DISCUSSION PAPER SERIES

No. 2649

EXPLORING THE NICHE OVERLAPS BETWEEN ORGANIZATIONAL ECOLOGY AND INDUSTRIAL ECONOMICS

Paul A Geroski

INDUSTRIAL ORGANIZATION

Centre for **E**conomic **P**olicy **R**esearch

www.cepr.org

EXPLORING THE NICHE OVERLAPS BETWEEN ORGANIZATIONAL ECOLOGY AND INDUSTRIAL ECONOMICS

Paul A Geroski, London Business School and CEPR

ABSTRACT

Exploring the Niche Overlaps Between Organizational Ecology and Industrial Economics*

The goal of this essay is to bring the work of organizational ecologists on population dynamics to the attention of economists. Following a relatively brief exposition of the basic structure of the arguments made by organizational ecologists, we explore a number of areas where cross-fertilization between organizational ecology and economics seems promising. These include: examining the limits of competitive exclusion, exploring how models that focus on selection between firms might apply to selection between products, linking models of population dynamics to models which explain changes in market structures over time and understanding the sources of structural inertia that limit the ability of firms to react to market events. We conclude by making a few observations on what each group of scholars might learn from the other.

Paul A Geroski
Department of Economics
London Business School
Sussex Place
Regents Park
London NW1 4SA
UK
Tel: (44 20) 7262 5050
Fax: (44 20) 7402 0718
Email: pgeroski@london.edu

Submitted 04 October 2000

NON-TECHNICAL SUMMARY

There is a large literature in economics that looks at the entry and exits of firms into and from particular markets. Most of this literature is focused on identifying specific factors which facilitate or block entry/exit and much of it is cross section in nature, looking at conditions across a wide range of firms or markets at a given time. Very few economists have taken a very long-run, longitudinal view of entry and exit into particular markets, and few are, therefore, familiar with the work of a group of sociologists – generally known as organizational ecologists – who have looked at the demographics of industry populations. This group of scholars have produced detailed studies of the population history of a number of markets and have extracted a range of stylized facts from them. These facts and the body of theorizing which has grown up around them, is both an interesting and important literature, and one that is highly complementary to the rather different type of work that economists have concentrated on. The goal of this Paper is to introduce the literature on organizational ecology to non-specialists and it tries to identify the major parallels or overlaps with industrial economics.

Organizational ecology is based on the premise that organizations are relatively inflexible and slow to change (slow relative to the speed with which their environment changes). This means that the rise and fall of organizations is likely to be driven by selection pressures rather than by adaptation. The implication of this is that the history of a market is likely to be reflected in the rise and fall of the population of organizations who inhabit it. To explain these life-cycle dynamics, organizational ecologists have developed analogies with simple ecological processes that describe the colonization of niches in the wild. The two main drivers of population dynamics in these are density dependence and the law of competitive exclusion. The first describes how population growth rates at any time are affected by the current size of the population; the second describes the nature of competition between two different populations that are trying to colonize the same niche.

There are several important parallels between this body of work and that which has been developed by industrial economists and we pursue four of them in this essay:

1. Niches play a very similiar role in ecology arguments as markets do in the arguments of economists, but they are defined in quite a different manner. Further, the process by which different populations colonize a niche is likely to create sub-niches that are close analogues to what economists would define as market segments;

2. The process by which new organizations become established in niches (often called 'legitimation' by organizational ecologists) is very similar to the process by which new standards are erected in markets;

3. Organizational ecologists think of the effects of competition on particular members of a population as analogous to the effects of congestion, and they think of concentration as (essentially) a measure of the degree of heterogeneity between firms. Although one can find traces of the first view in simple oligopoly models, the second view is not one which has had more than an informal effect on how economists think of the drivers of market concentration;

4. At the base of most organizational ecologists' models is a presumption that organizations are relatively inflexible. This means that entry and exit are seen by them as very important drivers of change. Economists think of these issues in terms of adjustment costs and barriers to entry.

The essay concludes by trying to draw some lessons for industrial economists from the organizational ecology literature, and some lessons for organizational ecologists from the industrial organization literature. For economists, there are (at least) four of these:

1. Organizational economists – like ecologists more generally – use evolutionary arguments as the basis of many of their models. This is not a road that economists have chosen to travel down, at least until recently. The appeal of this approach to modelling is greatest in situations where multiple equilibrium prevail, since in these cases the equilibrium which is selected in the market depends on the process by which selection occurs.

2. Much of the empirical and theoretical work done by economists on entry and exit lacks a longer term perspective, and many of the models which economists use seem unequal to the task of accounting for the life-cycle population dynamics which have been repeatedly observed in a number of industries;

3. The principle of competitive exclusion is an argument that helps to account for the structure of niches in the wild. For economists, it is potentially a way to explain how competitive pressures lead to the emergence of differences between firms and about how markets become segmented.

4. Fourth and finally, economists need to take seriously the possibility that organizations are rather rigid and do not change easily in response to market forces. This is often tackled in the economics literature under the heading of adjustment costs and it is possible that more serious thought – particularly toward the issue of whether, and to what extent, adjustment costs are endogenous to, or a by-product of, the competitive processes might help us understand more of what we observe in markets over time.

I.   INTRODUCTION

An economist who trespasses into the intellectual territory currently colonized by ecologists will find that much of the terrain is more than a little familiar. Ecologists are concerned about competition for resources, and they examine equilibria which show how constraints imposed by the environment affect the relative sizes of different populations. Their models often look at how competition affects specialization and the efficiency of resource use, and there are more than a few analogies between the process of speciation in the wild and that of innovation in markets. However, there are differences as well. One is that most members of natural populations do not behave strategically, and, as a consequence, the competitive struggle for resources within and between natural populations can often be described by ecologists in relatively simple terms using relatively simple models. Another difference is that the theory used by ecologists is typically less static than economics: ecologists are less interested in the properties of equilibria and more interested in the process that leads to equilibrium. This is particularly true of population ecologists, who explore models which describe how particular populations rise and fall over time.

Industrial economists have long been interested in what determines the number of firms operating in particular markets, and a good deal of recent research has looked into the determinants of entry into, and exit from, markets. However, this work has had a very strong cross-section feel to it, and it lacks a longer, evolutionary perspective. In fact, there are a number of interesting regularities in the growth or decline of populations of particular organizational types (or forms) over time (of firms in a market, trade unions in a particular society, day care centres in a particular city, etc). Most populations take time to become established. When they finally are established, the population often grows extremely rapidly: growth rates first increase and then gradually diminish over time. Eventually, population size peaks and then declines, sometimes drastically. Much of the interesting work on these population dynamics has been undertaken by a group of sociologists who have drawn upon the work of ecologists (and demographers) and, as a consequence, are often referred to as "organizational ecologists". The goal of this essay is to explore some of the common ground between organizational ecologists and industrial economists. In particular, I want to ask: "*what (if anything) can economists learn from organizational ecology?*" and "*what (if anything) can organizational ecologists learn from industrial economics?*".

The plan is as follows. In Section II below, I will set out the basic structure of the arguments one encounters in the organizational ecology literature that are of most interest to industrial economists. My goal here is to establish the language and basic skeleton of the arguments that we shall draw on later on in the paper, and not to exhaustively survey this literature. The four following sections examine specific features of the arguments made by organizational ecologists, and identify cross-overs between them and similar arguments or issues which have arisen in the industrial economics literature. The topics which will be covered are the following. In Section III, I will explore the relationship between niches and markets; in Section IV, I will look at the issue of legitimating new organizational forms, and analogous processes which arise when new products are introduced into markets; in Section V, I will explore the relationship between population size, market size and market concentration; and, finally, in Section VI, I will examine the presumption of organizational ecologists that organizations are rigid and relatively slow to respond to market events, contrasting it with the (opposite) presumption held by most economists that organizations are relatively pliable. Section VII contains a few final thoughts.

There is one caveat to all of this. As an industrial economist, I (and my colleagues) are interested mainly in one particular type of organization, namely commercial firms that operate in markets. By contrast, organizational ecologists are interested in a much broader range of organizations, including those that do not operate primarily in market environments. Almost everything that I have to say about organizational ecology and industrial economics is restricted to this sub-class of organizations. I have no idea how restrictive this is, but it is almost certainly worth an examination, and by someone who is far better informed about these matters than I am.

.

II. ORGANIZATIONAL ECOLOGY

The two basic building blocks of organizational ecology are the concepts of a *population* and a *niche*.[1] A population is a collection of organizations with a similar degree of environmental dependence, a common reliance on certain resources which limits the range of activities they can undertake and shapes their structure. The unusual feature of this conception is that organizations are defined not in terms of what they do, but it terms of the types of resources that they use and the way that they use them.[2] By this criteria, two organizations which look the same or serve the same purpose may belong to different populations if their resource needs are different: for example, despite the fact that they are both retailers, Amazon and Walmart probably belong in different populations. A niche is just a collection of resources that can sustain a population. Organizational ecologists tend to identify a niche which is specific to each population: the niche of a particular population is the set of resources which can sustain that population. *"Niche overlap"* describes a situation in which two populations compete for a similar set of resources, while *"niche width"* describes the breadth of the resource set needed to sustain a particular population (or, the degree of specialization in resource use of that population).

density dependence and competitive exclusion

The two interesting sources of population dynamics discussed by organizational ecologists are *density dependence* and *the principle of competitive exclusion*. Roughly speaking, the former describes the consequences of within population competition for resources, while the latter examines the effects of between population (or *"diffuse"*) competition. Density dependence describes how the size of a particular population at any time affects the rate of birth into and death from that population. Density typically has two different effects on population size. In most circumstances, density dependence describes the adverse effects of crowding on population growth, and cannot, therefore, be sensibly identified without first ascertaining the *carrying capacity* of the particular niche in question. Carrying capacity is a measure of how many members of a particular population a particular niche can sustain, and it depends on both the resources which that population needs, and the efficiency with which they can be extracted from the environment. It is usual to measure carrying capacity in terms of the maximum number of members of a particular population that the niche in question can sustain. When a population is close to the carrying capacity of the particular niche it inhabits, crowding is likely to reduce birth rates and raise mortality rates, slowing population growth. There are, however, circumstances when population density can stimulate population growth. This usually happens in the early stages of niche colonization (as we shall see) when only a few pioneering organizations are present, and when their activities create positive externalities of various types for other, later arriving population members (e.g. they may help to construct a mutually beneficial infra-structure, and so on).[3]

In it's most extreme (and implausible) form, the principle of competitive exclusion argues that two populations which try to inhabit the same niche cannot co-exist in equilibrium: one will always exclude the other by out-competing it for the use of resources that both of them utilize. Exclusion will be total unless the weaker population can defend itself. This it may be able to do by specializing in the use of those resources which are not intensively used by the dominant population, and avoiding becoming dependent on those resources in the niche which the dominant population uses intensively. Somewhat more generally, competitive exclusion describes a set of forces that generate equilibria in which relatively few populations compete head-to-head for specific resources in a given niche. The main implication of the principle is this: the more populations that inhabit a niche and the tighter are the resource constraints in that niche, the more extensive will be the degree of specialization in resource use by the different populations. The consequence of *tight niche packing* is likely to be a more efficient use of the niche's resource base by it's inhabitant populations.[4]

The best way to appreciate the role that density dependence and competitive exclusion play in the models of organizational ecologists is to think about the process of niche colonization. Suppose that a new set of resources becomes available in a particular place for some reason. Entry occurs as members of a particular population colonize the new niche, and as more and more populations are attracted to the niche. If only one population can colonize the niche, there will eventually be some equilibrium number of individuals of that population in the niche. If more than one population tries to enter, some of them will fail and exit, while the surviving populations will gradually seek out (or perhaps create) sub-niches and differentiate themselves (in terms of their resource use) from others. Wide niches, and niches that extensively overlap with other niches, will obviously sustain a richer, more heterogeneous collection of populations than isolated niches which contain few resources.

legitimation and competition

As interesting as these equilibrium configurations are, what is also interesting is the process by which they are reached. Early colonists in a particular niche are likely to face very different conditions to those faced by later colonists who arrive when the niche is relatively well developed. Since this is bound to affect population growth rates, it is worth building it directly into the argument. One way to do this is to use the concepts of *legitimation* and *competition*.[5] Legitimation describes the process by which a new organization becomes established and accepted, while competition describes the effects of crowding on population growth rates. The basic story is as follows. Suppose that a new niche opens up which supports a new form of organization. Since the organizational form in question is new, there will be relatively few entrants and their failure rate is liable to be high. However, as time passes and all relevant agents become more used to the new organizational form, birth rates will begin to rise and mortality rates fall, increasing net population growth rates. Once the niche starts getting full, competition for resources sets in. As crowding continues and the population gets close to the niche's carrying capacity, birth rates begin to fall, mortality rates begin to rise and net population growth tails off. Eventually the population hits the niche's carrying capacity, and further population growth is impossible.

Legitimation and competition are in fact different forms of density dependence. Legitimation is a process in which density stimulates growth, largely because existing members of the population generate positive externalities for themselves and new entrants. Competition, on the other hand, describes the effects of congestion: existing members of the population create resource scarcities and other negative externalities for themselves and for entrants (and for other less fit populations who also inhabit the niche). Taken together in a simple model they generate something that can look like an S-curve mapping population size over time: legitimation explains the initial convexity

while competition explains the subsequent concavity which (eventually) brings population size into line with the carrying capacity of the niche (or sub-niche) it inhabits.

It is probably worth spelling this out slightly more formally, using a particularly simple model (one which many economists will recognize from the literature on new technology diffusion). Suppose that $N(t)$ is population size at time t, $N(0) > 0$ is the initial size of the population and $N'(t)/N(t)$ it's rate of growth,. Then the simplest version of the competition and legitimization story (sometimes called "*linear density dependence*") can be written as $N'(t) = [\alpha - \beta N(t)]N(t)$. For small $N(t)$, $N'(t) \approx \alpha N(t)$ and the population grows exponentially at constant rate α (reflecting the positive effects of legitimation on population growth). If $\beta > 0$, then crowding occurs, and this eventually slows population growth (this is the competition effect which creates the subsequent concavity). In the limit, $N(\infty) = \alpha/\beta$, which is the carrying capacity of the niche.[6] Of course, the effect of population size on the growth rate $N'(t)/N(t)$ may be more complicated than this (particularly if density has very different effects on birth and mortality rates, or if β varies over time), and this will (needless to say) lead to more complicated time paths than a simple S-curve. When more than one population contests the niche, things are liable to become even more complicated. Let $M(t)$ be the size of the second population. Since the two populations compete for resources, it is natural to write $N'(t) = [\alpha - \beta N(t) - \psi M(t)]N(t)$, and similarly for $M'(t)$. The parameter ψ describes the effects of competitive exclusion or "*cross population density*" (there will be an analogous but not necessarily symmetric parameter describing the effects of $N(t)$ on $M'(t)$). Roughly speaking, if ψ is large relative to β, then the M population is likely to crowd out the N population; if $\psi = \beta$ the two populations are (to all intents and purposes) the same; finally, if ψ is small relative to β, then the two populations may end up co-existing in a stable equilibrium.[7]

III.   NICHES AND MARKETS

At first glance, "niches" and "markets" seem to play a similar role in the models of ecologists and economists, and discussions by organizational ecologists about competition within and between populations inhabiting particular niches seem familiar but just a little weird to economists. However, there are actually important differences between the way ecologists think about niches and the way that economists think about markets. I will discuss two of these differences, and then turn to an area where the two approaches seem to complement each other in a productive way.

definitional differences

The first difference between how organizational ecologists define niches and how economists define markets is that ecologists tend to think of each population as having it's own niche, and they worry about it's width and overlap with other niches. Management scholars tend to think this way as well, for they frequently talk about the market of a particular firm and distinguish it from that of another, apparently competing firm. Economists, by contrast, tend to think of markets as being defined independently of the particular firms that inhabit them: markets are platforms which can host a (potentially) wide variety of different firms, some competing more closely with each other than others. Further, particular firms can inhabit a range of markets simultaneously. For an economist, the basic features of a market are exogenous (at least in the simplest models), while the number and relative size of firms that operate in the market is endogenous. When niches are population specific this distinction between exogenous drivers (of market or niche size) and

endogenous outcomes (population size) becomes harder to maintain. Further, when niches are defined to be population specific, it can be very difficult to talk coherently about inter-population competition.

Second and perhaps more fundamentally, when an economist thinks about market boundaries, s/he typically thinks about demand: products that have a high cross-elasticity of demand belong in the same market, while those which are less perfect substitutes belong in different (but nonetheless related) markets. Economists usually examine market boundaries by estimating cross-elasticities, looking at residual demand curves, correlating price changes between similar products or examining trade flows. Indeed, in economist's minds most markets are linked by a chain of substitution in demand which spreads the effects of price competition more widely than the limits of the particular market where it occurs. The problem with this is that the participants of most markets are producers as well as traders and consumers, and this means that supply side considerations must play a potentially important role in determining the boundaries of markets. When economies of scale are large, firms can lower costs by increasing production volumes, and, when this leads to lower prices, markets will necessarily be larger than they would otherwise be. Similarly, when economies of scope exist, firms that sell a range of related products will achieve lower costs than specialist producers, and when this leads to lower prices, market boundaries will also expand. Further, changes in technology which lead to product or process innovations are bound to alter market boundaries, as are changes in the distribution or wholesale/retail outlets in which products are sold. Concentrating solely on cross-elasticities in demand as a criteria for identifying market boundaries seems to be excessively narrow and even possibly misleading.[8]

resource bases and population sizes

In fact, there is a lot to be said for thinking about markets in terms of resources. Firms need to generate profits to survive and grow, and to do this they need to use various resources. Customers are resources that generate a stream of revenues. In some markets, these revenues are costly to obtain and firms must advertise extensively; in other markets, revenues can be generated relatively easily by an appropriate price structure. Suppliers are also resources, although they typically involve a stream of costs that must be set against the revenues obtained from the inputs they provide. Consumers and suppliers together constitute what might be thought of as the "resource base" that firms use to generate net revenues. In this view, a market is a collection of consumers and suppliers linked by a particular set of production and distribution activities: markets will exist whenever some number of firms can at least break even by undertaking those activities, and they will often take their distinctive features from the particular characteristics of those activities.[9]

Since resources support populations, there must be a relation between the size of the resource base and population size. If, as we have just argued, the defining features (or resource base) of a market lies in the nature of both demand and costs, it is relatively straightforward to work out how the basic features of a market environment determines the (equilibrium) size of the population of firms operating in that market. What makes a firm viable (and able to grow) is an ability to at least break even. Since profits are revenues less the variable and fixed costs used to generate them, it follows that the carrying capacity (i.e. equilibrium number of firms) of any particular market depends on the number of consumers, average net revenues per unit sold (or price-cost margins) and the size of fixed costs of operating in that market. It is worth making this point more precisely. Suppose that all firms in the market have the same variable and fixed costs, and charge the same price. Then, total industry profits are: $\pi = \theta S - Nf$, where θ is the difference between prices and variable costs expressed as a percentage of price (the "price - cost margin"), S is total sales by all N firms (i.e. price times the quantity sold by each firm summed over all firms) and f are the fixed costs per firm.

The carrying capacity of the market is the total number of firms that can operate and just break even, and that is given by $N^* = \theta S/f$. Clearly, larger markets where fixed (or entry) costs are low and price competition is not too vigorous will support larger populations than smaller, more competitive markets where fixed costs are substantial.

The importance of this observation this. If resources support populations, then it must be possible to devise a mapping from fluctuation in the size of resource bases to corresponding (or, induced) changes in population size. If, for example, market size grows logistically (as it often does for new products), then it seems reasonable to believe (all other things taken into account) that the size of the population of firms meeting that demand will also grow logistically. However (as we shall see in Section V below), the relationship between market and population size is nowhere nearly as simple as this, and this raises some questions about just how population sizes are related to the size of resource bases.

niche creation

The principle of competitive exclusion suggests that as firms compete for the same resources, they will begin to specialize, selling their goods/services to different subsets of consumers, using different subsets of suppliers to produce the same or somewhat different goods/services, or both. Ecologists often discuss these issues under the heading of "*resource partitioning*".[10] Confusingly, economists are likely to refer to this as a process which involves segmenting the market, or creating "market niches", but the idea is basically the same. Market segmentation typically means selling to different groups of consumers (upmarket or downmarket, those living east or west of the Mississippi River, etc), while market niches are typically identified by the fact that firms who inhabit them produce somewhat different products (e.g. customized suits, prestige fragrances, etc) and sell them to (presumably) small subsets of consumers. One way or the other, the creation of these niches or segments is likely to be endogenous, reflecting the competitive pressure created by the scramble for resources to generate net revenues.

The interesting question, of course, is what is the limit of this process? This does not seem to have been a major issue for organizational ecologists, but it is one that economists have thought a lot about. The answer is that competition will encourage firms to specialize in "market segments" or "market niches" which are no smaller that what some economists call a "*strategic market*". A strategic market is defined as the <u>minimum</u> collection of products and geographical area that a firm must serve in order to remain viable in the long run, and an easy extension of the formal argument developed above shows that the size of a strategic market depends on the volume of demand, the degree of competitiveness and the height of fixed costs.[11] The size of strategic markets is determined by economies of scale, economies of scope and the diversity of tastes of consumers. If all consumers prefer the same product variant and economies of scale are large, markets will be geographically broad (they may even be global) but narrow in terms of product range. Firms who try to serve only a small group of consumers in such markets are always likely to be vulnerable to large producers who can use their large sales base to leverage economies of scale and lower costs and (consequently) prices. On the other hand, when (individual or different groups of) consumers have a taste for diversity and economies of scale are small, then small ("niche") players can survive by serving a small group of consumers with some particular product variant that they prefer. If economies of scope are large, then firms will have to produce a range of products to protect themselves from the competitive incursions of broad line producers who exploit economies of scope to lower costs or improve their product offering.

Like the partitioning of a niche in the wild, the fragmentation of a market into a series of strategic markets is likely to reflect the degree of competition for resources between firms operating in that market. In the limit as more and more firms try to force their way into a particular market, all of the strategic markets contained in that market will be filled, and positive net entry will cease. Any given market will contain some number of strategic markets (much as any niche in the wild contains a number of sub-niches), and the number of these will effectively determine the degree to which firms can specialize (or limit the number of different populations which co-exist in a particular niche).

IV. LEGITIMATION AND STANDARDIZATION

Legitimation is a process which is used by organizational ecologists to explain the (apparently) slow speed of colonization of new niches by new organizations. Legitimation is about social acceptance, about becoming "taken for granted". When a particular organization has become legitimated, it will be able to secure the resources it needs to grow and prosper. To gain this status, members of the population will need to explain and justify the purpose of their organizations to various interested parties (consumers, suppliers, regulators, etc etc), something which will be easier the more members of the population there are. At low levels of population density, members of a new population will find it difficult to gain acceptance simply because most potentially interested parties will have had little contact with them and are likely to be unfamiliar with their purpose; as population numbers grow however, contact with outsiders is likely to increase exponentially, and that will make acceptance progressively easier to achieve.

establishing new product markets

These arguments bear more than a passing similarity to at least three arguments that have been developed by economists (and other scholars) to explain why <u>new products</u> sometimes take a long time to become established in markets. The first is the *epidemic model of diffusion,* which is a mainstay of the literature that tries to explain why take up rates on new products or processes first rise and then fall over time, tracing out an S-curve over time. [12] The epidemic model is a story about information diffusion, and builds on the observation that the important information which potential adopters need to make a sensible adoption decision is likely to be both experiential and tacit. As a consequence, it can only be passed on by word of mouth from other users, meaning that the speed of take up at any particular time depends on the stock of current users. When the new product first appears on the market, there are very few early users around to generate and transmit information to (i.e. to infect) the large stock of non-users. However, as existing users gradually come in contact with more and more non-users, the stock of users rises and so, as a consequence, does the infection rate. Eventually, the stock of non-users in the population diminishes and the rate of infection falls as the many users find it hard to discover new non-users to transmit information to. Needless to say, this argument is an example of density dependence.

The second explanation about why new products take some time to become established in markets is the *dominant design hypothesis*. The basic idea here is that new products typically emerge from a very wide range of different prototypes or product variants that embody different product characteristics which might be of value to consumers. In very young markets, these product designs compete with each other, a process which stimulates (and facilitates) learning by consumers (of which product characteristics are valuable, of how the product can best be used, and so on) and by producers (of how to produce the product economically). Gradually, consumers come to understand the potential usefulness of the product and to value particular product characteristics. This

"consensus" eventually leads many of them to prefer certain product variants over others. On the supply side, firms that guess right about the emerging consumer consensus rush ahead to invest in plant and equipment to exploit economies of scale and lower prices (or create new distribution channels to make the product more widely available), activities which reinforce the attractiveness of the consensus good. Eventually, most or all of the other product variants disappear (either altogether or into specialized sub-niches), leaving the one (or two) "dominant design(s)" alone in the (mass) market. Note that this argument is basically an example of competitive exclusion.[13]

The third explanation of slow new product take up is about the creation of *standards* (a process which is very similar to the creation of a dominant design). Standardization is a process that can bring large benefits to consumers. A product standard defines how the product will be used (or interface) with other products, it forms the basis of a blueprint for production that allows some firms to invest in realizing economies of scale and others to produce complementary products and it makes it possible for consumers to realize whatever network externalities exist. Since standards enable many different market participants to co-ordinate their activities, getting all of these agents to agree on a particular set of specifications is likely to be a difficult and complicated process. Sometimes standards take a long time to become established ("*excess inertia*") and this slow "choice" process will slow the establishment of the market for the new product. Standards processes are basically a type of legitimating process. [14]

legitimation .... of what?

The very close analogy between the creation of dominant designs and standardization processes on the one hand, and legitimation processes on the other prompts several observations. The first and probably most important is the question of whether it is new organizations or new organizational forms that need legitimation, or the new products and services that they provide. For organizational ecologists, it is organizations that are interesting, but most economists are inclined to think that it is what organizations do that matters more. For example, trade unions were a relatively new type of organization when they first appeared, and it took some time for them to become established. Was this because people needed time to get used to the new organizational form, or because it took time for workers and employers to understand and accept the services that the new organization offered? Day care centres are new organizations, as were banks in the Middle Ages and newspapers after that, but were the relatively slow initial rates of population growth of these organizations a consequence of what they were or what they did?

Needless to say, there is no easy answer to this question. Unusual new products will almost certainly require the development of unusual organizational forms if they are to reach the market, and unusual organizational forms are likely to develop different types of new products and services than other, more conventional organizations. Further, as new products develop, the organizations which provide them may undergo a change (think of the Ford Motor company before and after the Model T) or they may disappear and be replaced by other organizations serving the same purpose in a different way (think of retailing before and after the arrival of the Internet). In fact, one might argue that competition occurs on two levels simultaneously: there is competition between products or services in the market and then, at a second and deeper level, there is a competition between different types of organizations to provide those products or services. As markets evolve, both the products that define them and the organizations which provide those products change over time. It is, however, hard to talk sensibly about the emergence of a market by talking solely (or even mainly) about the organizations which provide whatever it is which is traded on that market. Market based organizations probably gain most of their legitimacy from what they do, not what they are. [15]

The analogy between dominant designs, standards and legitimation prompts a second observation, and this is that it is probably not helpful to think of legitimation as a simple density dependent process. Think of typical standards games. The product that eventually becomes the standard is often that which everyone expects to prevail, and not necessarily that which is best suited to consumers needs or cheapest to produce. Under these circumstances, consumers and (even more clearly) producers have every incentive to behave strategically and try to manipulate the "choice" between different standards in a way that suits them. This includes producers of those products embodied in the "old standard" which the "new" standard displaces. As is well known to industrial economists, this feature of standards battles generates a wide range of potential equilibria, and the eventual choices made by the market can look pretty arbitrary. Describing all of this as a simple density dependent process may seem plausible at first sight (the early capture of a large market share can insure that a fast first mover wins the standards battle), but it can be misleadingly simple (a second mover may halt the first movers momentum by persuading potential consumers to wait a little longer). It seems much more sensible to think of this process in game theoretic terms, and map out the actions which different players (different organizational forms) use to win the battle (i.e. become legitimated). Indeed, it is these actions which both establish the standard and, at the same time, determine the number of users of that standard.

The third and final observation which emerges from the analogy between standardization and legitimation processes is the simple one that these processes take their unusual form because of competitive exclusion. This is very clear in the case of standards battles (or in the creation of a dominant design): network externalities and large economies of scale in production make it unlikely that more than one standard will prevail in equilibrium (and hence the need to make a choice). Similarly, new organizational forms that require legitimation compete with other forms are already legitimated or are seeking to become so. New forms of organizations displace older, more traditional organizations which provided similar goods or services (or might have gotten around to doing so in due course), and legitimation is a process by which the former displace the latter in the general perception. In practice, this means that it is difficult to understand arguments about "legitimation" taken in abstract: when a new type of organization becomes accepted, it does so only because the legitimacy of several "similar" types of already established organizations have been re-evaluated. While the size of the population of the new type matters in this, what also matters (and may matter more) is the size of already established organizational populations and the actions which they take in response to the appearance of the new form (compare the reception given to trade unionism in the US and in different European countries). All of this is to say that legitimation is likely to be part of a process of competition which occurs between different populations, "old" and "new".

V. COMPETITION AND CONCENTRATION

Organizational ecologists concentrate most of their intellectual entry on understanding variations in population sizes over time. The usually do this by modelling variations in *vital rates*"; i.e. entry and exit. However, selection in markets often rewards existing firms differently, and this means that there is a third driver of market structure that needs to be considered: differential growth between firms. Whenever different firms in the same market grow at different rates, market structures can become more or less concentrated.

competition and congestion

Economists have always thought of competition in terms which are similar to the arguments about density dependence put forward by organizational ecologists. The analogy is particularly clear with Cournot competition. Firms are assumed to choose output, and these choices together determine market prices. In an equilibrium with N identical firms producing a homogeneous product, prices will be inversely related to N exactly as one might expect from a density dependent process. If at this equilibrium, prices are above average costs, then more firms will enter and prices will fall. On the other hand, if too many firms choose to produce too much output, then market prices will fall below average costs (i.e. the market will become too congested) and some firms will exit. When the products in the market are differentiated, similar principles apply (although in this case the amount of congestion felt by firm i will differ from that felt by firm j if the cross elasticity between product i and (let us say) other products k differs from that between j and k).

Somewhat more generally, it is beyond doubt that there is a useful analogy to be made between competition and density as measured by the number of firms in the market. Further, it is not hard to see how this insight can be made to produce a prediction that the number of firms in a market will increase at gradually increasing and then decreasing rates over time. As before, let profits be $\pi(N) = \theta S - Nf$, so that the equilibrium number of firms present at any time, $N^*(t) = \theta(t)S(t)/f(t)$, depends on the values of these variables over time. Density can, in principle, have three effects on $\pi(N)$ at any time t: increases in N may help to "legitimate the market" or stimulate diffusion of usage, thus increasing S; increases in N are likely to stimulate price competition, reducing θ; and increases in competition caused by increases in N may stimulate advertising or R&D wars which effectively increase f. Since the first effect is likely to be present only in the early stages of the market, while both the second and third effects will occur only after the market has been established, it is not too hard to see the basis of an argument which suggests that the population growth rate, $N'(t)/N(t)$, will first rise and then fall with $N(t)$.

However, the analogy between competition and density breaks down if firms choose prices rather than quantities (i.e. if competition is Bertrand). In this case, prices are likely to fall to the level of average costs if even as few as two firms are in the market, a state of affairs which does not seem easy to square with the label "congested" (although of, course, both firms will be producing a large quantity of output, and it is the total volume of output produced which causes the "congestion" which lowers prices). The analogy between competition and density also breaks down whenever potential entry constrains behaviour. Suppose, for example, a single monopolist operates in a market surrounded by many potential entrants who will enter if price rises above average costs. Clearly the most likely equilibrium outcome in this situation is a single firm producing at price equals average cost. Measured in terms of the number of active firms, the market can hardly be described as congested. Finally, consider what might happen as firms begin to colonize a market. Early movers will be aware that more entrants are likely to follow them into the market, and will try to pre-empt them in various ways. This may result in an equilibrium with relatively few firms present in the market, although pre-empted potential entrants will have played a role in shaping it's structure. These examples all turn on two points: first, the number of active firms is not necessarily related to the total quantity of output produced (except in the Cournot model when all firms are identical), so that density as measured by firm numbers differs from that as measured by total quantity produced and sold; and, second, firms do not have to be active to affect market outcomes, meaning that the effects of congestion can be present even if the firms that cause it are not.

shakeouts

Be this as it may, it is worth stressing that there are at least two serious problems with the argument made by organizational ecologists that competition will gradually retard the growth of industry

populations and bring firm numbers into line with the carrying capacity of the market. The first problem is that, in practice, most markets experience a major shakeout in the number of producers at least once in their history, while the second is that this shakeout often occurs as the market in question is expanding, leading to an inverse relationship between firms numbers and market size. Let us consider each problem in turn.

The arguments put forward about legitimation and competition in a linear density dependent model generate an S-curve tracing out the size of industry populations over time. S-curves do not, however, turn down: numbers rise at rising and then falling rates, hitting a long run equilibrium asymptotically when the rate of growth drops to zero. If a population grows according to the rule $N'(t)/N(t) = [\alpha - \beta N(t)]N(t)$ from an initial starting point $N(0) < \alpha/\beta$, then it will never overshoot the carrying capacity, $N^* = \alpha/\beta$, or decline. Since the facts typically suggest that this is not the case, this particular property of the model is a serious shortcoming. There are, of course, several ways that it might be remedied. One possibility is to allow for an entry process driven by expectations that contains enough positive feedback to create speculative bubbles of optimism which entice too many firms to enter when market fundamentals will not justify entry on that scale[16]. Another is to allow for non-linear effects of density on population growth rates. A third possibility is to allow for what organizational ecologists call "*density delay*".[17] This is an argument which suggests that organizations founded in period of high density bear a permanent scar and are always at least slightly more likely to exit than organizations of the same size and age who were founded in easier times. Density delay might arise because organizations founded in crowded niches have poor organizational designs, have been starved of particularly crucial resources or have been shunted off into unpromising sub-niches. If, as organizational ecologists believe (see Section VI below), organizations are not very flexible, these early choices freeze such organizations into sub-optimal structures and make them vulnerable as increasing density increases competitive pressures.

What makes one uneasy about these remedies is that the shakeouts which occur particularly in the early stages of many markets are often very extensive, and they sometimes occur as the market enters a fast growth phase (usually associated with the creation and development of a mass market). There are several arguments that one might use to account for this odd and unexpected negative correlation between the number of firms in a market and the size of that market over time.[18] The dominant design hypothesis is one. Before a dominant design is established, the market is likely to be populated by many firms, each promoting it's own product variant. However, when a dominant design becomes established, only those firms who have been championing that (or very similar designs) will survive. The establishment of the dominant design is, of course, what is needed to create a mass market, and hence one is likely to observe the market to grow most rapidly at exactly the same time that its population shrinks. Another argument which produces a similar prediction turns on the inflation of sunk costs which arises when firms compete to establish their brands, invest in process innovation, create new distribution channels or attempt to buy up scare inputs. Such expenditures typically have three effects: they stimulate market growth, they raise fixed costs and so limit the number of firms able to survive on the market, and they create differential advantages between firms, allowing some to displace others. Although it is by no means inevitable, active competition can stimulate an extremely rapid rise in such costs, and that will almost certainly induce exit on a large scale and raise levels of market concentration.[19]

two ecological models of market concentration

When industry populations fall sharply, market concentration (i.e. the percentage of sales accounted for by the leading firms) is likely to rise. This is an interesting phenomena to explain, and organizational ecologists have developed two lines of argument that is a very interesting alternative

to the kinds of models of market structure which economists typically explore. The arguments are based on notions of "*resource partitioning*", and they are stories about competitive exclusion between two populations of firms who try to colonize the same market. I will refer to them as "*competition between generalists and specialists*" and "*r,K competition*".

Suppose that we are considering a market that has many sub-niches composed of consumers who prefer slightly different variants of the same basic product. There are essentially two strategies which firms in this market might follow. Some firms – "*specialists*" for short – might opt to colonize one particular sub-niche (or strategic market), and serve it exclusively. Other firms – "*generalists*" – might try to develop a single, all purpose product or a compact product range which enables them to serve a number of sub-niches effectively. The generalists will generally be the firms we recognize as market leaders, and their grip on the market will be larger the larger are economies of scale and scope and the more homogeneous are consumer's preferences.[20] Competition between generalists is likely involve exploiting economies of scale to drive prices down, and may also involve an inflation of fixed costs through increases in advertising or R&D intensity that will, in time, induce a shakeout amongst generalists. One way or the other, their presence will force specialists into sub-niches, and encourage them to rely on different resources. Indeed, it may be that the general, all-purpose products or services produced by generalists stimulates a demand for more customized specialist products, creating more sub-niches for specialists to populate. In this case, one might argue that the two types of firms are symbiotic: the presence of each creates opportunities for the other and, in this sense, each "releases" resources that the other needs.

One basic strategy choice that firms might make is that between operating as a specialist or operating as a generalist. Another basic choice is between what are sometimes referred to as "r-strategies" and "K-strategies".[21] r-strategies involve the quick, opportunistic use of resources: such firms are focussed on short run returns, and operate by spotting opportunities and acting quickly to take advantage of them. K-strategies involve making substantial investments to develop the market and open up protected positions of market power: such firms are necessarily slower to act, but are much more powerful competitors than r-strategists. Consider how a market might develop following a major technological breakthrough. Initially, no one is likely to be very clear about what kind of opportunity is available and how it might best be exploited. In these circumstances, only r-strategies are likely to be worth pursuing. However, as the market grows and develops (filling up with r-strategy firms), it becomes more and more attractive to consider choosing a K-strategy. Eventually one or more firms do so, and this causes two things to happen. On the one hand, the investments that these firms make help to develop the market and may usher in a phase of extremely rapid market growth; on the other hand, the arrival of several K-strategy firms will almost certainly induce the exit of many of the early r-strategy types. As this displacement process occurs, one observes a fall in industry numbers, a rise in industry concentration and an increase in market size.

ecological and economic models of market structure

There seem to be two observations worth making about these arguments. The first is that in these organizational ecology models, concentration is a measure of firm heterogeneity: it describes the collective market share of generalists or K-type firms. Descriptively, this has a certain intuitive appeal: Microsoft has a very different strategy and structure from the many boutique software houses which operate in the same industry, and it is not entirely clear that it competes head-to-head with many of these boutiques. Economists are used to thinking of concentration as a measure of market power (i.e. of power to control price) or a reflection of differential efficiency (market leaders have a large market share because their costs are lower than other firms). These ways of

interpreting concentration indices have strong normative implications. If, however, concentration is merely a measure of the relative size of the population of one type of firm in a particular market, then it is not quite so clear that high levels of concentration are necessarily a cause for concern.

The second observation is that these two arguments have the common feature that they are basically about how two (or more) populations of firms come to colonize a single market. This is important because concentration is about size inequalities (as well as fewness of numbers), and to explain levels of concentration one must explain the (probably endogenous) emergence of differences between firms. One can do this either by letting some firms change their characteristics (e.g. by making investments in advertising to create a brand name or by investments in R&D to develop product or process innovations), or by assuming that firm characteristics are relatively fixed and working with a model in which the proportion of firms of different types varies over time. Economists have always been inclined towards the first route; organizational ecologists, on the other hand, have typically followed the second. The choice between them depends, of course, on how difficult it is for firms to adopt new strategies as market circumstances change, and this leads us to the question of just how flexible organizations are.

VI. STRUCTURAL INERTIA AND LOCK-IN

The basic premise which underlies the interest of organizational ecologists in the dynamics of industry populations is the view that organizations are relatively inflexible, meaning that organizational characteristics change more slowly than the formation of new organizations. Hence, when exogenous shocks dictate the need for a change in industry structures, the birth of new organizations and the death of old ones bears the brunt of the change (i.e. selection dominates adaptation as a source of change).

organizational adaptability and selection

The view that organizations are relatively inflexible (particularly large ones) is not confined to organizational ecologists. "*Structural inertia*" has recently become a relatively hot topic in the management literature, stimulated by a number of examples where leading firms proved to be unable to adapt to market changes, and were displaced by brash, young entrants.[22] There are quite a number of hypotheses about the causes of structural inertia in this literature: internal resource reallocation decisions inevitably become "political", meaning that they are likely to be slow and full of inefficient compromises; slightly more broadly, narrow managerial mindsets or the lack of genetic diversity amongst top managers, both of which might make them generally unimaginative; the tendency for precedents to become normative standards and for current versions of recent history to constrain the perception of options for the future; and hubris and arrogance, something which is particularly likely to affect relatively successful firms and make them slow to adapt to changes in their environment. Those economists who are concerned about structural inertia usually describe it as a consequence of "*rent displacement*": firms that already generate profits from exiting activities are less likely to introduce new products which displace (or cannibalize) these earnings than outsiders who have nothing to lose. As a consequence and until it becomes plain that existing rent streams are lost, they will have weaker incentives to innovate and cannibalize their current products and the rents that they generate. Like the argument about hubris and arrogance, this particular argument is interesting because it suggests that structural inertia is a consequence of

success, meaning that positions of market leadership are unlikely to persist for long periods of time.[23]

This last observation is related to an argument sometimes made by organizational ecologists that the factors which create inertia in some circumstances can also be a source of competitive advantage in other circumstances. This means that inertia may the consequence of selection pressures in very competitive markets; i.e. that it is selected for in certain circumstances, or is a by-product of selection based on other, related factors. One of these factors is the need for reliability. Large organizations that deliver a product or service to many consumers need to insure that the delivery is exactly right (and as promised) each time a sale occurs, and this requires them to develop tight internal control systems[24]. Firms need stimulate their employees (and also important suppliers and customers) to act as a coherent, self-monitoring team (and to persuade individuals to forsake opportunities for opportunistic behaviour). This is liable to require managers to make a number of long term investments or commitments which constrain their flexibility to act in the short run (e.g. commitments to lifetime employment will not be credible if employees are laid off in every cyclical downturn). Firms also make investments in plant to exploit scale economies or investments in marketing, and, since these investments usually involve a substantial component of sunk costs, they too lock firms in to particular activities. Finally, firms sometimes get "*too close*" to their customers, meaning that they focus too much attention on the particular sub-niche which they currently operate in and miss out on promising (or ultimately threatening) developments which occur elsewhere in the market. Most of these arguments suggest that young firms operating in new markets will be more flexible that older firms who operate in well established markets.

barriers to entry and adjustment costs

All of these arguments create a strong presumption that organizations are likely to be rather inflexible (particularly large, successful ones in well established markets). By contrast, most economists share a (usually unstated) presumption that organizations are fairly pliable, and we have traditionally worried more about the strength of selection pressures than about the ability of firms to adapt to change. Constraints on the ability of firms to change their activities are traditionally discussed under the heading of "*adjustment costs*", while constraints on the ability of firms to enter markets and displace inefficient incumbents are discussed under the heading of "*barriers to entry and exit*". Although there is much dispute about how large they are in particular cases, most economists regard barriers as relatively permanent features of markets while adjustment costs are typically viewed as causing no more than transitory difficulties for firms anxious to make changes which will increase their profits. If one supposes that "transitory" is a synonym for "insubstantial" (as sometimes happens when people think uncritically), then one is almost certain to think that the forces that impede selection are more important than those which slow adaptation. Further, there is a large economics literature on strategic competition which describes the various strategies which incumbents might follow to block or pre-empt entrants. Since many of these actions are effectively adaptations to the changed environment which makes entry possible in a particular situation, many economists have developed an unstated presumption that incumbent firms are often adaptable enough to make entry unnecessary. This is, of course, exactly opposite to the presumption shared by organizational ecologists.

It is possible to imagine a number of ways in which this difference in view might be resolved empirically. However, it is also possible that both presumptions are misplaced. Two observations are pertinent in this context: first, selection and adaptation might be complements and not substitutes as mechanisms of change; and, second, the pliability of firms and the height of entry barriers may vary in systematic ways over time.

The argument which suggests that adaptation and selection are not substitutes turns on the fact that barriers to entry can cause two problems: they limit the force of selection pressures by blocking entry, and they weaken the incentives of protected incumbents to respond to change and, as a consequence, reduce the speed of adaptation. If adaptation and selection are substitutes, then one will observe either one or the other mechanism guiding markets to a new equilibrium when circumstances change. If, however, barriers to entry block entry <u>and</u> slow adaptation by incumbents (who need not fear competitive challenges from entrants), one will observe either no change or change which occurs through entry and incumbent adaptation simultaneously. When barriers to entry are high, little or no change occurs; when barriers are low, on the other hand, change occurs either through selection (if barriers to entry and exit are relatively low) or adaptation (if adjustment costs are relatively low).

Thinking about selection and adaptation in an evolutionary perspective also suggests that the pliability of firms and the height of entry barriers are likely to co-evolve together, effectively making them complements and not substitutes. The argument proceeds as follows. Early in the life of a new market, technological opportunities are likely to be fecund and largely unexplored, and consumer preferences are not yet well formed. Entrant firms are generally small and entry barriers are low; as firms know that product specifications are undetermined, they retain a willingness to experiment and adapt their ideas to market developments. However, at some stage, the market becomes a mass market. This may arise because a dominant design emerges, or just because many consumers become aware of the virtues of a range of related product variants. Either way, the big issue for producers is scaling up their production and selling operations. This almost always involves major investments in exploiting economies of scale, in developing and managing distribution channels, in creating brand names, and so on. To adapt, organizations must develop rigid internal routines, and create teams inside the firm and partnerships with significant outside players to support these routines. All of this begins to cause lock-in for the various reasons described above. Note that the firms who are first to make these investments often gain an almost permanent competitive advantage over their rivals (confusingly referred to as a *"first mover advantage"*), and, in this sense, it seems clear that selection pressures may force firms to make investments that can lock them into particular activities. These investments also create entry barriers, for they force new firms to enter in on a large scale to be competitive or to spend enormous amounts of money to counter any product differentiation or cost advantages which incumbents may have created for themselves.

VII. SOME FINAL THOUGHTS

The goal of this essay has been to look at the literature on organizational ecology and ask what can economists learn from it. Since trade is normally two-way, such an exercise is likely to throw some light on the question of what (if anything) organizational ecologists can learn from economics. Under these circumstances, it is natural to group my final observations under these two headings.

what (if anything) can economists learn from all of this?

There are, I think, four areas where the work of organizational ecologists might make a substantial contribution to the work of economists. The first of these is to help economists develop an evolutionary perspective on the phenomena that they seek to explain. Economists worry a lot about both the existence and the salient properties of equilibria, but do not spend much time thinking

about how equilibria are established.[25] However, at least some markets abound in externalities that create multiple equilibria (standards battles come to mind), and in these situations one needs to understand how the market stumbles towards equilibrium in order to know which equilibria it eventually gets to. That is, when processes are path dependent, the path is as interesting as the eventual steady state.[26] This seems to be particularly the case with the diffusion of new technologies or the take-up of new products. While economists typically treat this as a demand side phenomena, the supply side focus of organizational ecologists on the evolution of market structures makes it plain that supply and demand do in fact co-evolve, that S-curves describing new product diffusion are (or should in principle be) related to those describing population numbers. Modelling this in a sensible and coherent way remains a major challenge.

Second, organizational ecologists and economists have both done quite a lot of work modelling entry and exit rates. The two literatures overlap in several areas (e.g. economists share some of the concerns that organizational ecologists have with mapping out the effects of age on survival rates[27]), and there are some interesting techniques and methodologies which organizational ecologists use which economists might find interesting to experiment with. However, the main area where economists can learn from organizational ecologists is in developing a broader, whole life cycle perspective on entry and exit. Much of the economics literature on entry and exit is cross section in nature, and almost none of the models economists use to explain particular incidents of entry in particular sectors at particular times can be easily adapted to explain the longer run movements in entry and exit that we typically observe over an industry's life cycle. At the very least, we ought to use models of entry and exit which encompass (or can easily be made to do so) most of the known facts about entry and exit, including those generated by organizational ecologists.

Third, the principle of competitive exclusion is a tool which may make it much easier for economists to unravel the source and structure of both product differentiation and production specialization in markets. Business schools are full of professors who teach their MBAs to seek out some kind of distinctive or unique advantage, and to avoid head-to-head confrontation with rivals. Entrant firms are instructed not to assault barriers head on, but to circumvent them by expanding the market or changing the basis on which competition take place. This is, in a sense, competitive exclusion in practice. For economic theorists, competitive exclusion challenges the usefulness of the perfectly competitive benchmark. In the conventional story, prices above average costs induce the entry of yet more firms producing exactly the same product as incumbents, and this drives prices down. However, if competitive exclusion is the rule, then new entrants will not choose to compete head on with incumbents if they can help it (i.e. unless they are very much more efficient); instead, they will differentiate themselves in various ways that do not necessarily drive prices down. Competitive exclusion suggests that market segmentation and the creation of market niches is likely to be endogenous to the competitive process.

Competitive exclusion is about creating or exaggerating differences between firms, and this is important because it is what underlies the rise of concentration in markets. Thus, to explain movements in concentration, one will almost certainly need to explain the origin and persistence of permanent differences between firms. This has always been difficult for industrial economists, and it seems clear from a reading of the organizational ecology literature that one way to deal with the problem is to suppose that markets are colonized by several populations of firms of different types (i.e. pursuing different (relatively inflexible) strategies using different production or distribution structures). If it is hard to model how firms undertaken major changes in their activities, then there is a genuine economy to be gained by supposing that they cannot and modelling what we do understand, namely the competition between different types of firms in the market. This approach is

not without precedent in economics (see, for example, the models of "noise traders" in the behavioural finance literature), but it is one that we have not explored very fully.

Fourth and finally, economists need to take seriously the possibility that leopards do not change their spots. Firms sometimes find it difficult to revise their strategies, and usually find it difficult to reorganize their structures. This means that their choices at any one time can permanently constrain their options, limiting their ability both to innovate and also to imitate their more successful rivals. We need to know more about the factors which give rise to adjustment costs, and more about what constrains the ability of organizations to change. The theory of the firm in economics is pre-occupied by the question of why firms exist, and it is both very narrow and very static. Further work in this area might be usefully extended to address the question of how firms grow and develop over time, and this, in turn, will force people to think through issues associated with what makes change difficult for firms. Doing this might help us gain a deeper understanding of when selection pressures are likely to dominate adaptation as a mechanism of change in markets.

what (if anything) can organizational ecologists learn from all of this?

As an economist reflecting on the organizational ecology literature, four things strike me as problem areas which could, in due course, limit the applicability of this body of work. The first is the heavy reliance on density dependence to drive dynamics. In simple biology models, this seems fine: if too many ants inhabit a particular square foot of forest, birth rates are liable to plummet and mortality rates will almost certainly rise. However, the difference between ants and the people who build and then manage organizations is that the latter sometimes think and act strategically. A manager who acts in anticipation of entry is not responding to congestion, but to the threat of it; most managers who makes choices today that involve some form of sunk costs will almost certainly try to anticipate what competitive conditions tomorrow will look like. In both cases, it is not the current state (much less the current density) of the market which matters (although clearly it is not wholly irrelevant).

The most obvious application of this point is in the area of legitimating processes. As we have noted, it is not always clear what is being legitimated, a new organization or a new product or service which that organization is pioneering. Further, almost every model developed by economists which explores specific mechanisms by which (something like) legitimation happens reveals that density dependence is much too simple a story. Legitimation is something which matters quite a lot to those affected (the champions of the new organizational form, and the defenders of the older, potentially displaced form), and it is hard to take seriously the suggestion that they do not play a strategic game to get their way. This, in turn, almost certainly means that expectations, pre-emptive moves and other competitive tactics will probably be more important in establishing legitimacy than the current population size.[28]

The second observation is that there seems to me to be too much reliance on single population models in the organizational ecology literature. This is partly reflection of the over-reliance on density dependence in this literature (density dependence is hard to define easily and operationally when more than one population is present), and partly a reflection of the difficulties there are in writing specific models of inter-population competition that are susceptible to empirical implementation.[29] As is probably clear by now, it seems to me that competitive exclusion is both a more interesting and a more powerful insight into the competition for resources in niches, and this is necessarily a multiple population story. In practice, I think that this means that modelling the size of an industry population is always going to be rather less interesting than modelling the evolution of concentration in a particular niche (or market) market, and that modelling the evolution of a

particular market in isolation is never going to be as useful as modelling the co-evolution of several populations in overlapping niches (or markets).

Third, organizations do change, and to start from the premise that they do not seems unreasonable. What strikes an economist reading the organizational ecology literature is not just the focus on modelling the number of firms (or organizations) over time rather than modelling the evolution of concentration levels, but the absence of a way to think about those organizational changes which dominate the newspaper headlines, namely mergers. One does not observe (say) birds of a particular species in the wild "merging" to create a bigger and better bird (much less birds of different species doing so), but one does see organizations (and not just market based organizations) doing exactly this. This is a form of organizational change which may well be endogenous to the evolution of market (waves of consolidation often happen in mature markets for example), and it often seems to be driven by bandwagon effects (firms often start buying up their rivals to prevent their rivals from buying them out, or because they are afraid of being left out). And, consolidation waves can have a profound effect on the subsequent development of the market.

Fourth and finally, organizational ecologists have a very narrow conception of organizational performance, namely survival: either an organization survives or it does not, and that is about all there is to it. This is something which they sometimes think of as a virtue[30], but economics find it rather unsettling. Although populations are homogeneous in the eyes of organizational ecologists, in reality they are not. Firms differ in size (for a start), and this means that some have outgrown others, probably because they have generated enough profits (or have engineered a sufficiently rich cash flow) to finance the investment needed to outgrow their rivals. This is an interesting and important part of the evolutionary process, and to make any progress with it, one needs to look at performance measures such as growth rates or profitability. Survival is interesting, but it is just not rich enough to describe the experiences that firms go through as their markets change and develop over time.

REFERENCES

Aldrich, H., C. Zimmer, U. Staber and J. Beggs (1994) "Minimalism, Mutualism and Maturity: The Evolution of the American Trade Association Population in the 20th Century", in J. Baum and J. Singh (eds) <u>Evolutionary Dynamics of Organizations,</u> Oxford University Press, Oxford.

Aldrich, H. (ed) (1999) <u>Organizations Evolving</u>, Sage, Thousand Oaks, Ca.

Arrow, K. (1962) "Economic Welfare and the Allocation of Resources for Invention", in R. Nelson (ed) <u>The Rate and Direction of Inventive Activity</u>, Princeton University Press, Princeton New Jersey.

Barnett, W. (1990) "The Organizational Ecology of a Technological System", <u>Administrative Science Quarterly,</u> 35, 31-60.

Barnett, W. and G. Carroll (1987) "Competition and Mutualism Among Early Telephone Companies", <u>Administrative Science Quarterly</u>, 32, 400-421.

Barnett, W. (1996) "The Dynamics of Competitive Intensity", <u>Administrative Sciences Quarterly</u>, 42, 128-160.

Barnett, W. and M. Hansen (1996) "The Red Queen in Organizational Evolution", <u>Strategic Management Journal</u>, 17, 139-158.

Barnett, W. and G. Carroll 91995) "Modelling Internal Organizational Change", <u>Annual Review of Sociology, 1995, 217-236.</u>

Barron, D. (1995) "Credit Unions", in Carroll, G. and M. Hannan (eds), <u>Organizations in Industry</u>, Oxford University Press, Oxford.

Barron, D., E. West and M. Hannan (1994) "A Time to Grow and a Time to Die", <u>American Journal of Sociology</u>, 100, 381-421.

Baum, J. and C. Oliver (1991) "Institutional Linkages and organizational Mortality", <u>Administrative Science Quarterly</u>, 36, 187-218.

Baun, J. (1996) "Organizational Ecology", in S. Clegg, C. Hardy and W. Nord (eds) <u>Handbooks of Organizations</u>, Sage, Thousand Oaks, Ca.

Baum, J. and J. Singh (1994) "Organizational Niches and the Dynamics of Organizational Founding", <u>Organization Science</u>, 5, 483-501.

Baum, J. and J. Singh, (1994) "Organizational Niches and the Dynamics of Organizational Mortality", <u>American Journal of Sociology</u>, 100, 346-380.

Baum, J. and C. Oliver (1992) "Institutional Embeddedness and the Dynamics of Organizational Populations", <u>American Sociological Review</u>, 57, 540-559.

Boone, C. and A. Van Witteloostuijn (1995) "Industrial Organization and Organizational Ecology: The Potential for Cross-Fertilization", Organization Studies, 16, 265-298.

Brittain, J. and D. Wholey (1988) "Competition and Coexistence in Organizational Communities: Population Dynamics in Electronic Components Manufacturing", in G., Carroll (ed) Ecological Models of Organizations, Ballinger, Cambridge, Mass.

Carroll, G. (1985) "Concentration and Specialization: Dynamics of Niche Width in Populations of Organizations", American Journal of Sociology, 90, 1262-1283.

Carroll, G. (1997) "Long Term Evolutionary Change in Organizational Populations: Theory, Models and Empirical Findings in Industrial Demography", Industrial and Corporate Change, 6, 119-143.

Carroll, G. and M. Hannan (1989) "Density Delay in the Evolution of Organizational Populations: A Model and Five Empirical Tests", Administrative Science Quarterly, 34, 411-430.

Carroll, G. and M. Hannan (1995) Organizations in Industry, Oxford University Press, Oxford.

Carroll, G. and M. Hannan (2000) The Demography of Corporations and Industries, Princeton University Press, Princeton, New Jersey.

Christensen, C. (1997) The Innovators Dilemma, HBS Press, Boston, Mass.

Delacroix, J. and H. Rao (1994) "Externalities and Ecological Theory: Unbundling Density Dependence", in J. Baum and J. Singh (eds) Evolutionary Dynamics of Organizations, Oxford University Press, Oxford.

Delacroix, J. A. Swaminathan and M. Solt (1989) "Density Dependence versus Population Dynamics: An Ecological Study of Fails in the California Wine Industry", American Sociological Review, 54, 245-262.

Farrell, J. and G. Saloner (1985) "Standardization, Compatability and Innovation", Rand Journal of Economics, 16, 70-83.

Farrell, J. and G. Saloner (1986) "Installed Base and Compatibility", American Economic Review, 76, 940-955.

Foss, N. (1997) Resources, Firms and Strategies, Oxford University Press, Oxford.

Freeman, J. and A. Lomi (1994) "Resource Partitioning and Foundings of Bank Cooperatives in Italy", in J. Baum and J. Singh (eds) Evolutionary Dynamics of Organizations, Oxford University Press, Oxford.

Freeman, J. and M. Hannan (1983) "Niche Width and the Dynamics of Organizational Populations", American Journal of Sociology, 88, 1116-1145.

Geroski, P. (1999) "Thinking Creatively about Markets", International Journal of Industrial Organization, 16, 677-697.

Geroski, P. (2000) "Models of Technology Diffusion", forthcoming, <u>Research Policy</u>.

Geroski, P. and M. Mazzucato (2000) "Modelling the Dynamics of Industry Populations", mimeo, London Business School.

Gilbert, R. and D. Newberry (1982) "Pre-emptive Patenting and the Persistence of Monopoly", <u>American Economic Review</u>, 72, 71-83.

Gort, M. and S. Klepper (1982) "Time Paths in the Diffusion of Innovations", <u>Economic Journal</u>, 92, 630-653.

Greve, H. (1999) "The Effect of Core Changes on Performance: Inertia and Regression Toward the Mean", <u>Administrative Sciences Quarterly</u>, 44,

Hamel, G. and C. Pralahad (1994) <u>Competing for the Future</u>, HBS Press, Boston, Mass.

Hannan, M. (1997) "Inertia, Density and the Structure of Organizational Populations: Entries in European Automobile Industries, 1886-1981", <u>Organizational Studies</u>, 18, 193-228.

Hannan, M. , G. Carroll, E. Dundon and J. Torres (1995) "Organizational Evolution in a Multinational Context: Entries of Automobile Manufacturers in Belgium, Britain, France, Germany and Italy", <u>American Sociological Review</u>, 60, 509-528.

Hannan, M. and G., Carroll (1992) <u>Dynamics of Organizational Populations: Density, Competition and Legitimation</u>, Oxford University Press, Oxford.

Hannan, M. and J. Freeman (1977) "The Population Ecology of Organizations", <u>American Journal of Sociology</u>, 82, 929-964.

Hannan, M. and J. Freeman (1984) "Structural Inertia and Organizational Change", <u>American Sociological Review</u>, 49, 149-164.

Hannan, M. and J. Freeman (1988) "The Ecology of Organizational Mortality: American Labour Unions, 1836-1985", <u>American Journal of Sociology</u>, 94, 25-52.

Hannan, M. and J. Freeman (1989) <u>Organizational Ecology</u>, Harvard University Press, Cambridge, Mass.

Hannan, M., J. Ranger-Moore and J. Babazak-Holl (1990) "Competition and the Evolution of Organizational Size Distributions", in Singh, J. (ed), <u>Organizational Evolution</u>, Sage Publications, London.

Hannan, M. (1998) "Rethinking Age Dependence in organizational Mortality rates", <u>American Journal of Sociology</u>, 104, 85-123.

Hannan,. M. and J. Freeman (1988) "Density Dependence in the Growth of Organizational Populations", in G. Carroll (ed) <u>Ecological Models of Organizations</u>, Ballinger, Cambridge, Mass.

Haveman, H. (1994) "The Ecological Dynamics of Organizational Change: Density and Mass Dependence in Rates of Entry into New Markets", in J. Baum and J. Singh (eds) Evolutionary Dynamics of Organizations, Oxford University Press, Oxford.

Hunt, C. and H. Aldrich (1998) "The Second Ecology: Creation and Evolution of Organizational Communities", Research in Organizational Behaviour, 20, 267-301.

Jovanovic, B. and G. MacDonald (1994) "The Life Cycle of a Competitive Industry", Journal of Political Economy, 102, 322-347.

Katz, M. and C. Shapiro (1985) "Network Externalities, Competition and Compatibility", American Economic Review, 73, 424-440.

Kay, J. (1990) "Identifying the Strategic Market", Business Strategy Review, Spring, 1-24.

Klepper, S. (1997) "Industry Life Cycles", Industrial and Corporate Change, 6, 145-182.

Klepper, S. (1996) "Entry, Exit and Growth and Innovation over the Product Life Cycle", American Economic Review, 86, 562-583.

Klepper, S. and K. Simons (1997) "Technological Extinctions of Industrial Firms: An Inquiry into the Nature and Causes", Industrial and Corporate Change, 6, 379-460.

Klepper, S. and J. Miller (1995) "Entry, Exit and Shakeouts in the US in New Manufacturing Industries", International Journal of Industrial Organization, 13, 567-592.

Lomi, A. (1995) "The Population Ecology of Organizational Founding: Location Dependence and Unobserved heterogeneity", Administrative Science Quarterly, 40, 111-144.

Markides, C. (1998) "Strategic Innovation in Established Companies", Sloan Management Review, Spring, 31- 42.

Metcalfe, S. (1998) Evolutionary Economics and Creative Destruction, Routledge, London.

Mitchell, W. (1995) Medical Diagnostic Imaging Manufacturers", in G. Carroll and M. Hannan (eds), Organizations in Industry, Oxford University Press, Oxford.

Nalebuff, B. and A, Brandenburger (1996) Co-opetition, Harper Collins Business, London.

Nelson, R. and S. Winter (1982) An Evolutionary Theory of Economic Change, Harvard University Press, Cambridge, Mass.

Peli, G. andf B. Nooteboom (1999) "Market Positioning and the Geometry of Resource Space", American Journal of Sociology, 104, 1132-1153.

Petersen, T. and K. Koput (1991) "Density Dependence in Organizational Mortality: Legitimacy or Unobserved Heterogeneity?", American Sociological Review, 56, 399-409.

Ranger-Moore, J., J. Banaszak-Holl and M. Hannan (1991) "Density Dependent Dynamics in regulated Industries: Founding Rates of Banks and Insurance Companies" Aministrative Science Quarterly, 36, 36–65.

Ranger-Moore, J. (1997) "Bigger May be Better, but is Older Wiser?", American Sociological Review, 62, 903-920.

Rogers, E. (1995) Diffusion of Innovations, 4th ed., The Free Press, New York.

Roughgarden, J. (1996) Theory of Population Genetics and Evolutionary Ecology, Prentice Hall, Upper Saddle River, New Jersey.

Singh, J. and C. Lumsden (1990) "Theory and Research in Organizational Ecology", Annual Review of Sociology, 16, 161-195.

Stigler, G. (1951) "The Division of Labour is Limited by the Extent of the Market", Journal of Political Economy, 59, 59, 185-193

Stoneman, P. (1983) The Economic Analysis of Technology Policy, Oxford University Press, Oxford.

Strang, D. (1995) "Health Mantenance Organizations" in Carroll, G. and M. Hannan (eds), Organizations in Industry, Oxford University Press, Oxford.

Sutton, J. (1991) Sunk Costs and Market Structure. MIT Press, Cambridge Mass.

Swaminathan, A. (1995) "The Proliferation of Specialists in the American Wine Industry, 1941-1990", Administrative Science Quarterly, 40, 653-680.

Swaminathan, A. (1998) "Entry into New Market Segments in Mature Industries: Endogenous and Exogenous Segmentation in the US brewing Industry", Strategic Management Journal, 19, 389-404.

Swaminathan, A. and J. Delacroix (1991) "Differentiation Within an Organizational Population: Additional Evidence from the Wine Industry", Academy of Management Journal, 34, 697-692.

Tucker, D., J. Singh and A. Meinhard (1990) "Founding Characteristics, Imprinting and Organizational Change" in Singh, J. (ed), Organizational Evolution, Sage Publications, London.

Utterback, J. (1994) Mastering the Dynamics of Innovation, HBS Press, Boston, Mass.

Utterback, J. and F. Suarez (1993) "Innovation, Competition and Industry Structure", Research Policy, 22, 1-21.

Winter, S. (1990) "Survival, Selection and Inheritance in Evolutionary Theories of Organization", in J. Singh (ed) Organizational Evolution, Sage Publications, London.

Young, R. (1988) "Is Population Ecology a Useful Paradigm for the Study of Organizations?", American Journal of Sociology, 94, 1 - 24.

NOTES

---

[1] See Hannan and Freeman, 1977, 1998 and 1989, Carroll and Hannan, 2000, Singh and Lumsden, 1990, Young, 1988, Delacroix and Rao, 1994, Carroll, 1997, and others for expositions and critical commentaries of this literature; for comments and reflections on this work by economists, see Winter, 1990, and Boone and van Witteloostuijn, 1995.

[2] This is a little too simple. Organizational ecologists often talk about "organizational forms" which are abstract or stylized specifications of different organizational types, usually by reference to a cluster of associated features. Populations are collections of organizations with a common form: see Carroll and Hannan, 2000, Chapter 4.

[3] This is sometimes called *mutualism* in the ecology literature *(commensalism* describes a situation where the flow of benefits between populations is one way); interesting empirical studies that illustrate or explore these issues include Brittain and Wholey, 1988, Aldrich et al, 1994, Baum and Singh, 1994, and Barnett and Carroll, 1987 (amongst others); Lomi, 1995, examines "location dependence" as a source of mutualism. Economists sometimes use the language of "*competitors*" and "*complimentors*" to make the same distinction between firms or populations who compete for resources or who share a range of common interests; see Nalebuff and Brandenburger, 1996.

[4] For an economist, the most straightforward analogy is with product differentiation. In this context, the principle says that " in productionan entrant firm will have a strong incentive to differentiate it's product if it can than to produce a me-too look alike which competes solely on the basis of price with an established incumbent The effects of competitive exclusion may also manifest themselves as an increase in the degree of vertical specialization (or of the "division of labour). Stigler, 1951, argued that this was likely to occur as markets increased in size, but for markets of a given size vertical specialization is likely to increase as competitive pressures drive firms to seek least cost production profiles; i.e. specialize to take advantage of economies of scale, scope or learning in production.

[5] See Hannan and Carroll, 1992; for empirical work exploring legitimation processes, see Hannan and Freeman, 1988, Hannan, 1997, Hannan et al, 1995, Ranger-Moore et al, 1991, Barron, 1995, Strang, 1995, and many others; Baum and Singh, 1994a and b, report work on the effects of niche overlap. Legitimation almost certainly involves some element of "certification" by outside parties and for empirical work on such "institutional linkages", see Baum and Oliver, 1991 and 1992 (amongst others). Although legitimation and competition are the heavily featured in this literature, there are at least two alternative explanations for the rise (fall) and fall (rise) in birth (death) rates which we typically observe. One is heterogeneity (see Petersen and Koput (1991): if selection weeds out the less able entrants, then death rates should fall as density rises (at least until competitive congestion begins to take effect); the other is that the number of firms in a market should be proportional to market size (see Section III below), so that if the size of the market grows logistically then so will the size of the population.

[6] This equation is sometimes written by population ecologists as $N'(t) = rN(t)[(K - N(t))/K]$, where r is the *intrinsic growth rate* (i.e. that which would be observed in the absence of crowding) and K is the *carrying capacity* of the niche. Different populations are then characterized in terms of r and K: for example, a population with a very high r allocates most of it's energy to producing offspring as rapidly as possible, while a population with a high K invests in mechanisms that enable it to survive in crowded conditions (and therefore does not need to reproduce quite so rapidly). For further details, see Roughgarden, 1996, Chapter 17.

[7] The pair of partial differential (or difference) equations describing movements in N(t) and M(t) are often referred to as *Lotka-Volterra equations*; see, for example, Roughgarden, 1996, Chapter 21 for a thorough discussion.

[8] The literature on defining market boundaries is enormous; see Geroski, 1999 for a recent discussion.

[9] Notice that the resource base of a firm in the sense that we have just discussed is much wider than the internal skills or knowledge base which has been much emphasized in the literature on core competencies (e.g., Hamel and Pralahad, 1994, and others for popular accounts of this view; Foss, 1997 is a useful collection of the major academic papers in this area). Core competencies are typically regarded as durable team based activities that are hard to imitate and relatively unique. It is usually argued that they give rise to competitive advantages to the extent that they are distinct, and to persistent profits whenever rivals can be denied access to them.

[10] See Carroll, 1985, Hannan et al, 1990, Peli and Nooteboon, 1999, and others for work along these lines; for some interesting empirical studies using multiple populations in this spirit, see Mitchell, 1995, Swaminathan and Delacroix, 1991, and Swaminathan, 1995 and 1998.

[11] See Kay, 1990, who first developed the notion of a "strategic market". The definition focuses on "minimum" areas because it tries to distinguish between strategic necessity (what firms have to do) and strategic options (what they may choose to do). This distinction is sometimes made in the context of discussions of globals markets (do firms have to operate globally, or is this just an option that they may choose?).

[12] See Rogers, 1995, Stoneman, 1983, Geroski, 2000 and others for surveys of this enormous literature.

[13] See Utterback, 1994, for a reasonably comprehensive discussion of this hypothesis. It is worth remarking that the dominant design hypothesis makes a prediction about population dynamics which is hard to reconcile with the population S-curve that is the focus of much of the organizational ecology literature. The initial proliferation of new products in a market is usually driven by entry, and the consequence is that industry populations are initially very large. However, the emergence of a dominant design is almost always accompanied by a major shakeout of producers which leads to a large reduction in the number of firms in the market. The resulting time path of population numbers is usually not S-shaped; see Gort and Klepper, 1982, Klepper, 1997, and for some recent work on shakeouts, Klepper and Simons, 1997.

[14] Sometimes standards get set "too fast" (this is frequently called "*excess momentum*") and markets get locked out of later technological developments which deliver better quality products; sometimes the competition between standards is so fierce and mutually destructive that a standard fails to emerge at all. See Katz and Shapiro, 1985, Farrell and Saloner, 1985 and 1986, and many others.

[15] Indeed, it may be that commercial organizations face quite different legitimation processes than non-business organization (essentially because the basic "business" form is well accepted). See the comments by Delacroix et al, 1989 and in Hannon and Carroll, 1992.

[16] See, for example, the empirical models of industry population dynamics developed by Klepper and Miller, 1995, and Geroski and Mazzucato, 2000.

[17] See Carroll and Hannan, 1989, Tucker et al, 1990, and others; for some critical comments and an alternative view, see Utterback and Suarez, 1993.

[18] See Geroski and Mazzucato, 2000, Jovanovic and MacDonald, 1994, Swaiminthan and Carroll, 1995, Klepper and Simons, 1977, and others who report correlations of this type.

[19] For arguments which suggest that markets that are subject to competitive wars which inflate sunk costs (i.e. where sunk costs are "endogenous") are also likely to be highly concentrated, see Sutton, 1991.

[20] It is sometimes argued that generalists are favoured in more stable environments, but that when environments are turbulent, flexible specialists who can hop from sub-niche to sub-niche will be favoured. Other discussions describe generalists as having a "wide" niche, or as being more favoured to exploit niche "overlaps" than specialists. It has also been suggested that competition between specialists and generalists may squeeze out medium sized firms, leaving a concentrated market with a few large generalist firms and lots of little specialists. See Hannan and Freeman, 1983, amongst others.

[21] See the references cited in footnote 5 above. The other classic trade-off in organizational design discussed in the organizational ecology (and economics) literature is that between being flexible and using specialization to develop efficiency advantages; see Freeman and Hannan, 1983.

[22] For example, see Christiansen, 1997, Markides, 19987 and references cited therein.

[23] See Arrow, 1962. In the context of new product innovation, rent displacement arises when "new" and "old" products are substitutes. When they are complements, firms have an incentive to bring forward (rather than delay) "new" products and pre-empt rivals (see Gilbert and Newberry, 1982). This, in turn,. is likely to lead to the persistent of monopoly positions in the market.

[24] Or, in the phrase used by Hannan and Freeman, *"fixed repertoires of highly reproducible routines"*; see their 1984 paper, pp. 155. For recent work, see the review by Barnett and Carroll, 1995, and papers by Greve, 1999, Barron et al, 1994, Ranger-Moore, 1997, and others.

[25] This is not true for all economists. For interesting work in an evolutionary perspective, see Nelsonm and Winter, 1982, Metcalfe, 1998, Klepper, 1996, Jovanovic and Macdonald, 1994, and others.

[26] Recent work in this spirit in the organizational ecology literature includes Barnett, 1997, and Hansen, 1996.

[27] There is an enormous amount of work that has been done by organizational ecologists on this subject: see, for example, Chapter 13 in Carroll and Hannon, 2000, for some remarks and references.

[28] One reader suggested that the heavy dependence on density dependence in this literature reflects it's very empirical focus, and this is almost certainly true. For recent attempts to move into theoretical model building by organizati0onal ecologists, see Carroll et al, 1995, Hannan, 1998, and others.

[29] For some (relatively rare) work on "community ecology", see Baum, 1996, Hant and Aldrich, 1998, and some of the papers in Aldrich, 1999.

[30] For a stout defence of this practice, see Carroll and Hannan, 2000.