Beyond Rosenstein-Rodan:

The Modern Theory of Underdevelopment Traps

Karla Hoff

April 10, 2000

Abstract. The theme of this article is the importance – and the many causes – of *low-level equilibrium "traps."* Rosenstein-Rodan pointed out that spillovers may cause the return to an activity to increase with the number of others who undertake that activity. If spillovers are strong enough, both low- and high-level equilibria are possible, with no tendency of market forces to lead from the worse to the better state of affairs. This article shows how modern economic theory broadened our view of the sources of spillovers that could lead to "traps" with low innovation and inefficient institutions. Evidence from China is consistent with *local* underdevelopment traps. The article argues for an "ecological" perspective on development, where the influences from others in one's environment are a critical determinant of outcomes. This perspective provides the basis for the distinction between "deep" interventions, which change underlying forces, and "shallow" interventions, which do not.

Karla Hoff is a research economist at the World Bank. This article draws on Hoff and Stiglitz (forthcoming). The author would like to thank Irma Adelman for helpful comments, and Abhijit Banerjee, Arnold Harberger, Gustav Ranis, Debraj Ray, and Joseph Stiglitz for discussions of the issues raised in this article.

OUTLINE

Paul Rosenstein-Rodan (1943) famously argued that at an early stage of development, the investments of industrializing firms in one sector may increase the profitability of other sectors throughout the economy. Simultaneous industrialization of many sectors of the economy could be profitable for them all, even though no sector would be profitable industrializing alone. As a result, an underdevelopment trap was possible. Even the market mechanism need not succeed in coordinating the activities needed to ensure development.

In modern terms, there could be a *coordination failure*, where individuals' inability to coordinate their choices leads to a state of affairs that is worse for everyone than some alternative state of affairs that is also an equilibrium. The obstacle to achieving the better state of affairs is *not* a matter of technological opportunities (or even knowledge of those opportunities), nor resources or preferences, but *only* of coordination.

In the 1950s, the possibility of underdevelopment traps or "vicious circles of poverty" was elaborated on by many others (including Nurkse 1953 and Leibenstein 1957). But individuals are rarely convinced by those who do not address their concerns**.** Without a well-developed theory of the *sources* of externalities (spillover effects), the idea of an equilibrium trap had little influence on neoclassical economists of that period. They continued to use their models to argue that the market mechanism could coordinate

the changes needed for development (Krugman, 1992, 1995, and the comment by Stiglitz, 1992).

Advances in the last three decades in the modeling of externalities, technological progress, and scale economies have made it possible to provide formal models to capture Rosenstein-Rodan's insights. At the same time, information economics showed that neoclassical theory was based on a special case—perfect, costless information[1] – and its results on efficiency broke down as soon as one departed in almost any respect from that assumption. Before these theoretical developments, most economists thought that the implication of externalities was that the economy would be slightly distorted. But we now understand that the *interaction* of these slightly distorted behaviors may produce very large distortions.

Although it formalizes Rosenstein-Rodan's basic insight, modern work on coordination failures is very far from his original story in several respects.

- ***Remedies through international trade***. Rosenstein-Rodan [1943] was particularly concerned with income effects associated with increasing returns

[1] In this article, the term *neoclassical theory* is used as a short-hand for models that postulate maximizing behavior *plus* interactions through a complete set of perfectly competitive markets. This narrow definition is for convenience only. There is no consensus on the scope of the term neoclassical theory; it is sometimes (e.g., in Laffont 1989, p. 6) used broadly to include any "systematic exploration of the implications of rational behavior in economics." In that broad sense, all the models discussed in this article, except for one evolutionary model, are examples of neoclassical theory.

industries. In some cases, once an economy is opened to international trade, this argument loses its force, as Tinbergen (1967) pointed out early on.

- ***Channels of spillovers***. Whereas Rosenstein-Rodan focused on income effects, modern literature focuses on several other channels: spillovers present in the technology of the individual agent, spillovers when agents come together through a search process, spillovers in purely price-mediated interactions, and informational externalities. These spillovers can give rise to a wide range of "traps" (coordination failures) – for example, low-investment traps, high interest rate traps, predation, corruption, crime, low trust equilibria, inefficient ownership structures, dualism, business cycles, and "standard" securities (whose design may not respond to changes in the environment).[2]
- ***Role of government***. Rosenstein-Rodan argued that there could be coordination "from above" where government planned the process of industrialization. In contrast, most recent scholars recognize that there is no such thing as coordination "from above" because government is itself part of the endogenous set of institutions to be explained. Even in democracies, governments fail, just as markets do.[3] But a positive development that has

[2] Sources include Azariadis and Drazen 1990 (low investment in human capital), Piketty 1997 (high interest rates), Murphy, Shleifer and Vishny 1993 (predation), Tirole 1996 and Bardhan 1997 (corruption), Glaeser et al. 1996 (crime), Zak and Knack 1998 (trust), Hoff and Sen 2000 (the structure of ownership),Acemoglu 1996 (training and innovation), Kranton 1996 and Banerjee and Newman 1997 (informal exchange networks), Gale 1992 and Reding and Morales 1999 (standard securities and currency substitution), and Cooper 1999 (who provides many applications, including business cycles and examples from experimental economics).

[3] Besley and Coate (1998, pp. 151-152) provide a definition of *political failure* that is parallel to that of *market failure*. One begins in each case by defining the set of technologically feasible utility allocations. For the case of political failure, this reflects the available policy instruments, e.g. taxes, transfers, and investments. Political institutions are then modeled. By analogy with

emerged in recent years is to try more limited interventions to harness the spillovers among agents, and to try to design sequences of policy reforms that will make it more likely for "good" equilibria to emerge.

The goal of this article is to show how developments in economic theory in the last 30 years broadened our understanding of the channels of spillovers, and made possible a new understanding – which we call the "ecological perspective" – of pitfalls and opportunities in the development process. We emphasize three developments in modern theory: institutional economics, path dependence, and a radically broadened view of externalities and public goods.

The Place of Coordination Failures in Modern Economic Theory

Neoclassical theory and the Coase theorem

Neoclassical theory—as we use the term here – was the central economic paradigm until the mid-1970s. It studies price-mediated allocations in a setting of "complete markets." There is a market for all commodities that are, or could be, produced. The "virtual" prices ensure that every set of actions whose social benefits exceed their opportunity costs is undertaken.

We were always told that such models served only as a benchmark. Neoclassical economists recognized that their models did not take account of direct interdependencies among individuals that were not mediated through markets (e.g., Pigou's polluting

---

market failures, a *political failure* arises when equilibrium policy choices result in an outcome where it is technologically feasible (given available tax and transfer instruments, information,

factories). But by and large, they believed that these were relatively unimportant and that interdependencies that were mediated through markets (pecuniary externalities) did not have efficiency effects (for example, Mishan 1971, Cheung 1973).[4]

In an extension of neoclassical economics, Coase [1960] argued that when an economy departed from the complete markets assumption of neoclassical theory, private agents would negotiate to efficient outcomes. In that tradition, North and Thomas (1973) in their economic history of the West *(The Rise of the Western World*), argued that the institutional changes in the West, 900-1700, were driven by changes in relative scarcity values of products and factors; as with competition among firms in neoclassical economics, superior institutions ultimately eliminated inferior institutions.

Institutional economics outside of the "straitjacket" of neoclassical economics

Another strand of the literature, however, recognized that markets were inherently limited by problems of information and enforcement.[5] There could never be the complete

---

etc.) to implement a Pareto-improving policy, but that policy will not be an equilibrium choice.

[4] It is true that in an economy with a complete set of markets, it is efficient to ignore pecuniary external effects. Such effects affect only distribution, and the distribution effects "net out": gains by agents whose prices increase are precisely offset by losses to agents who must pay higher prices. There are no welfare losses from the allocation effects of price changes because equilibrium prices always are equated to marginal social costs and benefits. However, in economies with incomplete markets, pecuniary externalities generally do not net out. A general framework is Greenwald and Stiglitz (1986). One application of that idea (Hoff 1998) shows that in an economy where lenders cannot distinguish borrowers who differ in their probability of default, pecuniary externalities from an improvement in technology can dissipate some, all, or more than all of the gains from the technological change. The reason is that the marginal firm may be the lowest quality; if so, he produces negative expected value (getting an implicit subsidy from the lower risk , higher quality borrowers). As the technological change induces new entry of marginal borrowers, the interest rate rises to reflect their lower average quality, which hurts all borrowers and leaves banks, as before, just breaking even.

set of markets in goods, risks, and futures on which the efficiency results of neoclassical theory rest. Non-market institutions arise in response to limits on markets, but there need be no forces that ensure efficiency.

This can be put another way. Individual actions that are privately rational given the environment that individuals are in, need not be socially rational. There might be another set of individual actions that would create a *different* environment, within which a different set of actions would be an equilibrium, and that environment might be a better state of affairs for all concerned. There could be multiple equilibria in institutions and no presumption that the best equilibrium was selected by market forces.

This can be illustrated in a simple way (following de Meza and Gould 1992). Suppose that the state defines property rights, but that with respect to a certain resource (e.g., forests), an individual must incur a fixed cost (e.g., to build a fence or hire a patrol service) to enforce his property right. Without this private expenditure, all other individuals will be able to freely use his private forest. The benefit to an owner from enforcing his property right is that he can hire labor to exploit his forest and collect the resource rents. Thus, in deciding whether to enforce his property rights, an owner

---

[5] Whereas most authors are associated with one strand or the other, it is striking that North's work helped to advance both. North's early work, which one might call "North I", was in the Coasean tradition and pioneered its application to economic history. North's later work, which one might call North II, disparages the prospects for understanding economic history as a more or less inevitable movement towards more efficient institutions: “Throughout most of history, the experience of the agents and the ideologies of the actors do not combine to lead to efficient outcomes” (North 1990, p. 96; see also North 1994). I owe to North (from his comments at a conference in May 1999) the metaphor of the straitjacket.

compares his potential rents to the enforcement cost. These rents will be larger, the lower the reservation wage of workers. In equilibrium, the reservation wage of workers depends on how many other owners are enforcing their property rights. As the fraction of property owners who enforce their rights increases, the outside opportunities of workers fall and, thus, so does the reservation wage. With lower wages, potential resource rents rise. Two stable equilibria may therefore exist, one in which all owners enforce their property rights, wages are low, and rents are high; and another one in which none do, wages are high, and potential rents low, so that it does not pay any owner to enforce his property right. See Figure 1.[6]

As Coase [1937] emphasized, when enforcement of private property rights is costly, a market may or may not be the best allocation system. But as Coase did not recognize, whatever the best allocation system is, a decentralized economy may not reach it.

A very general insight of recent theoretical work is that while institutions may have, as their intention, the improvement in economic outcomes, there is no assurance that that will be the case. Institutions may be part of an equilibrium, and yet be dysfunctional. For example, Arnott and Stiglitz [1991] consider the consequences of the social institutions that arise as a result of the incomplete insurance provided by markets because of moral hazard problems. They show that informal social insurance may crowd out market insurance and lower social welfare. Developing countries may be caught in a

[6] Formally, suppose each resource owner who enforces his property rights hires L workers, and the value of their output is F(L). His rents are thus $F(L) - w(x)L$, where w is the wage function, which decreases with the fraction x of resource owners who enforce their property rights. Let the enforcement cost be C. There are two equilibria if $F(L) - w(1)L > C > F(L) - w(0)$.

vicious circle in which low levels of market development result in high levels of information imperfections, and these information imperfections themselves give rise to institutions—for example, informal, personalized networks of exchange relationships (Kranton, 1996) —that impede the development of markets. Banerjee and Newman 1997 show that dualism – the idea that market forces play out in one sector but not in another—can be explained as the consequence of a self-sustaining network. Dualism may be one equilibrium among several.

A further implication of the modern theory of coordination failures is that improvements in any existing set of institutions—"good mutations"—may not survive on their own if they require accompanying changes in other social institutions (Greif 1997). "If the institutional matrix rewards piracy, then [only] piratical organizations will come into existence..." (North, 1994, p. 361).

Path Dependence

Recent historical accounts go beyond the observation that there are multiple equilibria and show that economic outcomes exhibit path dependence. Moreover, temporary shocks can have longlasting effects—there is *hysteresis.*

The distribution of wealth in the past is one of the most important channels through which history can have potentially large, permanent effects. The literature on this nexus is much too extensive to cite. Here we summarize a few central ideas. One line of thought emphasizes political influences. Engerman and Sokoloff (1997), for example, find that

the historically highly unequal distribution of wealth in the colonies of the Americas that practiced plantation agriculture had longlasting effects through the legal, educational, and political institutions that were adopted. Another line of thought, summarized in Hoff (1994), shows that agency costs in credit and labor markets depend on the distribution of wealth; individuals with little or no wealth may have no access to credit and face limits on the kinds of labor and land rental contracts that they can enter into. Through this means, the impact of a given initial distribution of wealth may affect wage rates, interest rates, investments, and bequests and may persist indefinitely over time (Banerjee and Newman, 1993 and Mookherjee and Ray, 1998, 1999).

History also affects outcomes by affecting beliefs. An obvious case is where expectations are (at least partly) adaptive: individuals expect people to behave in the future as they have in the past. But even with fully rational expectations, history can cast a long shadow. A simple example, based on Tirole (1996), concerns corruption. Suppose that each individual's past behavior is observed imperfectly. Thus the reputation of a each individual member of a group (e.g., an employee in an organization, a firm in an industry) depends on not only his *own* past behavior, but also the *group*'s past behavior. The revelation that an industry or organization was corrupt in the past will *increase* the time it takes for any given individual within the group to establish a reputation for honesty. This will *lower* his incentives to be honest. And thus a history of corruption can raise the incidence of corruption in the future above the level it would have been if individuals did not suffer from the "original sin of their elders." There is hysteresis.

A radically broadened view of externalities and public goods

Coase himself recognized the limits imposed by transaction costs, but many of his followers did not. They tended to argue (counter the view in Rosenstein-Rodan) that real-world externalities were hard to find. In the 1970s, the iconic example of externalities was still Meade's apple farmer and the beekeeper (who each provide "unpaid factors" to the other). Cheung (1973) showed that contracts internalized these externalities. The iconic example of public goods were lighthouses. Coase (1974) showed that throughout history, private arrangements had developed to address this problem, too.

Modern theory, in contrast, suggests that those working in the Coase tradition were looking for inefficiencies *in the wrong place*. The iconic examples of technological externalities--the pastoral examples and the lighthouses, as well as many others emphasized by Chandler's history of American business--*are* ones where the "unappropriated benefits" can be internalized through private arrangements. Such private arrangements include mergers, which change the boundary between what is transacted in the market and what is transacted within the firm. But there are many other externalities not amenable to easy solution. They include information externalities, group reputation effects, agglomeration effects, and knowledge spillovers. They also include pecuniary externalities (Newbery and Stiglitz 1982, Greenwald and Stiglitz 1985). Pecuniary externalities often look analytically like externalities of the familiar technological sort. Recall the example above on property rights, where as a larger number of people fenced

in their forests, the return to fencing went up. In that example, the spillover effects were transmitted *only* through the change in the wage rate.

Modern theory radically broadens our notion of spillover effects. It shows that there are many cases where even the price vector can be viewed as a public good. In such cases, the price vector is not a deterministic outcome that one can mechanically derive from supply and demand functions. Instead, each individual's choices in a society may contribute to a better or worse equilibrium price vector. There are multiple, Pareto-rankable equilibria. In one equilibrium, the price system points the way to an efficient outcome, better for everyone than the alternative equilibrium outcomes; but there are other equilibrium prices that do not.

"Ecological Economics"

Whereas neoclassical economics emphasizes the forces pulling toward equilibrium—and with similar forces working in all economies, all should be pulled toward the same equilibrium, modern development economics focuses more on evolutionary processes, complex systems, and chance events that may cause systems to diverge. Thus, it tends to be influenced more by biological than physical models. Near the end of the *Origin of Species*, Darwin (1859) wrote, in thinking about the Galapagos Islands:

> [The plants and animals of the Galapagos differ radically among islands that have] the same geological nature, the same height, climate, etc…. This long appeared to me a great difficulty, but it arises in chief part from the deeply seated error of considering the physical conditions of a country as the most important for its inhabitants; whereas it cannot, I think, be disputed that the nature of the other inhabitants, with which each has to compete, is at least as important, and generally a far more important element of success (p. 540).[7]

[7]Darwin (1859) devotes two chapters, XII and XIII, to this idea.

The economy is like an ecosystem, and Darwin was implicitly recognizing that ecosystems have multiple equilibria. Far more important in determining the evolution of the system than the fundamentals (the weather and geography) are the endogenous variables, the ecological environment. Luck—accidents of history—may play a role in determining that and, thus, in the selection of the equilibrium.

The table tells the main story of the change between the old and new views of spillover effects. From these spillover effects, it is easy to formulate models with underdevelopment traps. We elaborate on these examples in the next section, and present an empirical test for farm households in rural China in the following section.

Old and Modern Views of Externalities and Public Goods

	Old view: Iconic examples	***"Ecological" view***
Externalities	Beekeepers and apple farmers Polluting factories	Pecuniary externalities in: • the enforcement of property rights • the definition of goods (qualities) • ownership structures • demand effects on nontradeables produced with increasing returns Search externalities Externalities in contract enforcement
Public goods	Lighthouses	The price vector Group reputation

		Knowledge (e.g., that a certain technological result is feasible)

Some examples of underdevelopment traps

Among the many models of traps in modern theory, three major ones stand out--those relating to direct spillovers in technology or ideas, those relating to expectations of behavior, and those relating to the thickness or size of the market. We discuss examples of each kind.

Direct externalities in innovation: A low R&D trap

One way to view R&D is that it transforms a set of known facts and accepted principles into a potentially profitable new application. The expected return to an investment in R&D is increasing in the stock of ideas that are in the public domain. If some part of the outcome of private research seeps into the "local public pool," then the more private research that is conducted, the larger the pool of ideas upon which each producer in the community draws. (We assume costs of communication delimit the scope of communities.) With a richer stock of ideas, the incentive of each producer to undertake R&D rises.

To analyze this situation, consider a simple model in which the profit (utility) of any producer (all producers are assumed identical) depends on prices, his own level of R&D (his action a^i, which can be any value between 0 and 1) and the level of R&D of all others (their action a). Since we will be concerned here only with the set of symmetric equilibria, we consider only the case where all other producers choose the same action.

Thus, we write the profit function as $U^i(a^i ; a, p(a))$, where p is the price vector (which itself depends on the vector of actions of the agents). Assume for each agent decreasing marginal returns to an increase in the level of his action. Each agent chooses its action to maximize its utility, given the actions of others. (Each agent is small enough that there are no strategic interactions, and it ignores its effect on p). The reaction function

(1) $u^i_1(a^i; a, p(a)) = 0$

characterizes the action that the representative agent i will take for all possible values of a selected by the remaining actors. u^i_1 represents the partial derivative of u^i with respect to the first argument a^i. (1) states that, given a, the agent cannot obtain a higher payoff by a marginal change in the level of his action. Figure 2 depicts the case where a higher action a by all other agents will lead the remaining agent i to follow suit. A higher action by other agents increases the marginal return to higher action by each. The actions of different agents are *complements.*

The interior, symmetric equilibria are values of a* that solve the equation:

(2) $u^i_1 (a^*; a^*, p(a^*)) = 0$

Figure 2 illustrates a low-level equilibrium trap at $a^{*\prime}$ and a stable high-level equilibrium at $a^{*\prime\prime\prime}$. When others do little R&D, it does not pay any firm to do much R&D, but a

shock that changes the level of R&D by each firm to a level even slightly above a*″ will generate a discontinuous response that shifts the equilibrium to a*‴.

A self-sustaining set of institutions

The literature on equilibrium traps is not only about the *level* of activities (more or less R&D or more or less investment) but also about the *kinds* of behaviors and institutions that individuals adopt. Do individuals behave bureaucratically or do they seek out innovations? Do they become producers or predators? Do they rely on informal arrangements to enforce contracts, or not? In each of these cases, an individual's relative gain from whatever choice he makes (as compared to the alternative) may depend on the number of other individuals that make the same choice, as we show in three examples.

Bureaucrats and innovators. Sah and Stiglitz [1989] formulate a model of societal equilibrium in which individuals can choose to behave "bureaucratically" or "innovatively." Bureaucrats make life for innovators more difficult, and conversely. Let x be the fraction of the population that chooses to be innovative. Let U(I; x, p) be the utility associated with the innovative strategy, and let U(B; x, p) be the utility associated with the bureaucratic strategy. Each individual chooses the activity that yields him the greater utility, taking x and p as given, where p is a function of x: p= p(x). Then it is easy to see that there may be multiple equilibria. If most people choose to behave bureaucratically, then it may pay only a few people to behave innovatively, and conversely. An interior equilibrium (where x is between 0 and 1) is a fraction x* that solves the equation

$$U(I; x^*, p(x^*)) = U(B; x^*, p(x^*))$$

Equilibria also may exist where all agents make the same choice, one entailing bureaucratic behavior if

$$U(I; 0, p(0)) < U(B; 0, p(0)).$$

and another entailing innovative behavior if

$$U(I; 1, p(1)) > U(B; 1, p(1)).$$

A slight variant of this model can be used to explore evolutionary dynamics. Assume that rather than the individual's *choosing* to be either innovative or bureaucratic, differential reproductive rates are a function of utility levels, so that

$$d \ln x/dt = k [U(I; x, p) – U(B; x, p)]$$

for some positive constant k. Then the set of equilibria will be the same as before, and the equilibrium upon which the economy converges depends on its history. Historical events—e.g. the opening of a country to international competition that differentially hurts "bureaucratic" firms—may move the economy from one equilibrium to the other, thereby affecting the long-run rate of technological progress.

Rent-seekers, cash crop producers, and subsistence producers. A variant of the preceding model, in Murphy, Shleifer, and Vishny [1993], focuses on rent-seeking by government officials. The model sheds light on why some countries fail to develop at all when rent-seeking (predation) makes property insecure. Consider a farm economy in which each individual chooses to engage in one of three activities. He can produce a cash crop for the market, but the output from the activity is vulnerable to rent-seeking. Or he can produce a subsistence crop, in which case his output is not vulnerable to rent-seeking. Or he can be a rent-seeker and expropriate part of the output of the cash crop producers. An equilibrium is an allocation of the population among the three activities. Suppose that, over some range, as more resources move into rent-seeking, returns to cash crop production fall faster than returns to rent-seeking do. As a consequence, the returns to rent-seeking *relative* to production for the market increase. This can give rise to multiple equilibria. An economy can be trapped in an equilibrium where the fraction of cash crop producers is low and returns to such production are low *because* the fraction of rent-seekers is high. But there is another equilibrium where the reverse is true.

Individualistic versus collectivist enforcement. Most development economists are agreed now that among the most important set of institutions in an economy are those that provide for the enforcement of contracts. Greif [1994] examines the cultural factors that might explain why two pre-modern societies (the Magribi in North Africa and the Genoese) evolved along different trajectories of societal organization. To illustrate the main ideas, he presents a model in which there are two kinds of actors: merchants and

agents. Agents carry out overseas trade on behalf of the merchants, and make one choice: to be honest or to cheat the merchant. A merchant also makes one choice: to rely on collectivist or individualist means to punish cheaters. Under *collectivist* enforcement, a merchant refuses to hire an agent who is known to have cheated *any* merchant in the collective group. Under *individualist* enforcement, a merchant punishes only agents who have cheated him. Greif shows that if a merchant believes that collectivist enforcement is likely to occur, then it may not be in his interest to hire an agent who is known to have cheated other merchants. That makes such expectations *self-fulfilling*.

The intuition for this result is straightforward: an agent who already has damaged his reputation has little to lose by cheating again, and so he will be more easily tempted to cheat his current employer than would an agent with an unblemished reputation. That makes the agent who has already damaged his reputation by cheating an undesirable prospect to hire. On the other hand, if the merchant believes that individualist enforcement will occur, then the motive for collectivist enforcement is absent. Thus, two equilibria, one entailing collectivist enforcement and the other individualist enforcement, may exist. The equilibrium that is "selected" will depend on beliefs (culture).

In the short run, reliance on individualist enforcement will be more costly since it forgoes the stronger, group-level punishment mechanism. But in the long run, individualist enforcement will strengthen the forces contributing to the emergence of state-level mechanisms to enforce contracts and adjudicate conflicts. By facilitating the

widening of markets and anonymous trades, such institutions, in turn, tend to promote long-run growth. Greif [1994] interprets the history of the West in just such terms.

The structure of ownership. Whereas many writers in the Coase tradition have empahsized that, once one took account of transactions costs, private negiations would lead to an efficient ownership structure. (A modern, qualitied statement is Grossman and Hart, 1986.) This implication, however, may break down when the ownership structure has spillovers for others. Hoff and Sen (2000) examine a simple setting where owners of residential property negotiate with would-be residents. Each would-be resident household chooses between home-owning or renting the residence, knowing that only as a homeowner will the household have incentives to expend effort in maintaining the property. Surplus is created when homeowners (rather than absentee landlords) expend effort in maintenance. But for low-income households, imperfections in the credit market mean that there is a cost to homeownership: the real interest rate for borrowers is higher than for that for savers. In choosing whether to rent or purchase their residence, a household compares the benefit of the expected surplus (the appreciation in the value of its home) with the transaction cost of borrowing. An improvement by one homeowner unavoidably increases the value of the parcels owned by others in the neighborhood. Thus, one impact of a larger number of homeowners in the neighborhood is that the return to homeownership increases. When these spillover effects are strong enough, Hoff and Sen show that there may be multiple equilibria in the critical level of income above which an individual will choose to become a homeowner.[8]

[8] There are two interpretations of the model. The one we describe here focuses on equity investments by residents. An alternative interpretation focuses on equity investments by

As illustrated in Figure 3, there may exist a low-level equilibrium trap where a minority fraction $x^{*\prime}$ of individuals buy equity in their homes and put in high effort, the resulting local spillovers are low, and this supports the majority decision to stay with a rental contract and expend low effort. Only individuals with income at or above the critical level $y^{*\prime}$ become homeowners. On the other hand, when a majority fraction $x^{*\prime\prime\prime}$ of individuals in the neighborhood are homeowners, they generate the higher level of local spillovers that makes that better state of affairs a stable equilibrium. The critical income level falls, respectively, to $y^{*\prime\prime}$ or $y^{*\prime\prime\prime}$.[9]

A further consequence of spillovers among homeowners is that when the neighborhood composition is endogenous, one may see the agglomeration of homeowners. Even if the poor do not have different preferences for housing than the rich and even if they internalize externalities no less than the rich do, rich and poor households may live in communities that exhibit very different characteristics--the rich in a community with high levels of homeownership and high levels of home maintenance, and the poor in a community with low levels of both. In this and in other cases discussed in Durlauf (1996a), the magnification due to interaction effects may be compounded by

---

entrepreneurs. The model is a kind of parable of capitalism, where private ownership of capital (homes by residents, firms by entrepreneurs) energizes an economy and yet, because there are spillovers across agents, it is not the only equilibrium state of affairs.

[9] Formally, let F(y) be the fraction of households with income below y. Then an equilibrium is defined by a critical income level y* above which a household chooses to become a homeowner, and a fraction x* of households who are homeowners, such that $1-F(y^*) = x^*$. Equivalently, $F^{-1}(1-x) = y^*$. A stable equilibrium is one where the $F^{-1}(1-x)$ curve cuts the y* curve from above, so that for perturbations in expectations below (above) x*, the actual income level is greater (less) than the critical income level. We discuss the equilibrium concept in the appendix.

the endogenous formation of interaction groups. Local poverty traps can be *self-organizing*.

"Big Push" theories of industrialization

As modern theorists have emphasized, the relevance of models of complementarities rests, in general, on *diffuse externalities*. For if externalities were not diffuse, negotiation among the affected parties-- including mergers among firms -- should internalize them. In the process of industrialization, channels of diffuse interaction effects include demand effects, spillovers from human capital accumulation, and search costs.

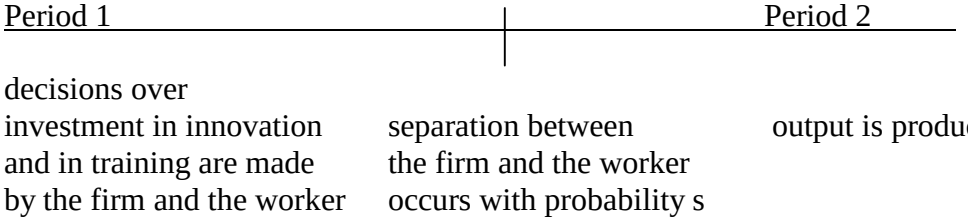
The modern theory of traps based on demand effects depends on two factors: scale economies and some nontradable input into production. For example, if intermediate goods are nontradable (they cannot be imported), then increasing returns in their production can generate external economies at the level of final (tradable) goods. An expansion of industry in an economy increases the demand for these nontradable inputs, which lowers their average costs and increases the available variety. With greater variety of intermediate inputs, production of final goods may be more efficient (e.g., computer technicians who specialize in particular programs can troubleshoot problems faster than generalists). It can thus be the case that when all other sectors industrialize, it pays the remaining sector to do so, but when all other sectors use a traditional technology that does not require intermediate inputs, it pays the remaining sectors to do so, too. An underdevelopment trap can thus be sustained even when the economy is fully open to

international trade [Helpman and Krugman 1985, ch. 11; Rodríguez-Clare 1996; Rodrik 1996].

There are a variety of ways one can think of the nontradable inputs. One way is that they represent different categories of specialized skilled labor, e.g. computer technicians and software designers. As Rodrik [1996: 2] argues, "A worker's decision to invest in a specialized skill depends both on the demand for the particular skill and the existence of complementary skills in the economy." But this example raises the question, why can't a single firm train the labor force it needs and thereby internalize the externalities among the decisions of employees and between their decisions and those of the firm? Acemoglu (1997) suggests a reason. He shows that even perfect contracting *within* a firm and perfect capital market may fail to internalize the social consequences of the decisions made by workers and firms. His explanation relies on *search costs.*

Acemoglu's model has two kinds of actors: firms, which may adopt new technology or not; and workers, who may become trained to use the new technology, or not. A worker's investment in training pays off only if he is employed by a firm that has innovated; and a firm's investment in innovation pays off only if it employs a worker that is trained. There are a large and equal number of firms and workers. Each firm employs just one worker. There are two time periods. In the first period, a firm is matched with one worker, they jointly make decisions over training and innovation, and there is complete contracting between them, i.e., no information problems or transactions costs. At the end of the first period, there is some risk of separation. If separation occurs, a firm

has to find a new worker, and a worker has to find a new firm. In the second period, output is produced. The time line is illustrated below:



If there were no search costs in the labor market, separation between a firm and employee would not create a loss. If separation occurred, the worker would simply move on to another firm that had adopted the new technology, and all the surplus from training and investment would be captured by the firms and workers who made the investments. But suppose that search is costly. With costly search, matching will be imperfect. There is no guarantee that the firm with the investment in the new technology will be matched with the worker who has the training.

For simplicity, assume the matching process is random (but any assumption short of costless, perfect matching would serve, too). Then the probability of a good match is the proportion ϕ of firms with the new technology (which is equal to the proportion of the workers who are trained). From the perspective of the firm and its worker making their investment decisions in period 1, the combined returns from training and innovation at a present value cost C are equal to $-C + [1-s]\alpha + s\phi\alpha$, where s is the probability of separation and α is the payoff to the new technology (with $\alpha > C$). This says that with probability 1-s, the pair do not separate and so they capture the return α on their

investment. With probability s, the pair separate and thus the expected combined return on their investment is only $\phi\alpha$.

By substituting $\phi = 1$, we can see that an equilibrium where all firms innovate and all workers are trained exists: the private returns to training and investment are positive. By substituting $\phi = 0$, we can see that an equilibrium without training and innovation may also exist. The combined expected gains to the firm and worker from innovation and training when no one else adopts the new technology are only $[1-s]\alpha - C$, which will be negative if the probability of separation, s, is sufficiently close to one. In this example, therefore, *a possible equilibrium is no innovation and no training in the economy*. Another consequence of costly search, which we do not develop here but which Acemoglu develops, is that there is imperfect competition in the labor market. This depresses the worker's return to training, which further erodes his incentives to train.

To recapitulate, the reason for the multiplicity of equilibria is that a firm's likelihood of finding the right worker depends on the *thickness* of the market (the number of trained workers). And the worker's likelihood of finding the right employer also depends on the *thickness* of the market provided by firms who have adopted the new technology. Of course, without a risk of separation (s=0), there would be no inefficiencies since there would be no interactions with future employees or employers. The inefficiency arises because of an externality between the worker and his *future* employer, and between the firm and its *future* employee, which cannot be internalized because the identity of the actor with whom one may be matched is unknown.

In contrast, Rosenstein-Rodan identified the obstacles to training only with incomplete contracting between a given firm and his employee: "There are no mortgages on workers--an entrepreneur who invests in training workers may lose capital if these workers contract with another firm" (1943, p. 205). This imperfection is not necessary to generate inefficiency, and with the imperfections of search and competition modeled in modern theory, multiple equilibria, each of which may be inefficient, are possible.

An Econometric Test:

Local poverty traps among farm households in China

Formalizing the idea of underdevelopment traps has led to testing. It is beyond the scope of this paper to review that literature.[10] Instead, we present the results from just one test, using Chinese census data, based on Jalan and Ravallion (1998) and Ravallion and Jalan (1996, 1999). China provides a good place to examine the theory for several reasons. Because the law severely limits geographic mobility in China, and there is also limited mobility of capital, factors move little in response to differences in opportunities across regions. One can thus treat the assignment of households to particular counties as random (not the result of self-selection), and view each household's investment opportunities as a function of its own local opportunities. Further, there are remarkable geographic differences in levels of living and in growth rates within China. For example,

[10] Examples from this literature are Azariadis and Drazen 1990 and Easterly and Levine 2000, who provide evidence for underdevelopment traps based on cross-country growth patterns, and Glaeser et al. 1996, who provide evidence of social interaction effects in cross-city crime levels.

one finds a rural poverty rate in the inland mountainous province of Guizhou in 1990 that is 7-10 times higher (depending on the poverty line) than in the neighboring coastal province of Guangdong, only a few hundred kilometers away.

The data are from a six-year panel of 5,600 farm households in southern China over 1985-90. Jalan and Ravallion estimate two models, which are derived from optimizing behavior.[11] The first is a simple expository model where the only two variables that matter for the consumption growth rate of a household are initial household wealth per capita (HW) and mean wealth per capita in the county of residence (CW). The estimated equation for the growth rate, g, is (t-ratios in parentheses):

(3) $g = -.143 - 0.0166 \ln HW + 0.0378 \ln CW$

(5.61) (5.91) (8.13)

The results indicate that in counties where average wealth is higher, average growth of household consumption is higher. Thus, there is divergence over the 6-year period of the survey. Jalan and Ravallion interpret this result to mean that an increase in the average wealth of the *county* increases the marginal return to *own* household wealth. This is due entirely to geographic externalities, rather than increasing returns to own wealth at the farm-household level, since the negative coefficient on HW implies that there are

---

[11] The key equilibrium condition equates the intertemporal marginal rate of substitution with the marginal product of 'own capital', which is a function of the initial endowment of own capital and the amount of community capital. The econometric analysis then tests the hypothesis that this function is decreasing in own capital and increasing in county capital. The estimation method

decreasing returns to capital within households. Within the model, the results suggest that a high level of household wealth in a high-wealth region can have the same marginal product as a low level of household wealth in a low-wealth region.

We illustrate these results in Figure 4. Let *K* denote the household's capital stock, and $\overline{K}$ denote the average household capital stock in the county. The econometric results suggest that marginal productivity function is downward sloping with respect to own capital, and shifts up with an increase in the average level of capital in the county. (Ignore points 1 and 2 in the figure for now.)

Figure 5 graphs the equation g = 0; that is,

(4) $g = -.143 - 0.0166 \ln HW + 0.0378 \ln CW = 0$

and also plots the actual values of household wealth and county wealth from the survey. Notice that every household is near the critical line. (The reader may check his understanding of the graph by noting that a typical household whose per capita wealth is ln 6 yuan will enjoy rising or falling consumption over time, respectively, as the household lives in a county with per capita wealth lower or greater than ln 6.5 yuan.) It is clear from the plot that there is a large subset of the data for which county wealth is too low, given household wealth, to permit rising consumption. Spillover effects appear to be large enough to generate poverty traps.

---

controls for latent household and geographic effects in consumption growth rates at the level of

We now use Figure 4 to illustrate the possibility of dual equilibria. For this purpose, it is useful to make the simplifying assumption that every household in a county is identical, so $K = \overline{K}$. Point 1 is an underdevelopment trap where household capital is low and the returns to new investment are low *because* others' capital is low. But there is another equilibrium at point 2 where the reverse is true.

The richer model that Jalan and Ravallion estimate does not use county wealth but instead the detailed county-level variables listed in the table. The table shows their main results (dummies for county, period, mountains/plains, coastal/inland, etc. are deleted).

Geographic variables	**Coefficient estimate**	**t-ratio**
Farm machinery usage per capita (x1000)	**0.0420***	**3.4328**
Cultivated area per 10,000 persons	**0.0013**	**1.5013**
Fertilizer used per cultivated area	**0.0023***	**4.5678**
Population density (log)	**0.0160**	**1.6949**
Proportion of illiterates in 15^{+} population (x100)	**0.0159**	**0.9000**
Infant mortality rate (x100)	**-0.0313***	**-2.5295**
Medical personnel per capita	**0.0011***	**3.6882**
Proportion of pop. empl. nonfarm commerce (x100)	**0.0067***	**2.1156**
Kilometers of roads per capita (x100)	**0.0741***	**4.3033**
Proportion of population living in the urban areas	**-0.0228**	**-1.0254**

Source: Jalan and Ravallion, 1998, Table 2.

the household.

The results indicate that both of the county variables that relate to the extent of modernization in agriculture (farm machinery usage per capita and fertilizer usage per acre), and also the proportion of the population employed in non-farm commerce, have highly significant positive impacts on individual consumption growth rates. A one standard deviation increase in farm machinery usage in an area adds 0.6 percentage points to the annual consumption growth rate holding all else constant; a one standard deviation increase in fertilizer usage adds 1.5 points. By comparison, a one standard deviation increase in rural road density add 0.7 points. Following the same basic procedure as above (setting g = 0 and evaluating all but one of the variables at its mean value), Jalan and Ravallion show that the magnitude of these spillovers is large enough to generate underdevelopment traps, consistent with the implication of their simple, expository model.

Perspectives on Policy

Work on coordination failures suggests that development may be both easier and harder than was previously thought. While under the older theory, "all" one had to do to ensure development was transfer enough capital and remove government-imposed distortions, under the new theories, "all" one has to do is to induce a movement out of the old equilibrium, sufficiently far, and in the right direction, that the economy will be "attracted" to the "good" equilibrium. While this may require fewer resources, it may require more skill. Some policies could lead the economy to an even worse equilibrium. That is, even after the policies were removed, their ill effects would persist.

One response to the modern literature on coordination failures has been to emphasize the limitations in our knowledge of the combination of activities that should be coordinated and, hence, the dangers of a using the power of the state to establish a particular coordination mechanism. Jeffrey Sachs, for example, points out that the problem of highly centralized coordination of activities by government, as occurred in the centrally planned economies, is not so much that they never experienced rapid growth, but rather that they suffered from a lack of inventiveness and became "prematurely grey" (attributed to Sachs by Matsuyama, 1998). Matsuyama compares the problem of coordination to "*the problem of hundreds of people, scattered in a dense, foggy forest, trying to locate one another*..." (p. 134). Neither governments alone, nor markets alone, can solve it. Early writers who correctly pointed out the sources of coordination failures drew the wrong policy lessons when they interpreted coordination failures as a call for a 'big push' industrialization centrally controlled by the state.

A further issue is that to make the analysis of intervention precise requires a dynamic framework. Only in a dynamic framework can one ask whether an initial coordination failure will in fact transmit itself over time. Why wouldn't forward-looking agents, with sufficiently low discount rates, adopt a *path* (that might include the option of changing their behavior several times) that would permit as an equilibrium a self-fulfilling move away from a bad equilibrium to a good one? Is there really any scope for policy? Adsera and Ray (1998) address these questions in a setting where each agent makes a discrete choice between two activities (which could be interpreted as entry into a high-technology sector that offers a high return in the long run if it obtains a certain critical mass, versus a

low-tech sector. These authors obtain a striking result: *If* the positive externalities from moving to the more favorable set of activities appear with a time lag (that can be made arbitrarily short), *then the final outcome depends entirely on initial conditions unless there is some gain to being the first to switch*. To put it another way, without some gain to being among the first to switch, each individual will rationally wait for others to switch first, and so no one will switch at all! Initial conditions will thus determine the entire equilibrium outcome.

Adsera and Ray are thus able to show that there is a *potential* role for policy to enable an economy to break free of history. A temporary intervention can 'force' an equilibrium, and yet, once the equilibrium is attained, the intervention is no longer necessary to support it. This has the advantage that by the time agents have learned how to corrupt the rule-administering process, the rule may no longer be needed. We next consider two such interventions.

Coordinating good equilibria

A temporary change in government behavior may be able to force an equilibrium if the path to the new equilibrium entails a revision of beliefs, and the revised beliefs sustain the new equilibrium. For example, Tirole's model (1996), discussed above, demonstrates the role that an anti-corruption program of sufficient duration and severity can play in switching an economy from an equilibrium with high corruption (sustained by

expectations of high corruption) to one with low corruption (sustained by expectations of low corruption).[12]

There are situations in which an economy is characterized by multiple equilibria, some preferred by a policy maker over others, but in which the equilibria cannot be Pareto ranked. In those cases, there may be interventions that switch an economy to the better equilibrium by forcing a change in the distribution of income. The classic example of multiple equilibria in the neoclassical model arises where the labor supply curve is backward-bending. There may exist one market equilibrium with low wages, high labor supply, and high profits; and another with high wages, low labor supply, and low profits. The low-wage equilibrium is more favorable to capitalists, the other to workers. In such a setting, minimum wage legislation could serve to "rule out" the low-wage equilibrium. Once the high-wage equilibrium was attained, the minimum wage law would not be a binding constraint. That is, no effort need be expended to enforce the wage, because starting from the high-wage equilibrium, there is no supply of workers at the lower wage.[13]

---

[12] A historical case is Korea in 1961. President Park inherited a corrupt bureaucracy, from Synghman Rhee, that chose policies on the grounds of self-enrichment. Within a month of seizing office, he dismissed about the top 10% of bureaucrats, jailed owners of conglomerates for corruption, and sent the rest of the bureaucracy to two-week training courses in management, efficiency, and public spiritedness. He then personally monitored the performance of the "economic bureaucrats" and shifted them from one bureau to another quickly, so that they could not develop corruption networks. The result was a total transformation of the functioning of the government and its interaction mode with the chaebols, from a soft state to a hard one. Park then proceeded to design the subsequent development plan.(personal correspondence of Irma Adelman,; Mason, 1980).

[13] Other examples of temporary policy that can force a shift from one to another equilibrium are bankruptcy law and a ban on child labor. Miller and Stiglitz [1999] present a model in which a bankruptcy law that establishes stronger debtor rights eliminates the "bad" equilibrium in which there are large numbers of bankruptcies resulting from the large transfers associated with large

Sequencing of policy reforms

Public choice theory has provided considerable insights into the nature of political processes, including the problems associated with the formation of interest groups (Becker 1983, Olson 1965). For instance, free rider problems play an important role in determining which interest groups form, just as they play an important role in the provision of public goods more generally. Public actions affect the costs and benefits associated with interest group formation. Since the costs of interest group formation are, to some extent at least, fixed costs, interventions that affect the dynamics of the political process—thereby affecting subsequent outcomes—can be thought of as *deep* interventions. They entail irreversibilities.

An example of the dynamics of the political process may help illustrate what we have in mind. Assume government is contemplating privatizing a monopoly. There are several potential buyers. Each has an interest in ensuring that the regulations that prevail after privatization allow him to continue to enjoy the monopoly profits, and perhaps even leverage the monopoly power further. But each, thinking that he has a small probability of winning, is unwilling to spend much to ensure this "collective" good (or bad, depending on one's perspective). Moreover, each may face large costs of identifying who the other potential buyers are. Even if a potential buyer succeeds in identifying the others, if they are numerous there would still be a free rider problem, each claiming

---

creditor-friendly bankruptcies. Basu and Van [1998] show how child labor laws can eliminate a "bad" equilibrium with child labor. In the good equilibrium that results, no one actually wants to have his children work**.**

publicly that he himself will obtain high profits through increased efficiency rather than by exploiting monopoly power.[14] But *once the privatization has occurred*, there is a single party who is the "winner." There no longer is a collective action problem, and the winner has the incentive and resources to fight legislation imposing regulation or competition. Thus, before the privatization, it may be possible to pass rules to promote competition (since there is no organized resistance in the private sector)[15] and there may be, admittedly weak, public interest groups pushing for it. The sequencing of reforms—whether regulatory policies precede or follow privatization—matters. In one sequence, one may end with a competitive or regulated industry, where the benefits of privatization in terms of lower consumer prices are realized. In the latter case, one may end up with an unregulated monopoly, one which, to be sure, may be more efficient than it was as a public sector producer. But it may be more efficient not only in producing goods, but also in exploiting consumers.

It is precisely because history matters that interventions can be effective in the long run. A perturbation to the system at one date can have permanent effects. By contrast, in neoclassical and related theories, it is fundamentals—including those associated with the political process—that determine long-run outcomes.

[14] Palfrey and Rosenthal (1984) present a model in which the *larger* the number of potential beneficiaries of a discrete public good, the *less* likely the public good is to be supplied.

[15] In the next section, we discuss the case, which is especially relevant in transition economies, where there is organized resistance *within the government* to privatization.

A word of caution: Deep versus shallow interventions

When interventions to promote economic reform are not "deep" in the sense defined above, not only may their effects be undone, but they may actually be hurtful, at least in some dimensions. Consider again the issue of privatization. One of the principal arguments against governments running enterprises is that public officials skim off the rents. It is also argued that privatization eliminates the scope for this kind of political abuse.[16] In many cases, unfortunately, this has not proved to be the case. One should have been suspicious when allegedly corrupt political leaders embraced the doctrine of privatization. The current set of public officials realized that by corrupting the privatization process, they could appropriate not only some of today's rents, but a fraction of the present discounted value of rents *of the future*. The rhetoric of privatization theory was useful as a cover for corrupt policies.

In many cases, too, we have learned that the privatization process may even have limited efficacy in stemming the flow of *on-going* rent-seeking by government. For instance, if local authorities have regulatory oversight (environmental, building permits, etc.), local government approval is needed for continued operation. It matters not what

[16] In the transition economies, it has been argued that privatization of natural monopolies and highly concentrated industries should proceed even when government is too divided between pro- and anti-reform forces to create a regulatory regime prior to privatization (Boycko, Shleifer, and Vishny 1996). But this argument would seem to violate the following straightforward criterion of consistency: *If one argues that government cannot implement a policy a (e.g. industry regulation) because of a trait b (a divided government), then one cannot also argue that government should do a policy P (privatization), unless one can show that P is consistent with the trait b.* If the reformers have enough power to impose privatization, then the argument that they cannot impose regulation is consistent—in the above sense—only if privatization is less costly to the ministries than regulation would be, i.e., *because the ministries privatize to themselves* (Hoff and Stiglitz 2000).

pretext the government needs to "hold up" the company. Eliminating one pretext still leaves a plethora of others. Privatization thus does not effectively tie the hand of government. It is only a deep intervention, which changes the nature of government behavior, that will succeed in addressing these concerns. We earlier provided one example from Korea.

Finally, consider the unsuccessful agricultural privatization in Russia in 1991-1999, based on Amelina (2000). In 1991, Russia legalized individual farming and dismantled the subsidies for cooperative farms. Yet six years later, the share of agricultural land used by cooperatives had fallen little: from 91% in 1991 to 80% in 1997. One might have hoped that the introduction of private property rights would have caused farmers to exit the inefficient system of cooperative farms and produce for themselves. But market institutions for providing inputs to the farmers for storage, processing, transport, and insurance were not in place. When the Soviet system collapsed and cooperatives were left without federal support, district politicians to varying degrees took up the task of ensuring the supply of inputs and subsidies to the cooperatives, as the Soviet center had once done.[17] This removed the potential demand new market institutions and for suppliers capable of servicing the needs of small producers. Amelina interviewed households to learn their reasons for remaining within the cooperative system. Among the top two reasons (out of a choice set of 10) in both districts she studied was that "*There is no other place to work"* (Amelina, p. 94).

[17] Amelina's comparison of two districts finds that this was more true in the district in which agriculture bulked larger in the local economy. In that district, most politicians had risen through the ranks of the cooperative system. They had highly developed "human capital" in transferring funds to and from the cooperatives, and a large political stake in meeting cooperatives' needs.

Conclusion

Developments in economics over the past 30 years have validated Rosenstein-Rodan's basic intuition. A critical determinant of actions is one's environment, including the behaviors of other agents in that environment. Whereas we used to believe that the implication of externalities was that the economy would be slightly distorted, we now understand that the *interaction* of these slight distortions may produce very large distortions. An economy may be "trapped" in a bad equilibrium, even though there exists a better state of affairs that would also be an equilibirum.

Modern theory has extended Rosenstein-Rodan's insight very far. We now see that some of the basic distinctions developed in standard theory do not hold. There is no simple technology-based distinction between activities that produce externalities and those that do not, or between activities with public good properties and those with private good properties. The externalities that matter for welfare are not just direct interdependencies (Meade's beekeeper and apple farmer). We now recognize many classes of systematic externalities, of which an important example are those that arise in purely price-mediated interactions. Given history, beliefs, and chance, certain behaviors are rewarded, others are not. Rewarded behaviors will tend to increase relative to others, and that may further increase the rewards to those behaviors. Initial differences in circumstances or beliefs may not only persist, but be magnified over time.

Development policy in this view is both easier and harder than it was before. It is easier because, in general, there is slack. The lack of resources need not be the fundamental constraint on development. A temporary policy intervention, or a seemingly minor shock, may produce discontinuous change. But policy is harder because there is no single easily identifiable source of failure that is waiting to be resolved.[18] Neither the transfer of capital, nor free markets and international trade, nor the emergence of an entrepreneurial class ensures development. In some environments, the entrepreneurial class become entrepreneurs in predation! In the view outlined here, development requires a set of complementary changes in the behavior of agents, which not even the market mechanism can coordinate. We suggested certain policies – policies that change beliefs, temporary reforms in law, and changes in the distribution of wealth – that may contribute to coordinated changes to shift an economy to a better equilibirum.

We emphasized, finally, the distinction between shallow interventions -- which do not change the incentives of the key players and do not entail irreversibilities and thus may fail to improve matters -- and deep interventions. The way in which a set of reforms is *sequenced* may make the difference between a deep intervention and a shallow one, and we offered examples with respect to corruption and privatization.

We hope we have conveyed the intellectual excitement generated by the idea that multiple equilibria, some of which are desirable and some of which are "traps," can occur

[18] Despite a long history in development economics of arguing that there was such a factor. See Adelman, forthcoming.

due to the collective interdependence in decision-making.[19] The lesson to draw from this literature is that coordination failures abound and are important. Neither the market alone nor government alone can solve them. There are in many cases misguided incentives in the private sector. There are a different set of misguided incentives in the public sector. But it need not be the case that the misguided government cannot correct the misguided private sector. There may be a social equilibrium in which the forces are balanced in a way that is Pareto-improving relative to a situation in which the government's hands are completely tied, and certainly better than one in which the private sector's hands are completely tied.

Mathematical Appendix

This appendix highlights the logic and common mathematical structure of many of the models described in this article. We focus on *static* models of *market* equilibria. By *static* we mean that the interactions across agents are treated as contemporaneous, rather than intertemporal. This assumption is made for simplicity. (One can interpret

[19]Consider the simple adage, "If a man can …make a better mousetrap than his neighbor, though he builds his house in the woods, the world will make a beaten path to his door" (attributed to Ralph Waldo Emerson by Bartlett 1980). And consider the favorable case where people know about the invention. From the perspective of the literature on coordination failures, the outcome predicted by the adage might still require that individuals expect that there will be enough users to make services in mousetrap repair affordable, that search costs for those services not be prohibitive, that there is confidence that improved mousetraps would not be stolen, that barriers sufficiently restrict the free movement of mice so that one mousetrap can make a difference in one's environment, and that there be a means for the disposal of dead mice.

these models as describing the sensitivity of outcomes to the assumptions placed on expectations. Durlauf (1996) shows that these models are equivalent to ones where all individuals have the same expectations and agents interact through the expectations formation process.)

By *market* models, we mean that there are a large number of actors so that the effect of the action of a *single* actor on others is infinitesimal. The models are structurally similar to games with strategic complementarities, but whereas in games, each player is aware that his actions may affect the actions of others, in the market equilibrium models on which we focus, such strategic interactions are ruled out by assumption. We would argue that for analyzing problems of interactions of many actors, the models upon which we focus are more relevant than the game-theoretic models.

Each model consists of a set of *actors,* the set of feasible actions for each actor (*strategy sets),* and the *payoff functions*. The payoff functions depend on one's own actions, those of others, and prices (which themselves depend on the actions of all individuals).

The table provides a taxonomy that distinguishes three ways of modeling actors: as identical (column I), with individual differences in payoff functions (column II), or with individual differences in strategy sets (column III). The table distinguishes two ways of modeling strategy sets: continuous or discrete. The models described in this article can be placed into one of the six categories defined by this matrix. Although we did not describe such cases here, there are also hybrids of these six types. For example, in one version of Acemoglu (1997), workers' choice variable (training) is continuous but firms' choice variable (to innovate or not) is discrete.

A taxonomy of models with complementarities

		ACTORS		
		I	*II*	*III*
		*Actors **are identical***	*Actors differ in their payoff functions*	*Actors differ in their strategy sets*
ACTIONS	*Continuous choice variable*	R&D (Romer 1986)		Training and innovation (Acemoglu 1997)
	Discrete choice variable	Property rights (de Meza-Gould 1992) Innovation (Sah and Stiglitz 1989) Contract enforcement (Greif 1997) Rent-seeking (Murphy-Shleifer-Vishny 1993)	Innovation (Sah and Stiglitz 1989) The structure of ownership (Hoff and Sen 2000)	Big push (Helpman and Krugman 1985; Murphy-Sheifer-Vishny 1989; Rodriguez 1996; Rodrik 1996) Training and innovation (Acemoglu 1997)

Class IC. Identical actors and continuous actions

This class of models hypothesizes identical actors with preferences (profits) of agent i being $u^i(a^i ; a, p)$, where a^i is the agent's own action, 'a' is everyone else's action, and 'p' is a vector of prices –itself a function of the entire vector of actions. Each action is a continuous variable. We summarize everyone else's action by the variable 'a' because we limit our discussion to the case of *symmetric* equilibria. We described the individual's reaction function in equation (1) above, and repeat it here in order to be complete:

$$u^i_1(a^i; a, p(a)) = 0$$

We assume that an increase in everyone else's action (a) raises u^i . As also noted above (equation (2)), the interior equilibria are the values of a* that solve

$$u^i_1 (a^*; a^*, p(a^*)) = 0$$

If complementarities, captured in this model by the condition that $u^i_{12} > 0$, are sufficiently large, there may be multiple Pareto rankable equilibria, as illustrated in Figure 2. Each individual is better off in the equilibrium where all choose a higher action.

Class ID. Identical actors and discrete activities

Another class of models hypothesizes identical actors but *discrete* actions or activities. With just two activities, the payoff to any activity depends on the *fraction* x of agents that undertake, say, the first activity. Thus, the utility function of the i^{th} agent can be written as $U^i = U^i(a^i; x, p(x))$, where a = 1 if the individual undertakes the first activity, and a = 2 if he undertakes the second activity. p is a function of x: p= p(x). The individual chooses his activity, a^i, to maximize $U^i(a^i; x, p(x))$, taking x as given. With a continuum of agents, an interior equilibrium is described by the values of the fraction x that solve

$$U^i(1; x^*,p(x^*)) = U^i(2; x^*, p(x^*))$$

Complementarities exist in this model if the *relative* return to the first activity is increasing in the fraction of the population that undertakes the first activity. Formally, the partial derivative of the payoff function with respect to x, denoted U_x^i, satisfies

$$U_x^i (1,x,p(x)) - U_x^i(2,x,p(x)) > 0.$$

With complementarities, multiple corner solutions are possible. A corner solution where all individuals choose action 1 exists if

$$U^i(1; 1,p(1)) > U^i(2; 1, p(1))$$

This states that when all other individuals choose the first activity, it is individually optimal to choose the first activity. Another corner solution exists where all choose action 2 if

$$U^i(2; 0, p(0)) > U^i(1; 0, p(0))$$

This states that when all individuals choose the second activity, it is individually optimally to choose the second activity.

In some specializations of the model that we discussed (de Meza and Gould, 1992, and Murphy, Shleifer and Vishny, 1989, section IV and 1993), the impact of other individuals' actions is entirely through prices. All that matters is the "atmosphere", and

the atmosphere can be represented solely by the price system. Thus, the utility function of the i^{th} agent can be written as $U^i = U^i(a^i; p(x))$.

The model can be generalized to an arbitrarily large number of discrete activities. In Murphy, Shleifer, and Vishny [1993], there are three activities: cash crop production, a subsistence activity, and rent-seeking (predation). The returns to the subsistence activity, denoted by γ, are exogenous, while the returns to cash crop production and rent-seeking are decreasing in the ratio n of people engaged in predation relative to those engaged in cash crop production. An interior equilibrium is described by values n^* that solve

$$U^i(1; p(n^*)) = U^i(2; p(n^*)) = \gamma$$

Suppose that over some range of n, the returns to cash crop production are decreasing more steeply than the returns to predation. This implies that, over some range of n, the *relative* returns to predation are increasing in n. In this case, multiple Pareto-rankable equilibria, some characterized by a high level of predation, and others characterized by a low level of predation, may exist.

Class IID. Individual differences in payoff functions and discrete activities

In the preceding class of models, some individuals chose one action, others chose another. All individuals were identical; and so the theory provides no explanation of why some chose one, and some chose the other—and in fact, it makes no difference. All that is required is that individuals be indifferent as to what they do. But, in general, there *are* important individual differences. Whenever such differences exist, they may explain

why some individuals choose one action rather than another. The next category of models entails *individual differences* in payoff functions.

The structure of these models is such that there is some attribute of the individual, reflected in, say, his utility function or wealth, and denoted for simplicity by c; and there is a probability distribution of individuals according to c, say F(c).). Individuals have a choice of two activities, '1' or '2. The individual chooses his activity, a^i, to maximize $V^i(a^i; x, c)$, taking x as given. (For simplicity, we suppress the dependence of payoffs on p(x).) The utility functions have the structure that we can order individuals by c, such that there exists a critical value c* such that individuals whose attribute is above c* prefer activity 1, while individuals whose attribute is below c* prefer activity 2. Formally,

$$V(1, F(c^*), c^*) = V(2\ F(c^*), c^*)$$

$$V(1, F(c^*), c) > V(2, F(c^*), c) \quad \text{for } c > c^*$$

and

$$V(1, F(c^*), c) < V(2, F(c^*), c) \quad \text{for } c < c^*.$$

Complementarities are defined, as above, by the condition that the relative return to activity 1 is increasing in the fraction x of individuals undertaking activity 1: $V_x^i(1,x,c) - V_x^i(2,x,c) > 0$. When complementarities are sufficiently strong, there can exist multiple solutions for c*.

Class III. Individual differences in strategy sets

Multiple equilibria can also emerge from the interaction several different kinds of agents. Consider a situation in which there are groups of actors that differ in their strategy sets, e.g., firms and workers. (For simplicity, we will represent each group by a single agent, but in fact each group can consist of a large number of agents. In that case, we solve for the symmetric equilibrium of each class of agents using the techniques of Class IC.)

Suppose there are two groups of actors, and suppose the action of the first is a continuous variable denoted by 'a', and the action of the second is a continuous variable denoted by 'b'. Then the first group maximizes a payoff function $v^1(a; b, p(a,b))$ with respect to a, given b and p; and the second maximizes $v^2(a; b, p(a,b))$with respect to b, given a and p.

The interior equilibria are the solutions to the equations

$$v_a^{\,1}\,(a^*,b^*,p(a^*,b^*)) = 0$$

and

$$v_b^{\,2}\,(a^*,b^*,p(a^*,b^*)) = 0$$

There may exist multiple values of (a*,b*) that solve these equations if there are complementarities between the two groups of actors, which is captured by the condition that $v_{ab}^{\,i} > 0$.

References

Acemoglu, Daron. 1997. "Training and Innovation in an Imperfect Labour Market." *Review of Economic Studies* 64(220) July: 445-464.

Adelman, Irma. Forthcoming. "Fallacies in Development Theory and Their Implications for Policy." In Gerald Meier, ed., *Pioneers in Development.* Oxford: Oxford University Press, forthcoming.

Adsera, Alicia and Debraj Ray. 1998. "History and Coordination Failure." *Journal of Economic Growth* 3(3) September: 267-276.

Amelina, Maria. 2000. *False Transformations: From Stalin's Peasants to Yeltsin's Collective Farmers* Working Paper (Washington, DC: World Bank), forthcoming.

Arnott, Richard and Joseph E. Stiglitz. 1991. "Moral Hazard and Nonmarket Institutions: Dysfunctional Crowding Out or Peer Monitoring?" *American Economic Review* 81(1) March: 179-190.

Azariadis, C. and A. Drazen. 1990. "Threshold Externalities an Economic Development." *Quarterly Journal of Economics* 105, 501-526.

Banerjee, Abhijit J. and Andrew F. Newman. 1993. "Occupational Choice and the Process of Development." *Journal of Political Economy* 101(2) April: 274-298.

_____. 1998. "Information, the Dual Economy, and Development." *Review of Economic Studies* 65(225) October: 631-653.

Bardhan, Pranab. 1997. "Corruption and Development: A Review of Issues." *Journal of Economic Literature,* 35: 1320-46.

Bartlett, John. 1980. *Familiar Quotations.* (Boston: Little, Brown & Co.).

Basu, Kaushik and Pham Hoang Van. 1998. "The Economics of Child Labor." *American Economic Review* 88(3) June: 412-427.

Besley, Timothy and Stephen Coate. 1998. "Sources of Inefficiency in a Representative Democracy: A Dynamic Analysis." *American Economic Review* 88(1) pp. 139-154.

Boycko, Maxim, Andrei Shleifer, and Robert W. Vishny. 1996. "Second-best Economic Policy for a Divided Government." *European Economic Review* 40(3-5) April: 767-774.

Cheung, Steven S. 1973. "The Fable of the Bees: An Economic Investigation." The Economics of Legal Relationships: Readings in the Theory of Property Rights, ed. Henry G. Manne, 457-470. New York: West Publishing Company.

Coase, Ronald. 1960. "The Problem of Social Cost." *Journal of Law and Economics* 3: 1-44.

_____. 1974. "The Lighthouse in Economics." *Journal of Law and Economics* 17 (2) 357-76.

Cooper, Russell W. 1999. Coordination Games: Complementarities and Macroeconomics. Cambridge, UK: Cambridge University Press.

Darwin, Charles. 1993 (1859). *The Origin of Species by Means of Natural Selection* Modern Library Edition. (New York: Random House).

de Meza, David and J.R. Gould. 1992. "The Social Efficiency of Private Decisions to Enforce Property Rights." *Journal of Political Economy* 100(3) June: 561-580.

Durlauf, Steven. 1996a. "Neighborhood Feedbacks, Endogenous Stratification, and Income Inequality." In William Barnett, Giancarlo Gandolfo, and Claude Hillinger, eds. *Proceedings of the Ninth International Symposium in Economic Theory and Econometrics* (Cambridge: Cambridge University Press), pp. 505-534.

Durlauf, Steven. 1996b. "Statistical Mechanics Approaches to Socioeconomic Behavior." University of Wisconsin. Manuscript.

Easterly, William and R. Levine. "It's Not Factor Accumulation: Stylized Facts and Growth Models. World Bank. Manuscript.

Engerman, Stanley and K. Sokoloff. 1997. "Factor Endowments, Institutions, and Differential Paths of Growth among New World Economies: A View from Economic Historians of the United States." How Latin America Fell Behind: Essays on the Economic Histories of Brazil and Mexico, 1800-1914, ed. Stephen Haber. Stanford, 260-304. CA: Stanford University Press.

Gale, Douglas. 1992. "Standard Securities." *Review of Economic Studies*, 59, 731-755.

Glaeser, Edward, B. Sacerdote, and Jose Scheinkman. 1996. "Crime and Social Interactions." Quarterly Journal of Economics. CXI. 507-548.

Greenwald, Bruce and J.E Stiglitz. 1986. "Externalities in Economics with Imperfect Information and Incomplete Markets." *Quarterly Journal of Economics* May: 229-264.

Greif, Avner. 1994. "Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies." *Journal of Political Economy* 102(5) October: 912-950.

Grossman, Sanford J. and Oliver D. Hart. 1986. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy* 94 (4): 691-719.

Helpman, Elhanan and Paul Krugman 1985. *Market Structure and Foreign Trade*. Cambridge, MA: MIT Press.

Hoff, Karla. 1994. "The Second Theorem of the Second Best." *Journal of Public Economics* 54: 223-242.

_____. 1998. "Adverse Selection and Institutional Adaptation." Paper presented at the NEUDC, manuscript.

Hoff, Karla and Arijit Sen. 2000. "Homeownership, Coordination Games and Polarization in Neighborhoods." World Bank. Manuscript.

Hoff, Karla and Joseph E. Stiglitz. Forthcoming. "Modern Economic Theory and Development." In *Pioneers in Development*, Gerald M. Meier, editor. Oxford: Oxford University Press.

Hoff, Karla and Joseph E. Stiglitz. 2000. "The logic of political constraints and reform, with applications to privatization." World Bank, manuscript.

Jalan, Jyotsna and Martin Ravallion. 1998 "Geographic Poverty Traps? A Micro Model of Consumption Growth in Rural China." Discussion Paper No. 86, Institute for Economic Development, Boston University.

Kranton, Rachel E. 1996. "Reciprocal Exchange: A Self-Sustaining System." *American Economic Review* 86(4) September: 830-851.

Krugman, Paul. 1993. "Toward a Counter-Counterrevolution in Development Theory." In *Proceedings of the World Bank Annual Conference on Development Economics1992*, 15-38.

Krugman, Paul. 1995. *Development Geography and Economics.* Cambridge, MA. MIT Press.

Laffont, Jean-Jacques. 1989. *The Economics of Uncertainty and Information*. Translated by J.P Bonin and H. Bonin. Cambridge, MA: MIT Press.

Leibenstein, Harvey. 1957. *Economic Backwardness and Economic Growth*. New York: Wiley.

Mason, Edward S. 1980. *The Economic and Social Modernization of the Republic of Korea*. Cambridge, MA: Harvard University Press.

Matsuyama, Kiminori. 1995. "Economic Development as Coordination Problems." In M. Aoki, H-K. Kim and M. Okuno-Fujiwara, eds. 1995.*The Role of Government in East Asian Economic Development* (Oxford, UK: Clarendon Press).

Miller, M. and J.E. Stiglitz. 1999. "Bankruptcy Protection against Macroeconomic Shocks: The Case for a Super Chapter 11." unpublished, World Bank, April.

Mishan, E. J. 1971. "The Post-War Literature on Externalities: An Interpretive Essay." *Journal of Economic Literature* 9: 1-28.

Mookherjee, Dilip and Debraj Ray. 1999. "Contractual Structure and Wealth Accumulation." Boston University. Manuscript.

_____. 1998. "Persistent inequality and endogenous investment thresholds". Boston University. Manuscript.

Murphy, K., A. Shleifer, and R. Vishny. 1989. "Industrialization and the Big Push." *Journal of Political Economy* 97(5) October: 1003-1026.

_____. 1993. "Why is Rent-seeking So Costly to Growth?" *American Economic Review* 83(2) May: 409-414.

Newbery, David M.G. and Joseph E. Stiglitz 1982. "The Choice of Techniques and the Optimality of Market Equilibrium with Rational Expectations. *Journal of Political Economy* 90 (2, April). 223-247.

North, Douglass C. 1990. *Institutions, Institutional Change and Economic Performance* (New York: Cambridge University Press).

North, Douglass C. 1994. "Economic Performance through Time." American Economic Review 84: 359-368.

North, Douglass C. and Robert Paul Thomas. 1973. *The Rise of the Western World: A New Economic History* (New York: Cambridge University Press).

Nurkse, Ragnar. 1953. *Problems of Capital Formation in Underdeveloped Countries.* Oxford: Oxford University Press.

Olson, Mancur. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press).

Piketty, Thomas. 1997. "The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing." *Review of Economic Studies* 64: 173-189.

Ravallion, Martin and J. Jalan. 1999. "China's Lagging Poor Areas." *AEA Papers and Proceedings: Income Distribution in China*. 301-305.

_____. 1996. "Growth Divergence Due to Spatial Externalities." *Economics Letters* November 1996, 53 (2): 227-32.

Reding, Paul and Juan Antonio Morales. 1999. "Currency Substitution and Network Externalities." unpublished, University of Namur, Belgium.

Rodrik, Dani. 1995. "Trade and Industrial Policy Reform." In Jere Behrman and T.N. Srinivasan, *Handbook of Development Economics volume 3B* (Amsterdam: North-Holland), pp. 2925-2982.

Rodrik, Dani. 1996. "Coordination Failures and Government Policy: A Model with Applications to East Asia and Eastern Europe." *Journal of International Economics* 40(1-2) February: 1-22.

Rodríguez-Clare, Andrés. 1996. "The Division of Labor and Economic Development." *Journal of Development Economics* 49 April: 3-32.

Romer, P. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political Economy*, Vol. 94. 1002-1037.

Rosenstein-Rodan, Paul. 1943. "Problems of Industrialization of Eastern and Southeastern Europe." *Economic Journal* 53(210-211) June-September: 202-211.

Sah, Raaj Kumar and J.E. Stiglitz. 1989. "Sources of Technological Divergence between Developed and Less Developed Countries." In Guillermo Calvo, et al., eds. *Debt,*

Stabilizations and Development: Essays in Memory of Carlos Diaz-Alejandro (Cambridge, MA: Basil Blackwell), pp. 423–446.

Stiglitz, Joseph E. 1998a. "The Private Uses of Public Interests: Incentives and Institutions. Journal of Economic Perspectives.

_____. 1998b. "Reflections on the Theory and Practice of Reform." Paper presented to Stanford University, September 17.

_____. 1993. "Comment on 'Toward a Counter-Counterrevolution in Development Theory." *Proceedings of the World Bank Annual Conference on Development Economics, 1992*, 39-49.

_____. 1999a. "Whither Reform? Ten Years of the Transition." Paper presented to the 1999 Annual Bank Conference on Development Economics, World Bank, April 30.

Tinbergen, Jan. 1967. *Economic Policy: Principles and Design* (Amsterdam: North-Holland).

Tirole, Jean. 1996. "A Theory of Collective Reputations (with Applications to the Persistence of Corruption and to Firm Quality)." *Review of Economic Studies* 63(1) January: 1-22.

Zak, Paul J. and Stephen Knack. 1998. 'Trust and Growth." IRIS Working paper No. 219.

Figure 1: Multiple equilibria (with corner solutions) in the level of enforcement

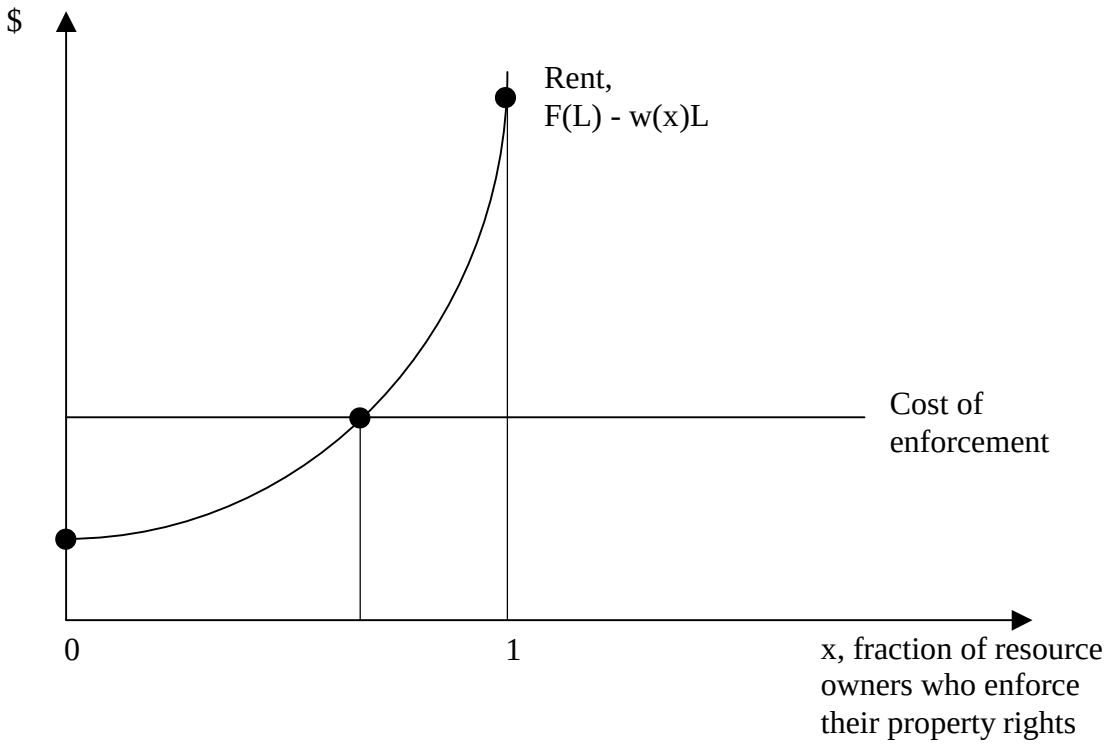


Figure 2: Multiple equilibria in a model with symmetric agents

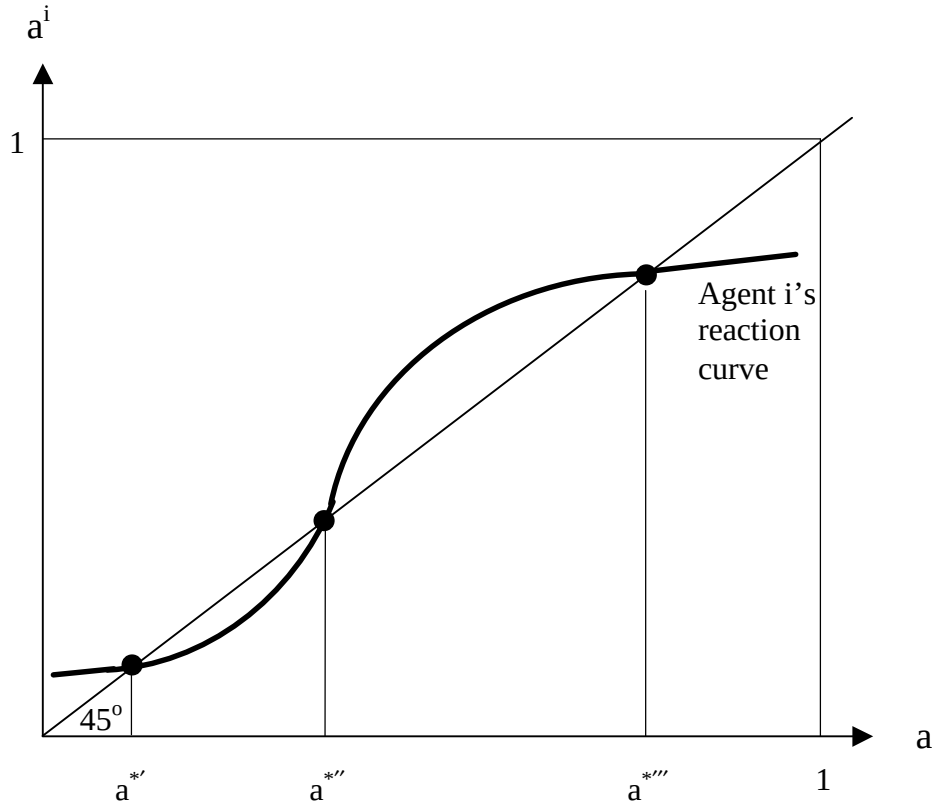
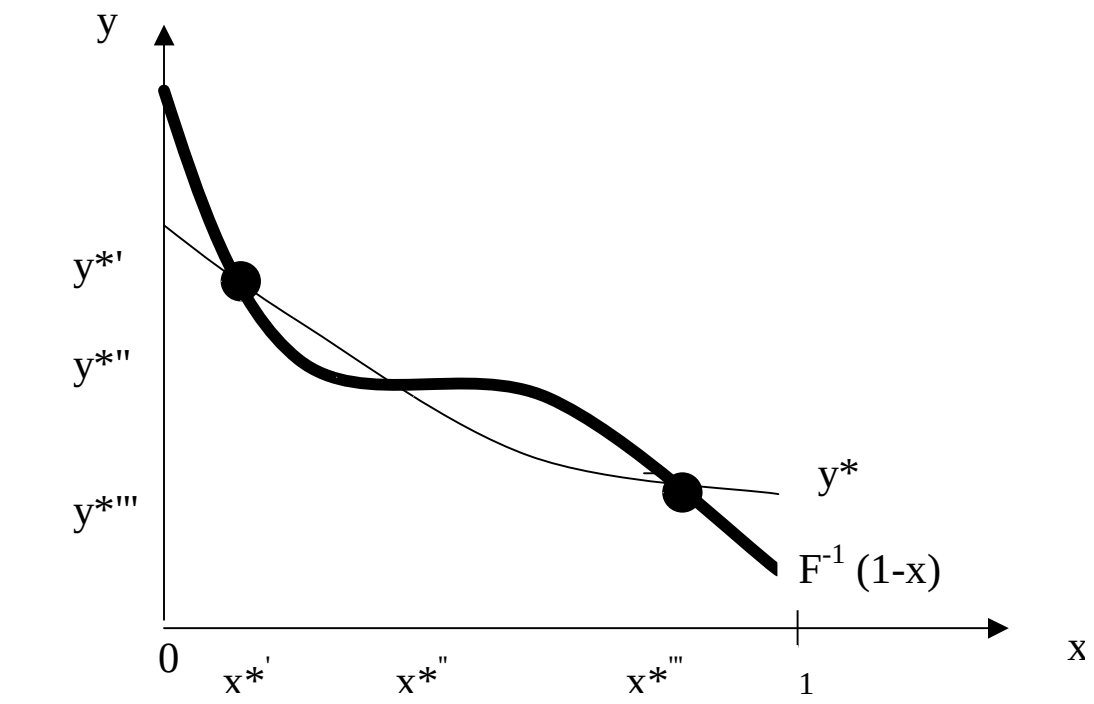


Figure 3: Dual stable equilibria in the fraction of homeowners



Actual income level of richest 1-x^{th} percentile of households

Critical income level to be a homeowner

Figure 4. The marginal productivity of household capital as a decreasing function of own capital , K, and an increasing function of average county capital, $\overline{K}$

.

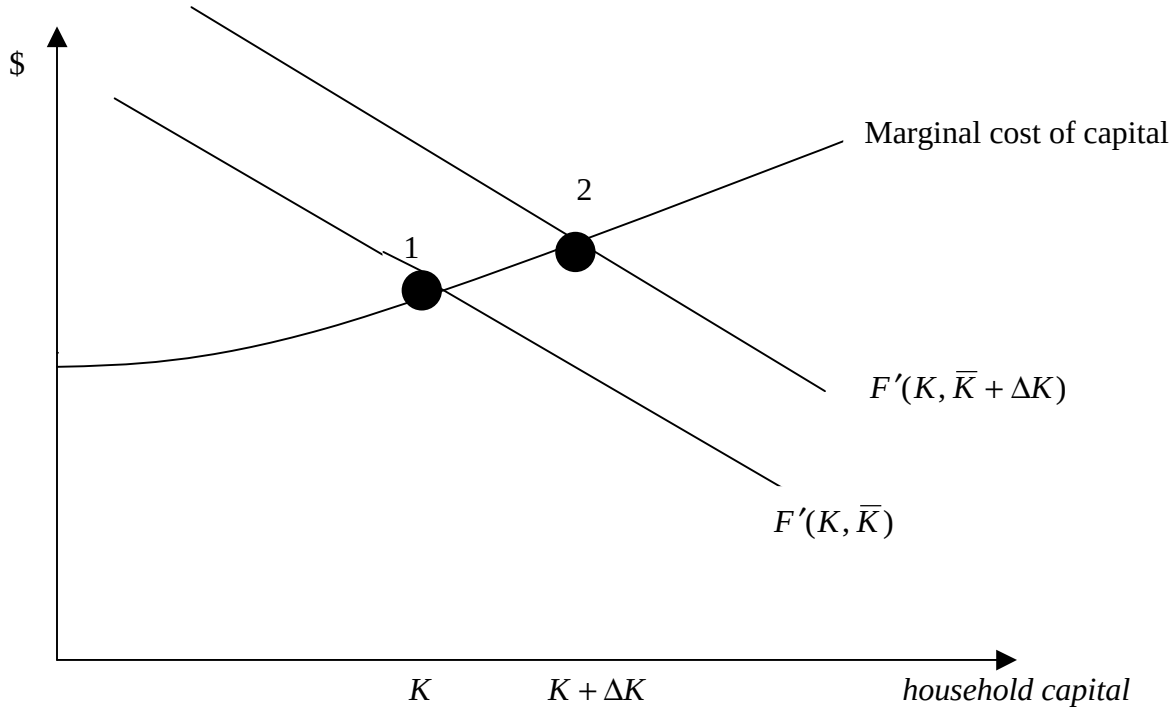
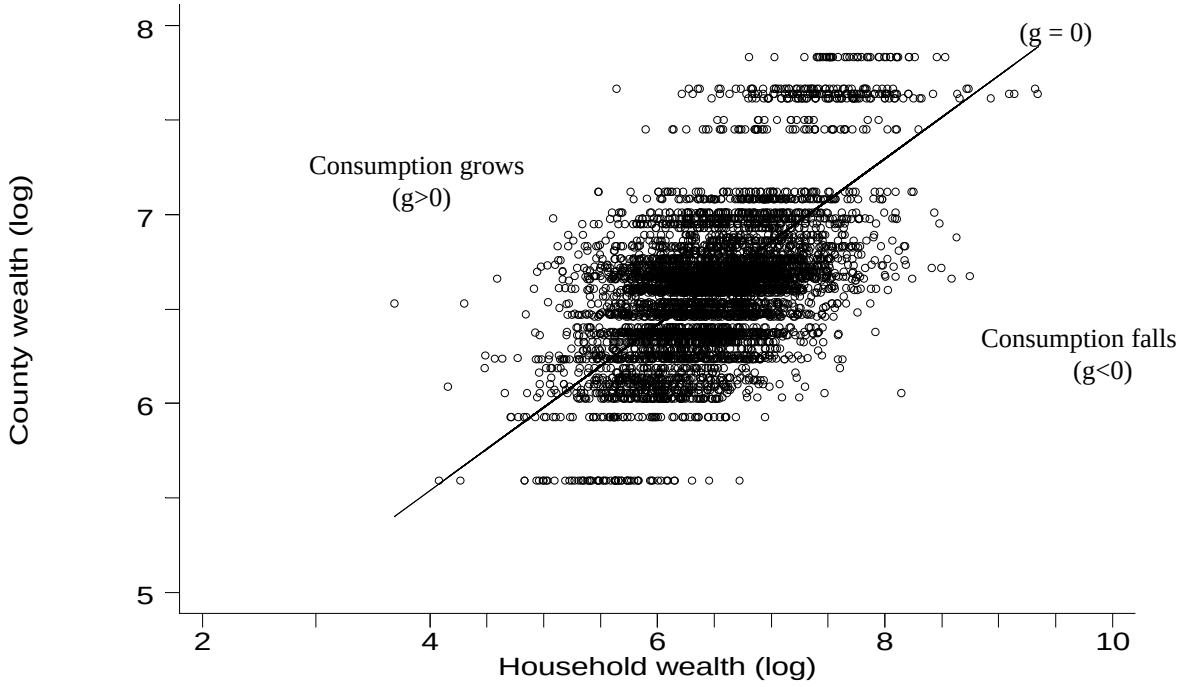


Figure 5: Minimum levels of county wealth to assure rising household consumption given household wealth



Note: Wealth is measured in yuan per capita at 1985 prices.

Source: Jalan and Ravallion, 1998, figure 1.