Go Back

OVERCOMING PATH DEPENDENCE

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Abstract:

In this proposal we draw attention to the nature of the phenomena traditionally labeled as path dependence. We seek to impress upon readers that there are at least two kinds of path dependence, given the path dependence that we have traditionally portrayed in system dynamics literature. We present a logic that discriminates between the two kinds of path dependence. This logic, taken forward, helps us develop strategies towards re-designing a system that will help weaken the rapidity of the impact of path dependence, or even arrest path dependence completely. The nature of these strategies depend on the nature of path dependence. In the course of the proposal we also lay out how we will illustrate some detailed examples to demonstrate an application of these arresting strategies.

Keywords: path dependence, insurance industry, equilibrium, process.

OVERCOMING PATH DEPENDENCE

INTRODUCTION

The phenomenon of path dependence has been around in nature for a very long time, and in fact, may be as old as nature itself. Hence its occurrence in natural phenomena comes less as a surprise than its occurrence in phenomena studied by the social sciences. In the topics of interest to the social sciences, path dependent phenomena are encountered in economics as well as sociology and also in the more recently constituted discipline of strategic management.

For example, a classic example of path dependence in economics is the original use and spread of the QWERTY design for keyboards. An important lesson here is that this solution was originally designed to slow down the human-machine interface because of machine design constraints. Even though this design constraint no longer exists today, the overall costs of shifting to a more scientifically and ergonomically designed keyboard are enormous and QWERTY looks here to stay well into the distant future.

In strategic management, the story of how VHS overcame Betamax's earlier entry into the market and its initial lead to almost wipe out the latter's presence is very much a part of contemporary MBA coursework. The lesson here is that the establishment of standards can be a short game. If played with a high commitment, the initial lead matters little but the end-result may not take long to be obvious.

Even though the phenomenon of path dependence has been around for a long, long time, academic attention on this phenomenon has been rather a modern issue. From the study of path dependence to its contemplated use is definitely less than a couple of decades old. Even rarer is a systematic exposition of what can be done to overcome the magnetic momentum of path dependence for those who find themselves unfavorably affected by this phenomenon. Understanding the cause and power of this phenomenon is something that is more suited to a discipline that emphasizes both quantitative and qualitative aspects. Thus, because of its peculiar way of interpreting the world, system dynamics has a special responsibility in forwarding academic advance in the understanding and application of this phenomenon.

Despite this special responsibility, there have been extremely few articles in *System Dynamics Review* in the last 15 years dedicated to advancing our understanding of phenomena related to path dependencies. Perhaps this is due to the ease with which system dynamics can explain the basic elements that are present in this phenomenon and other respected academics have therefore preferred to concentrate their energies elsewhere. The objective of this proposal is to propose a paper that can make a start in encouraging more academic attention to path dependence and its application using system dynamics. Specifically, this proposal is about a paper that seeks to develop in readers an appreciation of the subtle distinction between two kinds of path dependence and how one might address arresting the consequences of path dependence in each of these cases.

In the next sections of the proposal we lay out what is this subtle distinction, how we propose to address arresting the consequences of path dependence and what kind of examples we will provide to illustrate our proposed solutions.

KINDS OF PATH DEPENDENCIES

Given the lack of articles on path dependence cited above, it was useful to go through Sterman's book (2000) – *Business Dynamics.*: *Systems Thinking and Modelling for a Complex World,* published by McGraw Hill. Path dependence is defined as "a pattern of behavior in which small, random events early in the history of a system determine the ultimate end-state – even when all end-states are equally likely at the beginning" (ex-ante). In more technical terms, path dependence arises in systems whose dynamics are dominated by positive feedback processes.

Sterman (2000) cites two examples for path dependence. First is the example of the marble in a overturned bowl. Second is a simple model of path dependence called "The Polya Process". Taken together, these demonstrate the classic characteristics which define path dependence. Basically, this is the increasing inevitability of the final state of the system with the passage of time, which is not so obvious when the system starts to evolve. However, a more subtle and underlying feature is that after the system starts evolving and before the effective attainment of equilibrium, there is a process that guides the system and the variables in the system. This process, however simple or complicated, is also responsible for the intermediate values that the variables in the system transit through on the way to equilibrium. Let's call this process the equilibriating process.

Our submission is that this so-called equilibriating process can be usefully classified into two types. The classification is decided by the ability of the process to reverse or significantly change the implications about the final state of the system from the existing value of the indicating variable, when the time elapsed towards the attainment of equilibrium is relatively small. The implications of this definition are explained below with the help of two examples.

Process Influenced Path Dependence

The first example we take is the "Polya Process" as described in Sterman (2000). In this case outlined in the text, there is a very real possibility of ending up in a black equilibrium, even if the first or the first few draws is white. In other words, the process of adding stones that influences the probability of the outcome of the next draw (i.e. the equilibriating process) is such that it allows the overall process a realistic chance to overturn the result implied by the first draw (at least for the first few draws). The so-called lock in does not occur instantaneously but builds up rapidly (like a rapidly accumulating stock).

In such kinds of path dependence, the ultimate result reached is not a function of the initial displacement or the initial draw but a function of the history of the outcomes of the process that take it towards equilibrium. This kind of path dependence is quite common in social settings e.g. the setting of a standard, the evolution of a firm, the game of tennis, etc. The important distinguishing characteristic is summed by the comment about the tennis game: “As long as you keep winning the next point, you can win the match – irrespective of how far behind your opponent you are.”

Process Independent Path Dependence

The second example we take is the marble on the inverted bowl, again described by Sterman (2000). In this case, the initial displacement of the marble is enough to determine the final point where the marble will roll off the inverted bowl. The process that takes the marble from the initial displacement to its final resting place may be complex but is quite powerless to take the marble to a radically different direction than that indicated by the initial displacement. If the marble is initially displaced to the left of the inverted bowl, it will not come to rest on the right side of the inverted bowl.

Here the so-called lock-in occurs instantaneously. The events of the second instance are in direct contrast to the kind of path dependence portrayed in the first instance. The equilibriating process in this case does not have the ability to influence the outcome. Although examples of this kind of process independent path dependence that come to mind are from the natural sciences, there definitely are corresponding examples in social settings. Later, we shall be proposing one.

Path Independence

This is easily explained by citing the behavior of a marble in a normally standing bowl, not an inverted bowl. The marble always returns to the center of the bowl, which is also called the attractor (for the basin of attraction). In more technical terms, these kind of systems are dominated by negative feedback. In the paper stage we will try to impress upon the readers that there are two kinds of path independence, corresponding to the two kinds of path dependence that we are trying to distinguish.

ARRESTING PATH DEPENDENCE

Having made the distinction between process influenced path dependence and process independent path dependence, we turn to the seemingly un-addressed issue of how to arrest or slow down the impact of path dependence if it is working against you or you as the regulator of a competition process want to ensure that the phenomenon of lock-in does not lock-in an inferior kind of technology.

In our opinion, the distinguishing characteristic of process dependence and process independence is the relevant design issue if we want a way towards the objective mentioned in the last paragraph. Here below we sketch some details of each, leaving the full treatment to the final version of the paper.

Process Influenced Path Dependence

Since it is the outcome of the equilibriating process that determines path dependence in this case, there are at least two ways of achieving the objective of arresting the inevitability of path dependence here. The first intervention is very easily explained in technical terms – we can lower the coefficient or gain of the positive feedback loop that dominates so that if other negative feedback loops are present, they can have an influence over what is happening to the system. The second intervention is more drastic – to alter the equilibriating process itself so that it is no longer as heavily biased towards favoring a certain outcome as before.

In the final version of the paper, we propose to develop and extend the "Polya Process" model that is cited in Sterman (2000) to show how these suggested interventions can have an impact on the situation. This "Polya Process" is shown in Sterman's text and it is a reasonably simple model to duplicate and should be easily grasped by readers. Variations in the process of adding stones should lead to different kinds of outcomes while not compromising on the element of randomness that is there.

Process Independent Path Dependence

At first sight this may seem much more difficult, given the relatively weak effect of the equilibriating process – implying that it is pointless to manipulate the equilibriating process. Nevertheless, we can again suggest ways of achieving the objective of arresting the inevitability of path dependence here.

For example, we can re-use the intervention that corresponds to the one used above – we can lower the gain or the coefficient of the positive feedback loop that is dominating. In some cases this is enough to increase sufficiently the relative contribution of the negative feedback loops and arrest the tendency towards path dependence. However, in some of these cases, the lowering of the coefficient or the gain may reduce the amount of “energy” flowing in to the system and this has to be supplemented by a process that is not linked to the state of the system.

To illustrate the use of this kind of an intervention in a social setting, we will build a system dynamics model to simulate the growth dynamics of an insurance firm in the United Kingdom. This firm is mainly concerned with selling life insurance. The structure of the model is based on interviews with experienced managers and industry experts, but the structure will be sufficiently simplified and focused to illustrate the issues regarding process independent path dependence and process influenced path dependence. On one hand the model aims to be simple enough to represent only the essence of the cause of dynamic phenomena, while on the other hand it should be rich enough to test some simple propositions that we put forward, through simulation. It will capture the interplay between the four agent subsystems: headcount, skills, productivity and compensation. However, the same persons who assisted in the structural construction of the model will comment on the behavioral validity of the model.

In the simulation, we will have two stylized branches that are identical in all respects except in the endowment of a critical resource-stock. They would also be competing under stylized identical environments and market conditions. These branches are expected to demonstrate path dependence (Figure 1). Then we will implement our proposed solutions to demonstrate whether or not we can arrest process independent path dependence in a manner that has practical relevance for the insurance industry.

In the following section we present a brief background of the insurance industry and spell out why we eventually focus on the agency department of the branches of the firm concerned.

THE INSURANCE INDUSTRY AND THE TYPICAL FIRM

A typical British insurance firm sells “policies” to policy-holders who want to insure themselves, by paying small annual “premiums”. They make claims with the insurance company when they suffer losses covered for. The insurance firm is supposed to invest and grow the funds that accrue to them in order to keeping them secure, meet pay-out needs and return funds to mature policy-holders as and when necessary. Major players have a common set of tasks – selling insurance, selecting risks, fixing and collecting premiums, writing policies, investing money, keeping accounts, collecting, researching and analyzing statistics, processing claims and dealing with legal issues and cases. These tasks are executed either by building required skills as individual firms, or sharing them from a common pool – depending upon the quantum of required investment and the scope for differentiation. Given that new types of policies can be copied, it’s difficult to establish a sustained differentiation with respect to competitors.

Collecting, researching and analyzing statistics is a pooled activity, due to economies of scale. The scope to differentiate is limited[1] when it comes to processing claims. The financial performance of investments is legally required to be kept apart from the rest of the organization. There seems to be some scope for differentiation in sales of insurance policies. Demand can be generated through sales and marketing. As hinted above, the scope for differentiation through marketing is limited, as it is difficult to compete on prices and very difficult to sell differentiated products (policies) on a sustained basis.

Agents sell policies for commission. The agency department affords the greatest flexibility to firm management to establish a competitive advantage through differentiation and productivity[2]. Management decides what kind of agents to hire, how much training they get, how to train them, where to spread its agents and how to identify and retain its star performers. This department is responsible for the entry of new money streams. It is the largest cost item that can actively be managed in the business plan of the insurance company. For these reasons we focus on the agency department of firms in the insurance industry, and in particular, on the general agency system.

[1] No firm would want to establish either a reputation for compromising on payments or take a hit on its profitability by relaxing payment standards.

[2] Another way in which firms in the industry differentiate themselves is through the pattern of ownership of the equity structure of the firm. However, this makes an impact only during exceptional events in the history of the firm.

The Agency Department in the Insurance Firm

We will henceforth refer to the stylized department as a firm. The firm competes to sell policies to those who want to buy insurance. These products provide the insurance firm with premiums for the length of the life of the product, if they do not 'lapse'. The larger the product base (i.e. the inventory of live policies sold by the firm), the larger the cash flow and revenue to the insurance firm.

These sales are actually in a cycle of three stages. In the first stage, agents are recruited from the market to be employees of the firm and become part of the agent pool that goes out to sell policies to prospective customers in the market. Firms always seek to hire more experienced agents from the market and to retain the better-performing agents. In the second stage, policy sales accumulate as the body of policies in force and form the basis of the future revenue stream (as premiums) unless these policies lapse. Policy sales and lapses are a function of the skill level of the agents. In the third stage, agents are compensated based on the sales made and lapses occurred in that particular year.

When agents join the firm, they not only increase the headcount of sales employees but also add their sales skills to the skill pool of the firm. Also, from time to time, some agents quit the firm and some are promoted. These decrease the headcount of the sales employees as well as from the aggregate skill pool of the firm. While agents quitting the firm tend to have lower than the average skill level, those promoted will have a higher than average skill level. Thus it is a challenge to the management to maintain and improve upon the skill level of their agent base.

Agent compensation is of particular importance. If the agents perform above the performance level expected by the market, the compensation that results is also above market expectations. Conversely, performance inferior to market expectations leads to inferior compensation. In turn, compensation affects the quit rate of agents (the quit rate influences the lapse rate of new policies sold) as well as the attractiveness of the firm to new agents who are considering whether to join the firm.

We use a measure of performance closely related to the measure of new business expense ratio described earlier. It is defined as the ratio of net new products to the expenses incurred in selling these policies. We ignore products that mature because they are a function of the firm's existing portfolio of products and therefore, an indication of the past performance of the sales force. Hence,

$$\text{Profitability} = \frac{\text{Number of products sold} - \text{Number of products lapsed}}{\text{Total expenses of selling products}}$$

As our focus is on the agency department, we use the quantum of new products sold per year in lieu of the premiums earned annually due to new business. As we assume products of standard length and premium, the only dimension of distinction in sales is the number of products sold. Hence, larger the number of policies the firm can sell (that do not lapse), per labor cost unit, the greater the profitability of the firm.

FIGURE 1