

## Summary MOT1410: Positive Feedbacks in the Economy □ by W. Brian Arthur

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Negative feedback stabilizes the economy, which leads to predictive equilibrium for market shares and prices. In convectional theory it is understood that equilibrium is the best possible outcome, as it results in the most efficient use and allocation of the available resources. In real life, this convectional theory of diminished returns appears not to be very applicable and makes way for the theory of increasing returns.

In theory of increasing returns there are multiple equilibrium points, the effect of small economic shifts is magnified and predictable markets are not guaranteed. Furthermore, with positive feedback, increasing market share results in increasing returns, which in the beginning results in a very unstable market.

According to Alfred Marshall, if a firm initially manages to have a good start, it will be able to best its rivals further on. Theory of diminishing returns finds its way in resource-based parts of the economy where theory of increased returns is mostly applicable in knowledge-based economy. In knowledge-based economy, large initial investments are followed by a cheap incremental production. This incremental production is self-sustaining, as it results in gaining of the experience in producing current, and even easing the production of the new, products or technologies that then make this process more efficient and cheaper.

If increasing-returns mechanisms are important, why have they been largely ignored until recently? Some say, complicated products, with increasing returns, are a recent phenomenon. Orthodox economists avoided increasing returns. Some found existence to more solutions to one problem distasteful. Others could see that it would destroy their world of predictable equilibriums. Still others wondered how a market would select one of several possible solutions.

In the real world, small events help determine which firms entering a market come to dominate. Small events cumulate and become magnified by positive feedbacks to determine which solution is reached. It would be impossible to know in advance which solution would emerge.

Many studied increasing returns problems turned out to fit a general non-linear probability schema. With tools derived from these studies economists can define increasing returns problems, identify possible solutions and study the process by which the solutions is reached.

Suppose that firms enter an industry one by one and prefer to be located close to other firms. The first firm picks a location based on geographical preference. This influences other firms in choosing their location. Industrial concentration becomes self-reinforcing.

Similar consequences to the positive feedback loop were seen in the market for integrated circuits and television sets. The rules of positive feedback imply that it is much harder to regain control of a market than it is to hold on to it from the start. Affected manufacturers should not fight back and countries seldom retaliate, but rather conventional recommendations that rely on the open market and discourage monopolies while leaving R&D spending to companies should be followed. Subsidies and interference might be appropriate for the diminishing returns part of the economy, but not for technology-based parts that display dominance of increasing returns.

Policies that are appropriate encourage industries to be aggressive and strengthen the national research base. Joint ventures and strategic alliances are encouraged in new and competitive markets.

Other policies, such as subsidizing and protecting, are debatable and pose questionable benefits, having also been found to lead to retaliation scenarios in which nobody gains. Thus, the policies chosen by countries determine the shape of the global economy.

As technologies improve the positive feedback loop is reinforced, even in cases that lead to inferior technology being developed. Therefore, long-term dominance is not guaranteed although selectional advantage can be displayed, especially through market founder effects. Standards also play an important role, those that are established early in the development of a technology can be hard to be displaced, even by superior would-be successors. In essence, survival of the fittest is not a reliable maxim in positive feedback markets.

The diminishing returns economy has been portrayed like a large Newtonian system, with a unique equilibrium solution, were perturbations or temporary shifts are quickly negated by opposing forces called into action.

Given knowledge of future developments, it is possible in theory to forecast the path of the economy to high accuracy. Positive-feedback economics, on the other hand, finds parallels in modern non-linear physics and evolutionary thinking, where outcomes are often averaged out and all-important new structures and patterns can arise to provide a fresh layer of development. This is a non-deterministic and divergent new view of economics. Forecasting in this model is theoretically impossible, but states and times can be identified to steer an economy with positive feedbacks in the right direction. This new view portrays the economy as a complex system that is process-dependent, organic and always evolving.