Local Demand, Investment Multipliers, and Industrialization: Theory and Application to the Guatemalan Highlands

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Abstract

This paper investigates the role of demand in rural industrialization. We show that, when increasing returns are present, investment multipliers and multiple equilibria can result from demand for intermediate inputs and non-homothetic preferences. We then examine small-scale industrialization in the Guatemalan Highlands. We find large differences in the extent and variety of non-farm production across municipalities and evidence of large entry and transportation costs. But the pattern of non-farm production does not fully conform to investment multipliers. We conclude that urbanization favors the emergence of specialized firms and that the export of non-farm products is important for industrialization.

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The starting point of this paper is a simple but unsettling observation: why do some rural districts have at their center an active small city with dozens of manufacturing, commerce and services businesses while others only shelter a rural market where itinerant merchants sell goods produced elsewhere? The economic literature on development and growth has historically focused on a larger but closely related question: why do countries that began not long ago with similar conditions now display dramatically different structures of production and standards of living. To answer this fundamental question, many explanations have been proposed: prosperous countries accumulate more physical and human capital than others, it is argued; they have a superior technology, better institutions, and a culture more attuned to the requirements of modern life; and they pursue better policies and are less subject to corruption and rent seeking.

It is hard to imagine, however, how any of these explanations can account for rural districts having more non-farm businesses and a more varied structure of production than their neighbors. Presumably, candidate investors can take their funds and experience to neighboring towns, so that physical and human capital can safely be assumed mobile across rural districts. In these conditions, it is tautological to say that a location has more industries because it has more capital: the local abundance of capital is precisely what needs to be explained.[1] Municipalities only a few miles away from each other also have access to the same technology, share essentially the same institutions and culture, and are affected by the same government policies in more or less the same way. The reason for observed differences must be sought elsewhere.

[1] Assuming immobile capital and labor, constant returns to scale, and no factor intensity reversals, the international trade literature has demonstrated that trade in goods leads to factor price equalization as capital-poor locations specialize in labor-intensive goods (e.g., Bhagwati and Srinivasan (1983)). If factors are spatially mobile, it is easy to see that the same assumptions generate indeterminacy in the location of capital.

Local demand is the candidate explanation we focus on here. Classical development economists were the first to emphasize the role of demand in the industrialization process.[2] In his famous shoe factory example, Rosenstein-Rodin (1943) argues that production creates its own demand: the wages that factory workers earn making shoes and other manufactures are spent on shoes and other manufactures. Supposing demand was initially too low to justify investing in a shoe factory, the parable goes, investing in all industries simultaneously would generate enough demand to make investments profitable *a posteriori*. The idea of a vicious circle of poverty, insufficient demand, and lack of industrialization was taken on by numerous classical development theorists, among which Nurkse (1953), Myrdal (1957) and Hirschman (1958). Hirschman enriched and extended the argument to encompass intermediate inputs. Input demand linkages between industries, he argues, create investment multipliers: demand for inputs by downstream industries incites upstream industries to initiate production, thereby creating demand for other upstream industries and fostering further entry. This is possible because industrial production is characterized by large fixed costs, and entry and investment are discrete decisions. The resulting pecuniary externalities may generate poverty traps.

The shoe factory parable did not, however, go uncontested. As early as 1955, Fleming noted that, under conditions of full employment, forcing one loss-making firm to produce can only subtract from national income, therefore *reducing* demand instead of expanding it. Recently, Murphy, Shleifer and Vishny (1989a) revisited the debate. Using a simple model with increasing returns, homothetic preferences, and no intermediate

[2] Strictly speaking, not all non-farm activities are industrial in nature, but we shall follow here a firmly established convention in economic development theory and call the move away from agriculture as a process of industrialization. To describe villages turning into rural towns, one could equivalently speak of urbanization (e.g., Henderson (1988), Abdel-Rahman (1988), Riviera-Batiz (1988)).

inputs, they proved Fleming right. They showed that equilibria with and without industrialization can coexist only in the presence of an industrial wage premium or of other sources of pecuniary externalities.

Wage premia may characterize large urban centers (Lewis (1954)), but they are unlikely to exist in rural towns: non-farm workers often engage in part-time farming and do not have to suffer any of the inconveniences of urban living. There is no reason to presume that they would require higher pay as, say, cobblers than as farmers. One must look for other interpretations to the shoe factory parable. It has long been noted that income elasticities are higher for non-farm goods and services than for primary commodities and subsistence goods (e.g., Matsuyama (1992)). It is also well known that non-farm activities rely on a multiplicity of intermediate inputs and services, many of which can be produced locally. Industrialization is characterized not only by increased diversity but also by industrial deepening, that is, the superposition of layers of intermediate inputs (Hirschman (1958), Ciccone (1993)). In this paper, we show that demand for intermediate inputs and a high income elasticity for industrial goods are sufficient to cause poverty traps.

To make a convincing case, we must establish that the location of demand matters in a world where goods move across space. We deal with this potential objection by showing that transportation costs generate location rents even when goods can be traded. To account for the existence of poverty traps, we also must explain how small differences in demand can result in noticeably different structures of production. To that effect, we show that fixed costs of production, high income elasticities for non-farm products, and intermediate input linkages combine to engender investment multipliers: investment by some generates demand for others and triggers further entry. Multiple equilibria arise when investment multipliers are so strong that they create their own demand.

We first illustrate the role of demand analytically. In section 1, we extend Murphy, Shleifer and Vishny's (1989a) Big Push model to an open economy with transaction costs and allow for non-homothetic preferences. We show that multiple equilibria can occur when final consumers have a high income elasticity for non-farm products.[3] Next, we generalize the approach to include intermediate inputs and rising marginal costs. We characterize the conditions under which entry occurs and, as Ciccone (1993) did for a closed-economy model with intermediate inputs, demonstrate the existence of investment multipliers and multiple Pareto ranked equilibria. Industrialization exhibits hysteresis.

To investigate how external factors affect industrialization, we construct in section 3 a simulation model of a prototypical rural town and subject it to changes in its economic environment. Results show that town residents are the main beneficiaries of successful rural industrialization. Increasing trade opportunities can benefit or hurt rural towns depending on their initial conditions. Finally, we examine in section 4 the pattern of non-farm production in three neighboring municipalities of the Guatemalan highlands. We find marked differences in the extent and variety of non-farm production among them as well as evidence of large entry and transportation costs. But the pattern of non-farm production does not fully conform to investment multipliers. Observations suggest that urbanization *per se*, that is, the geographical concentration of people in rural towns favors the emergence of small specialized businesses. Exports of non-farm goods and services to neighboring municipalities also appear to play a role in rural industrialization.

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[3] Matsuyama (1992) constructs a model where agricultural goods have a lower income elasticity than manufactures and shows that growth is an increasing (decreasing) function of agricultural productivity in closed (open) economies. We focus here on short-term multiplier effects.

Models of isolated economies where multiple equilibria are driven by local demand externalities may be missing an important part of the industrialization story. Conclusions and prospects for further research are presented at the end.

Section 1. Income Elasticity and Pecuniary Externalities

To begin, we examine the conditions under which non-homothetic preferences and increasing returns generate pecuniary externalities. Consider the following stylized economy. There are 2 types of goods. The first, an undifferentiated good *A*, stands for subsistence commodities like basic food and shelter. The second type of good is a continuum of differentiated commodities $x(q)$ indexed over $q \in [0, 1]$ that represent various local manufactures and services. Good *A* is produced with a constant returns to scale (CRS) technology; 1 unit of *A* requires 1 unit of labor. The price of *A* is taken as numeraire. The wage rate *w* thus equals 1. Differentiated goods can be imported from neighboring cities and rural districts at price *p*. They can also be produced locally by small, monopolistically competitive firms, each producing a single $x(q)$ good or service. Local producers of each differentiated $x(q)$ good have an increasing returns technology with fixed labor requirement *F*. One unit of labor produces θ units of output. We momentarily assume that local producers of differentiated goods cannot export their production. This assumption is relaxed later.

Consumers have a Cobb-Doublas utility as follows:

$$U = Max\{U_1, a + b\ U_2\}$$

where *a* and *b* are suitably chosen parameters[4] and

[4] We need $b > 1$ and $a = (1-s_1)\ln(1-s_1)\bar{y} + s_1\ln(s_1\bar{y}/p) - b[(1-s_2)\ln(1-s_2)\bar{y} + s_2\ln(s_2\bar{y}/p)]$. Thus, U_2 grows faster with income than U_1, but for $y = 0$, necessarily $U_1 > U_2$.

$$U_i = (1 - s_i)\ln A + s_i \int_0^1 \ln x(q)\, dq$$

Of their income y, they spend $(1 - s_i)y$ on good A and $s_i y$ on each differentiated good $x(q)$. Consumption shares jump at an income level $\bar{y}$ from s_1 to s_2 with $s_1 < s_2$. Given that local demand for industrial goods has a unitary price elasticity, imports serve the same function as CRS goods produced by a competitive fringe in the model of Murphy, Shleifer and Vishny (1989a): they ensure that non-farm producers charge a price equal to p. Non-farm profits are equal to revenues minus fixed and variable wage costs:

$$\pi = s_i y - w\,F - w\,l$$

The number of units sold is $\frac{s_i\, y}{p}$ and the variable labor required to produce them $\frac{s_i\, y}{\theta p}$. Since the wage rate is one, profits can be rewritten:

$$\pi = s_i y(1 - \frac{1}{\theta p}) - F$$

To demonstrate the existence of pecuniary externalities, we show that there are parameter values for which multiple Pareto ranked equilibria exist.[5] First consider a firm's decision to begin production when no other industrial firm is producing. Income y_1 is equal to L, which we assume to be smaller than $\bar{y}$. The profit of an entrant firm is:

$$\pi_1 = s_1 L(1 - \frac{1}{\theta p}) - F \qquad (1)$$

Equation (1) indicates that profits before industrialization are more likely to be negative when the size of the economy L is small, farm incomes are low and thus consumers are poor (low s_1), non-farm productivity θ is low, start-up costs F are high, and import prices

[5] Murphy, Shleifer and Vishny (1989a) explicitly contemplate this possibility. After having shown that an industrial wage premium can induce multiple equilibria, they indicate that a similar situation would result if industrialization implies urbanization and city dwellers' demand is more concentrated on manufactures. They do not, however, model this process formally.

p are low.

Second, consider the case in which all non-farm firms have entered. Total household income is labor income plus profits. In equilibrium, we get:

$$y_2 = \frac{L - F}{1 - s_2(1 - \frac{1}{\theta p})}$$

$$\pi_2 = s_2 \frac{L - F}{1 - s_2(1 - \frac{1}{\theta p})}(1 - \frac{1}{\theta p}) - F \qquad (2)$$

It is easy verify that there are many parameter values at which a firm would not enter if no one else has -- $\pi_1 < 0$ -- firms make positive profits when all have entered -- $\pi_2 > 0$ -- and incomes with entry are strictly higher than incomes without entry -- $y_2 > y_1$.[6] (The latter condition is required so that there indeed exists a $\bar{y}$ such that $y_2 > \bar{y} > y_1$ and $s_2 > s_1$.)

Multiple equilibria are illustrated in Figure 1. On the horizontal axis is profit π; on the vertical axis is non-farm demand D. The $D(\pi)$ schedule expresses demand $s_i y$ as a function of the profit component of income π; it jumps at $\bar{y}$ as consumers switch from a low consumption share s_1 for non-farm goods and services to a high consumption share s_2. The $\pi(D)$ schedule maps profits as a function of demand. Point A is the equilibrium with zero profits and no entry; point B is the equilibrium with entry. Of these two equilibria the low equilibrium A is a poverty trap or vicious circle: low incomes induce little demand for non-farm goods and services, and thus little investment. A high income elasticity for non-farm goods -- that is, a large "jump" from s_1 to s_2 -- is an essential element for a poverty trap to exist in this model.

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[6] When p=1, θ=2, F=0.2, L=1, s_1=0.3 and s_2=0.5, for instance, the three conditions are satisfied and two equilibria exist.

The high equilibrium in Figure 1 corresponds to Rosenstein-Rodin's shoe factory parable: high incomes generate a large demand for industrial goods, thereby justifying industrial investments *ex post*. Fleming's critique nevertheless still applies: forcing investment may be disastrous if anticipations are pessimistic and consumption patterns do not change. Unlike in Murphy, Shleifer and Vishny's (1989a) wage premium model, not only is coordination among investors crucial, consumers must also raise their demand for non-farm goods in anticipation of higher incomes. Since exogenous income shocks may eliminate some equilibria or add new ones (see point C on Figure 1, corresponding to an exogenous income transfer S), it is easy to see that a temporary increase in income may trigger the diversification of production into non-farm goods and services. Provided that consumers and producers remember the past and prefer not to change their decisions too often,[7] the process of industrialization is partly the result of historical events: there is hysteresis (e.g., Krugman (1991), Matsuyama (1991)).

For simplicity of exposition we assumed that consumption shares jump discretely at some income level $\overline{y}$ and that $D(\pi)$ has the kinked shape shown in Figure 1. As is clear from the graph, this is not necessary: multiple equilibria may exist even if the shift from s_1 to s_2 is gradual, as long as $D(\pi)$ and $\pi(D)$ intersect more than once. This can only happen if the consumption of non-farm goods increases more rapidly than income over some interval, that is, if subsistence goods are inferior over that interval. Finally, profits need not be negative at the low intersection point between $D(\pi)$ and $\pi(D)$. Multiple Pareto ranked equilibria may then exist for which entry is profitable even at the low

[7] If economic agents are memoryless, then past equilibria cannot influence future behavior. If agents remember the past but can change their decisions instantaneously at no cost, they may in principle switch arbitrarily between low and high equilibria over time. Such paths are not plausible, however, if agents find it difficult to coordinate their actions. We assume here that past equilibria serve as focal point for current behavior. See Fafchamps (1995) for discussion.

equilibrium, but capacity utilization is lower than in the high equilibrium. We then have:

$$y_1 = \frac{L - F}{1 - s_1(1 - \frac{1}{\theta p})}$$

$$\pi_1 = s_1 \frac{L - F}{1 - s_1(1 - \frac{1}{\theta p})}(1 - \frac{1}{\theta p}) - F$$

For multiple equilibria to exist in this case, it must be that $y_1 < y_2$ -- so that a $\bar{y}$ exists at which consumption shares change -- and $\pi_1 < \pi_2$. The only requirement for these conditions to hold is that $s_1 < s_2$. By extension, if the consumption share of industrial goods jumps not once but several times, more than two equilibria are theoretically possible. The model can also be expanded to account for various levels of industrial sophistication if we assume that there are not one but several categories q of non-farm goods and services. The same caveat applies, however: low category goods must be jointly inferior over some range of income for multiple equilibria to arise.

Industrialization and Exports

Pecuniary externalities are possible even when non-farm output is exportable to nearby cities and rural districts, provided there are transaction costs in trade. To see why, suppose industrial production can be exported at a unit producer price of $p - t$. Parameter t captures the various transaction costs required to sell output in distant markets (e.g., transportation, marketing, insurance, credit, and warehousing costs). These costs may be incurred by the producer itself or by various intermediaries; either way, they deduct from profits. If $t = 0$, local demand does not matter and multiple equilibria do not exist. To keep the algebra simple, we assume that marginal cost is constant up to a level of output $\bar{k}$ above which it increases rapidly; $\bar{k}$ is assumed larger than the domestic market.[8]

[8] Without these additional assumptions, exports by producers whose constant marginal cost is smaller

Producers continue to sell on the local market at price p. Profits can now be written:

$$\pi = s_i y + e(p - t) - \frac{s_i y}{\theta p} - \frac{e}{\theta} - F$$

Exports e are zero if the profit per unit is smaller than the marginal cost, i.e., if $p - t < \frac{1}{\theta}$. They are equal to $\bar{k} - s_i \frac{y}{p}$ otherwise. We already examined the case in which $e = 0$. Let us now demonstrate that multiple equilibria can exist even when $e = \bar{k} - s_i \frac{y}{p}$. When no firm has entered, income y_1 is, as before, equal to L. The profit made by a single entrant is:

$$\pi_1 = \frac{s_1 t L}{p} + \bar{k}(p - t - \frac{1}{\theta}) - F$$

It is an increasing function of $\bar{k}$; it is also a decreasing function of transaction costs t since, by assumption, $\bar{k} > s_1 L/p$.

When all firms have entered, we have:

$$y_2 = \frac{L - F + \bar{k}(p - t - \frac{1}{\theta})}{1 - s_2 \frac{t}{p}}$$

$$\pi_2 = \frac{\bar{k}(p - t - \frac{1}{\theta}) - F + \frac{s_2 t}{p}}{1 - s_2 \frac{t}{p}}$$

It is easy to verify that parameter values exist such that $\pi_1 < 0$, $\pi_2 > 0$ and $y_2 > y_1$.[9] By the same token, multiple Pareto ranked equilibria may exist in which different positive levels of output are produced.

than $p - t$ would be unbounded. In the next section we introduce increasing marginal cost and dispense with this assumption.

[9] For instance, keep the same parameter values as before and set $t = 0.3$, $\bar{k} = 1.5$, and $F = 0.4$.

Section 2. Intermediate Inputs and Investment Multipliers

We now generalize the model to include intermediate inputs, increasing marginal costs, labor migrations, and differences in fixed and variable costs across industries. The resulting model is similar in spirit to that of Ciccone (1993) but allows for trade. As before, there are two types of production: CRS agriculture, and increasing returns to scale industries.[10] All goods are traded but there are transportation and transaction costs. Workers who cannot be employed locally temporarily migrate to a nearby town or plantation and remit their wages net of migration costs.[11] Agricultural producers export part of their output and derive income from agricultural profits and labor migrations. Assuming that the economy is a net exporter of all farm products and labor, the optimal level of agricultural output does not depend on local industrial conditions. Combining consumption demand over all consumer groups we write the aggregate demand system for non-farm goods and services $i \in M$:

$$C_i = C_i \left(Y + \sum_j \pi_j ,\, p\right)$$

where Y is income from agriculture and migration, and π_j stands for profit in industrial sector j -- possibly zero. Aggregate income elasticities for particular goods result from changes in individual consumption shares and shifts in the relative incomes of various consumer groups. We assume that individual preferences are such that the price elasticity of the market demand for non-farm goods is ≤ 1.[12]

[10] Services fall in either category, depending on whether their production can be characterized as constant or increasing returns to scale.

[11] We ignore the possibility that residents of the rural district may permanently migrate to another part of the country, thereby subtracting permanently from local demand.

[12] This assumption is sufficient -- but not necessary -- to guarantee that local monopolists charge the import price. It is satisfied, for instance, if individual consumers have the preferences specified in section 1 but is compatible with other preferences as well.

Each industrial good $i \in M$ can either be imported at price $p_i(1+\mu)$ or produced locally by a single producer. Industrial producers behave like monopolists on their local market; imports play the role of a competitive fringe. Local producers therefore sell locally at the import price. They can also choose to sell abroad at the export price $p_i(1-\mu)$. To produce they must incur a fixed cost $\overline{f_i}$ and an increasing variable labor cost $w\ \theta_i\ Q_i^2$ where Q_i stands for output and w for the wage. Increasing marginal cost arises from the existence of non-traded inputs like management and entrepreneurship. Firms also must purchase intermediate inputs $\sum_j a_{ji} p_j (1+\mu)\ Q_i$ where the a_{ij}'s are input-output coefficients. Production is net of the use of own output as intermediate input. Profit is:

$$\pi_i = Q_i(1+\mu)(p_i - \sum_j a_{ji} p_j) - w\ \theta_i\ Q_i^2 - \overline{f_i}$$

Average cost has the usual U shape. As in section 1, non-farm producers enter only if they make a non-negative profit.

Local Demand, Industrial Profits and Entry Decisions

Within each industry, production occurs in one of three possible market equilibria: net export, autarky, and net import. These equilibria are depicted in Figure 2 as points *A*, *B*, and *C* respectively. Parameters α_i and β_i stand for the import and export prices net of intermediate input cost: i.e., $\alpha_i \equiv (1+\mu)(p_i - \sum_j a_{ji} p_j)$ and $\beta_i \equiv p_i(1-\mu) - \sum_j a_{ji}\ p_j(1+\mu)$. They represent the net revenue per unit sold on import and export markets. The $2\ \theta_i\ w$ line is the marginal cost of production. The D_C curve stands for the local demand for good i in equilibrium *C*; for simplicity, the local demand curves corresponding to equilibria *A* and *B* are omitted from the figure.

In equilibrium *A*, local demand cuts the α_i line at *d*. Quantities $0Q_i^X - ad$ are exported at net price β_i. The rest is sold locally at net price α_i. Variable profits on the domestic market correspond to the trapeze 0*ade* (the dark shaded area); variable profits on exports correspond to the triangle *Ace* (the light shaded area). In the autarky equilibrium *B*, local demand is *af*. All of local production $0Q_i^B$ is consumed locally. Variable profits correspond to the trapeze 0*afB*. Finally, equilibrium *C* is the net import case. The marginal cost equals the net price at point *C*. Variable profits are the triangle 0*aC*. Optimal levels of output and profits for each equilibrium are derived in Appendix 1.

As is clear from Figure 2, variable profits are an increasing function of local demand. The relationship between profits and local demand is analyzed in detail in Appendix 1. If fixed costs $\overline{f_i}$ are high and local productivity low, profits can never be positive, irrespective of local demand. If, on the other hand, fixed costs are low and local productivity high, profits are positive even if local demand is nul. In between, profits increase with local demand. Entry occurs if variable profits are greater than fixed costs. As an illustration, let $\underline{D}_1$ be the level of local demand at which a new entrant would brake even when producing good 1. The resulting relationship between local demand and output is shown in Figure 3. When local demand is less than $\underline{D}_1$, the good is not produced locally. If local demand is greater than $\underline{D}_1$, entry takes place. Output is constant except in the autarky range, where it increases with demand.

Investment Multipliers and Multiple Equilibria

We now show that the discontinuity of local output at $\underline{D}_1$ is the source of investment multipliers. The local demand for an arbitrary industrial good *i* has two components: final demand and intermediate demand, i.e.:

$$D_i = C(Y + \sum_j \pi_j) + \sum_j a_{ij} Q_j$$

As output of good i jumps discretely to $\frac{\beta_i}{2\theta_i w}$ when local demand rises above $\underline{D}_i$, so does the derived local demand for intermediate inputs. This jump may be sufficient to trigger entry in another sector as well, say j. Entry in sector j in turn may increase intermediate demand for sector i, raising profits in that sector and final demand for both goods. These changes combined could trigger entry in yet another sector k, leading to further rounds of increase in intermediate demand, profits, and final demand. Demand linkages thus result in an investment multiplier close in spirit to the backward linkages and final demand linkages described in Hirschman (1958) and to the input complementarities discussed in Ciccone and Matsuyama (1993).

In section 1 we showed that if the income elasticity for good i is high enough (and other goods jointly inferior) multiple equilibria may arise. Intermediate input demand, alone or in combination with income elasticities, is also a potential source of multiple equilibria. To see why, consider two industrial sectors labeled 1 and 2. Then it is easy to show that parameter configurations exist for which there are three equilibria: one in which neither good 1 nor good 2 are produced; one in which either good 1 or good 2 is produced; and one in which both are produced (see Appendix 2 for a formal argument). By extension, the maximum possible number of equilibria in a model with M non-farm goods is $M+1$.

Section 3. External Factors and Industrialization

To investigate how industrialization is affected by external factors, we construct a simulation model of a prototypical rural district in the Third World and use it as a laboratory to investigate the effect of various exogenous shocks on non-farm production. For the most part, the model resembles closely a standard neo-classical Computable General Equilibrium (CGE) model (see Dervis, de Melo and Robinson (1982)), except that industrial production is as in section 2. Output, incomes, and consumption shares are loosely calibrated on data collected by Helms (1993) on rural municipalities in the Guatemalan Highlands (see Section 4). A complete list of the model's equations is given in Appendix 3.

There are three categories of households -- rural poor, rural rich, and residents of the small municipality town. There is no government in the model. Consumption follows a Linear Expenditure System (LES). Income elasticities are higher for non-farm than for farm goods. Rural households collect income from local wages, temporary migration, agricultural production, and, possibly, exogenous transfers. We abstract from permanent migrations and treat population as constant. The rural poor grow only a staple food, corn. In addition to labor and agricultural income, town residents receive profits from non-farm activity. There are four agricultural production activities, each with its own land base and its own constant returns to scale CES production function. Agricultural production elasticities are given reasonable values for smallholder agriculture (see Helms (1993)). Part of agricultural output is consumed locally; the rest is exported. The consumer and producer prices of agricultural goods are both equal to the export price $p_i(1-\mu_i)$. For simplicity, we assume that migration is unrestricted so that local wages equal migrants' wages net of migration costs. Given these assumptions, one can solve for agricultural output and for agricultural and labor incomes independently from non-farm production. Final demand for all goods is obtained by aggregating consumption demand from all three household groups.

We postulate the existence of twelve categories $m \in M$ of non-farm activities, each with its own productivity coefficient θ_m and fixed cost $\overline{f}_m$. We abstract from credit rationing issues and assume that local investors can freely raise the funds to finance learning and start-up costs. The annual fixed cost of production $\overline{f}_m$ corresponds to the yearly repayment of these one-time costs.[13] Due to the existence of transportation and other transaction costs in inter-municipality trade, the price municipality residents pay on an imported good i is $2\mu_i$ higher than the price they receive when they export the same good. We initially assume that transaction costs μ_i are equal across sectors.[14] Imports play the role of competitive fringe: local producers of industrial products charge the import price to local consumers and collect the lower export price on exports. Profits and costs are as in section 2.

Parameter values for non-farm activities are chosen so as to capture the stylized features of small-scale industries in rural districts of the Third World: transportation and other transaction costs are large; more sophisticated industries have higher start-up cost, lower variable cost (i.e., higher margins), and use other non-farm activities as inputs (e.g., trade, services, other manufactures; see section 4). To keep the model as transparent as possible, non-industrial activities are ranked by order of sophistication and parameterized in a simple, stylized fashion. High rank activities are assumed more productive -- they have a lower θ_i -- but more costly to initiate -- they have a higher $\overline{f}_i$. Industrial deepening is captured by postulating a triangular input-output matrix in which

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[13] Adding credit constraints would unduly complicate the model without significantly adding to it. Even with credit constraints, investors should be able to eventually save enough to finance the investment by themselves. Credit constraints only slow down the speed at which the municipal economy adjusts but leave our qualitative conclusions unchanged.

[14] This is a simplification. In practice, transaction costs are higher for services than for manufactures.

activity of rank i requires 0.2 units of each non-farm goods of rank $i-j$, $j = \{1,..,i-1\}$ as intermediate input. Values of θ_i and $\overline{f_i}$ are chosen so that the economy has three possible equilibria: one without any non-farm output; one with seven non-farm sectors in operation; and one with all twelve sectors.[15] Each equilibrium is locally stable.

The three equilibria are displayed on Tables 1a and 1b. The first equilibrium -- which serves as reference point for later simulations -- is one in which all non-farm goods are imported. The municipality ’town’ remains a village: all households derive their income exclusively from agriculture and migration. In the second equilibrium, seven of the twelve non-farm goods and services are produced locally. These are mostly small-scale activities requiring a small initial investment. Profits are tiny but local employment generation is ten times bigger, as shown by the decrease in outside migrations. Intermediate input linkages are limited but present. Most non-farm output is consumed locally; a small portion of it is exported. Since by assumption all non-farm profits go to town residents, their income goes up slightly while that of rural households remains unchanged. The third equilibrium is one in which all twelve non-farm goods and services are produced locally. Non-farm profits raise the income of town residents by two thirds, fueling further demand for non-farm goods. The demand for intermediate input by high rank activities is stronger than in the second equilibrium, resulting in imports of low rank goods. Employment generation is large.

The model thus captures three possible states in which a rural municipality can be: one in which it remains exclusively rural; one in which simple craft activities generate employment but little prosperity; and one in which the local economy is more prosperous

[15] Each equilibrium is found by arbitrarily raising Y for one iteration and letting the system adjust as described in Appendix 3. It is of course possible to pick parameters so that more or fewer equilibria exist.

and diversified while maintaining its predominantly rural character.[16] Equilibrium 3 is Pareto superior to equilibrium 2 which itself is Pareto superior to equilibrium 1.

Small-Scale Industrialization and External Shocks

To understand better what factors affect the development of small-scale industrialization, we conduct a series of experiments that illustrate possible variations in economic environment, namely: a temporary increase in exogenous income; a redistribution of income within the municipality; changes in prices and wages; and a reduction of transaction costs. In all the simulations we begin at one of the three equilibria and let myopic investors enter and exit until expected profits equal realized profits.

A temporary shock in exogenous income, which for simplicity we allocate entirely to town residents, can force the municipal economy from one equilibrium to another. For instance, a one-period increase in exogenous income greater than 10 units pushes the economy from the first to the second equilibrium. Similarly, a one-period exogenous increase of 22 units or more pushes it to the third equilibrium. A temporary drop in income can similarly bring the village from a higher to a lower equilibrium. When investors are myopic, which equilibrium the economy is at depends on past history.

Redistributing income (or assets) from the rural rich to the rural poor can trigger small-scale industrialization, as often argued in the development economics literature (Adelman (1973), de Janvry (1981), Taylor and Bacha (1976), Mellor (1986)). But it can also impede it, as Murphy, Shleifer and Vishny (1989b) have shown. In our stylized economy, taking 100 units of income away from the rich and giving it to the poor elim-

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[16] Presumably we could have added other sectors and allowed the municipality to fully urbanize. This exercise is beyond the scope of the present paper and is left for further research.

inates both the no-industrialization and the full industrialization equilibria. The only remaining equilibrium is one in which five of the twelve non-farm goods and services are produced, all fairly unsophisticated. Employment goes up, but non-farm profits are small.

Changes in agricultural prices affect rural industrialization. For instance, a small drop in the cost of fertilizer, an imported input, raises agricultural incomes and output and increases demand for non-farm goods (Table 2, column 1). One of the three equilibria, that without industrialization, disappears. Welfare increases for all households, but town residents benefit the most thanks to the increase in non-farm activity. A small increase in all agricultural prices leaves only the full industrialization equilibrium (Table 2, column 2). Welfare increases significantly for the rural rich but town residents are the largest beneficiaries of the rise in agricultural prices, thanks to the local investment boom. In contrast, the rural poor, who are net buyers of corn, are moderately penalized. Migrations drop dramatically.

Changes in the price of non-farm goods and services elsewhere have a strong effect on local industries (Table 2, column 3). A small decrease in the price of non-farm goods eliminates the partial and full industrialization equilibria: given the technology available to its residents, the municipality is unable to compete with cheaper imports. Compared to the no-industrialization equilibrium, the welfare gain for all household groups is minimal because of the overwhelming importance of subsistence items in their consumption basket. Relative to the partial and full industrialization equilibria, however, a drop in the price of non-farm goods and services implies a drastic reduction in the welfare of town residents as all local industries become non-profitable.

The last column of Table 2 combines the three experiments and simulates what would happen if transaction costs were to decrease, i.e., if μ dropped from 0.3 to 0.26. This experiment is meant to capture the effect that, say, the construction of a paved road or subsidized transportation may have on a typical rural municipality. Simulation results show that both the no-industrialization and the full industrialization equilibria vanish. Only two intermediate equilibria remain -- one with three non-agricultural activities (shown in Table 2), one with seven, similar to equilibrium 2 in Table 1. Employment generation in the three sector equilibrium is large but non-farm profits are low. The rural rich are the main beneficiaries of the change, being the major exporters of agricultural commodities. Township residents benefit or suffer from the change depending on the initial state of the local economy. If the municipality previously had no non-farm activities, the increase in prosperity brought about by the road spills over to a few non-farm investors. In contrast, if the municipality was initially highly diversified, opening its economy to cheaper imports forces many local industries to close down and reduces the welfare of township residents.[17]

Changes in the net wage received by migrants are simulated in Table 3. A sufficiently high increase in net migration wages eliminates both high and low equilibria, leaving a single equilibrium with only three non-farm sectors. Other non-farm activities are no longer competitive at the higher labor cost. The rural poor are the major beneficiaries of the wage increase. Migration increases dramatically. Conversely, a wage decrease leads to a significant drop in migrations and a decrease in the poor's welfare. It also raises domestic competitivity and eliminates the no-industrialization equilibrium.

[17] It should be possible to construct examples in which increased trade opportunities lower welfare for all, provided lost profits are large and shared by all and the welfare gains from higher selling prices for farm surpluses and lower buying prices for imported manufactures are small. This issue is left for further research.

Local agricultural output goes up. Some of the discouraged migrants are now absorbed into the local town economy, producing import substitutes for the rural rich and town residents. As a result of local industrialization, the latter actually benefit from the drop in wage income.

To summarize, simulation results indicate that non-farm activities in rural municipalities are likely to respond positively to increased local prosperity and expectations, but are vulnerable to loss of competitiveness with respect to imported substitutes. The balance between the two determines the degree of sophistication of the local economy. Town residents are the main beneficiaries of successful local industrialization. Rural roads may boost non-farm activities in backward areas, but hurt them in already industrialized rural towns.

Section 4. Small-Scale Industrialization in the Guatemalan Highlands

We now investigate whether demand driven investment multipliers and multiple equilibria help account for observed patterns of rural industrialization. Three municipalities in the department of San Marcos in the Guatemalan Highlands provide the empirical backdrop for this section: Tejutla, Comitancillo, and Concepcion Tutuapa. They were selected because they constitute representative examples of typical rural communities of the Third World, with low incomes and poor transportation. We begin with a brief description of the area.

Description of the Area[18]

The three municipalities are fairly homogeneous: all belong to the same Mayan Indian group, the *mam,* and all three have the same level of geographical isolation and high altitude. Two of the three municipalities have comparable populations -- 34,778 people in Comitancillo, and 35,504 in Concepcion Tutuapa (1989 figures). The third, Tejutla, is smaller, with 20,748 inhabitants. Like the rest of the Guatemalan Highlands, the three municipalities are mostly rural. They host a preponderance of small farms, nearly all of whom use family labor to grow corn for their own subsistence. Wheat, potatoes and vegetables serve as cash crop. Yields and cash crop output are higher in Tejutla. Seasonal migration supplement family incomes, over half of which come from off-farm sources. Lower cash crop incomes in Comitancillo and Concepcion are compensated by a higher incidence of work migration to cities and plantations.

Table 4 contains the results of an economic activity census of all permanent businesses operating in the three municipal towns. Tejutla boasts a greater number and range of businesses than does Comitancillo, which in turn exceeds Concepcion Tutuapa in this respect. The contrast between the three municipalities is confirmed in Table 5 which summarizes sales, margins (sales minus material inputs), and fixed investment costs for non-farm activities. The ranking of the three municipalities evident in Table 4 is mirrored in sales volume, gross margins, and fixed investment in commerce, manufacturing and services, both at the firm level and the aggregate level. Aggregate fixed investment in Tejutla is more than 6 times larger than in Concepcion Tutuapa. Tejutla is also more urbanized: 9.5% of its population resides in the municipality town, versus

[18] The reader is referred to the Tax (1963) and Helms (1993) for details about the area and precise references.

2.1% in Concepcion and 3.2% in Comitancillo.

What can account for the observed pattern of non-farm production in the three municipalities? One could say that Tejutla has a higher capital-labor ratio than other municipalities, but it would simply beg the issue: if returns to investment were higher in the other municipalities, investors could easily take their business there. Incentives to move do not appear to be present, however. Table 5 indeed indicates that gross margins are higher the more industrialized the municipality is -- a finding that is difficult to reconcile with a pure neo-classical theory of growth. Alternatively, one could say that Comitancillo and Conception Tutuapa are less industrialized because they have a comparative advantage in agriculture. Again, the facts contradict this assumption: yields and cash crop output are higher in Tejutla than in the other two municipalities. Finally, one could argue that more varieties of producer services (e.g., photocopies, lawyers, direct mail) are available in Tejutla than in the other two districts. But why Tejutla has more variety of non-farm products is precisely what we want to understand.

Is local demand the explanation? To investigate this possibility, we must ascertain whether conditions are present for investment multipliers and, possibly, multiple equilibria to emerge: do non-farm goods have a high income elasticity? Are demand linkages present? Are entry costs sizeable? And are transportation costs high?

The Conditions for Investment Multipliers to Exist

Judging from available data on consumption among rich and poor in the Guatemalan highlands (see Helms (1993)), expenditure elasticities are higher for non-farm than for farm products: the elasticities of total expenditures on furniture and equipment, and on clothing and footwear are around 1.2-1.3. The expenditure elasticity for transportation and recreation is around 2.0-2.1. In comparison, the expenditure elasticity for food and beverages is 0.8.

Demand linkages are present as well. Linkages between non-farm activities and the local economy are strongest through the generation of employment in the non-farm sector. Local manufacturing firms import much of their raw materials from outside the municipality but they use several of the more sophisticated services provided in Tejutla. Manufacturing, commerce and personal services also generate a derived demand for lodging, cafeterias, and transportation.

Ease of entry varies from one category of non-farm activities to another. Data collected in the municipalities show that commercial enterprises present a relatively easy access (Table 5). With the exception of a gas station in Tejutla which artificially raises commercial margins and fixed investment per commercial firm in that municipality, sales margins are low and commerce requires small investments in capital and skills. The sector caters predominantly to the poorer segments of the municipal market.

Manufacturing, in contrast, represents a significant challenge for potential investors. Relatively high capital and learning investments, sophisticated machinery, and high levels of competition with imports from outside the municipality make the sector difficult to enter. For instance, most manufacturers spend more than one year learning the trade as apprentices, and many travel outside the municipality for learning (Helms (1993)). This sector caters to those people in the municipality able to afford consumer goods beyond the basic food basket and is expected to react strongly to a generalized increase in municipal incomes.

The services sector is not homogeneous in terms of ease of entry. Some services, such as a cafeteria or a barber, require relatively low levels of investment in equipment and learning time. Other services, such as transportation, require a large physical capital investment, but rather low learning costs. In contrast, lawyers or dentists in the region incur comparatively high learning costs, but relatively low capital investments. Many service activities represent luxuries for local inhabitants and thus are sensitive to local demand conditions. To summarize, entry in manufacturing and many service activities requires sizeable investment and learning costs.

Road conditions between the three municipalities and the rest of the world are bad. Although the distances involved are small -- only 32, 36 and 61 Km. from Tejutla, Comitancillo and Concepcion, respectively, to the nearest town of San Pedro -- there are no paved roads. Given the mountainous nature of the terrain, roads are mostly impassable during the rainy season. Transportation costs for travelling between the municipalities and major towns are high, both in terms of fares and time spent in the process of travelling (Helms (1993)). Fares charged on various modes of transportation to the most common destinations range from Q10 to Q100 for a one person round trip ticket with one quintal of merchandise. This largely exceeds a day's wage, which ranges from Q5 to Q8. Prices charged by pickups for cargo within the municipalities equal or exceed the cargo rates charged by large trucks to the capital city. This reflects the heavy wear and tear suffered by small pickups on country roads. Because of poor road conditions, trips take an inordinately long time. The speed of travel from San Pedro (the nearest town) to the municipalities varies between 12 and 16 kilometers an hour during the dry season. This travel time, combined with time spent arranging transport or waiting for buses to leave, implies a significant transactions cost for doing business across municipal boundaries.

The Role of Local Demand

We have seen that the conditions for the existence of investment multipliers are all satisfied. Can we infer that municipal industrialization is explained by investment multipliers? To try to answer this question, we examine the size of the market for non-farm goods. Combining data from different sources, we construct estimates of income per head and aggregate consumption expenditures in the three municipalities (Table 6). Estimates show that, even though income levels are higher in Tejutla than in Comitancillo and higher in Comitancillo than in Concepcion Tutuapa, overall income levels are quite low. As predicted in section 3, town residents have higher incomes and are the main beneficiaries of successful rural industrialization. Yet, even an urban dweller in Tejutla (the highest income group) earns as little as 70 US dollars a month on average. Low income levels imply that the demand structure for average households in the three municipalities remains basic and that much of their demand could be met by local enterprises.

One may get a sense of the total size of the market for locally produced non-farm products by considering aggregate demand in each municipality. Table 6 shows that total demand is largest in Comitancillo, thanks to its larger population and its intermediate level of income per head. If the size of the local market is what determines the extent of industrialization, one would expect Comitancillo to be the most industrialized of the three municipalities. As can be seen from Tables 4 and 5, there are indeed more non-farm activities in Comitancillo than in poorer Concepcion Tutuapa. But Tejutla does not fit into this pattern. In spite of its smaller population and aggregate demand, it boasts a greater number and range of businesses than the other two municipalities: aggregate fixed investment in Tejutla is more than 6 times larger than in Concepcion Tutuapa, although aggregate non-farm demand is only 18% higher.

Table 6 provides a possible explanation. While differences in total demand across municipalities are small, differences in urban demand are large. Both aggregate non-farm investment and monthly sales of non-farm products turn out to be roughly proportional to *urban* consumption in each municipality. These findings suggest that urbanization *per se* may play a role in the industrialization process. Why could that be? One possibility is that town residents rely more on purchased goods and services than rural dwellers. If city dwellers' demand is more concentrated on manufactures, Murphy, Shleifer and Vishny (1989a) argue, multiple equilibria may arise in which industrialization favors urbanization and vice versa. Could this explanation apply to the Guatemalan highlands?

Perhaps. Even though the distance between the municipality town and neighboring villages is small, transaction costs nevertheless exist within the municipality itself. Residents of the local town find it easy to purchase non-farm goods produced locally, but rural residents face commuting costs to and from the municipality town. A way for them to save on these costs is to bundle purchases when they visit the town on market day, potentially generating congestion and driving prices up. Alternatively, they may emphasize home-made goods and services in their consumption basket, or acquire crafts and services from village-based, part-time producers.[19] Given that rural dwellings are dispersed, the volume of sales by village-based producers is probably too small to justify full specialization. The contrast between Tejutla and Concepcion Tutuapa could thus be understood as an example of multiple equilibria driven by urbanization: because more people in Tejutla live in the municipality town, there is more urban demand for non-farm

[19] In the absence of information on the origin of consumed goods, aggregate demand figures presented in Table 6 do not distinguish between home-produced goods, village crafts and services, and purchases from the municipality town. More empirical work is needed to clarify this issue.

products and thus more investment in specialized non-farm businesses. The development of non-farm production in turn attracts more urban investment and thus more urbanization. The situation is formally similar, although not identical, to that depicted in Figure 1: urbanization triggers a change in the composition of municipal demand in favor of industrially produced goods and services. If the shift in demand is sufficiently strong, it may be self-fulfilling. Whether this explanation is relevant for rural urbanization deserves more empirical research.

Close observation of the patterns of trade among municipalities suggests that other factors are at work as well. Municipal residents engage in trade among themselves and with other towns and cities through a system of rotating weekly markets. Table 7 presents the origin of products for sale on a typical market day. The data show that Tejutla and Comitancillo capture a larger share of their home market than does Concepcion. This finding is in line with the import substitution nature of much of municipal non-farm production and confirms that local demand matters. Exports matter too, however. Table 8 shows the origin of traders on a typical market day. The data indicate that a large proportion of market participants in Concepcion Tutuapa actually come from Tejutla. There are also a number of participants from Comitancillo in both Tejutla and Concepcion's market, but none from Concepcion in the other two municipalities. This can be interpreted as indirect evidence that Tejutla and, to a lesser extent, Comitancillo, export some of their products to Concepcion, but that the latter does not.

Combined with the fact that Tejutla is located on the road joining Concepcion Tutuapa to San Pedro, these findings suggest that the development of non-farm production in Tejutla has partly taken place at the expense of Concepcion Tutuapa. Tejutla's 'centrality' may have helped it capture a series of urban functions that it provides to its own population as well as that of Concepcion. These findings constitute indirect evidence that rural industrialization does not take place in isolation from what happens in neighboring towns and districts. Rural municipalities form a system that must be analyzed as a whole. Constructing models that isolate individual municipalities, as we have done here, may miss an important dimension of the industrialization process (see Fafchamps (1995)). Combining local investment multipliers with location effects will be the object of future research.

Conclusions and Prospect for Future Work

We have shown that non-homothetic preferences, intermediate input demand linkages, increasing returns, and transaction costs can combine to generate a multiplicity of Pareto ranked equilibria even in an open economy. These results extend previous work by Murphy, Shleifer and Vishny (1989a), Matsuyama (1992) and Ciccone (1993). Low equilibria resemble the Rosenstein-Rodin shoe factory parable and are consistent with Nurkse's (1952) aphorism "a country is poor because it is poor". In the presence of transportation and other transaction costs, investors may be discouraged from investing in places where people are poor, industrial activity is limited, and local demand is low. Because consumers' and investors' anticipations are mutually reinforcing, pessimistic expectations can result in a vicious circle of poverty. These ideas were formalized in two simple analytical models and further analyzed with the help of a simulation model.

We then turned to data on rural industrialization in three municipalities of the Guatemalan highlands. We argued that aggregate demand spillovers through a wage premium, as modeled in Murphy, Shleifer and Vishny (1989a), is not appealing as a model of rural industrialization and that non-homothetic preferences and input linkages are, *a priori*, a more promising avenue of enquiry. We noted significant differences across municipalities in the variety and extent of non-farm production. We found evidence of significant entry costs in manufacturing and certain services, and of large transportation costs across municipalities and between them and the nearest town. Yet there seems to be little relationship between the size of the non-farm market in the entire municipality, and the development of non-farm activities in the municipality town. Non-farm sales and investment appear closely linked only to urban incomes. Differences in aggregate municipal demand alone cannot, therefore, explain the observed pattern of rural industrialization. The urbanization process itself appears to favor a shifts toward purchasing non-farm goods and services instead of producing them at home or buying them from unspecialized, village-based producers. In the presence of transportation costs, the location of demand matters even within the municipality, and urbanization has the merit of concentrating demand in a single point.

The pattern of trade between municipalities further suggests that municipalities cannot be fully understood in isolation from each other. The central place theory argues that not all towns can be equally industrialized at the same time (Dicken and LLoyd (1990)). Activities that require large initial investments, the theory says, tend to be exclusively provided by more centrally located towns, leaving only activities with small fixed costs to peripheral towns and villages. One of the three Guatemalan municipalities seems to have fallen prey to such a mechanism. Extending our model to capture these phenomena will be the object of future research.

Appendix 1: Derivation of optimal output and profits

First, consider the case in which the industry is a net importer (Figure 2, point C). The optimal level of output and corresponding level of profit are:

$$Q_i^M = \frac{\alpha_i}{2w\ \theta_i}$$

$$\pi_i^M = \frac{\alpha_i^2}{4w\ \theta_i} - \bar{f}_i$$

Q_i^M is a constant and does not depend on local demand.

Next, consider autarky (Figure 2, point B). Output is equal to local demand D_i. Profit is thus:

$$\pi_i^A = D_i[\alpha_i - w\ \theta_i\ D_i] - \bar{f}_i$$

It is an increasing function of D_i as long as $\alpha_i > w\ \theta_i\ D_i$, which is always true in the autarky case (see Figure 2). The level of local demand $\bar{D}_i$ at which the industry switches from autarky to imports is $\frac{\alpha_i}{2w\ \theta_i}$.

Finally consider the net exporter case (Figure 2, point A). Optimal output and profit are:

$$Q_i^X = \frac{\beta_i}{2\ w\ \theta_i}$$

$$\pi_i^X = \frac{\beta_i^2}{4\ w\ \theta_i} - \bar{f}_i + 2\ \mu\ p_i\ D_i$$

Output is constant but profit increases with local demand. The level of local demand $\underline{D}_i$ at which the industry switches from exports to autarky is $\frac{\beta_i}{2\ w\ \theta_i}$.

Using the above results, it is easy to verify that profits increase linearly with local demand as long as the economy is exporting. In the autarky range, the rate at which profits increase in response to local demand decreases with the level of local demand.

Profits are not a function of local demand when the economy is net importer. Profits therefore increase with local demand up to the point where the economy becomes net importer. Beyond that point, they remain constant.

Appendix 2: Existence of Multiple Equilibria

For no output to be an equilibrium, the total demand for each good generated by agricultural and migration income Y alone must be lower than the minimum demand required to trigger entry, i.e.:

$$C_1(Y) < \underline{D}_1 \qquad \text{(a)}$$

$$C_2(Y) < \underline{D}_2 \qquad \text{(b)}$$

Suppose now that one of the two goods, say good 1, is produced. Denote the optimum level of output $Q_1^*(D_1)$ and the resulting profit $\pi_1(D_1)$. As we have seen, both are an increasing function of local demand, which itself is:

$$D_1 = C_1(Y + \pi_1(D_1))$$

Solving the above equation gives the equilibrium level of local demand D_1^* when industry 1 has entered. For it to be an equilibrium, it must be that:

$$C_1(Y + \pi_1(D_1^*)) > \underline{D}_1 \qquad \text{(c)}$$

$$C_2(Y + \pi_1(D_1^*)) + a_{21}Q_1^*(D_1^*) < \underline{D}_2 \qquad \text{(d)}$$

Finally, suppose that both goods are produced. The equilibrium final demand levels D_1^{**} and D_2^{**} can be derived by solving the following system of equations:

$$D_1 = C_1(Y + \pi_1(D_1) + \pi_2(D_2)) + a_{12}Q_2^*(D_1) \qquad \text{(e)}$$

$$D_2 = C_2(Y + \pi_1(D_1) + \pi_2(D_2)) + a_{21}Q_1^*(D_1) \qquad \text{(f)}$$

Equilibrium requires that $D_1^{**} > \underline{D}_1$ and $D_2^{**} > \underline{D}_2$. The three possible equilibria are illustrated in Figure 3. Point A corresponds to equilibrium 1 without entry. Point B is equilibrium 2 when only good 1 is produced. Both are locally stable. Point C is equilibrium 3 when production in industry 2 shifts the demand for good 1 to the right.

As long as both industrial goods are normal goods in final consumption, one cannot simultaneously have a fourth equilibrium in which only good 2 is produced. To see why, suppose such an equilibrium D_2^* did coexist in addition to the three others. This equilibrium would have to satisfy:

$$C_1(Y + \pi_2(D_2^*)) + a_{12} Q_2^*(D_2^*) > \underline{D}_1$$
$$C_2(Y + \pi_2(D_2^*)) < \underline{D}_2$$

Two cases must be considered, depending on whether $\pi_2(D_2^*) >< \pi_1(D_1^*)$. Suppose π_2 is greater. Then it must be that $C_1(Y + \pi_2) + a_{12} Q_2 < \underline{D}_1$ while at the same time $C_1(Y + \pi_1) > \underline{D}_1$, a contradiction since $\pi_2 > \pi_1$ and both goods are normal goods. Alternatively, suppose that π_1 is greater. Then we must have that $C_2(Y + \pi_1) + a_{21} Q_1 < \underline{D}_2$ while at the same time $C_2(Y + \pi_2) > \underline{D}_2$, an impossibility. A fourth equilibrium is thus ruled out.

Appendix 3: Equations of the Simulation Model

Price definitions:

$$p_i = \overline{p}_i(1 - \mu_i) \quad \text{for } i \in A$$
$$p_m = \overline{p}_m(1 + \mu_m) \quad \text{for } m \in M$$
$$p_f = \overline{p}_f(1 + \mu_f) \quad \text{for } f \in F$$
$$\alpha_i = p_i - \sum_j a_{ji}\, p_j \quad \text{for } i,j \in A,\ M,\ F$$
$$\beta_i = \overline{p}_i(1 - \mu_i) - \sum_j a_{ji}\, p_j \quad \text{for } i,j \in A,\ M,\ F$$

Agricultural production function:

$$Q_i = \delta_i \overline{K}^{1-\rho_i} L_i^d{}^{\rho_i} \quad \text{for } i \in A$$

Agricultural labor demand equation:

$$w = \alpha_i \, \delta_i \, \rho_i \, \overline{K}_i^{1-\rho_i} \, L_i^{d\,\rho_i - 1} \quad \text{for } i \in A$$

Income definition:

$$y_h = w \, L_h^s + \sum_i \Omega_{ih}(\alpha_i \, Q_i - w \, L_i^d) + s_h + \Phi_h \sum_m \pi_m \quad \text{for } i \in A, \; m \in M$$

Local consumption demand:

$$C_{ih} = \lambda_{ih} + \frac{\kappa_{ih}}{p_i}(y_h - \sum_j p_j \, \lambda_{jh}) \quad \text{for } i \in A, \; M$$

Domestic demand definition:

$$D_m = \sum_h C_{mh} + \sum_j a_{mj} Q_j$$

Optimal level of output if good is imported

$$Q_m^M = \frac{\alpha_m}{2 \, w \, \theta_m}$$

Optimal level of output if good is exported

$$Q_m^X = \frac{\beta_m}{2 \, w \, \theta_m}$$

Minimum local demand for investment if autarky

$$\underline{D}_m^A = \frac{\alpha_m - [\alpha_m^2 - 4 \, w \, \theta_m \, \overline{f}_m]^{\frac{1}{2}}}{2 \, w \, \theta_m}$$

Minimum local demand for investment if good exported

$$\underline{D}_m^X = \frac{-\beta_m Q_m^X + w \, \theta_m (Q_m^X)^2 + \overline{f}_m}{2 \, \mu_m}$$

Minimum local demand for investment

$$If(2 \, w \, \theta_m \underline{D}_m^A > \beta_m) \; then \;\; \underline{D}_m = \underline{D}_m^A \;\; else \;\; \underline{D}_m = \underline{D}_m^X$$

Output after entry

$$Q_m = Min\{Q_m^M, \, Max\{Q_m^X, \, D_m\}\}$$

Profit after entry

$$\pi_m = \beta_m Q_m - w\ \theta_m Q_m^2 - \overline{f}_m + 2\ \mu_m \overline{p}_m\ Min\{D_m, Q_m\}$$

Labor demand in industry:

$$L_m^d = \theta_m Q_m^2$$

Migration definition:

$$M_h = L_h^s - \sum_{i \in A} L_i^d - \sum_{j \in M} L_j^d$$

Balance of trade (holds by Walras Law)

$$\sum_{i \in A,M,F} (Q_i - D_i) + w \sum_h M_h + \sum_h s_h - \sum_{m \in M} \overline{f}_m = 0$$

Sets

A	set of all agricultural goods
M	set of all industrial goods
F	set of all intermediate inputs in agriculture (fertilizer only)

Variables

C_{ih}	consumption demand for good i by household h
p_i	consumption price of good i
y_h	income of household h
w	wage rate
L_h^s	labor supplied by household h
M_h	migration labor by household h
α_i	import price of good i net of intermediate input cost
β_i	export price of good i net of intermediate input cost
L_i^d	labor utilized in the production of good i
s_h	exogenous transfer to household h
π_m	profit in industry category m
D_m	domestic demand for industrial good m
Q_m^M	optimal level of non-agricultural output if good m is imported
Q_m^X	optimal level of non-agricultural output if good m is exported
$\underline{D}_m^A$	minimum local demand for investment to take place if autarky
$\underline{D}_m^X$	minimum local demand for investment to take place if exporting

$\underline{D}_m$	minimum local demand for investment to take place

Predetermined Variables and Parameters

$\overline{K}_i$	fixed factor of production -- i.e. land -- in crop *i*
$\overline{f}_m$	annual fixed cost in the production of industrial good *m*
$\overline{p}_i$	price parameter: average exogenous price for good *i*
μ_i	price parameter: transaction cost for good *i*
a_{ij}	input-output coefficient: quantity of good *i* to produce 1 unit of good *j*
δ_i	crop production parameter: multiplicative term
ρ_i	crop production parameter: share of labor
Ω_{ih}	share of profit generated by crop *i* going to household *h*
Φ_h	share of non-agricultural profits going to household *h*
λ_{ih}	demand parameter: required consumption of good *i* by household *h*
κ_{ih}	demand parameter: consumption share of good *i* for household *h*
θ_m	non-agricultural cost parameter: inverse of productivity of labor

Solving the model

The model is iteratively solved on a spreadsheet as follows. We begin with an exclusively agricultural economy and derive optimal agricultural output and non-industrial incomes Y_h for each household category $h \in$ {poor, rich, urban}. Agricultural output and non-industrial incomes are not affected by what happens in the industrial sector. We then compute aggregate consumption demand for each industrial good $C_i(Y)$ and compute for each sector the profits anticipated by myopic investors given current wage, prices, and final demand $C_i(Y)$. If profits are positive in a given sector, entry takes place and investment multipliers kick in: profits are distributed to consumers, final demand is recomputed, changes in intermediate demand are introduced, and anticipated profits recomputed. If more sectors decide to enter, we redistribute profits, and recompute demand and anticipated profits again. If a sector makes losses, we assume it exits. Iterating until no more sector enters or exits and anticipated profits equal realized profits yields a static Nash equilibrium. The solution of this iterative algorithm can also be construed as the outcome of a simple dynamic process whereby investors decide to enter or exit on the basis of actual demand.

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Table 4. Census of Economic Activity in the Three Municipalities

	All Municipalities	Tejutla	Comitancillo	Concepcion Tutuapa
Commerce				
Simple Store	106	54	28	24
Tavern	37	12	18	7
Grocery Store	18	9	7	2
Pharmacy	15	5	5	5
Agric. Supplies Store	6	6		
Corn Warehouse	3	3		
Bookstore	3	2	1	
Fabric and Clothing Store	3	3		
Hardware Store	1	1		
Gas Station	1	1		
Total Commerce	193	96	59	38
Manufacturing				
Cobbler	13	7	5	1
Tailor	20	3	12	5
Baker	15	7	5	3
Carpenter	11	5	4	2
Corn Mill	8	4	2	2
Tanner	5	5		
Butcher	3			3
Metal Mechanics	3	2	1	
Brick Factory	1		1	
Ice Cream Factory	1	1		
Marble Factory	1	1		
Total Manufactures	81	35	30	16
Services				
Cafeteria	25	12	6	7
Transportation	25	7	7	11
Radio and Watch Repair	9	3	3	3
Photographer	6	4	2	
Lodging	5	2	2	1
Typewriting Institute	4	2	2	
Barber	3	2	1	
Photocopies	3	3		
Lawyer	2	2		
Direct Mail USA	2	2		
Dental Clinic	1	1		
Leather Painter	1	1		
Beauty Parlor	1	1		
Veterinarian	1		1	
Total Services	88	42	24	22
Total	362	173	113	76

Source: Helms (1993)

Table 5. Sales, Margins, and Fixed Investment Levels ('000 Quetzales per month).

	Tejutla		Comanticillo		Concepcion Tutuapa	
	Average Per Firm	Aggregate	Average Per Firm	Aggregate	Average Per Firm	Aggregate
Sales						
Commerce	4.9	301.0	1.4	56.1	1.2	33.5
Manufacturing	2.8	97.1	1.7	52.0	0.8	14.9
Services	1.3	62.7	0.8	23.6	1.3	46.2
Total	2.7	460.8	1.2	131.7	1.2	94.6
Margins						
Commerce	0.9	54.0	0.3	10.2	0.2	6.0
Manufacturing	1.1	37.6	0.6	22.0	0.3	6.0
Services	0.5	33.9	0.4	12.4	0.7	24.9
Total	0.7	125.5	0.4	44.6	0.5	36.9
Fixed Investment						
Commerce	28.2	496.1	2.4	79.7	1.8	70.4
Manufacturing	10.7	449.6	5.6	118.4	4.2	64.3
Services	37.1	2,333.6	32.4	1,267.2	34.0	373.7
Total	18.9	3,279.3	13.0	1,465.3	6.7	508.4

Source: Helms (1993).