

# Path Dependence

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Path dependence explains how the set of decisions one faces for any given circumstance is limited by the decisions one has made in the past, even though past circumstances may no longer be relevant.

In economics and the social sciences path dependence can refer to either outcomes at a single moment in time or to long run equilibria of a process. In common usage, the phrase implies either:

(A) that "history matters" - a broad concept, or

(B) that predictable amplifications of small differences are a disproportionate cause of later circumstances. And, in the "strong" form, that this historical hang-over is inefficient.

The first usage, (A): "history matters" is trivially true in the explanatory context; everything has causes. And, in these fields, the direct influence of earlier states isn't notable (compare "path dependent" options in finance, where the influence of history can be non standard).

It is the narrow concept, (B), that has the most explanatory force and which is covered in this article.

### **Illustration**

Consider as an example the Videotape format war; Two mechanisms independent of product quality could explain how VHS achieved dominance over Betamax from a negligible early adoption lead:

A network effect: videocassette rental stores observed more VHS rentals and stocked up on VHS tapes, leading renters to buy VHS players & rent more VHS tapes, until there was complete vendor lock-in.

A VCR manufacturer bandwagon effect of switching to VHS-production because they expected it to win the standards battle.

An alternative analysis is that VHS was better adapted to market demands (e.g. having a longer recording time). In this interpretation, path dependence had little to do with VHS's success, which would have occurred even if Betamax had established an early lead.

Positive feedback mechanisms like bandwagon and network effects are at the origin of path-dependence. They lead to a reinforcing pattern, in which industries 'tip' towards one or another product design. Uncoordinated standardisation can be observed in many other situations.

Economics

Path dependency theory was originally developed by economists to explain technology adoption processes and industry evolution. The theoretical ideas have had a strong influence on

evolutionary economics (e.g., Nelson & Winter 1982).

There are many models and empirical cases where economic processes do not progress steadily toward some pre-determined and unique equilibrium, so that the nature of any equilibrium achieved depends partly on the process of getting there. The outcome of a path dependent process will often not converge towards a unique equilibrium but instead reach one of several equilibria (sometimes known as absorbing states).

This dynamic vision of economic evolution is very different from the neo-classical economics tradition, which in its simplest form assumed that only a single outcome could possibly be reached, regardless of initial conditions or transitory events. With path dependence, both the starting point and 'accidental' events (noise) can have significant effects on the ultimate outcome. In each of the following examples it is possible to identify some random events that disrupted the ongoing course, with irreversible consequences:

In economic development, it is said (initially by Paul David in 1985) that a standard which is first-to-market can become entrenched (like the QWERTY layout in typewriters still used in computer keyboards). He called this "path dependence", and said that inferior standards can persist simply because of the legacy they have built up. That QWERTY vs. Dvorak is an example of this phenomenon has been re-asserted, questioned, and continues to be argued. Economic debate continues on the significance of path dependence in determining how standards form.

Economists from Adam Smith to Paul Krugman have noted that similar businesses tend to congregate geographically ("agglomerate"); opening near similar companies attracts workers with skills in that business, which draws in more businesses seeking experienced employees. There may have been no reason to prefer one place to another before the industry developed, but as it concentrates geographically participants elsewhere are at a disadvantage, and will tend to move into the hub, further increasing its relative efficiency. This network effect follows a statistical power law in the idealized case, though negative feedback can occur (through rising local costs).

Buyers often cluster around sellers, and related businesses frequently form Business clusters, so a concentration of producers (initially formed by accident & agglomeration) can trigger the emergence of many dependent businesses in the same region.

In the 1980s, the U.S. dollar exchange rate appreciated, lowering the world price of tradable goods below the cost of production in many (previously successful) U.S. manufacturers. Some of the factories which closed as a result could later have been operated at a (cash-flow) profit, after dollar depreciation, but re-opening was too expensive. This is an example of hysteresis, switching barriers, and irreversibility.

If the economy follows adaptive expectations, future inflation is partly determined by past

experience with inflation, since experience determines expected inflation and this is a major determinant of realized inflation.

A transitory high rate of unemployment during a recession can lead to a permanently higher unemployment rate because of the skills loss (or skill obsolescence) by the unemployed along with a deterioration of work attitudes. In other words, cyclical unemployment may generate structural unemployment. This structural hysteresis model of the labour market differs from the prediction of a "natural" unemployment rate or NAIRU, around which 'cyclical' unemployment is said to move without influencing the "natural" rate itself.

Liebowitz and Margolis distinguish types of path dependence; some do not imply inefficiencies and do not challenge the policy implications of neoclassical economics. Only "third degree" path dependence - where switching gains are high but transition is impractical - involves such a challenge. They argue that such situations should be rare for theoretical reasons and that no real-world cases of private locked-in inefficiencies exist. Vergne and Durand qualify this critique by specifying the conditions under which path dependence theory can be tested empirically.

Technically, a path-dependence stochastic process has an asymptotic distribution that "evolves as a consequence (function of) the process's own history". This is also known as a "non-ergodic stochastic process".

In *The Theory of the Growth of the Firm* (1959), Edith Penrose analyzed how the growth of a firm both organically and through acquisition is strongly influenced by the experience of its managers and the history of the firm's development.

## History

Recent methodological work in comparative politics and sociology has adapted the concept of path dependence into analyses of political and social phenomena. Path dependence has primarily been used in comparative-historical analyses of the development and persistence of institutions, whether they be social, political, or cultural. There are arguably two types of path-dependent processes:

One is the "critical juncture" framework, most notably utilized by Ruth and David Collier in political science. In the critical juncture, antecedent conditions allow contingent choices that set a specific trajectory of institutional development and consolidation that is difficult to reverse. As in economics, the generic drivers are: lock-in, positive feedback, increasing returns (the more a choice is made the bigger its benefits), and self-reinforcement (which creates forces sustaining the decision).

The other path-dependent process deals with "reactive sequences" where a primary event sets off a temporally-linked and causally-tight deterministic chain of events that is nearly uninteruptible. These reactive sequences have been used to link the death of Martin Luther King, Jr. with welfare

expansion and the industrial revolution in England with the development of the steam engine.

The critical juncture framework has been used to explain the development and persistence of welfare states, labor incorporation in Latin America, and the variations in economic development between countries, among other things. Scholars such as Kathleen Thelen caution that the historical determinism in path-dependent frameworks is subject to constant disruption from institutional evolution.

### **Social sciences**

An influential attempt to rigorously formalize path dependence within political science is that of Paul Pierson, partly drawing on ideas from economics. Herman Schwartz has questioned those efforts, arguing that forces analogous to those identified in the economic literature are not pervasive in the political realm, where the strategic exercise of power give rise to, and transform institutions.

The path-dependence of emergent strategy has been observed in behavioral experiments with individuals and groups.

### **Other examples**

A general type of path dependence is a typological vestige.

In typography, for example, some customs persist, although the reason for their existence no longer applies; for example the placement of the period inside a quotation in U.S. spelling.

Evolution is considered by some to be path-dependent: random mutations occurring in the past have had long-term effects on current life forms, some of which may no longer be adaptive to current conditions. For instance, there is a controversy about whether the panda's thumb is a leftover trait or not.

In the computer and software markets, legacy systems indicate path dependence: customers' needs in the present market often include the ability to read data or run programs from past generations of products. Thus, for instance, a customer may need not merely the best available word processor but rather the best available word processor that can read Microsoft Word files. Such limitations in compatibility contribute to lock-in, and more subtly, to design compromises for independently developed products if they attempt to be compatible. Also see embrace, extend and extinguish.