive periods. Then, it is easy to show that $s_{2k} = 1$ and $s_{2k+1} = 0$ for all k, i.e., all players choose to be active in every even period, is an equilibrium path. Likewise, $s_{2k} = 0$ and $s_{2k+1} = 1$ for all k, i.e., all players chooses to be active in every odd period, is also an

---

[4]The coordination failure literature is right about emphasizing the role of complementarities in business cycles, but the role of substitution should also be stressed. For example, in the search model of Diamond and Fudenberg (1989), business cycles are generated not only by the complementarity due to search externalities, but also by the restriction that agents must alternate between search and production activities. Complementarity alone, while often sufficient for multiple equilibria, cannot generate cyclical behavior.

equilibrium. In these equilibria, booms and recessions alternate.

Furthermore, the stationary path is unlikely to be observed. Consider, for example, the case of $\pi(0) > 0$. The stationary path, $s_t = 1/2$ for all t, in which one half is active in every even period and the other half active in every odd period, is indeed an equilibrium in this case. Yet, two lines of argument can be made to rule it out as "unstable." First, a small perturbation to this equilibrium, $s_{2k} = 1/2 + \epsilon$ and $s_{2k+1} = 1/2 - \epsilon$, cannot be an equilibrium if the discount factor is sufficiently close to one. To see this, consider the problem faced by a player, who is supposed to be active in every odd period and only in every odd period, at the beginning of an odd period. By following the original strategy, this player can earn $\pi(1/2-\epsilon)$ in every other period, starting immediately. On the other hand, by being inactive in two consecutive periods, this player can switch to be active in every even period, which generates $\pi(1/2+\epsilon)$ in every other period, starting one period later. Thus, this player has an incentive to switch if

$$\beta \, \pi\left(\frac{1}{2} + \epsilon \right) \; > \; \pi\left(\frac{1}{2} - \epsilon \right) \; .$$

which holds for any ϵ, if β is taken sufficiently close to one. Second, let us consider the following perturbation of the game: (1) the set of players is now taken to be arbitrarily large, but finite; (2) there is an arbitrarily small probability with which each player trembles, i.e., the player may be "inactive" even if s/he intends to be "active." Then, a sufficiently large number of simultaneous trembles will eventually occur, after which players will start synchronizing their strategies, thereby leading to "booms" and "recessions."

A similar argument can be made for the case of $\pi(0) < 0$. In fact, if $s^* > 1/2$, the stationary path, $s_t = 1/2$ for all t, cannot even be an equilibrium. The only stationary equilibrium is a stagnation, $s_t = 0$ for all t. "Recessions" may be necessary gestation periods for "booms." Its policy implication is rather striking: an attempt to stabilize business cycles may lead to stagnation. This is

not to say that policy interventions are always counterproductive, as "recessions" can also be too long.

One may object that cycles generated in the above example look too regular for business cycles. However, this is partly due to the strong symmetry of the models. For example, it is natural to think that different industries face different intertemporal substitution constraints. Interactions of two classes of industries, one with a longer cycle than the other, could potentially generate more irregular cycles. When the intertemporal substitution constraints are less rigid than assumed above, the possibility of "phase-locking" also arises. Alternatively, exogenous periodic productivity shifts, such as seasonal variations, may lead to surprising effects when coupled with internal cycles of industries. Exploring such variations would be a rewarding research program.

In the models discussed above, the range of products in the economy is fixed, and hence rents are not dissipated away by the process of entry. If unrestricted entry is possible, rents would disappear and so would the complementarity through the multiplier process. Startz (1989), for example, argues that the multiplier should be much smaller in the long run than in the short run. However, free entry brings another source of complementarity if the entry of new firms expands the variety of products supplied in the market. For the remainder of the paper, I will turn to this mechanism of complementarities, based on the endogeneity of the product space.

3.   Expanding Product Variety and Aggregate Increasing Returns

To understand how the entry process could lead to a complementarity, it is important to note that entry of new firms, by introducing new products and services to the market, gives rise to increasing returns at the aggregate level. The idea itself is not new. Young (1928), for example, stressed that progressive division and specialization of industries, rather than subdivision of labor within a firm, as an essential part of the process by which increasing returns are realized. The formal modelling of this idea is, however, fairly recent.

3.A. The Basic Model.

To demonstrate the idea, I will use the following stripped down version of the Dixit and Stiglitz (1977) model. Suppose that a single consumption good is produced by assembling a variety of differentiated intermediate inputs. The technology satisfies the property of constant returns to scale for a given set of inputs. More specifically, the production function takes a form of symmetric CES;

$$X = \left[\int_0^n [x(z)]^{1-\frac{1}{\sigma}} dz \right]^{\frac{\sigma}{\sigma-1}}, \qquad (\sigma > 1)$$

with x(z) being the amount of input z employed in production, and [0,n] represents the range of intermediate inputs available in the marketplace. It assumes that the direct partial elasticity of substitution between every pair is equal to σ. The restriction, $\sigma > 1$, implies that no input is essential; X is well-defined even if some differentiated inputs are not used at all. Such a restriction is necessary as we consider the situation in which the range of products offered may vary.

One implication of this specification of product differentiation deserves special emphasis. That is, the productivity of intermediate inputs increases the greater the range of inputs available. To see this, let us suppose that all varieties are produced by the same amount, which, in fact, would be the case in optimal and equilibrium allocations. By letting x(z) = x, we have

$$X = n^{\frac{\sigma}{\sigma-1}} x \quad . \qquad (5)$$

Let M = nx be the total inputs used. Then, the average productivity of inputs, $X/M = n^{1/(\sigma-1)}$, increases with n. This arguably captures the notion that the introduction of new capital goods and producer services of a highly specialized character would enhance the efficiency of the economy. Ethier (1982a) and Romer (1987) earlier interpreted this property of the CES specification as increasing returns due to specialization, or to the division of labor, in production. This interpretation

has recently been given a formal treatment by Weitzman (1994).

The costs of expanding product variety and of increasing specialization come from economies of scale in the production of differentiated intermediate inputs. If there were no scale economies, then productivity could rise indefinitely by adding more and more varieties to the list of differentiated products, and producing less and less of each variety. As before, let us suppose that production of x units of each variety requires ax + F units of labor; F is the fixed cost and a is the marginal labor requirement. For notational convenience, let us choose the unit of measurement so that a = 1 − 1/σ. Finally, the labor resource constraint is

$$L = n(ax+F) ,\qquad (6)$$

where L is the total labor supply in the economy. Combining (5) and (6) yields

$$X = \frac{n^{\frac{1}{\sigma-1}}}{a} (L-nF) .$$

Hence, the optimal product variety, one that maximizes the above expression, and per capita consumption are

$$n^* = \frac{L}{\sigma F} ,\qquad \frac{X^*}{L} = \left[\frac{L}{\sigma F}\right]^{\frac{1}{\sigma-1}} .$$

They are larger a) when the fixed cost is small, b) when the products are less substitutable, and c) when the size of the economy is large.

A market equilibrium for this economy consists of the competitive final goods sector with the constant returns to scale production function X and the monopolistically competitive intermediate inputs sector with the labor input function, ax + F. Taking the range of intermediate inputs available in the market n, the prices of intermediate inputs, p(z) for z ∈ [0,n], and the price of the final good P, as fixed, the final goods producers seek to maximize their profit by choosing the cost-minimizing input combination. It is straightforward to derive the demand function for each input
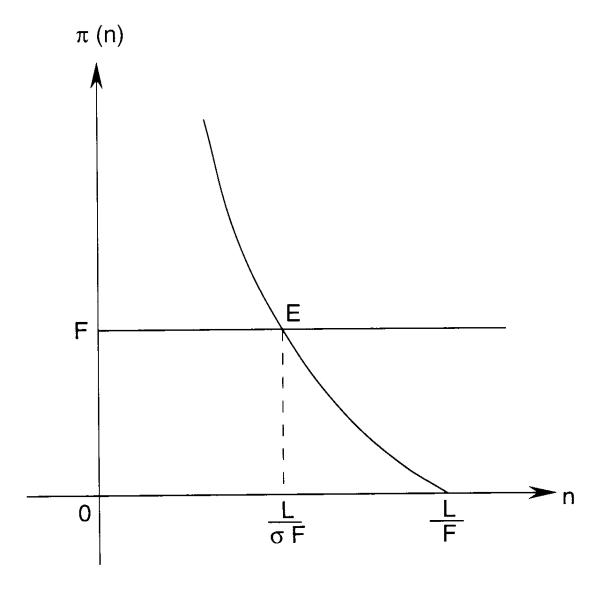
Fig. 2

$$\frac{x(z)}{X} = \left[\frac{p(z)}{P}\right]^{-\sigma} .$$

Furthermore, the zero profit condition implies that the output price must be equal to the unit cost:

$$P = \left[\int_0^n [p(z)]^{1-\sigma} dz\right]^{\frac{1}{1-\sigma}} .$$

Given the demand function derived above, each intermediate producer sets the price to maximize its profit. In doing so, it takes P and X as fixed. This means that the elasticity of demand with respect to its own price is σ, so that the profit-maximizing price satisfies $p(z)(1-1/\sigma) = a$, or $p(z) = 1$. The equilibrium price of the final good is hence

$$P = n^{\frac{1}{1-\sigma}} . \tag{7}$$

Note that an increasing availability of specialized inputs leads to a lower output price, although each input price remains constant. This is nothing but the mirror image of the efficiency effect of increasing specialization pointed out earlier.

The gross profit of each intermediate input firm (i.e., gross of the fixed costs) can be shown to be proportional to output produced:

$$\pi = (p - a) x = \frac{x}{\sigma} . \tag{8}$$

The labor market clearing condition is given by (6). Inserting this expression into (8), gross profit can now be expressed as a function of the number of firms:

$$\pi(n) = \frac{1}{\sigma - 1}\left[\frac{L}{n} - F\right]. \tag{9}$$

Note that this is a decreasing function of n, as shown in Figure 2. Entry of firms hence reduces the profit of incumbent firms. The entry process continues as long as gross profit exceeds the fixed cost, F. Thus, there is a unique equilibrium, depicted as point E in Figure 2. Some algebra shows that

equilibrium product variety and per capita consumption are

$$n^e = \frac{L}{\sigma F}, \qquad \frac{X^e}{L} = \left[\frac{L}{\sigma F}\right]^{\frac{1}{\sigma-1}}.$$

In market equilibrium, the variety of intermediate inputs, or the division of labor, is limited by the extent of the market; as the economy size increases, more firms stay and a wider range of products are offered in the market; this division of labor enhances the efficiency of production, and therefore consumers living in a larger economy will be better off. (As equilibrium profit is zero, the aggregate income consists only of wage income, so per capita output is equal to the equilibrium real wage in this model.) The equilibrium output of each firm is

$$x^e = \sigma F,$$

which is to say that, with a large fixed cost and in the presence of close substitutes, firms need to sell more to break even.

One may be surprised to see that the equilibrium allocation is efficient in this model. This is certainly not a robust feature of the model: a slight change in functional forms can destroy the equivalence of equilibrium and efficient allocations. Yet, it is worth asking why the equilibrium can be efficient in spite of monopoly pricing. The answer can be found in terms of the theory of second best: the price distortion happens to offset the other distortion present in this model. But, what is the other distortion? I will come back to this problem in Section 3.E.

3.B.   Economic Integration: The Effects of Trade

The basic model can easily be applied to international and interregional economics. Imagine that there exist two economies of the kind analyzed above, say East and West, and that they are originally isolated from each other. Furthermore, assume that the two economies have identical tastes and technologies. They differ only in labor supply. L^E denotes the labor supply of East and L^W that

of West. Now let us ask; "What would happen if the two economies are integrated?" The answer to this question crucially depends on the mobility of goods and labor.

First, suppose that the products can be transported at zero cost, but labor is immobile. Free trade in goods ensures that the same set of intermediate inputs is available everywhere, so that the final goods sector in both economies achieves the same level of efficiency, while the varieties produced in each region are determined by the labor resource constraint. Symmetry implies that the number of intermediate inputs produced in each region is proportional to the labor supply; East produces $n^E = L^E/\sigma F$ varieties, and West produces $n^W = L^W/\sigma F$ varieties. Both regions enjoy the same level of productivity, and per capita income in both regions is equal to

$$\left[\frac{L^E + L^W}{\sigma F}\right]^{\frac{1}{\sigma - 1}} .$$

As productivity depends on the availability of differentiated inputs in this model, economic integration through trade improves efficiency in both regions, and hence it is mutually beneficial. True, the larger economy may boast a much wider array of inputs produced than the smaller economy. However, as long as all the inputs are available at the same prices, this would not handicap the smaller economy. In fact, by comparing the situations before and after economic integration, it is easily seen that productivity gains are larger for the smaller economy.

With the notable exceptions of Negishi (1972) and others, imperfect competition and economies of scale received little attention in the theoretical trade literature for many years. The systematic study of trade in differentiated products has grown enormously during the last decade, following the path-breaking studies by Dixit and Norman (1980, Ch. 9), Krugman (1979), and Lancaster (1979, Ch. 10). I have touched on only one of many important lessons that come out of this literature: see Helpman and Krugman (1985, Chs. 6-9) and Helpman (1990) for more.

3.C. Economic Integration: The Effects of Factor Mobility.

Let us now suppose that there are impediments to trade, but economic integration makes it possible for some workers to migrate across the economies. Footloose workers migrate from the smaller economy to the larger economy, where the equilibrium wage is higher. As a result, the population distribution becomes more lop-sided. New firms are created in the larger economy, while firms are forced to close down in the smaller economy, which makes those who stay in the smaller economy worse off. With limited mobility of goods, increasing returns are now region-specific. This induces footloose workers to concentrate into one region. Economies of scale are realized only through agglomeration. It should be noted that economic integration benefits the immobile workers in the larger economy, while hurting those left behind in the smaller economy. This provides a striking contrast with the case of trade in differentiated goods, where all (immobile) workers gain and those in the smaller economy gain most. Faini (1984), Fujita (1990, Ch. 8.4), Helpman and Krugman (1985, Chs. 10-11), Rivera-Batiz (1988), and Matsuyama and Takahashi (1994) among others, discuss the effects of impediments to trade in differentiated goods on the regional distribution of economic activity.

In the policy debates concerning Europe 1992, North American Free Trade Area (NAFTA), and other regional trading blocs, much has been discussed about the possible impact on smaller economies. Many argue that, incorporated into a larger market area, small economies can enjoy all the benefits of economies of scale, and become main beneficiaries of economic integration. Others believe, however, that economic integration and the free movement of labor and capital lead to a concentration of economic activities into the center, leaving the peripheries underdeveloped. The above analysis suggests that both arguments have some theoretical merit and we need more detailed information about the process of economic integration in order to determine the impacts. See Krugman and Venables (1990) and Krugman (1991) for further exploration of this issue.

3.D.   Clustering Phenomena

The regional disparities caused by the migration of workers represent just one example of clustering phenomena, more general patterns that we observe everywhere in the real world. For instance, many industries tend to concentrate into a few areas within a country (Ellison and Glaeser 1994). On a much smaller scale, retail stores and restaurants tend to cluster together in certain sections within a city. Some sort of complementarity is obviously important for explaining retail store clustering, but we cannot entirely attribute it to the physical characteristics of products sold by these stores. True, restaurants and theaters tend to cluster together, as they offer complementary services. In more extreme cases, such as nuts and bolts or left and right shoes, complementarities are so strong that they are sold together in the same store. What is less obvious is why stores selling very similar products and hence competing directly for customers also cluster together. Examples abound, such as automobiles dealers, bookstores, camera shops, electronics shops, furniture stores, hair dressers, etc. Why are these stores not spread out geographically? The need to share common infrastructure may be one reason, but the universality suggests that there is something more that makes them cluster together.

A slight modification of the basic model, taken from Matsuyama (1992c), helps to explain why stores that sell similar products cluster together. The differentiated products, now interpreted as consumer goods, are divided into two groups, 1 and 2. Preferences are now given by $V(X_1,X_2)$, where

$$X_i = \left[\int_0^{n_i} [x(z_i)]^{1-\frac{1}{\sigma}} dz_i \right]^{\frac{\sigma}{\sigma-1}}, \qquad (\sigma > 1)$$

and n_i denotes the product variety offered in group i for i = 1 and 2. The upper-tier utility function, V, which aggregates the two composites of differentiated goods, is assumed to be homothetic. There are two types of labor, managers and workers, whose total supplies are K and L, respectively. Producing x units of each good requires $ax = (1-1/\sigma)x$ workers, as well as F managers. The services

of managers are required independent of x and hence constitute the fixed cost. From the market clearing condition for managers, the total number of firms is constant and equal to $K/F = n_1 + n_2$. This feature of the model helps us focus on the distribution of firms across the two groups.

Normalize the wage paid to a worker to one. As before, demand for each product has the constant price elasticity equal to σ, for any given distribution of firms across the two groups. With the marginal cost equal to $a = 1 - 1/\sigma$, each firm sets the price to be equal to one, $p(z_i) = 1$ for all $z_i \in [0, n_i]$. Hence, all firms in the same group operates at the same scale, $x(z_i) = x_i$ for all $z_i \in [0, n_i]$, and thus $X_i = n_i^{\sigma/(\sigma-1)} x_i$ and the gross profit per firm is $\pi_i = x_i/\sigma$. (This means that each manager employed in group i is paid $x_i/\sigma F$ for his/her services.) The price index of each group is $P_i = n_i^{1/(1-\sigma)}$. The relative demand of the two composites can be written, due to the homotheticity of V, as $X_1/X_2 = \Psi(P_1/P_2)$, $\Psi' < 0$, so that the ratio of the gross profit in the two groups depends solely on the ratio of product variety:

$$\frac{\pi_1}{\pi_2} = \frac{x_1}{x_2} = \frac{X_1}{X_2}\left[\frac{n_1}{n_2}\right]^{\frac{\sigma}{1-\sigma}} = \Psi\left(\frac{P_1}{P_2}\right)\left[\frac{n_1}{n_2}\right]^{\frac{\sigma}{1-\sigma}} = \Psi\left(\left[\frac{n_1}{n_2}\right]^{\frac{1}{1-\sigma}}\right)\left[\frac{n_1}{n_2}\right]^{\frac{\sigma}{1-\sigma}}.$$

To see what is involved in this expression, suppose that V is a CES: $\Psi(P_1/P_2) = \beta[P_1/P_2]^{-\epsilon}$, where ϵ represents the intergroup elasticity of substitution, while σ may now be referred to as the intragroup elasticity of substitution. Then,

$$\frac{\pi_1}{\pi_2} = \beta\left[\frac{P_1}{P_2}\right]^{-\epsilon}\left[\frac{n_1}{n_2}\right]^{\frac{\sigma}{1-\sigma}} = \beta\left[\frac{n_1}{n_2}\right]^{\frac{\epsilon-\sigma}{\sigma-1}}.$$

The relation between profit level and product variety depends on the relative magnitude of ϵ and σ.

For example, suppose that group 1 consists of restaurants and group 2 retail stores. A pair of restaurants or a pair of stores are much closer substitutes than dining and shopping ($\epsilon < \sigma$). Then, the profit level is negatively related to variety. If there are too many restaurants and a few stores in the city, restaurants will close down and new stores will open in the long run. Entry and

exit processes balance the numbers of the two types of establishments so as to equalize the profit rate across the two groups.

On the other hand, suppose that there are two streets in the city and products are grouped according to their location. It is costly to move back and forth between the two streets, but ex ante consumers are almost indifferent between the two locations. Then, ϵ is close to infinity, so that ϵ > σ and hence the profit level is positively related to the number of shops. Entry of a new firm, by attracting more customers, would benefit existing firms in the same street. This introduces complementarity in the locational decision, and entry and exit processes lead to all stores clustering into a single location. Of course, with the right distribution, firms may be indifferent between the two locations. Yet, such an equilibrium is unstable. The two stable equilibria in this example both correspond to complete concentration in the same location. It should be pointed out that, when clustering happens, there is no guarantee that the market mechanism picks the right place to cluster. For example, if β > 1 in the above example, it is better to cluster in location 1 than in 2. Yet, clustering in location 2 is a stable equilibrium allocation.

Note also that clustering of two products (and stores) can occur even when the direct partial elasticity of substitution between them, σ, is high, i.e., even when they are very similar products. What makes a pair of products complementary to each other is the presence of a third alternative, rather than the physical characteristics of the two products. In other words, what matters is the Hicks-Allen notion of complementarity. In criticizing the notion of complementarity defined by earlier writers, Hicks and Allen (1934) argued that the notion of complementary goods should be based on the property of market demand and proposed that two goods should be regarded as complements if what is now known as the Allen partial elasticity of substitution is positive. In fact, an explicit calculation shows that in our model the compensated demand function satisfies

$$\frac{P_j}{x_j(z)} \frac{dx_j(z)}{dP_j} \Big|_{V=const.} = \epsilon - \sigma$$

so that products in the same group are Hicks-Allen complements, whenever $\epsilon > \sigma$. Intuitively, when other shops in your area reduce their prices, you lose some of your customers; σ captures this business-stealing effect. Yet, your sale may still go up if the lower prices attract customers to your area, the effect captured by ϵ, more than enough to offset the business-stealing effect. If this is the case, then your shop and other shops in your area are complementary to each other in the sense of Hicks and Allen.

The discussion above assumed that V is a CES, but the main implications do not depend on this assumption. With a more general upper-tier utility function, this model can have any odd number of equilibria, with stable and unstable equilibria alternating. When evaluated at a stable (an unstable) equilibrium, products in the same group are Hicks-Allen substitutes (complements) with each other.

The traditional explanation of retail store clustering was based on Hotelling's (1929) "principle of minimum differentiation," which is not robust to small specification changes. Recent literature, such as Wolinsky (1983), emphasizes the role of consumer search in the presence of incomplete information. Much of modelling efforts is devoted to make products offered in the same location imperfect substitutes (i.e., finite σ). The analysis here suggests that the consumer's ex ante indifference between the locations is the reason why even a small amount of incomplete information often causes clustering in this literature.

The above model, with some modifications, can easily be applied to other contexts, as well. For example, the two groups can be interpreted as the two alternative transportation systems, say automobiles and railroads. Products are classified by whether they cater to the need of drivers or of train-riders. To the extent that the two modes of transportation are close substitutes, there are two stable equilibria, which can explain diversity across societies. In some societies, people use trains

frequently and there are more shops around stations than along highways, and there are many pocket-sized products. In others, people tend to drive more and there are more shops along highways than around railroad stations.[5]

Alternatively, groups can be classified according to dates. By interpreting ϵ as the intertemporal rate of substitution, the model can be extended to explain regular temporal variations, within a day, or a week, or a year. In such a model, there is no guarantee that the market mechanism chooses the right time to cluster activities. If this is the case, the government may be able to play a critical role in coordination, such as by introducing the daylight savings time or mandatory store closing hours.

3.E.   Anatomy of Market Failure.

In demonstrating clustering phenomena, it was also argued that the model of section 3.D. yields the possibility of inefficiency. Market equilibrium does not necessarily pick the right place or the right time in which to concentrate economic activities. Or, society may be stuck with a relatively inefficient industrial standard, despite there being a technologically feasible alternative, which would enhance efficiency if adopted widely.

The natural question is then: "what is the source of inefficiency?" Since the model does not have any technological externalities, one might be tempted to attribute the inefficiency to the pricing distortion. However, in the model discussed above, all goods produced are marked up at the same rate (due to the symmetry of the products and the absence of an outside good), so that there is no distortion in relative price. Free entry ensures that managers work in the firms offering the highest returns. Then, without any discrepancy between social and private costs/benefits of any individual

---

[5]It would be interesting to extend such a model to incorporate public goods, highways and railroads. Once more people have chosen to drive and more shops have established along highways, there would be a stronger political support to invest more on highways. Such a political process should further accentuate complementarities.

action, why is there inefficiency?

The source of inefficiency is the coordination failure across firms. Starting with an inefficient clustering equilibrium, no individual firm has an incentive to move to the other group, given that other firms continue to stay. But, why does the price mechanism fail to coordinate the actions of firms?

It might be instructive to interpret this inefficiency result in light of the First Fundamental Theorem of Welfare Economics. This theorem says that in economies with complete markets, competitive equilibria are Pareto optimal. This theorem is remarkable in that few restrictions on the properties of technologies are required. In particular, neither nonconvex technologies nor nonconvex consumption sets would cause any problem for Pareto optimality. The reason why this theorem does not apply to our model even in the absence of price distortions is the lack of complete markets. In order to be able to apply the theorem to the environment of our model, there must be competitive markets for all commodities (i.e., all potential products), as well as the markets for the two factors, in which prices are publicly quoted so that firms and consumers can signal their demand and supply for each commodity simultaneously for any vector of prices. This is indeed a very strong hypothesis. In the model above and in any monopolistic competition models, it is assumed more realistically that consumers demand only products that are available in the marketplace. What is critical here is that, before a new product is introduced, its price is not publicly quoted, so that there is no way for consumers to signal their demand for the product. When the firm enters, it not only creates a new product but also creates the market for that product.

The incompleteness of markets would not cause any coordination failure if all products are Hicks-Allen substitutes. When there are Hicks-Allen complements, however, a whole set of complementary products may fail to be introduced even when it is more efficient to introduce them. To understand this, it is useful to think that, from the consumer's point of view, products not yet

offered can be regarded as products offered at prices equal to infinity. When a single firm contemplates offering one of the products, quoting a finite price does not generate any demand for the product if complementary products remain prohibitively expensive. Only when a large set of complementary products are offered simultaneously and become available at reasonable prices, consumers are induced to signal sufficiently high demand for each good. This is the reason why the costs-benefit calculation of individual entry differs from that of simultaneous entry, regardless of whether one takes social or private points of view. In the standard general equilibrium model with complete markets, this coordination problem is artificially resolved by the Walrasian auctioneer, who quotes the prices for all potential commodities to which both consumers and producers respond.[6]

That the lack of complete markets is responsible for the inefficiency in the model should also become clear by showing that any equilibrium allocation is the solution to the optimal allocation problem, conditional on the set of goods produced, which will be left to the reader as an exercise.[7] The important message is that the market mechanism may be an efficient algorithm for solving how much to consume and produce, once a more fundamental problem of which commodities to consume and produce has been solved. In reality, of course, there are so many potential commodities that it is impossible to open markets for all: we must decide which market to open. The paradox is that we need to open all markets in order to collect the necessary information to know which market to open.

---

[6]Of course, it is possible that some commodities are not produced in equilibrium in a model with complete competitive markets. However, the equilibrium allocation is still efficient, as markets are open even for these non-produced commodities. There are publicly quoted equilibrium prices, to which consumers submit zero demand and producers submit zero supply. The equilibrium quantity is zero for these commodities precisely because there are no gains from trade. Another way of saying this is that the open but inactive market is fundamentally different from the closed market.

[7]This is because markets exist for all the commodities actually produced and consumed. This is different from the literature of incomplete security markets, surveyed by Duffie (1992), or from the sunspot literature surveyed by Chiappori and Guesnerie (1991), in which trading opportunities are restricted even for commodities that are a part of endowment bundle. The critical difference is that, unlike in these literatures, the set of goods consumed is determined endogenously in models of monopolistic competition.

Above, I have developed a monopolistic competition model with no price distortion in order to isolate the lack of complete markets as a sole source of inefficiency. It should be pointed out that the distortion due to the incompleteness of the market would not disappear in models with price distortions. Sometimes, the two forms of distortions can interact to produce a rather surprising result. For example, in the basic model of Section 3.A., the market equilibrium allocation is efficient. This is because the two forms of distortion exactly offset each other.

In many ways, the market failure in clustering phenomena discussed in this section resembles the "counterexamples" analyzed by Hart (1980) and Makowski (1980), who interpret them as a formalization of the pecuniary externalities discussed by Scitovsky (1954). In their examples, the inefficiency occurs when a set of complementary products fails to be produced, while in the model above the inefficiency occurs when a wrong set of complementary products are produced. Their examples also assume directly complementarity between the two goods, the nut and the bolt, produced by two independent firms, for which the coordination failure is difficult to justify. On the other hand, the possibility of inefficiency here arises as the lack of coordination among a large number of firms, possibly selling very similar products.

The possibility of inefficient clusters discussed above arises because the market mechanism may fail to pick the right place in which to cluster economic-activities. In the model, there is another clustering equilibrium, which is efficient. Hence, there is nothing wrong with clustering per se. This is an important point to keep in mind, particularly in the context of regional policies, as policy debates in this area often take it for granted that unbalanced regional growth is undesirable. However, this is not to say that an inefficient clustering equilibrium always co-exists with an efficient clustering equilibrium. Indeed, one can construct a variation of the above model, in which all clustering equilibria are inefficient, relative to the (unstable) equilibrium in which all types of products are offered. For such a model, see Matsuyama and Takahashi (1994), which discusses the

possibility of inefficient unbalanced regional growth.

4.   Circular and Cumulative Causation in Growth and Development

Complementarity in the entry process and associated expanding product variety is also useful

for understanding some fundamental problems of economic growth and development. Satisfactory

treatments of these issues, of course, require a dynamic model, and the literature has evolved

primarily by extending the dynamic monopolistic competition model of Judd (1985). Nonetheless,

I will refrain from developing dynamic models, as the static framework can illustrate many ideas in

the literature.

4.A.   Underdevelopment Traps

One critical aspect of the development process is that productivity growth is realized through

an ever greater indirectness in production. One of the main obstacles to economic development is

that complicated technologies often require a variety of local inputs and producer services. In

underdeveloped regions, the lack of local support industries force the use of relatively simple

production methods in downstream industries. This in turn implies a small market size for specialized

inputs; the lack of local demand prevents a network of support industries from springing up in the

economy. Thus, the two factors, the lack of demand and the lack of support industries, are mutually

interrelated. Not only is the division of labor limited by the extent of the market, but also the extent

of the market is limited by the division of labor. Such circular causation creates underdevelopment

traps. Of course, the circularity does not always imply a vicious circle. If the economy acquires more

than a critical mass of support industries, the very fact that the relation is circular generates a virtuous

circle. Over time, the division of labor becomes far more elaborate, the production process more

indirect, involving an increasing degree of specialized inputs. Through such a cumulative process, the

economy experiences productivity growth and a rising standard of living. In the presence of
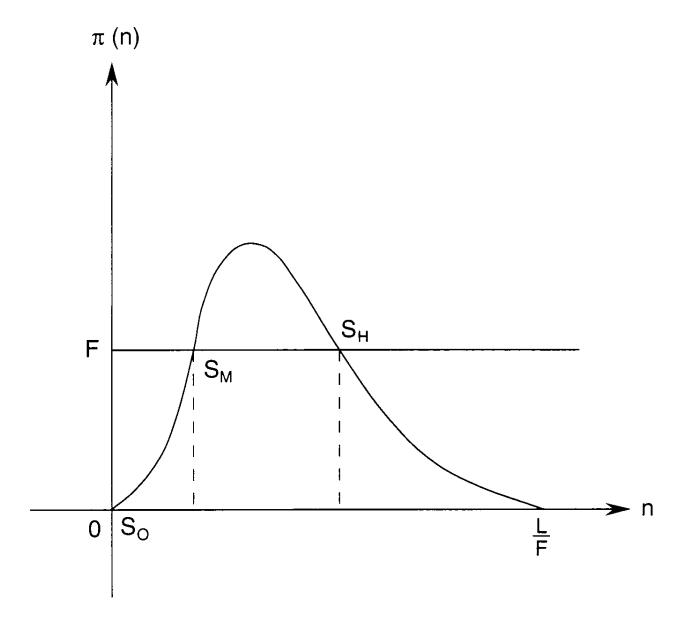
Fig. 3

complementarity, nothing succeeds like success, and poverty becomes its own cause.

Again, a slight extension of the model of section 3, taken from Matsuyama (1992c, Sec. 3), helps to capture this idea. Let us now suppose that a single consumption good is produced with the following constant returns of scale production function,

$$C = F(X,N) ,$$

where N is labor input. This specification allows the final goods industry to substitute between labor intensive and intermediate inputs intensive technologies. The relative demand for N and X is given by an increasing function of P,

$$\frac{N}{X} = \Phi(P) , \tag{10}$$

with the elasticity of substitution between X and N being equal to $\epsilon(P) \equiv dlog\Phi(P)/dlogP$. The pricing behavior of monopolistically competitive firms is the same as before, so that $p(z) = 1$ for all $z \in [0,n]$ and all varieties are produced by the same amount; hence (5) and (7) remain valid. The labor market clearing condition now becomes, instead of (6),

$$n(ax+F) + N = L . \tag{6'}$$

For any n, equations (5), (6'), (7), and (10) can be solved for x. From (8), the gross profit per firm satisfies

$$\pi(n) = \frac{L - nF}{(\sigma-1)n + \sigma \Phi(n^{\frac{1}{1-\sigma}}) n^{\frac{\sigma}{\sigma-1}}} . \tag{9'}$$

With a large $\epsilon(P)$, the profit function can be increasing in n. For example, suppose that F(X,N) is CES, with $\epsilon(P) \equiv \epsilon$. Then, $\Phi(P) = \beta P^\epsilon$ and the profit function has a single peak when $\epsilon > \sigma$. In this case, there are three equilibria, as shown in Figure 3. The middle equilibrium, S_M, represents the threshold level below which the firms make losses. If the economy is slightly above the middle

equilibrium, there is an inducement to start new firms. Profit per firm rises with the number of firms around the middle equilibrium, which makes it unstable. The other two equilibria, S_0 and S_H, are both stable. In the lower range, the limited availability of specialized inputs induces the final goods sector to use relatively labor intensive technologies, which implies a small market size for inputs producers. No firm is able to stay in the market, and $n = 0$, or S_0, represents a state of underdevelopment toward which the economy gravitates. The higher level equilibrium, S_H, on the other hand, is characterized by a wider range of intermediate inputs, a higher share of the intermediate inputs sector in GNP, and a higher total factor productivity.

More generally, this model could have an arbitrary number of stable equilibria, as constant returns to scale imposes very few restrictions on the relative factor demand function $\Phi(P)$. An example can easily be constructed by allowing the final goods sector to have access to a finite number of Leontief (i.e., fixed coefficient) technologies. Furthermore, it can be shown that per capita consumption (and labor productivity) is positively related to product variety across equilibria. The model is thus consistent with the idea of the stages of economic development.

The multiplicity of stable equilibria arises in this model because the benefits of a new input are not completely appropriated by the firm that introduces it. With an increasing variety of inputs, entry induces the final goods sector to switch to more intermediate inputs intensive technologies, thereby generating demand for other inputs. No individual firm, however, takes into account such pecuniary externalities. Of course, coordinated, simultaneous entry of firms would solve the demand spillover effects, making it possible for the economy to jump from S_0 to S_H. However, this is partly due to the static nature of the model. In an explicit dynamic setting, where starting up new firms require reallocation of current resources from production and the benefits of productivity growth are realized only in the future, Ciccone and Matsuyama (1992) show that the resource constraint makes coordinated entry unprofitable, and the economy cannot escape from the state of underdevelopment;

thus n = 0 becomes a poverty "trap."

It is worth pointing out that, at a more formal level, the mechanisms generating multiple equilibria in this model are similar to those discussed in Section 3.D. The possibility of substitution between labor intensive and intermediate inputs intensive technologies makes intermediate inputs complementary to each other (in the sense of Hicks and Allen), even when the rate of substitution between two intermediate inputs, σ, is high. It should also be noted that, although monopoly price distortions play a significant role, the underdevelopment trap cannot be eliminated merely by correcting price distortions. For the same reason discussed in Section 3.E., multiple equilibria and inefficient traps could still exist without any price distortion: see Matsuyama (1992c, Sec. 3).

4.B.   International Economics

The above model also suggests that international trade could be responsible for uneven development. To see this, consider the following model of a small open economy, adopted from Rodríguez-Clare (1993). There are two tradeable consumer goods, A and B, and preferences are given by $C_A{}^\alpha C_B{}^{1-\alpha}$. Both consumer goods sectors are competitive, and the production functions are $F_A(X_A,N_A) = X_A{}^\gamma N_A{}^{1-\gamma}$ and $F_B(X_B,N_B) = X_B{}^\delta N_B{}^{1-\delta}$, where $0 < \delta < \gamma < 1$. In the absence of international trade, this is analytically equivalent to an economy of a single final goods industry with the production function $F(X,N) = KX^{\alpha^*}N^{1-\alpha^*}$, where K is a positive constant and $\alpha^* = \alpha\gamma + (1-\alpha)\delta$ (hence $\gamma > \alpha^* > \delta$). Relative demand is then $\Phi(P) = (1/\alpha^*-1)P$ and the profit function is, from (9'),

$$\pi(n) = \frac{\alpha^*}{\sigma-\alpha^*}\left[\frac{L}{n} - F\right],$$

which is decreasing in n, as depicted by the dotted curve in Figure 4. There is a unique stable equilibrium, in which the economy produces both consumer goods. Equilibrium product variety is given by
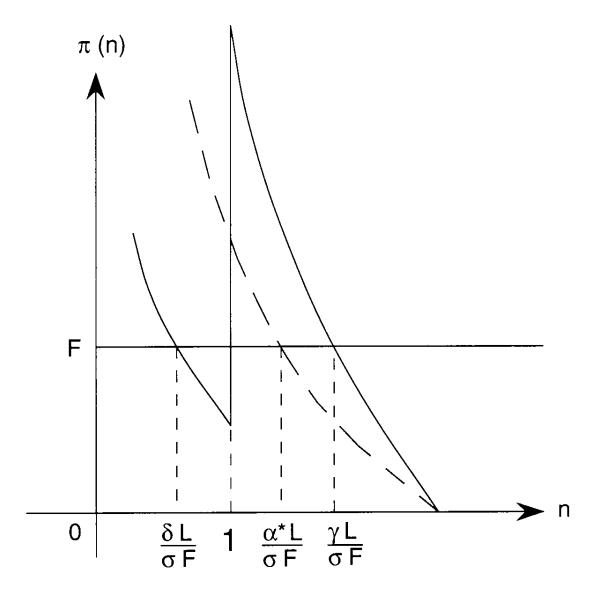
Fig. 4

$$n = \frac{\alpha^* L}{\sigma F} \; .$$

Suppose now that the economy trades in the world market, where the relative price of the two tradeable goods is exogenously given and equal to one. This open economy effectively becomes equivalent to a closed economy of a single final goods industry with the production function, $F(X,N)$ $= MAX\{X_A^\gamma N_A^{1-\gamma} + X_B^\delta N_B^{1-\delta}$, s.t. $X_A + X_B \le X$ and $N_A + N_B \le N\}$, whose elasticity of substitution between X and N is infinite at $P = 1$. This is because the possibility of trade makes the two consumer goods perfect substitutes for the competitive firms. With $\sigma < \epsilon(1) = \infty$, the economy may now have underdevelopment traps.

More specifically, the unit cost is equal to P^γ in sector A and P^δ in sector B, so that the economy specializes in A when $P^{\gamma-\delta} = n^{(\gamma-\delta)/(1-\sigma)} < 1$ or $n > 1$; it specializes in B when $n < 1$. The relative demand function is thus $\Phi(P) = (1/\gamma-1)P$ and $\Phi(P) = (1/\delta-1)P$, respectively. The gross profit is hence equal to

$$\pi(n) = \frac{\gamma}{\sigma-\gamma}\left[\frac{L}{n} - F\right] \; ,$$

if $n > 1$, and

$$\pi(n) = \frac{\delta}{\sigma-\delta}\left[\frac{L}{n} - F\right],$$

if $n < 1$. Note that the profit function jumps at $n = 1$, at which the economy switches between the two sectors. If $\gamma > \sigma F/L > \delta$, there are two stable equilibria, $n_A = \gamma L/\sigma F$ and $n_B = \delta L/\sigma F$, with $n = 1$ being the threshold level, as shown in Figure 4. In this example, international trade creates an underdevelopment trap. An economy with a small industrial base specializes in B, which make little use of local specialized inputs, hindering the development of an industrial base.

When an economy finds itself in such a trap, government intervention could be effective. For

example, imposing sufficiently heavy taxes on the production of B can reduce the threshold level below n_B. This eliminates the low equilibrium trap, leaving n_A the only equilibrium (Rodrik 1994). If $\alpha^*L > \sigma F$, autarky would also help to generate a critical mass of support industries, so that temporary isolation would help the economy to escape the underdevelopment trap.

Let us now briefly consider some implications of this model from the global point of view. Suppose that the world economy consists of many identical national economies of the kind analyzed above. Since the world as a whole is a closed economy, some economies have to specialize in B, while others specialize in A. Without any innate differences, national economies need to be separated into the rich and the poor. Furthermore, as larger fraction of the national economies succeeded in development, the world supply of A goes up relative to B, which reduces the relative price of A. This change in the relative price raises the threshold level of n, making the problem of development even harder for those remaining underdeveloped. See Markusen (1991) for the dynamic analysis along this line, demonstrating first-mover advantages in economic development in the presence of international trade.

The above model thus captures an element of the radical or structuralist views, expressed by Baran (1957), Myrdal (1957), and most notably by Prebisch (1950). Nevertheless, its policy implications should be interpreted with caution. First, the economy may be better off in the low equilibrium trap than in autarky. Specializing in B under free trade is worse than specializing in A under free trade, but this does not necessarily imply that specializing in B under free trade is worse than autarky. Second, the analysis treats nontradeability (or, more generally, transport costs) of specialized inputs as given. As Markusen (1989) and others have pointed out, reducing trade barriers on specialized inputs is generally desirable. This is the case even when some inputs are truly nontradeable. For example, in the above example, suppose that some specialized inputs are tradeable, while others are nontradeable. Initially, all tradeable inputs are banned, and the economy

is in the low equilibrium trap. Removing trade barriers on some tradeable inputs can help the economy to cross the threshold, which increases demand for inputs, including nontradeable ones. Hence, there is complementarity between tradeable and nontradeable inputs.

4.C.   Sustainable Growth

Note that in the previous model, the cumulative process of growth and development ultimately peters out. This is because the resource constraint eventually becomes strong enough to counteract demand complementarities. In industrialized countries, however, all indices seem point steadily upwards. On average and in the long run there are no signs of a slacking of economic development in these countries (Maddison 1982, Ch.2; Romer 1986). The recent literature on endogenous growth shows that complementary in the technologies of entry processes itself may be important for sustainable growth.

Again, the basic model of Section 3.A. can be used to illustrate the basic idea. As shown in Figure 2, the benefit of entry, gross profit, declines with new entries. In order to offset smaller profits, the cost of entry must also decline. One way of doing this, taken from Rivera-Batiz and Romer (1991) and Barro and Sala-i-Martin (1992), is to assume that starting new firms requires F units of the final good, instead of labor. The idea is that new generations of computers would help scientists design new products, hence this model is called "the lab equipment model" by Rivera-Batiz and Romer. Under this specification, entry also benefits from increasing returns due to specialization, which introduces a complementarity in the entry process and makes growth sustainable.

As labor is used only in manufacturing of inputs, the labor market condition becomes simply $nax = L$. Gross profit is thus $\pi = x/\sigma = L/(\sigma-1)n$, which is declining in n. The cost of entry, on the other hand, becomes PF, so that entry of new firms would continue as long as
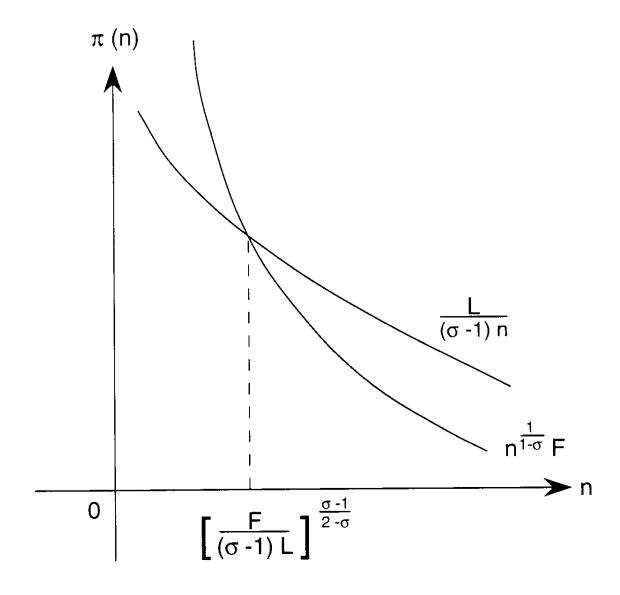
Fig. 5

$$\pi\ (n)\ =\ \frac{L}{(\sigma-1)\ n}\ \geq\ n^{\frac{1}{1-\sigma}}F\ , \tag{9''}$$

or

$$\frac{L}{(\sigma-1)\ F}\ \geq\ n^{\frac{2-\sigma}{1-\sigma}}\ .$$

If $\sigma = 2$, then both the benefits and costs of entry fall at the same rate, and the inducement to start up new firms always exists as long as $L > (\sigma-1)F$. If $\sigma < 2$, the case shown in Figure 5, the cost of entry falls faster than the benefit. This creates a threshold for development, but the cumulative process of growth, once started, will never stop.

An alternative way of generating sustainable growth, taken from Romer (1990) and Grossman and Helpman (1992, Ch.3) and others, is to introduce learning-by-doing in the process of entry, while maintaining the assumption of the fixed cost being paid by labor. More specifically, let us suppose that the amount of labor required in start-up operations declines with the number of firms, say, F/n^{λ}. Then the stock of knowledge useful for setting up new firms is increasing in n. The idea is that entrepreneurs starting new businesses or scientists designing new products can learn from past experience, hence named "the knowledge-driven model" by Rivera-Batiz and Romer. The labor market clearing condition is now

$$L\ =\ n\left[a\,x\ +\ \frac{F}{n^{\lambda}}\right]\ .$$

By substituting this expression in (8), one can show that the entry of new firms would continue as long as

$$\pi\ (n)\ =\ \frac{1}{\sigma-1}\left[\frac{L}{n}\ -\ \frac{F}{n^{\lambda}}\right]\ \geq\ \frac{F}{n^{\lambda}}$$

or

$$\frac{L}{\sigma F} \geq n^{1-\lambda} \quad .$$

If labor productivity in start-up operations is proportional to the number of firms ($\lambda = 1$), as assumed in Romer, and Grossman and Helpman, then there is always an incentive to start up new firms and introduce new products as long as $L > \sigma F$. If the learning-by-doing or knowledge-spillover effect is stronger ($\lambda > 1$), then the possibility of underdevelopment traps arises, but, again, the cumulative process of growth, once started, will never stop.

4.D.   Business Cycles: The Second Approach.

Because of the multiplicity of stable equilibria, the model of Section 4.A. and 4.B. can also be used as a building block for modelling business cycles. For example, one may adopt the approach sketched in Section 2.E. A combination of intertemporal substitution and intratemporal complementarity generates temporal agglomeration, and the economy alternates between "booms" and "recessions." Instead of repeating the argument, I will sketch an alternative approach in this section, based on "sunspot equilibrium", taken from Howitt and McAfee (1992) and Chatterjee, Cooper, and Ravikumar (1993). Although the sources of complementarities in these studies are not due to monopolistic competition, the approach should be adoptable to models of monopolistic competition as well.

The basic idea is easy to grasp. Consider the case of the two stable equilibria, say, n_A and n_B, as in Section 4.B. By replicating the static model over time without allowing any possibility of intertemporal allocation of resources (e.g., by assuming all goods are perishable), one can generate a rather trivial dynamic model. Now introduce a publicly observable random variable, called a "sunspot," which follows a Markov process with two-states, say A and B. The realization of the sunspot variable has no effect on the fundamentals of the economy; it is purely extrinsic uncertainty. Yet, it is possible for the sunspot variable to drive fluctuations in this economy. Suppose that all

agents believe that $n = n_A$ when the sunspot is in state A, and behave accordingly. Then, the equilibrium value of n is indeed equal to n_A. Likewise, if all agents believe that $n = n_B$ when the sunspot is in state B, then the belief is indeed confirmed in equilibrium. Thus, the belief that the economy is driven by the sunspot becomes a self-fulfilling prophecy. In such a sunspot equilibrium, a boom is coming if every agent believes that it is coming, and a recession is coming if every agent believes so. The sunspot variable acts as a device to coordinate the expectations of the agents.

What is discussed above is admittedly a caricature of the sunspot equilibrium. Instead of simply replicating the static model with multiple stable equilibria, one may construct an inherently dynamic model in which the number of firms, n, can change only slowly over time. The presence of some friction makes n a predetermined variable. Such a friction can be introduced either due to investment processes (Ciccone and Matsuyama 1992), to physical adjustment costs, to search processes (Diamond and Fudenberg 1989, Howitt and McAfee 1992; Mortensen 1989, 1991), or to a restriction on the frequency with which the agents can change their decision (Matsuyama 1991, 1992b). In the presence of such frictions, entry becomes an investment decision, so that potential firms make their entry decision based on the expectation of present discounted future profits, say Q. In the absence of any random shock, equilibrium dynamics can be depicted by the phase diagram, Figure 6, in which there are two steady states, n_A and n_B, as well as two convergent equilibrium paths, one for each steady state. In path A, entry takes place and the number of firms rises over time. In path B, exit takes place and the number of firms declines over time.

When the friction is sufficiently large, the economy converges to the lower steady state when the economy is initially in a neighborhood of n_B. This would be an underdevelopment trap. On the other hand, if the friction is small, path A can cover n_B and path B cover n_A, as depicted in Figure 6. In this case, one can construct a sunspot equilibrium, in which the economy is in a boom when the sunspot variable is in state A and in a recession when the sunspot is in state B. During booms,
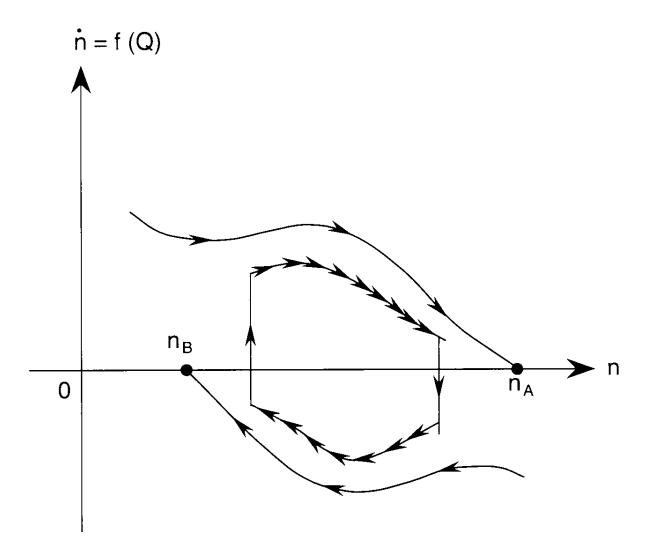
Fig. 6

the number of firms continues to rise and approaches n_A. When the sunspot switches to B, then the economy enters recessions, where the number of firms continues to decline and approach n_B. Along this sunspot equilibrium, the economy fluctuates within the range bounded by the two steady states.

This sunspot equilibrium has a couple of attractive features. First, unlike the approach sketched in Section 2.E., it is capable of mimicking observed patterns of business cycles: the time series can be described by autoregressive processes with Markov regime switchings (Neftçi 1984; Hamilton 1989). Second, it captures the procyclical nature of net business formations (Davis and Haltiwanger 1990). The drawback of the sunspot approach, relative to the approach discussed in Section 2.E., is that cyclical behavior is not inevitable. There are many other equilibria, including the one in which the sunspot variable is ignored by the agents: the belief that the sunspot is irrelevant is also self-fulfilling. However, one may be able to show that, under certain learning processes, the agents learn to believe in sunspots (Howitt and McAfee 1992; see also Woodford 1990).[8]

5.   Some Methodological Issues.

The class of models discussed above naturally raises many methodological questions. For those who work in this area, there is a familiar set of closely related criticisms and objections they encounter repeatedly when presenting their research. In this section, I address some of these questions, in particular, concerning the logic of coordination failures and multiple equilibria.[9]

---

[8]What I discussed here is the mere one particular kind of sunspot equilibrium. There are other types of sunspot equilibria in the literature, which are also used to model endogenous fluctuations. The discussion of these alternatives, however, requires inherently dynamic models: see Chiappori and Guesnerie (1991), Farmer (1993), and Guesnerie and Woodford (1992) for surveys.

[9]My view on these methodological issues is far from original. Yet, it has been shaped so gradually over the years through conversations as well as readings that I cannot attribute it to particular sources. In writing this section, however, I found it useful re-reading some of the articles, including Guesnerie (1993), Romer (1994) and Woodford (1987). Matsuyama (1993b, 1994) also discuss some issues in more detail.

5.A.   Coordination Failures.

One objection to the analysis of coordination failures based on complementarity is that, with huge gains from coordination, people should eventually manage to find a way of coordinating complementary activities, hence the inefficiency due to such a failure would not be relevant in practice. Some would even suggest that mergers can solve the problem entirely.

There are several ways of responding to this objection. First, unlike the couple rowing a boat together, or the two producers manufacturing the nuts and bolts, complementarities in the models discussed here arise as an outcome of market interactions among a large number of producers and consumers. Second, finding out which activities are complementary and can be combined most profitably is an enormously demanding problem in practice. In the models discussed above, this problem is made artificially simple, since there are at most two sets of complementary products and all products enter symmetrically within each set. But these assumptions, made for the sake of analytical simplicity, are not realistic features of the models. (And we know that these assumptions are "true," having set up the models, but the agents living in these environments may not be so fortunate.) In reality, one has to overcome enormous information problems. The set of all products, both existing and potential, is huge. Products are not generally symmetric. One has to find out which combination of products is complementary, and the number of possible combinations grows exponentially with the number of products. This is not to deny that there are isolated instances in which coordination problems have been identified and solved. Successful businesses are introduced regularly by those who discover (or stumble upon) a new way of combining complementary products: business books are full of such stories. But the very fact that these innovators can get fabulously rich in the process and yet, new ways of doing businesses are introduced year after year suggests that a large number of coordination problems are waiting to be discovered.

Third, even when the agents know which activities need to be coordinated, the problem is far

from being solved. Explicit coordination, such as the merger, is itself an activity that requires the use of resources. The important assumption in monopolistic competition models, though not always explicitly stated, is that firms achieve superior production technologies by specialization. An entrepreneur who attempts to manage many activities at the same time may face a production technology that is considerably less efficient than when these activities are managed by independent entrepreneurs.

Fourth, if mergers were costless, they would take place not only for the purpose of coordinating complementary activities, but also for restricting competition and enhancing monopoly power. In this case, other assumptions of the models studied in this paper--that the actions taken by an individual firm are negligible in the aggregate economy and there is no strategic interaction between firms--lose much of their plausibility. Of course, this is not to deny that multiproduct firms can sometimes overcome coordination problems: introducing explicit costs of coordination, and hence endogenizing the range of activities undertaken by a firm in monopolistic competition models, would be a desirable direction for future research. However, it is optimistic to suppose that entrepreneurial efforts can eventually solve all important coordination problems.

The second line of criticism against the analysis of coordination failures questions its logical consistency with the equilibrium analysis. For the equilibrium analysis to be valid, there must be some reason for all agents come to expect simultaneously that a particular equilibrium should prevail. Some may argue that the agents, if capable of coordinating their expectations, can equally well coordinate a change in their expectations, and move away from a Pareto dominated equilibrium to the Pareto-dominant one.

One possible response is that coordinating expectations is much easier than coordinating changes in expectations. The former can be achieved historically through conventions, customs, cultural beliefs, ideologies, or other processes of learning (or some may say, assimilation or

indoctrination). The formation of stable expectations indeed has an important social dimension, and many institutions can be viewed as responses to this problem. On the other hand, coordinating changes in expectations, and thereby initiating a concerted change in actions, requires a break from tradition and the institutional framework that helped agents to share the same expectations in the first place. These arguments, of course, have to be represented in an explicit dynamic setting, but many economists find them convincing, at least in the context of economic development and regional disparities.

The above response may not be convincing in the context of economic fluctuations, which is probably why many economists remain skeptical about the macroeconomics of coordination failures. In Section 2.E., I suggested a way of making it more plausible, by showing how agents naturally come to move in unison in the presence of intertemporal substitution. However, an altogether different response to the criticism may be more appropriate. The presence of Pareto-rankable multiple equilibria invalidates equilibrium analysis of business cycles; agents cannot coordinate their expectations, having difficult time in forecasting the forecast of others, which may be why business cycles are unpredictable and why there is so much demand for business forecasting.

5.B. Multiple Equilibria.

There is a more general objection to models with multiple equilibria. Models with multiple equilibria by nature have little predictive content. In particular, it is impossible to perform comparative static analyses. It might be also argued that models with multiple equilibria yield few empirically testable implications. Hence, as a matter of principle, we should only propose models with unique equilibrium as candidate models of the economy.

There are a number of responses to this objection. First, the mere fact that one model has a unique equilibrium does not necessarily mean that it has more predictive content than another model with multiple equilibria. It depends on the distance between assumptions and conclusions.

For example, suppose that we want to model resource allocation in a small town, which we know has only one shopping district. We can build a model with unique equilibrium, but in doing so, we may have to make the "realistic" assumption that there is only one shopping district. Alternatively, we can build a model, similar to one discussed in Section 3.D., in which there are many possible locations for shopping districts, and yet, under certain conditions, only one shopping district can survive in equilibrium. This model has multiple equilibria in that it does not say which location is actually chosen. In this case, the second model clearly has more predictive content: it can explain everything the first model explains, plus what the first model assumes. Furthermore, the second model can also explain what kind of changes leads to the formation of a second shopping district in this town--a possibility that the first model rules out by assumption. Or think of the problem considered in Section 4.B. One can build a model of North-South trade, assuming that the world is divided into two regions: North, which specializes in the A-sector, and South, which specializes in the B-sector. Such a model may have a unique equilibrium, but the model of Section 4.B. has more predictive content, in that it is capable of explaining when and why the world is divided into the rich and the poor. More generally, from any model with multiple equilibria, we can always build a model with unique equilibrium by simply ruling out all but one equilibrium allocation from the set of feasible allocations. But, doing so does not increase the predictive content of economic theory. This is not to deny that, for any given model, a smaller set of equilibria means sharper predictions. It is thus desirable to "refine" the set of equilibria by throwing away some highly implausible or "unstable" equilibria. But this is different from saying that it is desirable to "select" the unique equilibrium or to limit ourselves to models with unique equilibrium.

Models with multiple equilibria can also generate a large number of testable implications. At least three kinds of hypotheses can be tested. First, no matter how big the set of equilibria is, we can still test the model if all equilibria share some common properties. For instance, we can always test

the equilibrium conditions directly, as long as they impose some restrictions on observables. In models of business cycles with multiple equilibria, all equilibrium paths may share the same time series properties. Second, one can test how a change in an exogenous variable affects the set of equilibrium values of an endogenous variable (Milgrom and Chris Shannon 1994). For example, in the models of Section 4, a change in F shifts the set of equilibrium product variety, n, in the same direction across all stable equilibria. So, even if we do not know which equilibrium is actually chosen, we can still predict how n responds to a change in F on average, which can be tested by a simple regression. In this case, multiple equilibria even justify the presence of error terms, which a model with unique equilibrium would have to explain in a more ad hoc way, i.e., by introducing some "unobservable" variables (Jovanovic 1989). Third, the model may predict that a certain change in parameter values affects the number of equilibria, which could be tested in principle by comparing the experiences of different countries and different periods with different policy and regulatory regimes.

More generally, the very fact that certain parameter values ensure unique equilibrium while others imply multiplicity itself is a prediction of great significance. A government spending increase eliminates an underdevelopment trap in the model of Section 2.D. Free trade in the final good is responsible for divergent performances across economies in the model of Section 4.B. Prediction of this kind also provide us with a new way of conducting policy analysis. Depending on the objective, one may design policies, in the spirit of mechanism design, to generate a good equilibrium, to eliminate a bad equilibrium, or to ensure unique equilibrium. Analyses of this kind can be more useful as a guide for policymaking than comparative static analyses. We could be throwing away many important predictions if we look only at models with unique equilibrium.

That a parameter change can cause a discrete change in the set of equilibria also make models with multiple equilibria useful for explaining the possibility of a structural change, which may be initiated by a small change in the environment. This is an important message of the economics of

complementarity and cumulative processes: through the process of mutual interaction of complementary activities, a small shock can be amplified to create a large effect. The sensitive dependence also has an important policy implication. It is generally viewed, both by its advocates and its critics, that the literature on coordination failures, with its inefficiency results, justifies policy activism. However, the results in this literature can be interpreted as a case for a more prudent approach. The economics of complementarity and cumulative processes may indeed demonstrate the possibility of coordination failures. It may explain why active government intervention seems to have been successful in certain cases. But, it also poses a serious question concerning the replicability of such experiences; each society, each region, or each industry is unique; without detailed knowledge of the environment, the effects of policy interventions are extremely difficult to predict. And the inefficiency of original allocation means that, if we make a mistake, the welfare loss due to such a policy error is of the first-order magnitude.

Critics of models with multiple equilibria often seem to forget that they are designed to answer a different set of questions and to express different ideas from models with unique equilibrium. For example, models with multiple equilibria are the most natural framework for explaining diversity: why are there huge variations across regions and periods in productivity, standard of living, business practices, or the organization of industry? In a model with unique equilibrium, any attempt to explain the variations of per capita income forces us to introduce variations in other variables, such as saving rates and education, as is common in growth accounting exercises. Yet variations in these variables themselves are left unexplained, or need to be explained by introducing variations in another set of variables. Even worse, such an endless search for the cause may have the danger of encouraging the view that "we are so much richer than they are because we saved so much more and worked so much harder in the past, and because we are so much more prudent and industrious." In models with multiple equilibria, on the other hand, one can explain diversity across

economies without assuming inherent differences, which tends to suggest a completely different view. There is nothing special about the world we actually observe; it is merely one of many different conceivable outcomes, that happened to be chosen as a consequence of a long series of small historical accidents; or "small initial advantages we had in natural conditions have started cumulative processes of more saving and more education, until we became much richer." Needless to say, there is nothing wrong with unique equilibrium. There are many important questions that are better answered by models with unique equilibrium. But belief in the virtue of uniqueness has the danger of conditioning economists into certain prescribed patterns of thinking. It would force us to look only for problems that are easily predictable, which may lead us to think that the real world should be predictable and hence should be manipulable. It would lead us to believe that only a big change in the environment can cause a big effect, etc.

These responses may not convince the critics of models with multiple equilibria. Behind their objections and skepticism, there may also be some psychological resistance. Accepting multiplicity means abandonment of the deterministic view of the world. It means that there is nothing special about the world in which we live. It means that there are alternative forms of economic, political, and social systems that are completely different from the way our society is actually organized. And it is highly unsettling to admit the possibility that a slight change in the environment may result in drastic changes. This may be why economists tend to impose from the beginning parameter restrictions that ensure uniqueness, even when there may be no supporting evidence for such restrictions -- a tendency that is so deeply entrenched that we are rarely aware of it. And once these restrictions become standard, they become "natural" and "plausible." In many of the models studied in this paper, multiple equilibria are generated simply by dropping "standard" parameter restrictions imposed in the literature. Some economists seem to be surprised how a small perturbation to standard assumptions can generate multiple equilibria in models of monopolistic competition.

6.   Concluding Remarks

In recent years, monopolistic competition models have frequently been applied in macroeconomics, international and interregional economics, as well as growth and development. The three features of monopolistic competition, the monopoly power of differentiated goods producers, the lack of strategic interaction, and the explicit analysis of entry and exit, make it a useful framework to examine the aggregate implications of monopoly distortions, increasing returns and expanding product variety. In this paper, I have presented a highly selective review in this area, with special emphasis on complementarity and its role in generating multiplier processes, business cycles, clustering, underdevelopment traps, regional disparities, and sustainable growth, or more generally, what Myrdal (1957) called the "principle of circular and cumulative causation."

I should point out that monopolistic competition is not the only way of modelling complementarity. As the self-adjusting nature of market forces in the standard neoclassical paradigm is due to efficient resource allocation, any departure from the standard paradigm would increase the chance of generating complementarities, thereby introducing instability and cumulative processes. For example, it is well-known that more decentralized trading processes, instead of well-organized Walrasian markets, create complementarities, which have been used to explain underemployment (Diamond 1982) and business cycles (Diamond and Fudenberg 1989), and the universal adoption of a single medium of exchange (Kiyotaki and Wright 1989; Matsuyama, Kiyotaki, and Matsui, 1993). In macroeconomics, the lack of complete enforceable contingent contracts is emphasized as the mechanism of generating coordination failure in financial and investment decisions (Diamond and Dybvig 1983; Pagano 1989; Gale 1992; Acemoglu 1993), as well as complementarity between real and financial sectors (Bernanke and Gertler 1989; Banerjee and Newman 1993; Kiyotaki and Moore 1993; Greenwood and Smith 1994). Information externalities also generate complementarities and cumulative processes, which are used to explain a variety of phenomena, such as custom, fashion, and

fads (Banerjee 1992, Bikhchandani, Hirshleifer, and Welch 1992), and business cucles and market crashes (Caplin and Leahy 1994, Chamley and Gale 1994, Zeira 1994). Recent work on political economy also demonstrates that political constraints may lead to an inefficiency trap (Roberts 1989; Fernandez and Rodrik 1991; Persson and Tabellini 1994).

For that matter, pure technological externalities, either static Marshallian external economies or dynamic learning-by-doing effects, would be enough to generate complementarities. Many existing studies (including my own) used external economies to model the phenomena discussed in this paper, while maintaining the other assumptions of the neoclassical paradigm; see, for example, Arthur (1990), Ethier (1982b), Krugman (1981, 1987), Matsuyama (1992d), and Young (1991) for international and interregional inequalities and industrial localization; Azariadis and Drazen (1990), Durlauf (1993) and Matsuyama (1991) for underdevelopment traps; Lucas (1988, 1993), Romer (1986), and Stokey (1991) for sustainable growth. Howitt and McAfee (1992) and Mortensen (1989, 1991) also rely on pure externalities to generate business cycles in search models. Even some monopolistic competition models, such as the knowledge-driven models of sustainable growth discussed in Section 4.C., rely on pure technological externalities. Pure technological externalities resulting from knowledge spillovers are surely important in explaining some of these phenomena. But at the same time, assuming externalities in the standard paradigm would be viewed as a cheap way of generating complementarities. Krugman (1991), for example, argues against relying too much on assuming pure externalities. My own view on this matter is that models with pure externalities are often useful and convenient for exploring the consequences of complementarities, but should be taken at most as a reduced form that is meant to capture some underlying mechanism generating complementarities. Any result, particularly on the effects of policies, needs to be interpreted with great caution. For any change in the environment might also affect the nature of complementarities itself, as illustrated by a couple of examples in this paper.

References:

Acemoglu, Daron, "Labor Market Imperfections, Innovation Incentives and the Dynamics of Innovation Activity," unpublished, MIT, 1993.

Arrow, Kenneth J., and Frank H. Hahn, General Competitive Analysis, (San Francisco: Holden-Day), 1971.

Arthur, W. Brian, "'Silicon Valley' Locational Clusters: When Do Increasing Returns Imply Monopoly?" Mathematical Social Sciences, 19 (February 1990): 235-251.

Azariadis, Costas, and Allan Drazen, "Threshold Externalities in Economic Development," Quarterly Journal of Economics 105 (May 1990): 501-526.

Baran, Paul A., The Political Economy of Growth, (Monthly Review Press, 1957).

Banerjee, Abijit V., "A Simple Model of Herd Behavior," Quarterly Journal of Economics, 107 (August 1992): 797-817.

Banerjee, Abijit V., and Andrew F. Newman, "Occupational Choice and the Process of Development," Journal of Political Economy, 101 (April 1993): 274-298.

Barro, Robert J., and Xavier Sala-i-Martin, "Public Finance in Models of Economic Growth," Review of Economic Studies 59 (October 1992): 645-661.

Beath, John, and Yannis S. Katsoulacos, The Economic Theory of Product Differentiation, (Cambridge: Cambridge University Press), 1991.

Benassy, Jean-Pascal, "A Neo-Keynesian Model of Price and Quantity Determination in Disequilibrium," in Gerhard Schwödiauer (ed.), Equilibrium and Disequilibrium in Economic Theory, (Boston: Reidel), 1978.

Benassy, Jean-Pascal, "Imperfect Competition, Unemployment and Policy," European Economic Review 31 (1/2), (February/March 1987): 417-426.

Benassy, Jean-Pascal, "Monopolistic Competition," in Werner Hildenbrand and Hugo Sonnenschein, eds., Handbook of Mathematical Economics, vol. IV, (Amsterdam: North-Holland), 1991.

Benassy, Jean-Pascal, "Classical and Keynesian Features in Macroeconomic Models with Imperfect Competition," 1994, forthcoming in Huw Dixon and Neil Rankin, The New Macroeconomics: Imperfect Markets and Policy Effectiveness, Cambridge University Press.

Bernanke, Ben, and Mark Gertler, "Agency Costs, Net Worth, and Business Fluctuations," American Economic Review 79 (March 1989): 14-31.

Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch, "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," Journal of Political Economy, 100 (October 1992): 992-1026.

Blanchard, Olivier J., and Nobuhiro Kiyotaki, "Monopolistic Competition and the Effect of Aggregate Demand," American Economic Review 77 (September 1987): 647-666.

Caplin, Andrew S., and John Leahy, "Business as Usual, Market Crashes, and Wisdom after the Fact," American Economic Review, 84 (June 1994): 548-565.

Chamberlin, Edward H., Theory of Monopolistic Competition, (Cambridge: Harvard University Press), 1933.

Chamley, Christophe, and Douglas Gale, "Information Revelation and Strategic Delay in a Model of Investment," Econometrica, 62 (September 1994): 1065-1086.

Chatterjee, Satyajit, Russell Cooper, and B. Ravikumar, "Strategic Complementarity in Business Formation: Aggregate Fluctuations and Sunspot Equilibria," Review of Economic Studies 60 (October 1993): 795-811.

Chiappori, Pierre Andre, and Roger Guesnerie, "Sunspot Equilibria in Sequential Markets Models," in Werner Hildenbrand and Hugo Sonnenschein, eds., Handbook of Mathematical Economics, vol. IV, (Amsterdam: North-Holland), 1991.

Ciccone, Antonio, and Kiminori Matsuyama, "Start-up Costs and Pecuniary Externalities as Barriers to Economic Development," Working Papers in Economics, E-92-14, Hoover Institution, Stanford University, 1992.

Cooper, Russell, and Andrew John, "Coordinating Coordination Failures in Keynesian Models," Quarterly Journal of Economics 103 (August 1988): 441-463.

Davis, Steven, and John Haltiwanger, "Gross Job Creation and Destruction: Microeconomic Evidence and Macroeconomic Implications," NBER Macroeconomics Annual 1990.

Diamond, Douglas W., and Phlip H. Dybvig, "Bank Runs, Deposit Insurance, and Liquidity," Journal of Political Economy 91 (June 1983): 401-419.

Diamond, Peter A., "Aggregate Demand Management in Search Equilibrium," Journal of Political Economy 90 (October 1982): 881-894.

Diamond, Peter A., and Drew Fudenberg, "Rational Expectations Business Cycles in Search Equilibrium," Journal of Political Economy 97 (June 1989): 606-619.

Dixit, Avinash K., and Joseph E. Stiglitz, "Monopolistic Competition and Optimum Product Variety," American Economic Review 67 (June 1977): 297-308.

Dixit, Avinash K., and Victor Norman, Theory of International Trade (Cambridge University Press: Cambridge), 1980.

Domowitz, Ian, R. Glen Hubbard, and Bruce C. Petersen, "Market Structure and Cyclical Fluctuations in U.S. Manufacturing," Review of Economics and Statistics 70 (February 1988): 55-66.

Duffie, Darrell, "The Nature of Incomplete Security Markets," in Advances in Economic Theory: Sixth World Congress, Vol.II, edited by Jean Jacques Laffont (Cambridge: Cambridge University Press), 1992.

Durlauf, Steven D., "Nonergodic Economic Growth," Review of Economic Studies 60 (April 1993): 349-366.

Eaton, B. Curtis, and Richard G. Lipsey, "Product Differentiation" in Richard Schmalensee and Robert D. Willig, eds., Handbook of Industrial Organization, (Amsterdam: North-Holland), 1989.

Ellison, Glenn, and Edward L. Glaeser, "Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach," Working Paper, Harvard University, 1994.

Ethier, Wilfred J., "National and International Returns to Scale in the Modern Theory of International Trade," American Economic Review 72 (June 1982): 389-405.a)

Ethier, Wilfred J., "Decreasing Costs in International Trade and Frank Graham's Argument for Protection," Econometrica 50 (September 1982): 1243-1268.b)

Faini, Riccardo, "Increasing Returns, Non-traded Inputs and Regional Development," Economic Journal, 94 (June 1984): 308-323.

Farmer, Roger, The Macroeconomics of Self-Fulfilling Prophecies, (Cambridge: MIT Press), 1993.

Fernandez, Raquel, and Dani Rodrik, "Resistance to Reform: Status Quo Bias in the Presence of Individual-Specific Uncertainty," American Economic Review 81 (December 1991): 1146-1155.

Fujita, Masahisa, Urban Economic Theory: Land Use and City Size, (Cambridge: Cambridge University Press, 1989).

Gale, Douglas, "Standard Securities," Review of Economic Studies (October 1992): 731-755.

Galí, Jordi, "Monopolistic Competition, Business Cycles, and the Composition of Aggregate Demand," Journal of Economic Theory 63 (June 1994): 73-96.

Gordon, Robert J., "What is New-Keynesian Economics?" Journal of Economic Literature 27 (September 1990): 1115-1171.

Greenwood, Jeremy, and Bruce D. Smith, "Financial Markets in Development and the Development of Financial Markets," 1994, forthcoming in Journal of Economic Dynamics and Control.

Grossman, Gene M., and Elhanan Helpman, Innovation and Growth in the Global Economy, (Cambridge: The MIT Press, 1992).

Guesnerie, Roger, "Successes and Failures in Coordinating Expectations," European Economic Review 37 (April 1993): 243-268.

Guesnerie, Roger, and Michael Woodford, "Endogenous Fluctuations," in Jean Jacques Laffont, eds., Advances in Economic Theory: Sixth World Congress, vol. II. (Cambridge University Press; New York), 1992.

Hall, Robert E., "The Relation Between Price and Marginal Cost in U.S. Industry," Journal of Political Economy 96 (October 1988): 921-947.

Hall, Robert E., Booms and Recessions in a Noisy Economy, (Yale University Press: New Haven), 1991.

Hamilton, James D., "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," Econometrica 57 (March 1989): 357-384.

Hart, Oliver D., "Perfect Competition and Optimal Product Differentiation," Journal of Economic Theory 22 (April 1980): 279-312.

Hart, Oliver D., "A Model of Imperfect Competition with Keynesian Features," Quarterly Journal of Economics, 97 (February 1982): 109-138.

Hart, Oliver D., "Imperfect Competition in General Equilibrium: An Overview of Recent Work," in Kenneth J. Arrow, and Seppo Honkapohja, eds., Frontiers of Economics, (Oxford: Blackwell), 1985.

Heller, Walter P., "Coordination Failure under Complete Markets with Applications to Effective Demand," in Walter P. Heller, Ross M. Starr, and David A. Starret, eds., Equilibrium Analysis: Essays in Honor of Kenneth J. Arrow, vol. II, (Cambridge: Cambridge University Press), 1986.

Helpman, Elhanan, "Monopolistic Competition in Trade Theory," Special Papers in International Finance, No. 16, June 1990.

Helpman, Elhanan, and Paul R. Krugman, Market Structure and Foreign Trade, (Cambridge: The MIT Press, 1985).

Hicks, John R., A Contribution to the Theory of the Trade Cycle, (Oxford: Oxford University Press), 1950.

Hicks, John R., and R. C. D. Allen, "A Reconsideration of the Theory of Value, Parts I and II," Economica, N.S., February 1934, pp.52-76, and May 1934, pp.196-219.

Hirschman, Albert O., The Strategy of Economic Development (New Haven: Yale University Press, 1957).

Hotelling, Harold, "Stability in Competition," Economic Journal 39 (1929): 41-57.

Howitt, Peter, and R. Preston McAfee, "Animal Spirits," American Economic Review, 82 (June 1992): 493-507.

Jovanovic, Boyan, "Observable Implications of Models with Multiple Equilibria," Econometrica, 57 (November 1989): 1431-1437.

Judd, Kenneth L., "On the Performance of Patents," Econometrica 53 (May 1985): 567-585.

Kaldor, Nicholas, Economics without Equilibrium, (New York: M.E. Sharpe), 1985.

Kalecki, Michal, Essays in the Theory of Economic Fluctuations, (London: Allen & Unwin, 1939).

Kiyotaki, Nobuhiro, "Multiple Expectational Equilibria Under Monopolistic Competition," Quarterly Journal of Economics 103 (November 1988): 695-713.

Kiyotaki, Nobuhiro, and John Moore, "Credit Cycles," unpublished, University of Minnesota and London School of Economics, 1993.

Kiyotaki, Nobuhiro, and Randall Wright, "On Money as a Medium of Exchange," Journal of Political Economy, 97 (August 1989): 927-954.

Krugman, Paul R. "Increasing Returns, Monopolistic Competition, and International Trade," Journal of International Economics, 9 (November 1979): 469-479.

Krugman, Paul R., "Trade, Accumulation, and Uneven Development," Journal of Development Economics 8 (April 1981): 149-161.

Krugman, Paul R., "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economies," Journal of Development Economics, 27 (October 1987), 41-55.

Krugman, Paul R., Geography and Trade, (Cambridge: The MIT Press, 1991).

Krugman, Paul R., and Anthony J. Venables, "Integration and the Competitiveness of Peripheral Industry," in Christopher Bliss and Jorge Braga de Macedo, eds., Unity with Diversity in the European Community, (Cambridge: Cambridge University Press), 1990.

Lancaster, Kevin J., Variety, Equity, and Efficiency, (Columbia University Press: New York), 1979.

Lucas, Robert E. Jr., "On the Mechanics of Economic Development," Journal of Monetary Economics 22 (July 1988): 3-42.

Lucas, Robert E. Jr., "Making a Miracle," Econometrica 61 (March 1993): 251-272.

Maddison, Angus, Phases of Capitalist Development (Oxford: Oxford University Press), 1982.

Makowski, Louis, "Perfect Competition, Profit Criterion and the Organization of Economic Activity," Journal of Economic Theory 22 (April 1980): 222-242.

Markusen, James, "Trade in Producer Services and in Other Specialized Inputs," American Economic Review 79 (March 1989): 85-95.

Markusen, James, "First Mover Advantages, Blockaded Entry, and the Economics of Uneven Development," in Elhanan Helpman and Assaf Razin, eds., <u>International Trade and Trade Policy</u> (Cambridge: MIT Press), 1991.

Matsuyama, Kiminori, "Increasing Returns, Industrialization, and Indeterminacy of Equilibrium," <u>Quarterly Journal of Economics</u>, 106 (May 1991): 617-650.

Matsuyama, Kiminori, "Imperfect Competition, Foreign Trade, and the Multipliers: Machlup-Metzler Fifty Years Later," Working Papers in Economics, E-92-4, Hoover Institution, Stanford University, 1992a.

Matsuyama, Kiminori, "The Market Size, Entrepreneurship, and the Big Push," <u>Journal of the Japanese and International Economies</u>, 6 (December 1992): 347-364. b)

Matsuyama, Kiminori, "Making Monopolistic Competition More Useful," Working Papers in Economics, E-92-18, Hoover Institution, Stanford University, 1992c.

Matsuyama, Kiminori, "Agricultural Productivity, Comparative Advantage, and Economic Growth," <u>Journal of Economic Theory</u>, 58 (December 1992): 317-334. d)

Matsuyama, Kiminori, "Modelling Complementarity in Monopolistic Competition," <u>The Bank of Japan Monetary and Economic Studies</u> 11 (July 1993): 87-109. a)

Matsuyama, Kiminori, "Comments on Paul Krugman's 'Complexity and Emergent Structure in the International Economy'" 1993.b) Forthcoming in <u>New Directions in Trade Theory</u>, edited by Alan V. Deardorff, James A. Levinson, and Robert M. Stern, (Ann Arbor: University of Michigan Press).

Matsuyama, Kiminori, "Economic Development as Coordination Problems," presented at the World Bank Conference on the Role of Government in the Evolution of System Change, 1994.

Matsuyama, Kiminori, Nobuhiro Kiyotaki, and Akihiko Matsui, "Toward a Theory of International Currency," <u>Review of Economic Studies</u>, 60 (April 1993): 317-334.

Matsuyama, Kiminori, and Takaaki Takahashi, "Self-Defeating Regional Concentration," CMS-EMS Discussion Paper, No. 1086, Northwestern University, 1994.

Milgrom, Paul R., and John Roberts, <u>Economics, Organization, and Management</u> (New Jersey: Prentice-Hall), 1992.

Milgrom, Paul R., and Chris Shannon, "Monotone Comparative Statics," <u>Econometrica</u>, 62 (January 1994): 157-180.

Mortensen, Dale T., "The Persistence and Indeterminacy of Unemployment," <u>Scandinavian Journal of Economics</u> 91(2) (1989); 347-370.

Mortensen, Dale T., "Equilibrium Unemployment Cycles," Center for Mathematical Studies in Economics and Management Sciences Discussion Paper, #939, Northwestern University, 1991.

Murphy, Kevin, Andrei Shleifer, and Robert Vishny, "Industrialization and the Big Push," Journal of Political Economy, 97 (October 1989): 1003-1026. a)

Murphy, Kevin, Andrei Shleifer, and Robert Vishny, "Building Blocks of Market Clearing Models," NBER Macroeconomics Annual 1989. b).

Myrdal, Gunnar, Economic Theory and Under-Developed Regions, (London: Duckworth), 1957.

Neftçi, Salih N., "Are Economic Time Series Asymmetric over the Business Cycle?" Journal of Political Economy 92 (April 1984): 307-328.

Negishi, Takashi, General Equilibrium Theory and International Trade, (Amsteldam: North-Holland), 1972.

Negishi, Takashi, "Existence of Under Employment Equilibrium" in Gerhard Schwödiauer (ed.), Equilibrium and Disequilibrium in Economic Theory, (Boston: Reidel), 1978.

Negishi, Takashi, Microeconomic Foundations of Keynesian Macroeconomics, (Amsteldam: North-Holland), 1979.

Nurkse, Ragnar, Problems of Capital Formation in Underdeveloped Countries (New York: Oxford University Press, 1953).

Nurkse, Ragnar, Equilibrium and Growth in the World Economy: Economic Essays by Ragnar Nurkse, edited by Gottfried Haberler and Robert M. Stern, (Harvard University Press, Cambridge, Mass., 1962).

Pagano, Marco, "Endogenous Market Thinness and Stock Price Volatility," Review of Economic Studies 56 (April 1989): 269-288.

Persson, Torsten, and Guido Tabellini, "Is Inequality Harmful for Growth?" American Economic Review, 84 (June 1994): 600-621.

Prebisch, Raul, Economic Development of Latin America and Its Principal Problems, The Economic Commission for Latin America, (United Nations, 1950).

Rivera-Batiz, Franscisco L., "Increasing Returns, Monopolistic Competition, and Agglomeration Economies in Consumption and Production," Regional Science and Urban Economics, 18 (February 1988): 125-153.

Rivera-Batiz, Luis A., and Paul M. Romer, "Economic Integration and Endogenous Growth," Quarterly Journal of Economics 106 (May 1991): 531-555.

Roberts, Kevin W. S., "The Theory of Union Behavior: Labor Hoarding and Endogenous Hysteresis," unpublished, London School of Economics, 1989.

Robinson, Joan, Economics of Imperfect Competition, (London: MacMillan), 1933.

Rodríguez-Clare, Andres, The Division of Labor, Agglomeration Economies, and Economic Development, Ph.D. dissertation, Stanford University, 1993.

Rodrik, Dani, "Coordination Failures and Government Policy in Intermediate Economies: A Model with Applications to East Asia and Eastern Europe," unpublished, Columbia University, 1994.

Romer, Paul M., "Increasing Returns and Long Run Growth," Journal of Political Economy, 94 (October 1986): 1002-1037.

Romer, Paul M., "Growth Based on Increasing Returns Due to Specialization," American Economic Review Papers and Proceedings, 77 (May 1987): 56-62.

Romer, Paul M., "Endogenous Technological Change," Journal of Political Economy 98 (October 1990): S71-S102.

Romer, Paul M., "New Goods, Old Theory, and the Welfare Costs of Trade Restrictions," Journal of Development Economics 43 (February 1994): 5-38.

Rosenstein-Rodan, Paul N., "Problems of Industrialization of Eastern and South-Eastern Europe," Economic Journal 53 (June-September 1943): 202-211.

Rotemberg, Julio J., "The New Keynesian Microfoundations," NBER Macroeconomics Annual 1987, 69-104.

Scitovsky, Tibor, "Two Concepts of External Economies," Journal of Political Economy 62 (April 1954): 143-151.

Shleifer, Andrei, "Implementation Cycles," Journal of Political Economy 94 (December 1986): 1163-1190.

Silvestre, Joaquim, "The Market-Power Foundations of Macroeconomic Policy," Journal of Economic Literature 31 (March 1993): 105-141.

Startz, Richard, "Monopolistic Competition as a Foundation for Keynesian Macroeconomic Models," Quarterly Journal of Economics 104 (November 1989): 737-752.

Stiglitz, Joseph E., "Towards a More General Theory of Monopolistic Competition," in Maurice H. Peston and Richard E. Quandt, eds., Prices, Competition, and Equilibrium, (Oxford: Phillip Allan/Barnes & Noble Books), 1986.

Stokey, Nancy L., "Human Capital, Product Quality, and Growth," Quarterly Journal of Economics 106 (May 1991): 587-616.

Tirole, Jean, The Theory of Industrial Organization, (Cambridge: MIT Press), 1988.

Weitzman, Martin L., "Increasing Returns and the Foundations of Unemployment Theory," The Economic Journal 92 (December 1982): 787-804.

Weitzman, Martin L., "Monopolistic Competition with Endogenous Specialization," <u>Review of Economic Studies</u> 61 (January 1994): 45-56.

Wolinsky, Asher, "Retail Store Concentration Due to Consumers' Imperfect Information," <u>Bell Journal of Economics</u> 14 (Spring 1983): 275-282.

Woodford, Michael, "Three Questions about Sunspot Equilibria as an Explanation of Economic Fluctuations," <u>American Economic Review</u> 77 (May 1987): 93-98.

Woodford, Michael, "Learning to Believe in Sunspots," <u>Econometrica</u> 58 (March 1990): 277-307.

Young, Allyn A., "Increasing Returns and Economic Progress," <u>Economic Journal</u> 38 (1928): 527-542.

Young, Alwyn, "Learning by Doing and the Dynamic Effects of International Trade," <u>Quarterly Journal of Economics</u> 106 (May 1991): 369-405.

Zeira, Joseph, "Informational Cycles," <u>Review of Economic Studies</u>, 61 (January 1994): 34-44.