Breaking the Path of Institutional Development? Alternatives to the New Determinism

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BREAKING THE PATH OF INSTITUTIONAL DEVELOPMENT? ALTERNATIVES TO THE NEW DETERMINISM

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ABSTRACT

The concept of path dependence is being used in highly deterministic ways in neo-institutionalist analysis, so that studies using this framework have difficulty in accounting for, or predicting, change. However, the original Polya urn model from which path-dependence theory draws predicts that alternative paths will be possible. It can then be argued that actors will be able to use these when they perceive a need to change. This article seeks to capture this possibility through accommodating a Bayesian parametric decision-maker interacting with an environment. This makes it possible to examine how change may involve such processes as: the use of past or redundant institutional repertoires; transfer of experience across action spaces; or from other agents, through networks of structured relationships; the emergence of perceived 'one best' solutions. This approach points to the need to change how typologies are used in neo-institutionalist research, so that those features of cases that do not fit the pre-conceived framework of a type are not disregarded as 'noise', but properly evaluated as potential resources for change.

KEY WORDS • Bayesian • innovation • neo-institutionalism • path dependence • redundancy

Path dependence has become a key concept in social-scientific debates about institutional evolution over the past decade. Political scientists, sociologists, economists, and geographers have sought to use the concept as a means of understanding institutional stickiness; that is, why actors may fail to respond to changes in the environment even when such responses would lead to a better overall outcome.[1] Thus, path dependence serves explicitly as a counter to those forms

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of economic theory which posit that interactions between economically rational actors will lead to efficient outcomes (North 1990b; Pierson 2000b), and argues instead that inefficient equilibria may be stable. This broad claim stems from the basic theoretical foundations of path-dependence theory, which seeks to model situations in which there are increasing rather than decreasing returns. In such situations, inefficiencies and suboptimal allocations of resources can persist over time, even when actors are aware of them and are economically rational. But path-dependence theory cannot strictly speaking be used to address actors coping with changes to their environment, because it does not explicitly model that possibility. We plan here to remedy this by providing a simple account of how individual or collective actors may seek to respond to an environment with increasing returns, through patterns of behavior that are themselves subject to increasing returns, as most patterns of behavior are. Our central focus is therefore on how path-dependent development trajectories interact with exogenously changing environments.

Path-dependence theory needs this adaptation if it is to cope with situations where actors are able to search for alternative paths with some chance of success. The strict theory is not designed to model such possibilities, but they do occur in practice. Therefore, if we want to retain some of the central important insights of path-dependence theory but also model the way in which actors might be able to spring the trap, we need to make some radical changes to the original theory. Some scholars recognize the need to address path-dependence theory's deficiencies here, but have few direct solutions to offer (Pierson 2000a). Others have more or less excluded the possibility of change from their models, seeing path dependence as a near-inexorable force structuring outcomes over the long term (Putnam 1993).

The strict theory takes its fundamental inspiration from mathematical processes (Polya urn models) in which initial conditions and the chance occurrence of small events which happen to reinforce initial random choices may have a determinative effect on subsequent paths of development. But this implies the existence of alternative paths of development than the one taken, which may be 'rediscovered' when actors face a changed environment that makes new demands.

In this article we seek to provide a coherent account of how actors may seek to adapt to changed environmental circumstances through

changing their institutional responses to that environment. For us and many other neo-institutionalists, paths are institutions, clusters of patterned behavior that constrain the actions of individuals in particular ways. Individuals change and innovate, not by breaking free from all institutional constraints, but by changing the structures of the institutions themselves. Our interest is focused on this stage, not on the substantive goals of the changes. Here we adopt a functional account of institutions, but not a functionalist one. We posit that institutions exist in order to fulfil certain purposes, and that actors will seek to adapt institutions in response to changes in their environment, but we make no claim that institutional adaptation is driven by systemic factors, or that institutional change tends towards social efficiency.[2] A fundamental problem with functionalism is of course its neglect of power relations (Knight 1992). While power relations do not figure in path dependence as such, they may create external constraints that affect actors' ability to choose between paths. We show how power may have this effect in the body of our article (the third extension of our model).

More generally, however, we seek to advance on the current literature, which is rather better at explaining the circumstances under which actors will continue to act as they have always acted, even when their actions are no longer appropriate, than in discussing how they may adapt to new needs. We provide a simple account of the factors likely to affect actors' ability to respond appropriately to change, which we seek to complicate in successive steps, so as to incorporate new factors and possibilities that affect actors' capacities. We acknowledge that we are likely to annoy many people. Strict path-dependence theorists are likely to find our arguments mathematically under-specified, while many non-rational choice sociologists, on the other hand, will feel that we have conceded too much to the formalists. However, it is undeniable that the causal factors emphasized by both path dependence and sociological approaches are relevant to actors' capacity to respond to environmental change, and, furthermore, that these factors may interact in complex ways. Frameworks such as ours, which seek to bridge economic and sociological approaches to the explanation of human behavior (Di Maggio 1998), represent an important – and arguably necessary – step in the evolution of debate within the social sciences.

Our arguments emphasize the importance of redundancy in providing resources which actors may use to respond to unexpected

change. There is a recent tendency in the social sciences, and in political economy in particular, to emphasize how institutional systems tend to crystallize around coherent logics of ordering (Hall and Soskice 2001). However, such approaches may systematically overlook fruitful incoherencies within empirical social systems; institutional systems, far from being coherent, are characterized by redundancies, previously unknown capacities, and incongruities, which frequently provide the means through which actors – whether firms, policy entrepreneurs, or others – may seek to tackle new exigencies. Furthermore, the empirical process of institutional change and adaptation is likely frequently to involve initiatives that seek to build on these redundant capacities, 'breaking' the path rather than continuing along it.

We begin by returning to path dependence theory's roots, in Polya urn processes, reformulating the original arguments of Arthur (1994) and others in a manner that specifically incorporates the important role of redundant resources. We then seek to build out from the path-dependence perspective, progressively building in refinements that address how social embeddedness may create resources for actors seeking to respond to change. Next, we examine the significance of our arguments for the methodology of recent approaches to institutional comparison in political economy. We conclude by summarizing our main findings and demonstrating how they may provide an alternative path towards the understanding of institutional change and adaptation.

Current Debates on Path Dependence and Change

Path dependence has its origins in recent developments in economic theory, which seek to take account of how increasing returns may complicate equilibrium analysis. Neo-classical economists have typically worked on the assumption of decreasing returns, which allows more analytically tractable models in which rational economic actors will typically tend to converge towards the efficiency maximizing equilibrium. Path dependence, in contrast, suggests that there is no necessary tendency towards efficiency in situations where increasing returns apply. In a situation where there are a number of possible equilibria, path-dependence theorists suggest that early moves will often have a decisive effect in determining which of these equilibria is chosen. In so far as these early moves

may have a self-reinforcing impact on the probability of later moves, the final equilibrium reached will by no means necessarily be the most efficient one. Thus, path-dependence theory predicts that sub-optimal paths of development may be taken, which may persist even over the long term, and even in situations where actors realize with hindsight that a different set of initial moves would have been to everybody's advantage.

The theory of path dependence builds upon mathematical modeling techniques – so-called Polya urn processes – in which early events in a series have a substantial effect on later ones. Path dependence thus seeks to capture the frequently observed phenomenon that performance of an action can in itself make more likely its subsequent performance (Arthur 1994). This is very different from the more familiar case in probability theory. There, if one tosses a fair coin repeatedly, or if a blind agent repeatedly draws one of two balls, one red one white, from an urn and simply replaces them after each draw, there is an equal probability of either outcome. In both cases, the aggregated outcomes will tend towards a 50:50 ratio of heads to tails, or red balls to white balls, over repeated iterations. While one of the two possible alternatives might have a temporary dominance in the first few tosses or draws, this dominance will disappear over time.

Path dependence, in contrast, seeks explicitly to model circumstances in which early events increase the possibility of later events of the same sort occurring. Assume that, every time a ball of a particular color is pulled from the urn, it is returned, and a further ball of the same color is added to it (Arthur et al. 1987). Any random dominance of one color in the first few rounds now has major consequences. The chances of pulling further balls of that color rather than the other now increase sharply, and are further reinforced in subsequent rounds. Its dominance continues to increase, and eventually the second color will be drawn only rarely. Formally, the ensuing pattern takes the form of a random walk on a convex surface (Arthur 1990).

Arthur and others (David 1992a, b, 2000) argue that many economic situations are better modeled using increasing returns assumptions. For example, many scholars working on the economics of geographic location have argued that firm location tends to be dominated by predetermined factors, such as allocations of basic inputs, so that the location of firms across a given territory reflects an efficient allocation of resources. While these models

provide a good explanation of how firms in industries with clear geographical needs locate, they are far poorer at explaining the forces governing the location of firms in industries which have less need for exogenously allocated resources (e.g. knowledge-based ones) (Arthur 1994). Firms in these industries will often want to locate themselves not where basic inputs are to be found, but where other firms in the same industry are to be found. Thus, it is possible that agglomerations will be affected by chance events early in their history, when the first firms to arrive made random choices of where to locate, but whose existence then attracted resources such as skilled labor to the area, creating positive reasons for further firms to go there.

Path dependence further predicts that stable equilibria may be reached given increasing returns to scale, but that in many important instances one cannot predict *ex ante* which equilibrium will be reached because of the importance of initial perturbations to the final outcome. In more technical terms:

> Fluctuations dominate motions at the outset; hence, they make limit points reachable from any initial conditions. But they die away, leaving the process directed by the equivalent deterministic system and hence convergent to identifiable attractors (Arthur 1994: 123).

The lessons of path dependence extend considerably beyond industrial location theory. They can, for example, be used to analyze the development of science and technology in university or corporate research departments. Scientists may begin by trying a number of alternative solutions to a problem. Since, in the initial stages, there will be considerable uncertainty as to which alternative will be more successful, the initial choices among them will be more or less random. Gradually one begins to bring more returns than the others; it therefore begins to be chosen more systematically. It becomes a path. Resources are devoted to it rather than to the other, increasingly neglected, alternative possibilities. Eventually a point is reached where the once reliably successful path no longer delivers returns. But even if the scientists know this, it is extremely difficult for them to change: the laboratory's resources, their own training and expertise are so wedded to it. Simple path-dependence theory suggests that they cannot change at all, but must remain trapped in their doomed path until the laboratory closes.

Such processes are of direct relevance to social scientists in so far as they touch on questions of institutional development. Douglass

North (1990a) argues that institutions too are subject to the forces of increasing returns. In what is perhaps the most influential application of path-dependence theory, he seeks to explain a near-inexplicable puzzle for efficiency-based approaches to economics; why it is that countries in the developing world have not converged on the more efficient set of institutions offered by the developed world. He argues that the divergences in the economic histories of South and North America may in large part be explained by the differing initial institutional matrices they inherited from Spain and Britain, respectively.[3] Most recently, Paul Pierson (2000a, b) has sought to build upon this by offering a more general set of insights into institution-building as a path-dependent process. In Pierson's argument, initial institutional steps may have a strong conditioning effect on later ones. In so far as institutions generate learning effects, coordination effects and adaptive expectations, they may substantially affect trajectories of institutional development, so that later institutions reflect these earlier steps. Positive feedback may in turn lead to a single equilibrium that is likely to be resistant to change. As Pierson further points out (see especially 2000b), this provides an alternative to functionalist variants of rational choice institutionalism.[4]

Thus, path dependence gains much of its explanatory interest from its demonstration that persistently inefficient equilibria may result from initial choices. As such it is of considerable practical interest for social analysis. Frequently, both the learning curve and the opportunity cost of new learning make it very likely that actors will persist with familiar forms of action after these have ceased to produce rewards, and may even prevent actors finding alternative paths when these are in principle available. For example, if policy-makers have repeatedly solved problems using a particular decision technique, they may stay with it even when it has failed to produce results, because the cost and uncertainty of learning new techniques is too daunting. However, major change does occasionally occur, and path-dependence theory offers little guidance as to how changes of path may be modeled; this falls almost entirely outside the theory's ambit.

While Arthur (1994: 118–19) offers some preliminary contentions about the likely costs of changes, these do not serve (nor are intended to serve) as a theory. Two responses to this may be seen in the literature. Sophisticated applications of the theory (North 1990a; Pierson 2000a) acknowledge the difficulty. They seek to

avoid determinism, arguing that short periods of wide-ranging change are likely to be succeeded by much longer periods in which change continues, but is relatively closely bounded (Pierson 2000a); but they fail to advance arguments about what such wide-ranging change involves, and how actors will respond to it.[5] Less sophisticated versions misunderstand path dependence, arguing that paths are set at a given point in time, so that actors are ineluctably condemned to follow out a specific trajectory without possibility of change or exit.[6] Under such accounts, paths of development exercise an influence so compelling that outcomes are more or less completely determined.

Introducing a Bayesian Actor: Why Redundant Capacities Are Important

As we have discussed, path-dependence theory seeks to apply results derived from Polya urn processes to the understanding of causal processes in which earlier events in a sequence have a positive effect on the probability of similar events occurring later in the sequence. In the following discussion we build from the same set of assumptions, because we consider the strict path dependence model to be of major importance in explaining the widely observed phenomenon of persisting suboptimal and inefficient patterns of behavior. However, we make a major change in the form of the theory in order to model something beyond its reach: how path-dependent actors may perceive their failure and try to switch to new paths. These actors continue to be affected by the logic of path dependence; we do not seek here to refute that logic. Rather, by enquiring about the circumstances under which actors may make a successful escape, we may model a few typical forms that such change may take. Therefore, we seek to produce narrow and specific theories of change which do not rely on an exogenous *deus ex machina* or simply propose that 'anything goes'. In so doing, we seek to respond to the criticisms advanced by Katherine Thelen (2003) and others who suggest (correctly) that traditional path dependence theory has difficulty in explaining 'bounded innovation'.

Most conventional accounts of path dependence (e.g. Arthur 1994) fold the individual agent and her reaction to the action of others into the sequence itself (though some formulations (e.g. North 1990a) seek, as we do, to take account of the cognitive effects

of institutions). A firm makes a location decision that may reflect the previous location decisions of other firms, and may in turn affect the future decisions of other firms still. Path-dependence theory thus models the action of the agent itself as a single step in the mathematical process.

Specifically, we examine the actions and, more precisely, the decision to act of the agent in greater detail. In order to do so, we treat the agent's own action sequence in isolation from its effects on the environment, although we allow the agent to update her behavior in order to respond to environmental path dependences.[7] From this starting point we enable our actor potentially to benefit from interaction with a wider environment, by adding environmental components through a series of extensions to our basic model. The effect of these extensions is shown in Figure 1, which sets out the basic plan of the article.

Path dependence assumes a process in which balls are taken from an urn and replaced according to a specific logic. Our model differs in that it posits an agent that seeks to match developments in her environment by drawing from a separate urn. Assume an agent (A) and an environment (E). Each round, A incurs some small fixed cost, K, regardless of her action. Further, assume that both the agent and the environment draw balls from separate urns. Balls in each urn may be either red or white. As in Arthur's (1994) original example, we start with urns that have just one red and one white ball each. When a ball of either color is drawn from either urn, it is replaced, and a new ball of the same color is added to that urn. Both A and E draw balls unsighted from the urn; however, A, unlike E, may ascertain her ball's color after it has been drawn, but before she has seen E's ball. For a cost, C, which is additional to K, she may replace it and draw a new one, and may repeat this procedure until she has drawn a ball with which she is satisfied. E then draws its ball. Only A's final choice of ball will be returned to the urn along with another one of the same color. If the final choice matches the color then drawn by E, A receives a reward, R. The exercise is repeated infinitely. Under these circumstances A will seek to maximize the sum of rewards, subject to some discount factor, δ, so that future rounds of the game are not valued as much as the current round.

Assume further that A is a risk-neutral Bayesian decision-maker with knowledge of the basic parameters of the game (in particular that both her urn and that of the environment E are subject to

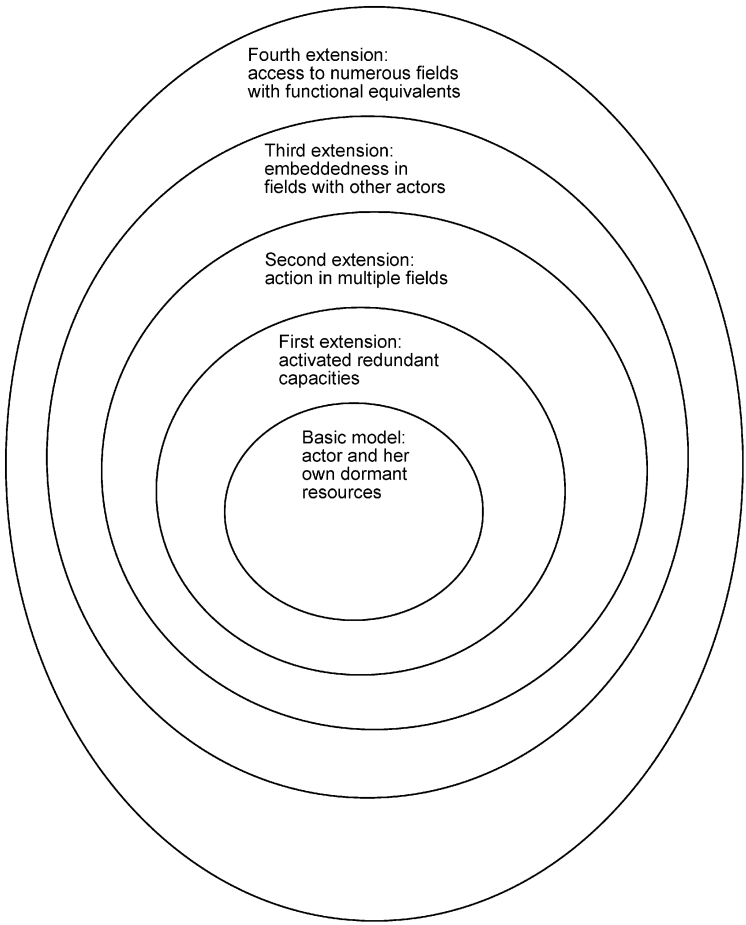

Figure 1. The Availability of New Paths to a Path-Dependent Actor

increasing returns).[8] If *A* wishes to maximize the sum of her rewards, she will need to solve a problem: given her information about which balls have been drawn, are the draws from *E*'s urn on a path *Pr*, in which red balls predominate, or *Pw*, in which white balls do? Bayesian calculation allows her to update her beliefs in each round, given the ball that *E* has played.

This provides a simple account of how individual actors may seek to respond to an environment with increasing returns, through patterns of behavior that are themselves subject to increasing

returns, as most patterns of behavior are (repetition allows learning). On the aggregate level it also presents a basic account of how actors may adapt institutions to a given environment. Like individuals, organizational actors may develop a standardized repertoire of institutional responses as they seek to adapt their behavior to a given environment. The teams of scientists in a research laboratory in the example suggested above would be examples of this, particularly as the laboratory's learned behavior is passed on to successive generations of new recruits. We do not solve the problem for particular parameter values; rather, by setting it out in a general fashion, we seek to come to a better understanding of the sensitivity of the model to changes in these parameters.[9] Through seeking successively to 'match' behavior or institutions to the demands of the environment, an actor may seek rewards. Most particularly, while the actor has no control over the environment, *E*, she does have some control over her own urn, and through deliberately selecting balls may seek to take advantage of the increasing returns from a specific course of institutional adaptation. We note that this account bears a strong resemblance to strategic games, most notably the Matching Pennies game, which has no equilibrium in pure strategies. However, what we seek to model here is not strategic action; rather it is an exercise in parametric decision-making, where a player seeks to respond to an environment which is not itself a strategic player.

In the first round of the game, *A* will know that there is a 50:50 chance of either red or white being drawn by *E*, and will not wish to incur the cost *C*, so she will simply present the ball that she has drawn at random. Let us assume that *E* establishes a path *Pr* soon thereafter, in which red balls predominate, in a random walk across a convex surface. *A* will conclude at some point that *E* has begun to establish this path,[10] and, if her expected rewards for so doing outweigh her expected costs, will begin to invest in search costs in order to present red balls. The speed of *A*'s adaptation to red path dominance will be a function of the variables: *C*, *R*, δ, plus a random element dependent on the 'luck of the draw'. In most circumstances, one may expect the dominant color to become more quickly established thereafter for *A* than for *E* – in so far as *A* is capable of forming beliefs about the environment and its future course of development, and guiding her own institutional path so as to match that of the environment. It must be remembered that red does not achieve 100% dominance; white balls remain in both urns and, until the number of red balls

approaches infinity, stand a small but finite chance of occasionally being drawn.

This provides a simple model of how behavioral routines or institutions may become matched to their environment. But what happens if the environment changes? Let us assume that for some exogenous reason E's urn is switched for a new one, containing again a single red and a single white ball, under the same conditions as for the original urn.[11] In this instance, however, draws from the urn become dominated by Pw, so that white becomes established as the dominant color.

In Breen's (2000) terms, the agent perceives the change from the perspective of her existing beliefs, but cannot immediately move to new, more appropriate ones. Depending on her precise beliefs, it is likely that A will at first consider the sudden appearance of white balls as examples of the occasional appearance of this color, which she has always experienced and has learned to disregard. Guided by this belief, A will persist with her path-dependent behavior, and will continue to present red balls.[12] After a time, however, it will become clear to her that there has been a true change of probabilities, and that her earnings are seriously declining. The length of this time period will depend on the strength of her beliefs, as well as a random factor. There will come a point where A realizes that she needs to locate white balls and may deem it rational to incur considerable search costs if necessary. A's willingness to switch to the new white path when she realizes this is appropriate will depend on three factors: (i) the relationship between costs (C, K) and rewards (R); (ii) the ratio of red to white balls in A's urn; and (iii) δ, the extent to which A discounts the future.

Clearly these parameters permit a wide range of variation; for purposes of illustration we examine two extreme cases. First, take the case where costs are high relative to rewards, where A's urn has a strong preponderance of red to white (so that it is difficult to switch over), and where δ is high, so that A discounts future rewards heavily. Under such parameter values, A is unlikely to incur the costs necessary to change the path in her own urn, so that she may consistently find white balls to match those of E. Given the cost K incurred each round, A will expect to incur losses if she seeks to remain in the game for the rare occasions when E presents a red ball given white ball dominance. A's expected future earnings from the game will very likely be outweighed by her costs.

Alternatively, if rewards are high relative to costs, there is a relatively low preponderance of red to white balls in A's urn, and δ is low so that A places a relatively high value on future rewards, one may expect A to seek to respond to the change in the environment by changing the path dependence of her own urn. She will accept search costs in order to find white balls, and may thus come to establish white-ball dominance. Search costs will then decline and earnings rise. Clearly, this may involve a lengthy transition period.

At the level of generality which our arguments involve, it is impossible to specify more precisely the relationship between the parameter values and the extent to which mid-range outcomes (in which some parameters point in one direction and others in another) will tend to leave A trapped in her path dependence, or incurring the necessary costs to find a new path. However, by specifically incorporating learning and adaptation costs, our model provides some basic insights into what change is likely to involve. A is capable of drawing both red and white balls from her urn in order to respond to a given environment. These may serve as a simple proxy in our argument for different possible patterns of behavior, or even more generally different paths of institutional development, which respond to different varieties of increasing returns in the environment, and themselves involve increasing returns (Pierson 2000a). In so far as a path becomes established in the environment (so that, say, red balls predominate in E's urn), a given set of responses which are well matched to that environment (red balls in A's urn) may also come to predominate. Other institutional possibilities exist (white balls in A's urn), and indeed may continue occasionally to affect actors' responses to the environment. Even when A has established red-ball dominance in her urn, she will occasionally draw white balls, which, in so far as they do not match the red balls typically produced by E, will be viewed as examples of institutional misfit and inefficiency. However, in situations where the environment has changed (E's red-ball dominance switches to white), such apparent examples of maladaptation change their significance, so that they become 'dormant resources', which actors will seek to draw upon, in order to respond better to changed circumstances. (White balls had, in fact, been cases of potentially useful redundancy during the period of red domination.)

This first model draws our attention to the existence of dormant resources, present but inaccessible in the pure path-dependence

case, but potentially accessible to the agent capable of searching into her past repertoire. (To return to our example of the science laboratory, in the early exploratory stages the scientists had experimented with, acquired knowledge of, and committed resources to alternatives to the path eventually selected. Depending on how far these alternatives developed before being rejected, and how long ago this took place, they may retain some capacity for access to them.) Our model also indicates in an abstract way the kinds of circumstances in which an agent might succeed in such a search. For example, the longer that an existing path has been in operation, or the more costly the search, the more difficult it will be to go back to the dormant resources.

These abstract ideas can be further developed to provide hypotheses about when search might be successful in specific contexts. For example, the 'costliness' of a search for a dormant resource by a policy-maker would be affected by such factors as the difficulty of again practising the dormant policy resource (a function of the re-learning curve and the cost of re-establishing support resources), the embarrassment of making a major change, and its degree of difference from, or even contradiction of, the dominant path which is to be rejected.

In their account of recent changes in Dutch social policy, Visser and Hemerijck (1997) show how some existing but neglected policy mechanisms were able to be used to enable policy actors to solve what had seemed, following strict path-dependence assumptions, some apparently intractable emerging problems. Our model helps explain both how the path-dependence trap was sprung, and why it was an existing, neglected mechanism, rather than a total novelty or imitation of external practices that was used to do so. Ebbinghaus and Manow (2001) refer to a similar concept in their idea of 'layered' institutions within welfare states, which they use to show how various European welfare states have defied the predictions of some path-dependence analysts and have reformed themselves. As institutions develop over long periods of time, argue Ebbinghaus and Manow, they cease to embody a simple logic, but a complex bundle, dormant elements of which may open up possibilities for change at difficult moments.

We note that our approach is not the only possible way to capture layering effects. Another, more complex case of layering which stays closer to the pure path-dependence model, and is perhaps easier to model theoretically, is well captured by Levi's (1996) analogy of

path dependence with an exfoliating tree. One might develop this analogy further – the larger boughs or branches of the tree exfoliate into smaller branches, and then into twigs. One might assume a limited number of boughs (Q, R, S, T) representing different approaches to solving, say, collective action problems. Each is divided into branches 1 to n. A set of agents develop a path dependence along branch $q1$. When faced with a need to change paths, the agents will find it easier to try another branch within Q than to shift to an approach within R, S, or T, because a shorter distance is involved in retracing steps down to the generic origin in Q than in seeking out a new bough.

An example may be found in the German vocational training system. From time to time it has undergone crisis as economic and technological changes create an environment that no longer matches its assumptions. However, in each case those responsible for implementing the system – a large number of agents in fact – have found ways of adapting it, always by returning to the generic 'bough' of the apprenticeship concept and finding a new branch to build out along. Initially designed for the *Handwerk* sector, it was successfully adapted to large-scale industry (Streeck 1992); designed for manufacturing, it had to adapt to services sectors; designed for the lower levels of educational qualifications, it was adapted to the rise in educational achievements (Crouch et al. 1999: Ch 5); designed for specific skills, it adapted to polyvalence; most recently it has been adapting to the new highly flexible occupations in mass media industries (Baumann 2002). There was often a time-lag while this adjustment was made, while those concerned either persisted with the old version or failed to find a means of adaptation. However, the fact that change was possible without either a total collapse of the model or exogenous borrowing means that the problem was solved by considering *hitherto unrealized potentialities of the system itself* – a procedure well captured by Levi's metaphor of exfoliation.

We note that our approach is limited to dealing with endogenous change, as fundamental to it is the claim that agents can change to new ways of behaving if they have some endogenous access to appropriate new behavior. It cannot deal with totally exogenous, bolt-on institutional borrowing. This may be illustrated by a practical example from a business context: the efforts of car manufacturers in Britain, Germany, and elsewhere to introduce Japanese work practices in the 1980s. To the extent that such change involved the introduction from outside of completely novel institutions, our

arguments have little contribution to make. However, in so far as efforts to adapt to these new challenges made use of older, pre-existing institutional repertoires that were rediscovered (Morris and Imrie 1992; Braczyk and Schienstock 1996),[13] our model may contribute to the understanding of such change.

Our arguments highlight a relatively under-appreciated implication of path-dependence theory: that more than one path of institutional development is possible, even if only one becomes established.[14] This means that the theory is only applicable to cases where alternatives exist somewhere within agents' repertoires, but have become forgotten or hidden through disuse or failure to appreciate their possible relevance.[15] However, they remain in existence (occasional white balls on a red dominant path), and may provide the seeds for new paths of development. If such possibilities do not exist, then in principle the path-dependence frame of reference is not applicable. Many current uses of path-dependence theory by social scientists do not include the idea of hidden alternatives. They make the assumption that a path is irrevocably set, so that agency has no scope to change it. Strictly speaking these writers do not need path-dependence theory; merely the simple argument that agents' possibilities to create change are entirely circumscribed by social structure. While our model predicts that paths under given sets of parameter values will be very difficult or costly to change, it does not predict that path change is impossible, and indeed sets out a set of conditions under which change will be more or less difficult to accomplish.

A First Extension: Redundant Capacity as Subordinate Path Dependence

Path-dependence theory necessarily deals only with situations in which actors can pursue one and only one path. This has been a useful base for most neo-institutionalist theory, which assumes, or asserts, that actors are confined to one typical course of action, usually dictated to them by their national context. This assumption is open to challenge, however. In complex societies actors may well face a diversity of typical modes of acting and solving problems. If this diversity is extensive, we have no need for the concept of path dependence; actors can more or less choose as they wish from an

open menu of possible responses. But it is also possible for this diversity to be limited, and for increasing returns to operate within each of this small number of alternatives, making movement between them difficult but not impossible.

This is such an important form of innovative action in the face of path dependence that it is necessary to be able to model it. We should be ready to use this extension whenever there is evidence that actors themselves operate in a heterogeneous institutional environment. We shall here model this by staying as closely as possible to the logic of the path-dependence model. The redundant capacity will itself be depicted, not as a random factor, but as the result of a second path dependence, subordinate to the main one.

In the terms of our model, the environment now draws from two urns. After every n rounds of the red-ball game already described (now called the dominant game) with E (now $E1$) A plays one round of a subordinate game in a second environment, $E2$, in which the path dependence is reversed, white balls being the subject of increasing returns. R is the same for both urns. The two environments are represented by two separate urns, which refill according to their opposite path dependences, but A has only one urn. If A has an understanding of the basic parameters of the game, she will have different Bayesian probability expectations for the two environments.

Let us further assume that at a certain point, as in the first game, $E1$'s urn changes to white dominance; there is no change in $E2$'s urn. One may assume that for most values of n, red will again have established a dominance in A's urn, as in the simple game. Again, A's specific behavior will depend on parameter values. For higher values of n (white-ball-dominant rounds are relatively infrequent), and/or C (searching for balls is relatively expensive), A may simply seek to create a red-ball dependence, and 'take her lumps' on the occasional rounds where the urn switches to $E2$. Here, A will behave much as she did in the original game, albeit with lower overall rewards. For lower values of n and C – the 'interesting' cases from our point of view – A may seek rewards from both paths, but again will have lower overall rewards than in the original game. She will not be able to take full advantage of the possibilities of creating path dependence in her own urn, and will have to incur higher search costs in matching both $E1$'s and $E2$'s draws. While A knows which game she is playing at any one time, the chances of finding a red ball at first attempt in the game with $E1$ are less than in the original game, while the game with $E2$ usually requires search costs

to locate a white ball. However, by the same token, when $E1$'s urn changes, A is able to adjust to the new path dependence more quickly than in the simple game, because she has a considerably higher proportion of white balls in her urn. A now finds that playing the two-environment game had greatly eased the transition.

This version of the model represents serendipitous redundancy, in which the need to switch between two different environments prepares actors better for completely unexpected changes in one of them. The independent variable here is the two environments. Bayesian actors will not take account of uncertain events in the future; in so far as they do not involve risk (i.e. expected probabilities), they cannot be translated into beliefs. They will therefore encounter serendipitous rather than planned redundancy.[16] The latter form may however be inserted into their environment; differing sets of environmental pressures may generate different forms of redundancy (Low et al. 2001), or what Goodin (1996) calls institutions that are designed 'around the risk of accidents'.

An example of its practical application appears in Hollingsworth and Hollingsworth's (2000) study of the institutional contexts of major scientific discoveries – an example which relates directly to our own of the scientific laboratory. The researchers found that institutions with particularly large numbers of such discoveries to their credit typically encouraged, even possibly constrained, specialists in one area of science to sustain knowledge and interest in other areas:

> [M]ajor discoveries occurred repeatedly because there was a high degree of interdisciplinary and integrated activity across diverse fields of science (thus, scientists with diverse perspectives interacted with intensity and frequency) . . . (p. 222).

Sometimes these scientists might have found this irksome, as they could have made more progress with their 'own research' had they not had to sustain the subsidiary areas. They may even have fallen behind colleagues in more specialized institutes. However, at points of major new breakthrough, where new combinations of knowledge were needed and therefore where continuing an existing line would have been inadequate, they had major advantages over those who were more specialized. The two-environment game enables us both to anticipate this outcome – but also to explain why the majority of academic institutions are structured in the opposite way and avoid redundancy by encouraging specialization.[17] They do not

take the risk of losing predictable routine returns by gambling on the chance of major discoveries.

Garud and Karnøe (2001b) present several similar examples of such unplanned synergies in their accounts of technological innovations, and develop an argument concerning redundancy when they say of entrepreneurs that they:

> . . . may intentionally deviate from existing artefacts and relevance structures, fully aware that they may be creating inefficiencies for the present, but also aware that such steps are required to create new futures (p. 6).

North (1990a: 74–81) anticipates the problem of incentives to acquire pure knowledge – which has no immediate payoff, but might have some in the future – and sees the particular structures chosen by firms as putting them into better or worse positions for dealing with it. Within the constraints of pure path-dependence theory, however, he has no way of modeling different potential solutions.

Neo-classical economists acknowledge that their models have extreme difficulty in dealing with how actors confront uncertainty, as opposed to risk. In so far as actors are willing to incur costs in order to take advantage of future uncertainty, they are acting within a Schumpeterian rather than marginalist framework. Hollingsworth and Hollingsworth's (2000) research organizations were Schumpeterians willing to take risks avoided by those engaged in marginal adjustments in order to reap large rewards when they suddenly arose.[18] Individual scientists within the institutes may occasionally have preferred to be marginalists, but they were constrained by the rules of their game. In a Schumpeterian framework, entrepreneurs are agents who either sustain redundant capacities or engage in temporarily less profitable activities, so that at certain moments they may boldly grasp new opportunities. Schumpeter himself insisted on the importance of monopoly for entrepreneurs, arguing that continual strong competition undermined the risk-taking that they required. This insight has been developed by evolutionary economists in their arguments about the need to protect research and development departments from erosion by competitive pressure (Nelson and Winter 1982), which is often more easily accomplished by monopolies (Lazonick 1991). We are here able to go beyond these accounts and identify as fundamental, not monopoly as such, but the capacity to retain redundant capacities

in order to be able to cope with new or changing environments.[19] Monopoly and limited competition are particular examples of how redundancy might be maintained. Other examples might be external constraint or simultaneous participation in different fields of activity, between which cross-over is encouraged. For Hage and Hollingsworth (2000) the essential point is a number of separate specialized areas connected to each other through an innovation network.

Such arguments about redundancy in scientific and economic entrepreneurship have clear relevance to paths of institutional development too. In so far as agents or their institutions are regularly exposed to different sets of environmental pressures, they will be likely to develop substantial redundancies. These redundancies will often make it easier for agents to adapt these institutions to new and unexpected sets of environmental circumstances.

A Second Extension: Solutions Already Used in Adjacent Fields

In the first extension we assumed that the agent had to take 'time out' from playing one game in order to play the other; there were opportunity costs, in particular in playing the subordinate game. However, this will not necessarily be so for a complex collective agent, who can simultaneously play different games in its different components. This increases the capacity of the entrepreneurial agent to spring path-dependence traps. Our model must therefore be extended in order to deal with such situations, when actors operate in multiple institutional environments.

Components of the collective agent can learn from each other, even as each acts out her own path dependence. While the character of learning is one of the reasons why actors find themselves caught in path-dependence traps, it can also be, as Williamson and Masten (1995: 116–17) note, the means by which they might break dependence (see also Pierson 2000b). In the case of our example of the science laboratory, this could be the case if the scientists' *teaching* activity has retained some interdisciplinary character. But this form of innovation capacity will be particularly important in the cases of collective actors operating over a wide social range. One interesting historical example would be the way in which late-19th-century Dutch elites began to apply lessons they had learned about conflict management in the religious field (the *verzuiling*

system) to conflicts emerging in industrial relations which could no longer be tackled in traditional ways (Hemerijck 1992). They could do this because of their acquired experience of using these mechanisms, understanding how they operated, and trusting them; *verzuiling* in the religious arena had become a self-reproducing path dependence involving substantial increasing returns to learning. It would have been far more difficult, say, for French elites suddenly to imitate emerging Dutch industrial relations policy, because they did not have the prior learning experience from a proximate field. The neo-Darwinian synthesis of evolutionary biology is also relevant here; Stephen Jay Gould (2002: 1234) talks at length about processes of 'exaptation'—'the evolutionary result of functional cooptation from a different source of origin'.

Another example would be the case of Norway in Karl's (1997) comparative study of petroleum. She found path-dependence theory of considerable value in explaining why states that had become dependent on petroleum revenues almost always failed to diversify their economic activity, even when it had become clear to them that oil dependence was harmful to their economies. At any one point in time it was always more profitable to continue with oil and not diversify. Almost alone among the oil-dependent states, Norway has long had a political system which makes changes through extensive and widely representative discursive processes; it alone succeeded in avoiding the trap. Path-dependence theory has to recognize the Norwegian case as one that was able to escape its laws, but is unable to explain how or why. Our model enables us to see that, because Norwegian elites were subject to influence by and could access the perspectives of a diversity of organized interests, many of whom were not connected to petroleum, they were able to have access to alternative paths and to develop diversified strategies.

By making some further simple amendments to the situation presented in the first extension, we can model such possibilities. We now give *A* two urns, *A*1 and *A*2, provided that she pays each time she chooses to move between them. (It is a basic assumption of the whole model that all changes of action are costly in one way or another.) The original search cost *C* is now *Cx*; the urn swap cost becomes *Cy*. The relationship between *Cx* and *Cy* is not determined *ex ante*. As in the previous example, we assume that *E1* develops a red-ball dominance, and *E2* a white-ball dominance. In this extension *A* will swap her urns to match the different path dependences

of *E*1 and *E*2 if *Cy* is not set at an unreasonably high level. We assume for simplicity that *A* will use urn *A1* to operate in environment *E*1 and will switch to urn *A*2 in *E*2. *A* will seek to establish a red-ball dominance in *A*1 and a white-ball dominance in *A2*.

While net profits are *ceteris paribus* lower than in the first, simplest version of the game, they will be the same or higher as those in the first extension. When *E*1's urn changes to white dominance, the relative values of *Cx* and *Cy*, as well as *A*'s Bayesian beliefs will determine her response. If, as we already assume, *Cy* is low enough that *A* has been prepared to switch urns on turns when *E* played *E*2, *A* will switch to urn *A*2 in order to respond to *E*1 as well as *E*2, and will quickly start to draw white balls. This allows us to model a situation that is somewhat different from the redundancies modeled in the previous extension. Now, an agent who has followed two paths of institution-building in two different environments or sets of circumstances may borrow from one in order to escape from an institutional path dependence in the other which is no longer appropriate. At its simplest level, this may involve lateral thinking, or, more broadly, as in the Dutch *verzuiling* case mentioned above, *Wahlverwandschaft* (Hemerijck 1992). This kind of innovation is more than mere *bricolage*, because taking responses originating in one action sphere and applying them in a new one can result in entirely new actions and institutions.

A Third Extension: Embeddedness in Networks of Policy Fields as a Resource for Responding to Change

By incorporating innovation through learned behavior from proximate fields, we have already gone some way towards bringing the insights of the sociology of 'embeddedness' (Granovetter 1985) within a framework of path dependence. Such learning allows agents to 'capture' external paths of institutional organization in a limited way; by recognizing this possibility, we open the way to dealing with more obviously exogenous phenomena, like imitations and impositions. In an open world it should not be assumed a priori that the walls around national or any other systems are impenetrable. Multinational firms, educational institutions, immigrants and consultants regularly penetrate them. Most neo-institutional literature is unable to deal with the implications of this, because it rests on the assumption that actors operate within bounded, coherent

systems (usually nation states). If this literature is to deal with the more open reality of the contemporary world, it must develop path-dependence theory in a way that relativizes pure endogeneity and pure exogeneity, making them endpoints of a continuum.[20] We can incorporate this new flexibility within the model while retaining the basic constraints of path dependence and avoiding resort to 'anything goes' ad hoc explanations by developing two ideas already implicit within the second extension: that of different levels of 'proximity' of different urns in the game; and that of costs of switching from one urn to another. This extension is useful whenever we are dealing with situations where actors interact heavily with others who themselves operate in different institutional environments. In the case of our science laboratory example, we can easily imagine diversity in the extent to which scientists are located in institutions where they interact with groups using strategies different from their own.

Let us assume that there are N urns, which are used by N agents all playing the simple game in N different environments. Each player has an urn with two of B different colored balls. These agents are not in competition with each other – indeed they do not interact directly, although they may copy each other's actions (i.e. draw from one another's urns) – and A is one among them. Further, they are situated on a plane in which some urns are more distant from A than others; closer urns are those that are less costly for A to emulate, and further urns are progressively more costly. Let us assume that A is playing the simple game in which both she and E have one urn. At some point E begins to draw a new color, which may be any one of B.[21] When this occurs, A may draw (blindly) from other urns in order to find the color which will bring the reward. A has no prior knowledge of the colors of the balls in the different urns, but may have some knowledge of the underlying probability distribution, and may remember the color of balls in urns that she has previously drawn from. To draw from another urn, A must pay cost dCy, where d is a positive function of the distance of the urn from A. This embodies the hypothesis that the difficulty of acquiring access to new practices increases with distance from the initial practice. 'Difficulty' may be constituted in various ways, such as a learning curve, or difficulty of communication with those in a remote location. 'Distance' may similarly have various meanings; it may be literal distance, or, more generally, institutional remoteness. (For a formal demonstration of the importance

of proximity for agents solving learning problems by observing others, see Anderlini and Ianni 1993.)

A's willingness to search out new balls as her environment changes will depend on (i) as always, her Bayesian beliefs; (ii) her acquired stock of knowledge of urns $N-1$; and (iii) the relationship between t, d^*, Cy, and *A*'s expected future earnings from finding the proper ball, where t is the expected number of searches necessary to find the appropriate ball, and d^* the expected distance from the urn containing the right ball.

As in all other forms of the model, these parameters may have values that make anything other than continuing to pursue the original path dependence too costly or difficult. Here, condition (iii) in particular may be especially burdensome. *A* may be faced with a choice of (a) trying to find a remote solution at possibly ruinous cost; (b) of searching intensively among more proximate urns, even in situations where she knows from the underlying probability distribution that the solution is unlikely to be found close by; or (c) continuing to follow the now failing path. This models a situation often faced by agents required to adopt exogenous solutions which do not fit with their past experience and institutional structures. Even if new ways can be learned given time, they may be so remote from the agent that success cannot be achieved before a total crisis arrives. There may be several examples of this in the history of Central and Eastern European countries during the 1990s. Firms and political elites were in a position where all available paths of development from the state socialist period seemed to have failed completely. International agencies and Western governments advised these actors that they must imitate approaches that were extremely remote in terms of their previous experience. The responses adopted provide examples of all three above possibilities (a, b, and c).

We note that this extended form of the model requires considerable operationalization before it can be used in research. The researcher must identify the relevant continuum of actors, the types of institutional practice in which they are engaged (i.e. the character of their urns), and the environments in which they operate. The idea of a full set of N possible solutions set at varying degrees of accessibility from *A* not only replaces the dichotomy between endogeneity and exogeneity of responses with a continuum, but enables us to consider constraints on and possibilities of action caused by relationships between *A* and a given social structure of opportunity.

She is not endowed with perfect knowledge as in much neo-classical theory, but is dependent on her location within that structure for both knowledge of and capacity to use innovations. The lock-in Grabher found in the Ruhr (1993a) during the crisis of the metals sector in the 1980s can be seen to be a case of this extension. All actors within the region were committed to metal manufacture, so that all attempts at solving the crisis involved attempts to reform that sector and no measures for developing new activities. In the terms of our model, all new possibilities were too remote from *A* to be practicable, while all other reasonably accessible players were committed to play the same color as *A* herself. However, Voelzkow and Glassmann (2004) have shown that some Ruhr cities at least have eventually been able to find new paths, largely through the actions of the Land government of Nord-Rhein Westfalen. This agent, which Grabher (1993a) argued was just as embedded as the Ruhr cities themselves in the metal-industry model, was nevertheless located so that it had access to other games. (To apply the concepts of Anderlini and Ianni's (1993) locality model, agents on the edge of a particular network of embedded relations are likely to have access to other, adjacent networks.) The eventual success of these cities in changing their course of economic development is compatible with our theory, which expects lengthy periods of adjustment and failed attempts to sustain previous paths before actors accept the need for more radical change, but does not rule out eventual success as impossible.

By introducing social structure, we may also begin to incorporate a major factor that is often neglected by path-dependence theories: power. Jack Knight (1992) defines power as involving the ability to constrain another's choice set. Under this definition, we may see how the 'distance' of particular urns need not be a happenstance feature of social structure; instead, it may reflect the power of external actors to make it more costly for *A* to adopt certain solutions. This again considerably improves the realism of the theory.

In practice it is often difficult to determine whether simple path dependence or a more complex sociological embeddedness lock-in is at work (Thelen 1999); the two may reinforce each other. For example, consider the case of the so-called Bismarckian systems of social insurance established in Germany and a number of other countries, which have become deeply embedded, and which are frequently described in the literature as having produced path dependences. Did these systems originate as the result of the chance

prior appearance of some instances of these particular schemes, which fact later led to their being adapted as a national standard? Or were they conceived because they corresponded to a particular balance of power and set of social relationships and compromises? If the former, we have a relatively pure case of path dependence, first-mover advantage and increasing returns as described in the probability theory literature. If the latter, we are instead dealing with something that needs explanation in terms of the balance of social relationships, for which path-dependence theory is less suited, and perhaps even unnecessary. However, it may not be easy to disentangle these two phenomena in empirical situations; indeed, social structural reasons for the persistence of institutions may change over time, as for example new groups acquire vested interests in old institutions.

For our present purposes, disentangling historical origins is not so important as the other end of the chain of events: understanding the character of practices which have become locked in, so that change and innovation are difficult. However an institution originated, some elements of learning curve and returns to scale may support its persistence against potential alternatives. This is a kind of quasi path dependence, with different origins from those discussed by Arthur (1994), but acquiring some characteristics of that model along the way. There is likely to be a cluster of supporting and opposing interests, cross-institutional links, etc., creating a structure of embeddedness.

A Fourth Extension: Functional Equivalents and Renewed Path Dependence

Finally, let us consider how the model might be extended to deal with a frequently occurring, difficult question. Given the strong possibility that functionally equivalent alternative solutions exist for many problems, how can agents ensure that, in a situation of widespread availability of alternative institutional models, they have an opportunity to choose among various viable possibilities, hopefully finding one which most 'suits' them? This dilemma also presents itself frequently to many groups in the post-communist societies of central and Eastern Europe. How can they, acting under conditions of difficulty and a need to make rapid changes, ensure that they make those reforms which are best suited to their

capacities and needs? More generally, we use this extension where we have evidence that there may be a number of functional equivalents potentially available to actors in the process of attempting change, and where they select one without thorough investigation of alternatives. In the case of our science laboratory, this would occur if our scientists begin to cooperate with one of a number of other departments who offer possibilities for innovation, neglecting the possibilities offered by others.

We can adapt our model to demonstrate such a context of choice; this strongly suggests the conclusion that such actors may have very little chance of making such optimal choices under certain conditions. The powerful logic of the original path-dependence concept is likely to reassert itself. To show this, we modify the third extension (in which A could search through the urns of her neighbors in order to find a new matching ball when E changes urns). Now, when E changes the ball color which it rewards, it is in principle willing to reward any one of m different colors, where $1 < m < B$ and where m excludes red. Let us further assume that different acceptable balls carry different rewards, $R1, \ldots, Rm$.

For the purposes of illustration, let us assume that $m = 3$, with three possible colors (white, blue, magenta). If A has decided to incur the search costs, she searches for a ball until she finds one for which a reward is presented, and finally happens upon a magenta one. She now knows that she will be rewarded if she presents further magenta balls; however, she has no knowledge that blue and white would also be rewarded, and if she finds any of these in the urns of her neighbors she will reject them and continue to look for magenta. While we do not specify any search function, it is reasonable to expect that under many circumstances A will start to build up a path dependence in magenta balls. The possibility of offering blue or white balls will never be discovered, even if presenting either of these would be more lucrative, or less costly.

Under these circumstances, Bayesian decision-makers can 'lock-in' to inferior choices (Arthur 1994). Arthur presents an example of a search algorithm that has similar consequences. Under these assumptions, the actual beliefs of agents have many of the characteristics of path-dependent phenomena; they tend to lock into repeated patterns that are not necessarily optimal. One might go beyond these arguments, to suggest that in a context where agents observe each other such effects may be contagious. Another actor, observing A's success, might conclude that A had indeed discovered an optimal

response to a given set of environmental problems, and might copy her. This demonstrates how the idea of 'one best way' can become rapidly established even if in reality a 'world of possibilities' (Sabel and Zeitlin 1997) exists, discovery of some among which would better suit the interests of some agents than the proclaimed one best way.

Implications for Institutional Research

In the previous discussion we constructed an account of how paths may be 'broken' by actors in their efforts to respond to changed circumstances; we now wish to suggest that our account has broader implications for the social sciences. Specifically, we show that it has relevance for current – and important – debates on institutional systems and their economic consequences. Recognition of the possibilities embedded in our model and its extensions, each of which has made the original path-dependence model approximate more closely to real-world choice and action situations, has significant implications for research on institutional change. We can observe action of the kind analyzed only if we allow for and positively seek elements of complexity, even incoherence, in the empirical stories we tell. The 'stylized facts' beloved of social science, which cut away at awkward empirical details to fit simple expectations, do not help in this task. Unfortunately, the main objective of much current research within the institutionalist tradition has been precisely to present national (and very rarely is the ontological priority of the nation state questioned) cases so that they fit neatly into homogeneous, internally isomorphic types. As we have noted, this approach dominates the literature on varieties of capitalism (Hall and Soskice 2001), as well as those on national systems of innovation (Lundvall 1992; Nelson 1993; Freeman 1995), welfare states (Esping-Andersen 1990), and social systems of innovation and production (Boyer and Didier 1998; Amable 2000).

These accounts assume that national systems possess an overall internal congruence, or they will give contradictory signals to agents (Amable 2000: 657). To the extent that such relationships apply, it becomes possible to establish the particular path dependence of a national system and therefore to make strong predictions, not mere post hoc empirical accounts, of the behavior of agents within it and the virtual impossibility of their making major changes.

Change is likely to occur only when whole systems change under the weight of exogenous pressure. These assumptions give the literature on economic diversity or comparative capitalism the power to make clear (if often incorrect) predictions, but are by the same token inappropriate for a research program in which an escape from path dependences and embeddedness can be modeled in entrepreneurial discovery of concealed, unacknowledged, or surprising potentialities of the available institutional repertoire. In fact, much recent work in the capitalist diversity literature makes it impossible by definition to carry out such a program. These authors are virtually bound to consider all evidence of modes of action which do not fit their overall characterization of a given national or supernational system as untheorized, empirical 'noise' which needs to be disregarded in the interests of an elegant and sharply profiled account. In contrast, our approach depends precisely on incongruities, incoherence, and within-system diversities for its attempt to build – not a series of ad hoc empirical objections – but a theory of crisis resolution and Schumpeterian change that does not require either exogeneity or prediction of inevitable failure (see also Hage and Hollingsworth 2000: 983).

For example, most accounts of the US–American production and innovation system assign it unambiguously to the 'liberal market' (Hall and Soskice 2001) or 'market based' (Boyer and Didier 1998) category, regarding it as virtually a paradigm case. If the vast role of the state-managed defence sector is mentioned it is as an aside (Amable 2000: 670), or is somehow argued around until it is presented as an aspect of the market model (p. 677). One of the problems of a vaunted paradigm case is that theorists start reading back from its empirical details into the terms of the theoretical type it is thought to embody. If the role of the US defence sector is regarded instead as *complementary* to the market in the true sense of that word – providing something substantively different from, and compensating for deficiencies in, an existing form – a very different account emerges (Hage and Hollingsworth 2000: 992; Hollingsworth 2000: 605, 613). In the terms of the current argument, the role of the US Defense Department becomes a white-ball game played alongside a red (market) one as in the first or second extensions. Following this path, an account of the US economy would explain its performance in terms of the range of institutional forms at its disposal, rather than see it as the realization of one such form. One might similarly present the high rate of immigration

into the USA as evidence of the capacity of firms and other organizations in that country to draw on a diversity of educational experiences, rather than treat relations between the US economy and the US education system as an institutional 'best fit'. The contribution of educational and cultural heterogeneity to innovation is already being strongly noted in certain parts of the Californian software industry.

Conclusions

In the preceding discussion we have sought to provide a more nuanced account of change in institutional systems. In doing so we have tried to extend and combine path-dependence theories in the following ways, resulting in the identification of a number of path-changing possibilities. It should be stressed that, although in the course of the discussion we have departed a long way from the probability theory base of pure path-dependence theory, the essential logic of that base and the constraints it imposes on social actors continue to play a key role, making it necessary to explain why actors cannot simply change strategies as an act of costless volition when confronted with the failure of the habitual paths, but must investigate a strictly limited number of possibilities, always with uncertain prospects of success:[22]

1. through incorporating a Bayesian decision-maker with her 'own' urn, more accurately to model the relationship between actors and their environments;
2. by introducing into the model the possibility of costed searches into other paths concealed within agents' own past experience, to enable them to stand a chance of pursuing possibility 1: the use of hidden or dormant alternatives within their own repertoires;
3. by introducing the possibility of agents playing simultaneous games, to enable them to pursue possibility 2: transfer of experience from different action spaces;
4. by introducing the possibility of agents having costed access to additional games, to enable them to pursue possibility 3: transfer of experience from other agents through networks of structured relationships – which in turn helps break down the rigid dichotomy between endogeneity and exogeneity as sources of actors' responses; and

5. by introducing the possibility of several viable alternatives, only one of which is likely to be discovered, to model how ideas of 'one best way' solutions become established.

This model provides a way of accounting for and studying innovation and entrepreneurship while taking advantage of the principal insights which path-dependence theory has made available to neo-institutionalist analysis. Our conclusions are similar to those already reached by Garud and Karnøe (2001a: xiii) in their model of entrepreneurs as embedded path creators, as 'neither insiders nor outsiders, but boundary spanners'. They reject the conventional idea of entrepreneurs and innovators as completely original, even exogenous, forces; entrepreneurs develop along the paths provided by history, but attempt mindfully to depart from it. By 'mindfulness' Garud and Karnøe (2001b: 23) mean consciousness of embeddedness and knowledge of when to use it and when to depart from it. They invoke Schumpeter's (1936) stress on the need for entrepreneurs to escape from the strict dictates of rational action. Their entrepreneurs therefore proceed through a path of 'chain linked deviation' (Garud and Karnøe (2001b: 26). This differs from a random walk in that at each step the agent places its next step purposively, though it is acting with only imperfect knowledge.

It must therefore be stressed that we are not contesting the currently dominant approach with a series of anti-theoretical empirical objections along the lines of classic English historiography. Rather, we propose the following approach to the study of path dependences – which shares some characteristics with that advocated by Pierson (2000a: 494–6). (Despite its growing inapplicability, we assume here the simple case of a study of an individual area of activity within an individual nation state.) First, the different modes of governance or institutional approaches at work within the sphere of activity should be discovered following an intensive research process, and specified in terms of theoretical models. Second, an attempt should be made to rank the modes found in terms of their relative dominance. (Here we have a conflict of method with that of the varieties of capitalism school. Having identified a single dominant system, the former excludes all information on subordinate systems from further analysis. The present approach retains them as part of the account.)

Third, a conceptual map must be developed of other institutional spheres within the society, described according to their proximity to

the area of activity at the centre of the research and according to their accessibility both to agents relevant to that industry and to those without. Fourth, the different modes of governance or institutional approaches at work within these other institutions must be specified, again in terms of theoretical models. Fifth, an attempt must be made to rank these in terms of their relative dominance. (Here occurs another conflict with the varieties of capitalism school. Having identified a single dominant system within these institutions, this approach demonstrates its *Wahlverwandschaft* with the main object of study, and excludes all contrary information.)

In practice it is unlikely that such a research program can be fulfilled in its entirety. However, even without adopting such a wholesale approach, two steps may help adjust research strategy in fruitful ways – neither of which involves resorting to stylized facts and other distortions. First, the range of institutions to be covered by the research needs to be limited to the scope of available knowledge. Thus, if there is well-established evidence that particular forms of parliamentary government are associated with certain kinds of production, it is legitimate to cite such evidence in support of an hypothesized *Wahlverwandschaft*. But if thorough evidence of this kind is lacking, it is not legitimate merely to assume the link because of its theoretical appropriateness; instead it is appropriate to remain silent about it.

Second, researchers into complex macro-social phenomena like the wider institutional structure of an economy may have to accept that, despite their theoretical identity, explanation and prediction are very different activities, and we may often have to limit ourselves to the former. When an event has already taken place, it is possible with various methodologies to reconstruct how and why it occurred, and to delve back into the ensemble of wider institutional processes involved. It is not possible to do this for future events, because researchers cannot tell which surprising combinations of institutional resources will in practice be used by creative, entrepreneurial actors – if they can, the changes are not surprising. As James Mahoney notes, path dependence research may require that one 'ruthlessly move back in history to uncover a point in time when initial conditions *cannot* predict the outcome.' (our italics)[23]

We shall continue to be taken by surprise by acts of true Schumpeterian entrepreneurialism as opposed to those of Hayekian or Northian incrementalism. However, we can at least conceptualize the likelihood of these occurring in terms of risk-taking. Schum-

peterian actions can be conceived as those which make unexpected and daring leaps in innovation. If we retain the basic assumption of the theory, that even such leaps as these have to draw on knowledge which is somehow already available, an innovative leap can be theorized as a decision to start drawing balls from a remotely located and unlikely urn. The idea of the 'leap' is apt. In terms of the model, this is always possible, but it is costly. Typical costs will be lack of knowledge whether the innovation will work, because the idea for it has been pulled from such a remote and unfamiliar institutional location. It is therefore reasonable to predict that most such attempts will fail, but a small but finite number will succeed. Further, we can specify the kind of conditions (e.g. redundancy) which will put agents in a position to carry out such innovations.

Such a model can be used in a number of different fields. We have taken examples from economic change, social policy development, and the organization of science; wherever innovation and entrepreneurship are possible, the model is relevant.

NOTES

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1. For a representative sample, see Deeg (2001), North (1990a), Pierson (2000a, b), Putnam (1993), Thelen (1999).
2. For reasons of simplicity, however, we do not try to model how actors' behavior may itself affect their environment in a recursive fashion. (We are grateful to Carlo Trigilia for bringing this set of issues to our attention.)
3. We note that North's account of institutional development in South America may be criticized for its lack of attention to the role of power relations; see Knight (1992), Solokoff and Engerman (2000); also Karl (forthcoming).
4. As Miller (2000) points out in response to Pierson, by no means all rational choice theories of institutions are functionalist, and basic results of rational choice theory suggest that inefficient outcomes are likely to be the norm in common social dilemmas. See, more generally, Knight (1992, 1995).
5. Pierson (2000a: 265) limits himself to observing that change is bounded 'until something erodes or swamps the mechanisms of reproduction that generates continuity.'
6. See, for example, the account of Italian regional development in Putnam (1993). While Putnam suggests in his conclusions that change is possible, he does not

seek to integrate this suggestion with the main body of his argument, which emphasizes how the dead hand of path dependence weighs on current political outcomes. On Putnam's misuse of path dependence theory, see Levi (1996).

7. For our purposes, an agent can be an individual person, a firm, or another collective actor, provided that it is reasonable to assume that the agent makes decisions as a unit. By 'environment' we mean the context within which the agent acts and from which she derives rewards. In the case of a firm, the environment would be the markets within which it sells its products. For policy-makers and decision-makers it would be the action space within which they operate and learn whether or not their actions have led to desired results.
8. For the application of Bayesian principles to social situations, see Breen (2000) and Western (2000).
9. We note that our use of quasi-mathematical notation may give an impression of greater precision and formality than is in fact the case. As should become apparent, we do not seek to use sophisticated formal theory, and we accept that some of our conclusions may be difficult to prove in mathematical terms at the level of generality that our arguments involve. However, we contend that our manner of explication is appropriate to our purpose, in that it allows us (a) to specify better the linkages between our arguments and the basic contentions of path-dependence theory, and (b) to express our arguments with a higher degree of clarity than would be possible in everyday language.
10. For the sake of simple presentation we ignore the possibility that A reaches a confounding learning equilibrium (Breen 2000). However, we note one interesting implication of such equilibria; they involve players converging on a set of beliefs in which they attach positive probabilities to each of the possible states of the world. This may lead to lower returns on any particular path, but may also make it easier for players to adapt to exogenous changes of the rules of the game, which involve switching from one path to another.
11. We note that such change is not incorporated into the initial parameters of the game. It would be possible to do so by having some probability p at each stage of the game that E's urn would change. In this case, A's expected payoffs would take p into account. However, what we wish to examine is the possibility of entirely exogenous change, which belongs to the category of uncertainty rather than risk, and thus cannot be anticipated by the actor involved. Thus we assume that A is aware that there is some possibility of path change occurring, but she cannot assess that possibility *ex ante*; she is in a situation of uncertainty. *Ex post*, however, she may realize what has happened after she updates her beliefs due to discomforting evidence. This is rather difficult to describe using formal Bayesian analysis, but provides a reasonably good account of how real actors will behave in conditions where unpredictable changes may occur.
12. We note that for some parameter values expected benefits will be less than expected costs, so that A will be unwilling to incur such costs. However, these are theoretically uninteresting for our purposes.
13. See also Herrigel (1993) on the conditions under which internationally oriented large firms have sought to make use of, or alternatively displace, local paths of development in their efforts to respond to a changed environment.
14. In our simple example, we assume there are two such ways; as we illustrate below, a number of paths of institutional development may be possible in a given set of

social circumstances. On path dependency and indeterminacy, see also Mahoney (2000).

15. Something like this is embodied in Douglas's (1987: 66–7) adaptation of Lévi-Strauss's idea of *bricolage*. For Lévi-Strauss this idea of rummaging around in disused practices for ways of solving problems was specific to 'primitive' societies; Douglas sees that it might equally happen in 'advanced' ones. But both see it as essentially conservative practice, rather than as a potential springboard for true innovation. Our formulation of the possibility of change within the initial model is a case of *bricolage*, but once we consider the transfer of practices from one field to another in which they have not previously been applied (as in the extensions), there is a possibility of true innovation.
16. Planned redundancy is different; the independent variable here is *A*'s urn. This means that one could incorporate some planned redundancy even into the simple, early model where there is only one urn. If *A* has some precognition that there is a *substantial* positive chance that her environment will change in the future, as in the first game, she *might* simply build in redundancy by every once in a while searching out a white ball. She will do this in the knowledge that this will reduce her own path dependence (and thus her expected payoffs) while the red-ball dominance lasts, but that it will also make it easier for her to switch whenever necessary.
17. See further, Lohmann (forthcoming).
18. Within the economy as such, the chances for super-profits occur because the entrepreneurial agent is willing to take a risk which others refuse, making possible temporary rents. (The super-profits of the Hollingsworths' (2000) scientists are rewards like Nobel Prizes, which can be seen as a kind of permanent rent.)
19. See also Low, Ostrom et al. (2001).
20. It should be noted that we are here dealing with the endogenous or exogenous nature of the *response* made by actors, not of the *shock* which stimulates the need for change.
21. This is not to imply that there is an equal probability that each of the *N* urns holds the solution, merely that there is a non-zero probability for each of them. For simplicity's sake, however, we do not specify either the distribution function or *A*'s search function.
22. We use 'possibilities' rather than 'strategies', because, even if agents behave rationally at each stage of the process, they do not choose a path with perfect knowledge of its consequences, so that accident, serendipity and structured opportunity play an important role in the adoption of particular routes.
23. Mahoney (2000), pp. 57–58.

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