




Path-Dependence

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Introduction

- *Why do clocks go clockwise? Why do people in most nations drive on the right? Why is the diamond business in New York concentrated into the area around west 47th Street? Why do nearly all typist learn the inefficient QWERTY keyboard layout? How did Microsoft's Windows and Intel's processors come to dominate the market for personal computers? Why are there so many 'winner-take-all' markets where success accrues to the successful, where the rich get richer and the poor get poorer?*
-  All these examples exhibit **PATH DEPENDENCE**

Definition

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- **Path dependence** is a pattern of behavior in which the ultimate equilibrium depends on the initial conditions and random shocks as the system evolves. In a path dependent system, small unpredictable events early in the history of the system can decisively determine its ultimate fate.
- A **path-dependent sequence of economic changes** determines an eventual outcome that can be exerted by temporally remote events where chance elements may dominate systematic forces → “lock-in by historical events” (Arthur, 1983)

Definition

2/2

- The claim for path dependence is that a **minor advantage** or a **seemingly inconsequential lead** for some technology, product and standard can have important and irreversible influence on the ultimate market allocation of resources, even in a world characterized by voluntary decisions and individually maximizing behavior.
- The path dependent literature goes together with a mathematical literature of **nonlinear dynamic models** (known as ‘chaos’ or ‘complexity models’), for which a key findings is “sensitive dependence on initial conditions”

Path dependence in VCRs: VHS vs Betamax

- Videocassette recorders (VCRs) are ubiquitous in homes, businesses and schools. The film industry earns significant revenues from sales of video rights. Much of this success depends on the **common format** used by the vast majority of VCRs, known as VHS, which ensures machines made by different companies are compatible with one another and with the tapes available in the market.
- How did VHS become a standard?

Path dependence in VCRs: VHS vs Betamax

- VHS was actually a latecomer to the home videorecorder market. Home video recording technology came of age in 1975 when Sony introduced the Betamax system.
- VCRs soon became the hot home electronics product of the late 1970s and early 1980s.
- As is common, larger production volumes, learning effects and increasing competitions led to huge price drops for VCRs even as their features and functionality increased. Demand soared.

Path dependence in VCRs: VHS vs Betamax

- Betamax and VHS technologies cost about the same. They were not compatible. Consumers had to choose which standard to adopt.
- The most important determinants of product attractiveness are compatibility and network effects.
- As the installed base of machines of a given format increased, the attractiveness of that format to potential new buyers increased, which in turn increased the market share of that format and boosted the installed base even further

Path dependence in VCRs: VHS vs Betamax

- Even more importantly, people tended to buy machines compatible with the broadest selection of prerecorded tapes. Video rental shops decided to stock tapes in the most common formats since these would rent more often and yield more profit. Movie studios, in turn, chose to offer their films in the format compatible with the most popular technology and orders placed by the video stores.
- These positive feedbacks mean that the format with the larger installed base of machines, all else equal, will be the most attractive to consumers and content providers.

Path dependence in VCRs: VHS vs Betamax

- By the late 1970s, VHS had gained a market share advantage over Betamax. Soon the majority of prerecorded tapes were also coming out in the VHS format. VHS market share and sales continued to grow while Betamax share steadily shrank.
- By 1988 the triumph of VHS was complete. Sony was forced to abandon Betamax technology for the home market and in 1988 announced that it was switching its product line to the VHS format.

Path dependence in VCRs: VHS vs Betamax

- **Klopfenstein (1989)** notes that VHS offered longer play and record time. Originally, the VHS playtime was 2 hours to 1 hour to Betamax; by 1988 the ratio was 8 hours for VHS to 5.5 hours for Betamax. In contrast, **Arthur (1994)** argues that Betamax had a sharper picture than VHS and was actually the superior technology.

Path dependence in VCRs: VHS vs Betamax

- An early VHS **price advantage** is a possible explanation. Price data, even if hard to get, seem to suggest that in 1978 VHS machines were about 7% cheaper than Betamax machines.

BUT: VHS machines were actually more expensive in 1981. Price does NOT seem to be a decisive factor in explaining how VHS overtook Betamax.

Path dependence in VCRs: VHS vs Betamax

- Cusumano, Mylonadis and Rosenbloom (1992) point to the **different business strategies** employed by the producers. Sony, seeking to profit from their proprietary technology, was reluctant to license Betamax to other firms. In contrast, Matsushita aggressively sought partners among other manufacturers, set lower licensing fees than Sony, and even delayed the introduction of VHS until they and their allies could agree on common technical standards.
- Aim: creation of a larger installed base!

Path dependence in VCRs: VHS vs Betamax

- The development of the prerecorded tape industry played a key role. RCA, Matsushita's largest customers in the US, sought to jump-start the market for general audience videos and thus VCR sales by offering two free VHS tapes with each VCR it sold. RCA also encouraged firm such as Magnetic Video to invest in VHS equipment to supply prerecorded tapes for the US market. Large scale production of prerecorded tapes for the US market.

Does the economy lock in to inferior technologies? The case of QWERTY

- If the dominant determinant of product attractiveness is compatibility and the availability of complementary goods, then a firm may become a market leader *even though its technology is inferior*.
- The **QWERTY keyboard** invented by Christopher Sholes in the 1870s is widely considered to be inferior to the 1936 Dvorak keyboards in terms of training time, typing speed, error rates, balance between the left and the right hands, and comfort, yet nearly everyone continues to learn the QWERTY layout.

Does the economy lock in to inferior technologies? The case of QWERTY

Three features of the evolving production system were crucially important in causing QWERTY to become **locked in** as the dominant keyboard arrangement.

- **Technical interrelatedness**

It refers to the need for system compatibility between keyboard ‘hardware’ and the ‘software’ represented by touch typist’s memory of a particular arrangement of the keys. The purchasers of the hardware typically were business firms that had faced few incentives to investing in providing its employees with a form of general human capital which could be taken elsewhere.

Does the economy lock in to inferior technologies? The case of QWERTY

- **System economies of scale**

The purchase of a QWERTY keyboard conveyed a positive pecuniary externality to compatibly trained typists. The overall user costs of a typewriting system based upon QWERTY would tend to decrease as it gained in acceptance relative to other systems

Does the economy lock in to inferior technologies? The case of QWERTY

- **Quasi-irreversibility of investments**

An important asymmetry appeared between the software and the hardware components of the evolving system: the costs of typewriter software conversion were going up, whereas the costs of typewriter hardware conversion were coming down. This was a situation in which the timing in developmental sequence made more profitable in the short run to adapt machines to the habit of men rather than the other way around.

The driving side in Sweden

- Is the escape from the IRREVERSIBILITY of path-dependent phenomena? ...sometimes there is...
- At the dawn of the automobile age it did not matter which side of the road people drove on. But as traffic density increased, the importance of a consistent standard grew. The more people drove on one side, the more likely was new drivers in adjacent regions would drive on the same side, increasing the attractiveness of that side still further, in a positive loop. Most nations rapidly converged to one of the two standard. Initially, the Swedes elected to drive on the left, as in Great Britain.

The driving side in Sweden

- As traffic and trade with the rest of Europe grew, it became increasingly inconvenient and costly for the Swedish systems to be at odds with the prevailing standard in Europe and North America. Seeing that the Swedish road and system auto was rapidly locking in, the Swedes engineered a remarkable change. In 1963, the entire nation began to drive on the right. Sweden's ability to effect this switch smoothly was due to massive prior education and a huge public works effort to change road signage. But the success of the switch also depended on the small size and low density of the population.