INCOME DISTRIBUTION, MARKET SIZE, AND INDUSTRIALIZATION*

KEVIN M. MURPHY
ANDREI SHLEIFER
ROBERT VISHNY

When world trade is costly, a country can profitably industrialize only if its domestic markets are large enough. In such a country, for increasing returns technologies to break even, sales must be high enough to cover fixed setup costs. We suggest two conditions conducive to industrialization. First, a leading sector, such as agriculture or exports, must grow and provide the source of autonomous demand for manufactures. Second, income generated by this leading sector must be broadly enough distributed that it materializes as demand for a broad range of domestic manufactures. These conditions have been important in several historical growth episodes.

INTRODUCTION

We present a model of industrialization caused by an increase in agricultural productivity or by an export boom, that raise incomes and therefore demand for domestic manufactures. As domestic markets become larger, increasing returns production technologies that could not break even in smaller markets come into profitable use and industry expands. The key role of productive agriculture or exports for generating domestic demand for manufactures has been emphasized in earlier work of Rosenstein-Rodan [1943], Nurkse [1953], Lewis [1953, 1954], Ranis and Fei [1961], and especially Fleming [1955]. Empirically, Ohkawa and Rosovsky [1960] document the great increases in agricultural productivity in turn of the century Japan, and Johnston and Mellor [1961] note the importance of the demand from farmers for growth of industry during that period. Similarly, Thorbecke [1979] and Ranis [1979] present evidence for the dramatic progress of agriculture in postwar Taiwan, and Ranis in particular stresses the role of demand by farmers at the initial stages of Taiwan's industrialization. Lewis [1953] makes increases in farm productivity and in cash crop exports a cornerstone of his proposed development strategy for the Gold Coast, on the theory that increased rural purchasing power would foster industrialization.

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The vibrancy of domestic agriculture or exports is not, however, always sufficient to bring about any industrialization. In some cases, although farm or export income is generated, it does not go to potential customers of domestic industry, and the relevant markets remain as narrow as ever. For industrial markets to expand, the composition of demand must concentrate buying power in the hands of consumers of manufactures. Large population, homogeneous tastes, and concentrated population all help to create large markets for manufactures.[1] But also of great importance to industrialization is the distribution of income, since the middle class are the natural consumers of manufactured goods. As has been pointed out by Baldwin [1956] and North [1959], extreme concentration of wealth in the hands of the very rich will manifest itself in the demand for handmade and imported luxuries rather than for domestic manufactures, even when farm or export income grows. The necessity of a middle class as the source of the buying power for domestic manufactures is the central message of our paper.

The effects of income distribution on the extent of industrialization seem to be important in a number of historical episodes. For example, in the first half of the nineteenth century, the United States greatly surpassed England in the range of consumer products it manufactured using mass production techniques. In contrast to high quality handmade creations of the English artisans, American producers offered standardized mass-produced utilitarian items such as rifles, cutlery or balloon-frame houses (which an English architect called bare, bald white cubes). This difference in production techniques seems to be accounted for by the difference in the composition of demand [Rosenberg, 1972]. Whereas in England manufactures were demanded by the quality-conscious upper class, that could not have possibly generated a large market, the American demand came from a large number of relatively well-off farmers. The large demand from this land-rich middle class enabled American manufactures to profitably sustain mass production.

This difference in the composition of demand and of techniques of production in the two countries have been described in the catalog for the 1851 London Crystal Palace exhibition (cited in Rosenberg [1972] p. 50):

> The absence in the United States of those vast accumulations of wealth which favor the expenditure of large sums on articles of mere luxury, and the

1. Chenery, Robinson, and Syrquin [1987] report that industrialization usually begins at a much lower level of income in high-population countries.

> general distribution of the means of procuring the more substantial conveniences of life, impart to the productions of American industry a character distinct from that of many other countries. The expenditure of months or years of labour upon a single article, not to increase its intrinsic value, but solely to augment its cost and its estimation as the object of *virtu*, is not common in the United States. On the contrary, both manual and mechanical labour are applied with direct reference to increasing the number or the quantity of articles suited for the wants of a whole people, and adapted to promote the enjoyment of that moderate competency that prevails upon them.

In the model presented below, the U. S. experience can be understood in terms of distribution of returns from farming and the demand by farmers for industrial goods.

Perhaps the best example of a country in which the distribution of rewards from a boom in a leading sector has led first to the failure and then to the success of industrialization is Colombia in the second half of the nineteenth century. In the 1850s and 1860s Colombia experienced a large boom in tobacco exports, which, however, failed to lead to widespread economic development. From about 1880 to 1915, Colombia went through a boom in coffee exports, the effect of which on industrialization has been much more widely pronounced. Harbison [1970] explains the difference between the two episodes by the fact that, technologically, tobacco had to be grown on large plantations and hence the income from the boom went to a very small number of plantation owners who spent it on luxury imports, whereas coffee was grown on small family enterprises with the result that income accrued to a large number of people who then demanded domestic manufactures. Harbison's [1970] analysis of Colombia illustrates precisely the point developed in our work:

> The lion's share of increased prosperity generated by coffee production was enjoyed by the large poor rural *mestizo campesino* class, not the small group of rich white urban landlords. These peasants, in turn, certainly did not buy for themselves and their children foreign travel and foreign education or other luxury imports. . . . Since such items could not be produced in Colombia, the use of tobacco-generated incomes to purchase these luxury imports had resulted in a long-term depression and decline in Colombian artisan manufacture without compensating growth in another domestic sector. But coffee generated incomes in the hands of Antioqueno farmers who spend precisely on those necessities. . . . The rapid expansion of coffee production redistributed income toward that segment of the population most likely to spend the incremental income on items characterized by high potential for generating domestic incomes—i.e. on domestic goods whose large-scale production could utilize modern low-cost technology—and not on imports.

Colombia's experience with the two leading sector booms thus shows exactly how income distribution affects the consequences of such booms.

The central economic assumption underlying our interpretation of these examples is the relevance of local demand composition,

as opposed to the world markets, for the choice of techniques. If world trade is costless and free of barriers, this assumption is untenable. In practice, however, transport costs, difficulties of penetrating foreign markets, and especially protectionism make the sizes of local markets relevant for a wide range of goods in many countries. In this paper we first focus on the case of a closed economy with agriculture serving as the source of high-powered demand for manufactures, and then let this role be played also by mineral or cash crop exports.

This paper describes how a country that has already procured some resources from an agricultural innovation or from a boom in cash crop exports industrializes. In our model no normative significance is attached to industrialization: it is a byproduct of wealth from agriculture or cash crop exports rather than a source of wealth by itself. In practice, however, industrialization seems to lead to the improvement of living standards. Rosenstein-Rodan [1943] accordingly associates industrialization with a shift to a better equilibrium growth path. This would be true if industrialization yielded technological spillovers that become a source of new wealth, or if it paid for an infrastructure that improved the opportunities to trade and to produce. While our model provides the building blocks for analyzing the welfare effects of industrialization, we defer this analysis to our companion paper [Murphy, Shleifer, and Vishny, 1989].

Section II below outlines the model, and equilibrium is characterized in Section III. In Section IV we compare the levels of industrialization for various levels of farm productivity and income distributions. Section V presents the analysis of an economy that exports a cash crop and imports food. Section VI concludes.

II. The Model

In this section we outline the microeconomic assumptions about the preferences, technologies, market structure, and income distribution of the economy we propose to study.

II.A. Commodities and Preferences

There is a unique homogeneous agricultural good called food. In addition, the consumption set includes a continuum $(0,\infty)$ of manufactured goods, labeled q. All consumers have the same preferences, with the utility function given by

$$U = \begin{cases} c & \text{for } c \leq z \\ z + e^{[-\int_0^1 (1-x(q))^{1/q} dq + \int_1^{\infty} x(q)^{1/q} dq]} & \text{for } c > z, \end{cases}$$

where c is the food consumption, z is the minimum amount of food required before consumption of manufactures begins, $x(q)$ is equal to one if good q is consumed and zero if it is not, and $1/q$ is the marginal utility of good q so that low index goods are more desirable.

Food is here assumed to be a necessity, characterized by the unit propensity to spend on it at low levels of income, and zero propensity to spend after z units are obtained.[2] The assumption of well-ordering of goods in terms of their desirability, and the assumption that goods come in discrete units that ensure satiation, have a strong implication. Specifically, richer people consume all the same things that poorer people do, plus some. Consumption increases take the form of increased diversity, and not of increased consumption of the same goods. In the case where a consumer buys all the goods in the interval $(0,q)$—which will be the case in our equilibrium—the contribution of such consumption to his utility is $\log(q)$. These preferences are thus a natural extension of Cobb-Douglass for the case of differentiated goods. In particular, they ensure a tractable solution for the optimal pricing problem in our economy.

This commodity space and preference structure yield the following simple demand curves. Each consumer spends all of his income on food until he gets z units of it. If he has income left over, he spends all of it on manufactures. He expands the menu of manufactures he buys in order of marginal utility per unit price. Richer consumers end up with a superset of manufactures bought by poorer consumers.

II.B. Technology and Property Rights in Agriculture

The production of food is governed by a unique decreasing returns technology $F(L_F)$, where $F' > 0$, $F'' < 0$, and L_F is the agricultural labor input. We are assuming that land is a limiting factor of production so that application of more labor in agriculture reduces marginal output. Agriculture is assumed to be perfectly competitive on the output side, and in fact the price of food is taken to be numéraire.[3]

2. All our results carry through, and have been carried through in the working paper version, under the assumption that the marginal propensity to spend on food falls below one but not to zero after z units are obtained. We shall mention the modifications of the analysis in this more general case throughout the paper.

3. Although we do not consider the possibility of increasing returns in agriculture (or in Section V in the export sector), it may be empirically relevant and interesting. For example, since production of sugar or tea is most economical on large plantations, benefits from such export crops are usually very unequally distributed.

The factor payments in agriculture consist of "wages" of agricultural laborers, w_A, and rent π^F. Since the price of food is numéraire, we have an identity that $\pi^F = F(L_F) - w_A L_F$. A long tradition in development economics denies the assumption that $w_A = F'(L_F)$. We only assume that the wage declines in L_F: $w_A'(L_F) < 0$, and that rents rise with L_F: $d\pi_F/dL_F > 0$. This will always be the case if, for example, farm labor is paid its value marginal product.

Since these assumptions imply that, as agriculture contracts, income is redistributed from landowners to wage earners, they capture the notion that poverty is manifested by excessive size of farm employment. Wages of agricultural workers are low because of their low productivity in cultivation of very marginal land. Expansion of agriculture without increases in productivity reduces w_A and therefore, if w_A is the dominant or only source of income for workers, it also reduces their standard of living. This is not a problem of numéraire. If we take instead agricultural wage as numéraire, then expansion of agriculture entails the rise of the food price. To the extent that wage earners are food consumers, their welfare declines as agriculture expands.

II.C. Technology and Market Structure in Manufacturing

Each good q is assumed to be produced in a separate sector that is small relative to the economy. Two technologies are assumed to be available for producing each good q. First, $\alpha > 1$ units of labor can be applied to produce one unit of output of any good q using the constant returns to scale (CRS), or "backstop," technology. In addition, good q can be produced with a fixed investment of C units of labor and a variable labor requirement of one per unit of output. The idea of two alternative technologies has been used by Shleifer [1986] and Shleifer and Vishny [1988] to illustrate the importance of market size in promoting the switch to IRS technology. Here, since the size of the market for q is equal to the number of consumers whose menu includes q (customer base), income distribution will determine the profitability of producing q with increasing returns.

Industrialization in this paper is taken to be substitution of increasing returns technologies for constant returns technologies in production of some goods. It seems very plausible to associate increasing returns with events that are commonly linked to indus-

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The effect of increasing returns in the leading sector on the income distribution is left for future work.

trialization, such as mass production, escape from the farm, concentration of labor in the same location, etc. Our focus of industrialization as substitution of increasing returns technologies for constant returns technologies ignores the expansion of the menu of available goods in the process of industrialization. Judd [1985] presents one such model of labor-absorbing rather than of labor-saving technological change.[4]

Industrialization of a sector will in part be determined by its market structure. We assume that the CRS technology for each q is at the disposal of a competitive fringe. If the manufacturing wage is taken to be w_M, any good q demanded will be readily produced and sold for αw_M by the fringe, which earns zero profit. In addition, we assume that the sector producing each q has a *unique* firm with access to IRS technology. This firm can decide whether to enter with IRS production or to leave its sector to the fringe. We assume that, after entry, monopolists in different sectors set prices simultaneously.

II.D. The Distribution of Shares

Since the levels of income and profits are determined endogenously in the model, the distribution we take as given is that of shares of manufacturing profits and agricultural rents. We make two further assumptions. First, to the extent that there are many rather than only one manufacturing sector, all shareholders are assumed to hold the market, i.e., identical shares in the profits of all firms. Second, and more importantly, we assume that each property owner owns the same fraction of profits as of rents. We do not consider the income distribution between capitalists and landowners, since they are assumed to be the same people. This assumption gives us a unique ordering of people by wealth independent of the exact sizes of agriculture and industry, and in this way greatly simplifies the accounting. As we discuss in Section III, however, the distribution of shares of profits and the distribution of shares of rents play very different roles in the model.

Most people in the economy are assumed to own neither rents nor profits, with the minimum share ownership for those owning something being $\underline{\gamma}$. The distribution of shares is given by $G(\gamma)$. We are chiefly interested in an economy with considerable inequality of ownership, so that many people do not benefit from increases in

4. Lewis [1967] discusses the empirical observation that in many countries industrialization has generated much investment and output without comparable gains in employment.

profits or rents. We denote by $N = L \cdot (1 - G(\underline{\gamma}))$ the number of shareholders in this economy.

II.E. Labor Market Equilibrium

So far, we have spoken about the agricultural wage and the manufacturing wage separately. We now discuss how they are related to each other in our model. Suppose that each person is endowed with one unit of labor which he supplies completely inelastically. Labor is assumed to flow between agriculture and manufacturing in response to wage differentials, but the total quantity of labor supplied is fixed. We assume that these flows occur until the rewards are equalized; i.e., $w_M = w_A = w$ in equilibrium.[5] This wage arbitrage condition has the important implication that the size of agriculture determines not only the agricultural wage, but also the manufacturing wage. Knowing L_F suffices to know both w and π^F. We lean on this fact heavily in the exposition below.

An agent's income y, can now be written as $y = w + \gamma(\pi^F + \pi)$, where $\gamma \in \{0,[\underline{\gamma},\infty)\}$.

In the course of this paper we make several assumptions about the actual income distribution. The first of these—the poverty assumption—states that wages are sufficiently low that a consumer without property income never buys manufactures:

(Poverty) $$w < z.$$

We make this assumption about the equilibrium wage because it is plausible for a land-poor country. Under the poverty assumption, consumers who own no property spend all their income on food, and are not contributing to demand for manufactures.

III. EQUILIBRIUM

III.A. The Extent of Industrialization

In the equilibrium we propose, all sectors producing goods 0 through Q for some Q industrialize. The entering monopolists displace the fringe in these sectors, but do not cut prices. The price of each manufacturing good is therefore αw, regardless of whether it is produced in an industrialized or a backstop sector. The Appendix shows that, under a plausible assumption on the distribution of

5. In Murphy, Shleifer, and Vishny [1988], we specify a model in which manufacturing wages exceed those in agriculture, and show that this can lead to multiple equilibria.

shares $G(\gamma)$, the Nash equilibrium between monopolists will in fact take the form of keeping prices at αw, and moreover, this equilibrium is unique. In this section we calculate the extent of industrialization, Q, that obtains in this equilibrium.

When all sectors $(0,Q]$ industrialize, and prices in all of them are kept at αw, the sector Q for whose monopolist it is marginally profitable to enter is one where variable profits just cover the fixed cost. Denote by N^* the sales of that sector, equal to the minimum efficient scale. For this sector, the break-even condition is

$$(\alpha w - w)N^* = Cw, \tag{1}$$

or

$$N^* = C/(\alpha - 1). \tag{2}$$

Since the range of goods consumed declines with income, consumers of Q are the N^* richest people in the economy. Sales to them generate high enough variable profits to allow sector Q to break even. But since fixed costs are the same in all industrializing sectors, the N^* richest people can be thought of as paying the fixed cost in each of them. The poorer customers then account for positive profits in inframarginal sectors $(0,Q)$.

The profit share of the N^*th richest consumer is given by γ^* such that

$$L(1 - G(\gamma^*)) = N^*. \tag{3}$$

Since Q is the good produced in the marginal sector, the consumer with share γ^* buys the goods $(0,Q)$. His expenditure on manufactures then equals the cost of buying them:

$$Q\alpha w = \gamma^*(\pi + \pi^F) + (w - z). \tag{4}$$

This yields the expression for the equilibrium Q:

$$Q = \frac{\gamma^*(\pi + \pi_F) + (w - z)}{\alpha w}. \tag{5}$$

The extent of industrialization, Q, is determined by income in the hands of the N^*th richest person, and can be solved for once that income is known.

The consumers of manufactures in this economy can be divided into two distinct classes. The upper class, consisting of the N^* richest consumers, buys all the manufactures produced in the industrial sector, and then spends some of its resources on backstop-produced items. The middle class, in contrast, consists of $N -$

N^* property owners below the N^*th richest person, and consumes only the manufactures produced by industrialized sectors. In this model, the size of the upper class is independent of the income distribution, assuming that there are at least N^* property owners. Wealth in the hands of the upper class, however, does depend on the actual distribution of shares, as well as on the level of income.

Figure I summarizes where expenditures of various consumers go. Some of the profit (and rent) income of both upper and middle class goes into bringing their food expenditure up to z. After that, the manufacturing spending of the upper class goes to cover the fixed costs of industrial sectors. All members of the upper class share equally in this expenditure, which for each of them equals the manufacturing spending of the marginal upperclassman. All those richer than N^* then buy goods with $q > Q$ from the backstop sector.

Since the upper class pays the fixed cost, the spending by the middle class is a source of pure profit for the industrializing sectors.

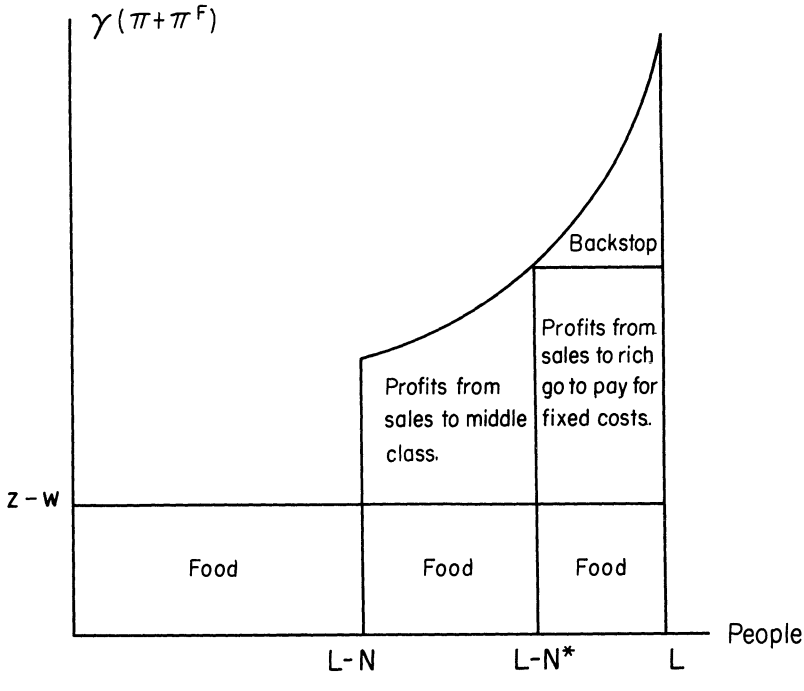

FIGURE I
Spending Patterns of the Population

As a result, sectors $(0,Q)$ earn a positive profit from their sales to the middle class. Low index sectors, with large customer bases, earn the highest profits, and high index industrial sectors the lowest. The total industrial profits in this economy depend on the share of wealth held by the middle class.

III.B. Market Clearing in Manufacturing: The MM Equation

Using expression (4) for Q, we can calculate the aggregate profits of sectors $(0,Q]$ as a function of the expenditure by their customers. Because these profits are part of the customers' incomes, industrial profits in this calculation are a function of themselves:

$$(6)\quad \pi = [(\alpha - 1)/\alpha]\{(\pi + \pi^F)(N^*\gamma^* + T + N(w - z)\} - C[(\pi + \pi^F)\gamma^* + (w - z)]/\alpha,$$

where $T = \int_{\gamma}^{\gamma^*} \gamma dG(\gamma)$ is the share of profits in the hands of the middle class. This expression is obtained by adding up profits across sectors, taking account of the customer base of each sector, and substituting for Q from (5) in the fixed costs term. In calculating the share of income materializing as demand for industrialized manufactures, we take account of the fact that an upperclassman spends only the share γ^* of profits in this way, while a member of the middle class so spends all of his profits. Expression (6) is easier to work with if we substitute for the fixed cost using (2). This yields

$$(7)\quad \pi = [(\alpha - 1)/\alpha][(\pi + \pi^F)T + (N - N^*)(w - z)].$$

In this equilibrium expression for profits, all the terms involving the upper class disappear. This is because the upper class pays for the fixed costs, and hence no profits are made from selling to it. Aggregate profits are simply equal to the profit rate $(\alpha - 1)/\alpha$ times the total expenditures by the middle class of manufactures.

To interpret (7) we eliminate industrial profits from the right-hand side:

$$(8)\quad \pi = \frac{[(\alpha - 1)/\alpha](\pi^F \cdot T + (N - N^*)(w - z))}{1 - T[(\alpha - 1)/\alpha]}.$$

The numerator of this expression is the profit from the autonomous expenditure on industrialized manufactures by the middle class. That is, it is the variable profit of the industrial sector realized from spending out of rents and wages, but not out of profits. Since these profits would be realized if all profits escaped the industrial sector and did not themselves contribute to demand, we call them high-

powered profits. High-powered profits can actually be thought of as coming from rents, since the wage is assumed to be less than z.

Expression (8) says that the total industrial profit is the high-powered profit times the multiplier,

$$1/[1 - T[(\alpha - 1)/\alpha]].$$

This multiplier exceeds one, since both $(\alpha - 1)/\alpha$ and T are smaller than 1.

The idea behind the multiplier is that out of each dollar of high-powered profit that industry distributes as a dividend, share T goes to the middle class. As these shareholders spend all of that dividend on manufactures (yielding the profit rate $(\alpha - 1)/\alpha$), in total the fraction $[(\alpha - 1)/\alpha]T$ of each dollar of high-powered profit comes back to industry as additional profit. Since the upper class takes care of the fixed cost, and the middle class is defined as spending only on industrialized manufactures, all the profits distributed to the middle class net of food spending come back as demand for the industrialized manufactures.[6]

Recalling that both π^F and w are uniquely determined by L_F, we can think of (8) as a relation between the size of agriculture L_F and industrial profits π. Whether this relation is positive depends on what happens to demand for manufactures as agriculture expands. The problem is that, as L_F increases, wages fall but rents rise, so that in general the effect on the income of the middle class is ambiguous. But since we are thinking of wages as returns to labor in subsistence agriculture, and have put a lower bound $\underline{\gamma}$ on the rent and profit ownership stakes, it is natural to assume that to the middle class profits are a more important source of income than wages. This is our "Inequality" assumption:

$$\text{(Inequality)} \quad \frac{d}{dL_F}[\pi^F T + (w - z)(N - N^*)] > 0.$$

In the economy we are looking at, the income of the middle class as a whole is assumed to rise with the size of agriculture.[7]

Under the inequality assumption, the numerator of (8) rises as agriculture expands. This implies that, as L_F increases, so do agricultural rents and therefore high-powered and total industrial

6. A similar analysis of multipliers characterizes recent macroeconomic models of imperfect competition, including Weitzman [1982], Hart [1982], Cooper and John [1988], and Shleifer and Vishny [1988].

7. The inequality assumption is made because it is plausible and because it enables us to sign the effects we are interested in. The model can be as easily analyzed without making this assumption.

profits. We denote this positive relation between L_F and π that reflects industrial market clearing as the *MM* curve. It describes the role of agriculture as the source of demand for industrial goods.

III.C. Market Clearance in Agriculture: The FF Equation

In equilibrium factor payments in agriculture must be equal to the value of sales:

$$wL_F + \pi^F = wL - (w - z)N, \tag{9}$$

which can be rewritten as

$$w(L - L_F) = \pi^F + (w - z)N. \tag{10}$$

The left-hand side of (10) consists of manufacturing wages spent on agriculture and so represents the exogenous inflow of demand into agriculture. The right-hand side, in turn, represents the flow of resources out of agriculture, i.e., rents spent on manufactures. In equilibrium, leakages into agriculture (left-hand side) must equal leakages out of it (right-hand side).

In this model the equilibrium employment and output in agriculture are independent of profits in manufacturing. This result is a consequence of the assumption that the propensity to spend on food is zero after z units are obtained, which implies that all profit earners get z units of food independent of profits. The food output must provide w units for each person without shares and z units for each person with shares. Since the wage is determined in agriculture by assumption, the food output is independent of manufacturing profits. In the (L_F,π) space, equation (10)—the *FF* curve—is vertical.

We could make the alternative assumption that the marginal propensity to spend on food is positive even after z units are obtained. In this case, some of the manufacturing profits would be spent on food, and so contribute to demand for agriculture. The manufacturing profits required to absorb a higher food output are then higher, and so the *FF* curve is upward sloping but not vertical. This change does not affect our results, with one important exception: it causes the welfare of wage earners to be inversely related to the level of industrial profits, since wages fall when the agricultural sector expands. Although this change points to some possibly adverse welfare consequences of industrialization for the poor, we do not believe that this is a serious problem in practice, mainly because large increases in food imports and in farm productivity typically accompany industrialization.

III.D. General Equilibrium

The analysis has so far yielded two market clearing relations between the size of agriculture and industrial profits (Figure II). By having set $w_A = w_M = w$, we have implicitly equilibrated the labor market. By Walras's law, we can omit one market, which in this context is the market for backstop-produced manufactures. Our analysis then involves studying the intersection of *MM* and *FF* curves.

IV. Analysis

Throughout the analysis of the model, we shall be principally concerned with the implications of any given change for industrialization. Our objective is to provide a positive story on the relationship between income distribution and industrialization. No necessary normative significance is attached to industrialization itself. Nonetheless, we do note some effects of industrialization on the poor.

We measure industrialization in two distinct ways. First, we look at the extent of industrialization, Q, calculated in subsection III.A, that measures the variety of goods produced using increasing returns. As equation (5) shows, the only aspect of income distribu-

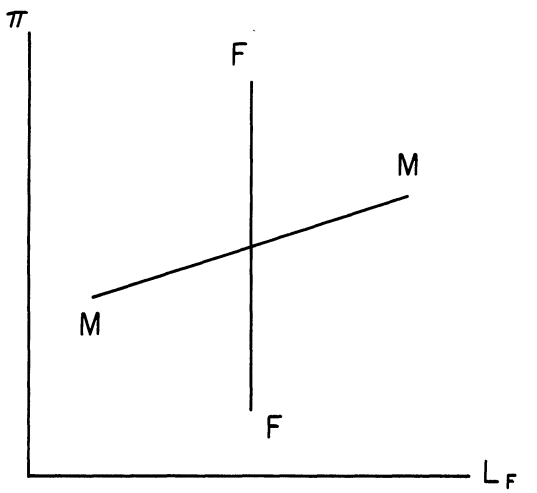

FIGURE II
Market Clearing in Agriculture (FF) and Industry (MM)

tion that determines the extent of industrialization is income in the hands of the $N^{*\prime}$th richest person. Although Q measures variety, it does not really capture the size of industry relative to, say, backstop. Accordingly, our second measure of industrialization is total employment in industry, consisting of people employed to cover both fixed and variable cost.

Employment in industry can be shown to equal

$$L_I = \frac{(T + N^*\gamma^*)(\pi + \pi^F) + N(w - z)}{\alpha w}. \tag{11}$$

Unlike the extent of industrialization, employment is determined by the total share of profits spent on industry, namely $T + N^*\gamma^*$. This share rises both with the share of profits in the hands of the middle class, T, and with the share that the upper class spends on industrial goods. Since $1 - T - N^*\gamma^*$ is the share of profits spent on backstop, employment in industry is maximized when that share is the lowest, which occurs when there is no inequality within the upper class. The size of industry is the highest when the least resources are spent on backstop-produced luxuries.

IV.A. Agriculture as the Leading Sector

In his recommendations for the economic development of the Gold Coast, Lewis [1953] stresses the need to raise agricultural productivity as a prerequisite for industrialization. Our formal model elaborates his logic, since a boost in agricultural productivity can substantially increase the size of the markets for manufactures, and so the extent of industrialization and employment in industry. In this sense, agriculture is the leading sector.

Suppose that a technological innovation changes the production function for food to $kF(L_F)$ with $k > 1$, and suppose that wage and rent schedules as a function of L_F rise by the same proportion. We claim that in this case employment in agriculture falls, farm output rises, and so do wages. At the same time, labor flows into industry as both the output of extant industrial sectors and the extent of industrialization increase. To see this, suppose that farm employment does not change, so that the supply of food rises by a factor of k. Since the demand for food by all the wage earners also rises by a factor of k, while the demand for food from rents does not rise, there will be an excess supply of food. Labor must then flow out of agriculture into industry and backstop, so its wage rises both because farm employment shrinks and because the wage schedule has shifted up. As industry absorbs the labor released by the farm

sector, the extent of industrialization, employment in industry, and the output in currently industrialized sectors all increase.

The same result can be seen by examining the shifts in the *MM* and *FF* curves in response to the technological change in agriculture (Figure III). As the previous paragraph illustrates, the *FF* curve shifts to the left, since demand in agriculture does not rise as fast as productivity. The *MM* curve shifts up, since each level of employment in agriculture now yields greater rents and high-powered profits. The overall effect is to reduce farm employment and to raise the extent of industrialization, Q, as well as industrial employment, L_I.

Technological change in agriculture in this model indeed precipitates industrial development, as the autonomous demand for manufactured goods increases, but also raises the living standards of the poor, as their food wages rise. In this sense, our model confirms Lewis's idea that improvements in agricultural productivity can foster industrialization. Our example also illustrates the frequent observation that labor moves out of the farm sector in the course of industrialization. In Section V we show that a similar

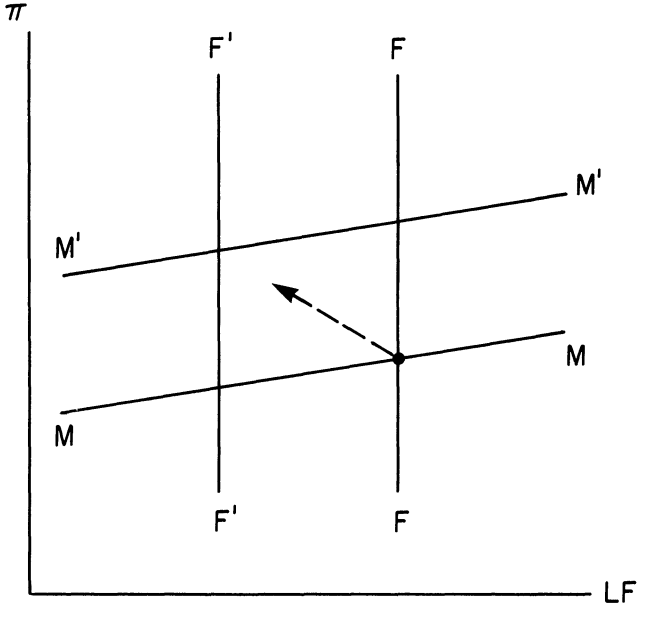

FIGURE III
Effect of Technological Progress in Agriculture

analysis applies also to the case of improvements in the ability to export, coming either from technological progress or from the lowering of trade barriers.

IV.B. Failure of Industrialization

Lucas [1988] finds the empirical observation that many countries with a low level of income also fail to grow to be an important challenge to the theory of economic development. While ours is not an explicitly dynamic model, it does have strong implications as to when industrialization fails completely. As we show below, this happens both in the case of too much equality and in that of too much inequality, although the latter case is probably more realistic. These are the cases where the interior equilibrium analysis of the previous section does not apply.

Take first the case of extreme equality, where everyone holds the same share of rents and profits. Excluding industrial profits, every consumer in this situation has the income of $F(L)/L$. In a poor country this is likely to fall short of z, in which case no consumer will be interested in manufactures. With all consumers buying just food, obviously no sector industrializes. Complete equality thus entails a total failure of industrialization, as the farm output per capita is too low to get anyone interested in manufactures at all.

Extreme inequality can also pose a problem for industrialization. Suppose that fewer than N^* people own all profits and rents. Then no sector can industrialize and cover its fixed costs, since only shareholders are interested in manufactures, and there are too few of them for their demand to cover the fixed cost. Under such an oligarchical income distribution, no conversion to increasing returns ever takes place, since no market is large enough for this to be profitable. This result also suggests that a more populous country is easier to industrialize, since sales at the minimum efficient scale N^* are more likely to be achieved.

This may be the appropriate place to comment on the different roles of rent and profit distributions in our analysis. The distribution of rents determines the level of high-powered profits. In particular, the previous result that N^* wealth holders are needed for industrialization is really the result that N^* rent holders are needed. For then autonomous demand would allow firms to cover the fixed cost. In contrast, the distribution of ownership claims to industrial profits determines the extent of spillovers and the multiplier. The higher is the fraction of profits (not rents) in the hands of the middle class, the more of these profits will return as additional

demand for manufactures. Ownership of profits in excess of those owned by the N^*'th richest person, in contrast, does nothing to promote industrialization.

The message of this analysis is that, in a poor country, income distribution could be responsible for the lack of industrialization, even when the income to start it is available. Extreme equality could mean equal distribution of misery, as no sectors industrialize for lack of demand. Similarly, oligarchical income distributions could pose problems for industrialization, as the small number of property owners demand goods whose production could not possibly be profitably industrialized. While the rich are served by the labor-intensive backstop sector (or imports), industry does not develop for lack of demand. Perhaps it is the case, then, that the problem of lack of growth could be traced to the smallness of markets, which in turn is accounted for by the absence of a middle class.

IV.C. Alternative Income Distributions

Begin with a "redistribution" of shares from the upper to the middle class (Figure IV). Assume first that this redistribution is

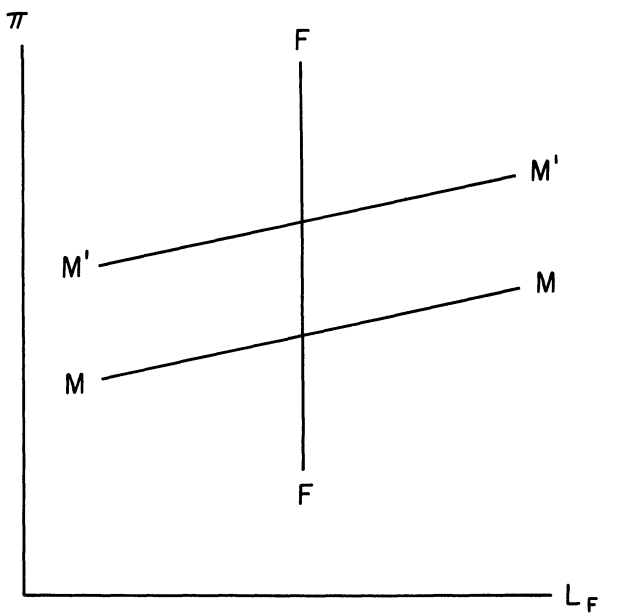

FIGURE IV
Effect of the Redistribution from the Rich to the Middle Class

sufficiently minor for the identities of the upper class to remain unchanged, and that no shares are taken from the N^*'th richest person. This "redistribution" can be thought of either as an actual transfer of shares, or better yet, as a comparative static on income distributions.[8] The effect of this redistribution on the manufacturing equilibrium is to shift the *MM* curve up. Any level of L_F will now yield a greater share of high-powered profits in the hands of the middle class as well as a higher multiplier since T rises. In contrast, the *FF* relation remains unchanged since the demand for food does not change.

The result of this redistribution is to keep the size of agriculture fixed, but to raise the demand for industrial goods at the expense of backstop. As a result, the equilibrium extent of industrialization, Q, rises since with his share γ^* unchanged and industrial profits rising, the N^*'th richest consumer can now afford a wider menu of goods. Industrial employment also rises, because $T + N^*\gamma^*$ rises, and employment in backstop declines since the rich now have less to spend. The wage and the welfare of wage earners do not change, since the food sector is not affected.[9] Note that if our redistribution had reduced the number of shares of the N^*'th richest person, the extent of industrialization, Q, would fall if profits did not rise enough in equilibrium for his income to end up higher. However, even if Q fell, industrial employment would rise, since fewer resources are spent on backstop.

Consider next a redistribution from the upper class to the poor, which is not large enough, however, to cause the poor to begin consuming manufactures (Figure V). This redistribution has no effect on the *MM* curve since neither the multiplier nor the share of rents owned by the middle class is affected. In contrast, since we shifted resources from people with marginal propensity to consume food of zero to those with an MPC of one, the agricultural employment and output must rise. The *FF* curve shifts to the right. The effect of this redistribution is to shift labor from the backstop to agriculture as the demand for food rises. This in turn raises high-powered profits with the result that industrialization becomes more extensive and industrial employment rises. In addition to the direct effect on the poor of the redistribution, there is an also an indirect adverse effect of a decline in wage as agriculture expands.

8. It can also be thought of as a labor income tax or a lump sum tax, except in this case the *MM* and *FF* equations must be appropriately modified.

9. If the middle class had a significant marginal propensity to spend on food (and especially higher than the rich), this redistribution would increase the size of the food sector and make wage earners worse off.

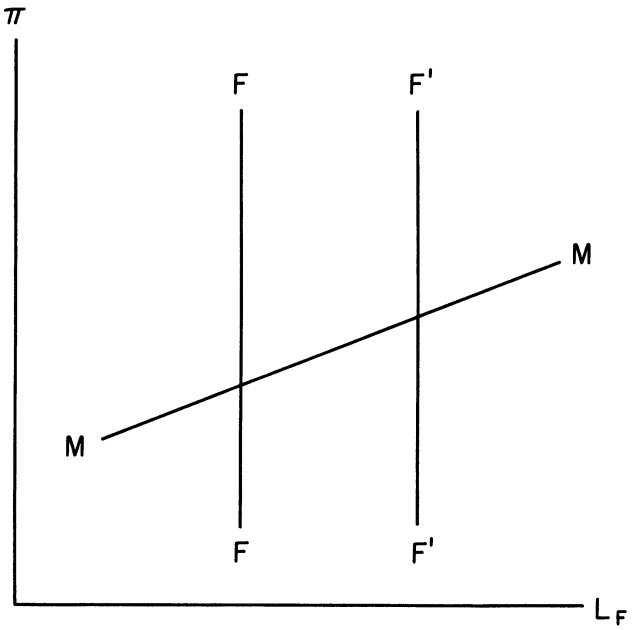

FIGURE V
The Effects of Redistribution from the Rich to the Poor

The direct effect, however, is stronger as otherwise agriculture could not expand in the first place. Similarly, the direct effect on the upper class of loss of shares and reduction in income cannot be offset by increased profits.

V. SOME ASPECTS OF THE OPEN ECONOMY

None of the issues addressed so far matter in a world of costless international trade. In that world, producers of each good face the world market, which in all likelihood is large enough to cover the fixed cost. In practice, however, trade is not costless. Transportation, marketing, establishing a reputation in product markets, and most importantly overcoming trade barriers all take costs. As a result, some goods will be traded, but for others the domestic market will remain the sole source of sales.

Consistent with our emphasis on the closed economy, the evidence offered by Chenery, Robinson, and Syrquin [1987] shows that 80–90 percent of manufacturing output in developing countries is sold domestically. At the same time, expansion of domestic

markets has often been a direct result of the growth of income from exports. Although one might expect a productive cash crop or mineral export sector to have the effect of causing the country to import more manufactures and to produce fewer of them at home, the more common consequence of exports is to foster domestic industrialization.

In the analysis of the closed economy, we have shown how a productive agricultural sector is necessary before consumers demand manufactures in sufficient quantities to render domestic industrialization profitable. In this section we argue that exports of cash crops, minerals, or light manufacturing goods enable a country to substitute efficient export production and food imports for inefficient domestic food production, so that food can be obtained in a roundabout and cheaper way. The net result of this productive roundabout means of obtaining food can often be more profits in the hands of the middle class and even food wages which are high enough that wage earners begin to demand manufactures. In this way, a productive export sector can raise the extent of domestic industrialization.

To make this point, we consider the special case of no trade in manufactures. The country exports a particular cash crop or mineral, and imports food. To keep the analysis close to the previous sections, we add to the list of commodities one export good R, which can be produced from labor with a concave production function $G(L_R)$, and yields no utility for domestic consumers. We assume that labor in the R-sector is paid its value marginal product, and the export profits from R are held in the same proportion as manufacturing profits and rents. The world price of food is taken as numéraire, and the world price of R in terms of food is given by E. We assume that the production of R is sufficiently cost effective that the optimal output of R is not zero. In this case, R will be produced until it is equally cheap to grow food domestically and to make R and exchange it for food in the world market:

$$E \cdot G'(L_R) = F'(L_F). \tag{12}$$

If trade is balanced, the value of food imports must equal $E \cdot G(L_R)$, in which case the food market clearing condition becomes

$$E \cdot G(L_R) + wL_F + \pi^F = wL - (w - z)N, \tag{13}$$

which together with (12) defines the equilibrium employment in agriculture. The FF curve, as before, remains vertical. High-

powered profits now come from both agriculture and exports, so that the *MM* curve becomes

$$\pi = \frac{[(\alpha - 1)/\alpha]\,((\pi^F + \pi^R)T + (N - N^*)(w - z))}{1 - T[(\alpha - 1)/\alpha]}, \tag{14}$$

where $\pi^R = E \cdot G(L_R) - wL_R$ denotes the export profits. Since higher farm employment still yields higher farm profits, the *MM* curve in the open economy is still upward sloping.

Opening up trade in this economy always raises wages, since labor is moved from the farm into more efficient production of exports. This effect is very similar to technological progress in agriculture, since labor is now used in efficient roundabout production of food (via production of exports and exchange of those for food). If wages rise above z, then wage earners will start to demand manufactures. This will increase the employment in industry. At the same time, the amount of profits in the hands of middle-class property owners can rise or fall when the country begins to export the cash crop, since the output share of property owners may be lower in the export sector than in agriculture. However, so long as the output share of property owners is not too much lower in the export sector, then high-powered profits should rise, and industrialization—measured either by Q or by L_I—should increase.

This analysis suggests that opening trade in some export good R can promote industrialization in the same way as does technological progress in agriculture (the *FF* curve shifts to the left and the *MM* curve shifts up). Both developments have the effect of expanding the domestic market for manufactures, and so allowing some increasing returns technologies to break even when they could not do so before. The idea that the wealth effect from international trade can raise the size of domestic markets has been stressed by Lewis [1953] in his recommendations for the economic development of the Gold Coast. This effect is probably also important in countries like Korea and Taiwan, whose protected domestic industries doubtless benefit from the demand generated by lower spending on food and other imported necessities. The international trade literature, even when it has focused on increasing returns [Helpman and Krugman, 1985], has not emphasized this wealth effect from trade governed completely by forces of comparative advantage.

The cases of East Asian NICs suggest another important way in which exports can encourage domestic industrialization, namely by providing the resources to import foreign technology. Cash crop exports encourage industrialization if their main effect is to lower

the cost of obtaining intermediate capital goods. In our framework, this can be modeled as the ability to import the fixed cost C at a price below the cost of providing it domestically. Given the abundance of cheap labor in LDCs, they often import sophisticated foreign capital goods, but protect final goods and manufacture them domestically.

In sum, the exports of domestic cash crops, minerals, or light manufactures can encourage domestic industrialization in two distinct ways. First, by importing food, the country can free up labor to work in manufacturing while at the same time creating demand from the combination of farm and export profits. This channel will be important so long as not all gains from trade materialize in higher wages spent on food. Second, the country can import capital goods to cut the cost of domestic production of final goods, and so reduce the minimum size of a market that can be profitably industrialized. The latter effect would be particularly important in a country that has a cheap labor, and that protects its final goods industries.

The analysis has so far assumed that each property owner owns the same share of profits from agriculture as from exports. Differential shareholdings, however, can have significant implications for the extent of industrialization, since the high-powered demand for manufactures depends on the total amount of profits in the hands of the middle class. For example, if the profits from the export commodity are narrowly distributed while the profits from agriculture are broadly held, then the incomes of the middle class and the demand for domestic industry might actually decline in response to opening up of exports. A similar effect arises if a country substitutes exports of oil, with narrowly distributed returns, for exports of a cash crop, with broadly distributed returns. Recent evidence from Nigeria's oil boom [World Bank, 1986] suggests that this is more than a theoretical possibility. In Nigeria the expansion of oil exports led to a contraction of cash crop exports, in part because of the appreciation of the real exchange rate. Since the returns from the exports of cash crops were more widely distributed than the returns from oil exports, the increase in domestic wealth associated with the expansion of oil exports failed to contribute to domestic industrialization.

VI. Summary and Extensions

The models presented above offered a tractable way to analyze industrialization interpreted as introduction of increasing returns

technologies. For both a closed economy and an economy with some open markets, our analysis stressed the role that composition of demand, as determined by the distribution of income, plays in industrialization. We identified the role of the leading sectors, such as agriculture or exports, in driving industrialization, but also showed that a boom in a leading sector might not suffice. For industrialization to take place, benefits from such a boom must be equally enough distributed to create large markets for domestic manufactures. Focusing on increasing returns and the size of domestic markets seems to offer insights that would be hard to obtain otherwise.

Several aspects of our models can be improved, and several additional questions can be profitably addressed in future work. First, we have considered only a simple theory of wage determination, where the real wages in the industry and on the farm are the same. If, as many observers (e.g., Lewis [1967]) have noted, real industrial wages are higher, several new results could emerge. For example, if industrial workers are wealthy enough to consume industrial goods, leakages from industry into agriculture would be smaller. In this case, the "balanced growth" effects whereby income from industrial production turns into demand for industrial goods will be stronger, which raises the possibility of a self-sustaining industrialization without autonomous demand. We explore such multiple equilibria in a companion paper [Murphy, Shleifer, and Vishny, 1988].

Second, we have not considered the question of the distribution of wealth among capitalists and landowners. This question gains particular significance in the open economy, where foreign competition might reduce profits but raise rents as the export and farm sectors expand. This question is also important in the context of the savings decision, especially if because of imperfect capital markets capitalists have higher savings propensities than landowners have.

Third, we have only focused on the income distribution as the determinant of market size. One can also consider other important determinants of market size, such as population size and average income, and ask various questions about industrialization in small versus large countries, as well as in poor versus rich countries. Chenery, Robinson, and Syrquin [1987] provide some evidence on these issues. One can also look at homogeneity of tastes and the concentration of population in one location, such as a city, as determinants of market size. For example, the United States might

have grown as fast as it did in the 1950s because conformity imposed a great deal of homogeneity of tastes, and so allowed producers to take advantage of increasing returns to a greater extent than they could if they had to produce variety. A cultural or state-enforced homogeneity of tastes might also have helped the growth of postwar Japan and socialist countries.

Finally, this work can be integrated into a two-stage model of economic growth, in which cash crop or mineral exports or domestic agriculture support domestic industrialization, which then leads to manufacturing exports. As the examples of Korea and Taiwan illustrate, domestic industrialization can teach companies the skills needed to become effective manufacturing exporters. To the extent that large enough domestic markets allow profitable domestic industrialization, which is necessary before manufactures can be exported, the model in this paper explains how countries lay foundations for becoming manufacturing exporters.

APPENDIX: NASH EQUILIBRIUM AMONG SECTORS

This Appendix shows that, under a plausible assumption on $G(\gamma)$, the unique Nash equilibrium is for monopolists in some subset of sector $(0,Q]$ to enter and to keep prices at αw. To show this, suppose that, for some Q, all sectors $(0,Q]$ convert to IRS technology. In none of these sectors can the entering monopolist raise the price above αw without surrendering his sales to the competitive fringe. The question is whether he will cut his price, assuming, as is appropriate in the case of small sectors, that he maximizes profits in terms of numéraire, which is food.

Suppose that all but one sector q do not cut prices, and consider the decision of the monopolist in that one sector $q \in (0,Q]$. Aside from good q, since all prices are the same, any consumer of manufactures with income y buys a segment $(0,q_y)$ of items. Customers of sector q include all those for whom the marginal utility of buying good q exceeds that of spending an extra dollar on food. If the monopolist in sector q charges $\tilde{p}$, these are the people for whom

$$\frac{1-\theta}{c-z} \leq \frac{\theta}{\tilde{p}q}. \tag{A.1}$$

Among buyers of manufactures, we know that

$$(c-z) = (y-z)(1-\theta). \tag{A.2}$$

From (A.1) then, the monopolist in sector q gets consumers with incomes

$$y \geq \tilde{p}q/\theta + z, \tag{A.3}$$

or

$$\gamma(\pi + \pi^F) + (w - z) \geq \tilde{p}q/\theta. \tag{A.4}$$

The last expression yields the ownership stake of the marginal customer for sector q at the price $\tilde{p}$, namely

$$\gamma(\tilde{p},q) = \frac{(\tilde{p}q/\theta) - (w - z)}{\pi + \pi^F}. \tag{A.5}$$

Since we are assuming that all sectors other than q are charging αw, in equilibrium all consumers with $\gamma \geq \gamma(\tilde{p},q)$ and none with $\gamma < \gamma(\tilde{p},q)$ buy the good q. Selling to them brings the variable profit of

$$\pi_q(\tilde{p}) = [L(1 - G(\gamma(\tilde{p},q)))](\tilde{p} - w), \tag{A.6}$$

since each customer buys only one unit. For $\tilde{p} = \alpha w$ to be optimal, it is sufficient that the profit function be nondecreasing in $\tilde{p}$ for all prices less than αw; i.e.,

$$[L(1 - G(\gamma(\tilde{p},q)))] - g(\gamma(\tilde{p},q))(q/(\theta(\pi + \pi^F)))(\tilde{p} - w) \geq 0. \tag{A.7}$$

The last inequality is equivalent to

$$\frac{g(\gamma(\tilde{p},q))}{L(1 - G(\gamma(\tilde{p},q)))} \cdot \frac{q \cdot (\tilde{p} - w)}{\theta(\pi + \pi^F)} < 1. \tag{A.8}$$

But from (A.5), we know that, under the poverty assumption, $w < z$:

$$\gamma(\tilde{p},q) > \tilde{p}q/(\theta(\pi + \pi^F)). \tag{A.9}$$

This implies that a sufficient condition for (A.8) to hold is

$$\frac{g(\gamma(\tilde{p},q))}{L(1 - G(\gamma(\tilde{p},q)))} \cdot \frac{\gamma(\tilde{p},q)(\tilde{p} - w)}{\tilde{p}} < 1. \tag{A.10}$$

Since $(\tilde{p} - w)/w$ is at most equal to $(\alpha - 1)/\alpha$, we have that a sufficient condtion for $\tilde{p} = \alpha w$ to be the optimal price is

$$1 > \frac{g(\gamma)\gamma}{L(1 - G(\gamma))} \cdot \frac{\alpha - 1}{\alpha} \tag{A.11}$$

for all stakes γ held by the potential marginal customers. These are

stakes γ such that $L(1 - G(\gamma)) < C/(\alpha - 1)$. We call (A.11) the inelastic demand assumption, and make it throughout.

To interpret this assumption, note that $g(\gamma(\tilde{p},q))\gamma(\tilde{p},q)$ is the number of new customers the monopolist in sector q gets per 1 percent price cut, $L(1 - G(\gamma(\tilde{p},q)))$ is his old customer base, and $(\alpha - 1)/\alpha$ is his profit rate per customer. The assumption (A.10) then says that the percentage gain in the customer base, times the profit rate per customer, cannot exceed one. In this model each monopolist is competing with food for customer dollars. As he cuts the price, the monopolist expands his customer base, but loses revenue on old customers. For the price cut to be unjustified, the monopolist cannot be gaining too many new customers relative to the revenue he loses on old ones. Put differently, the elasticity of his demand curve must be smaller than the inverse of his profit rate. In this case, the firm wants to keep its price as high as possible, that is, at αw. Although (A.11) seems to us to be a plausible assumption, we note that it fails when the distribution of shareholdings has large peaks or discrete spikes, in which case our no-price-cutting analysis does not apply.

A similar but more tedious argument shows that (A.11) also suffices to rule out price-cutting equilibria. Our equilibrium with no price cutting is unique when (A.11) holds. A proof of this is available from the authors.

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