

Industry Life Cycle

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Klepper (1997)

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***Industrial and Corporate Change*, 6 (1), 145-181**

«Evidence on entry, exit, firm survival, innovation and firm structure in new industries is reviewed to assess whether industries proceed through regular cycles as they age. A leading depiction of the evolution of new industries, the product life cycle, is used to organize the evidence. It is shown that the product life cycle captures the way many industries evolve through their formative eras, but regular patterns occur when industries are mature that are not predicted by the product life cycle. Regularities in entry, exit, firm survival and firm structure are also developed for industries whose evolution departs significantly from the product life cycle.» (p. 145)

Klepper (1996)

Entry, Exit, Growth, and Innovation over the Product Life Cycle
***The American Economic Review*, 86 (3), 562-583**

«A model emphasizing differences in firm innovative capabilities and the importance of firm size in appropriating the returns from innovation is developed to explain the regularities. The model also explains regularities regarding the relationship within industries between firm size and firm innovative effort, innovative productivity, cost, and profitability. It predicts that over time firms devote more effort to process innovation but the number of firms and the rate and diversity of product innovation eventually wither.» (p. 562)

Gort and Klepper (1982)

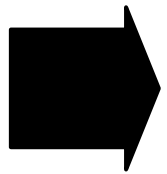
Time paths in the diffusion of product innovation
The Economic Journal, 92 (367), 630-653

«This study attempts to measure and analyse the diffusion of product innovations. [...] We trace the history of diffusion for 46 new products and examine the interrelations among diffusion, other aspects of technological change, price, output, and certain attributes of the relevant markets. To explain the 46 product histories, we construct a theory of the development of industries for new products. [...] A novel feature is that the historical sequence, or time path, of events is viewed as a critical determinant of the ultimate structure of new product markets. Thus **the time path of events determines not only the course traversed in reaching the end result but the ultimate market structure itself.**» (p. 630)

Product innovation

Two steps:

1. «the technical development of a new product»
2. «the introduction of the new product into the market»



«The length of the interval between the two steps varies substantially across new products, ranging from several months to several decades» (p. 630)

Main hypothesis

«**five stages in the evolution of the market with respect to the number of producers in it.** These five stages represent a prototype of the life-cycle of the market from its beginning up to, but not including, the period of eventual decay or contraction in absolute market size» (p. 630)

«the identification of stages in the history of a continuously changing phenomenon is, essentially, an **analytical convenience**. [...] The five periods, however, capture the major transitions in the forces that we believe determine the number of producers in a market during most of its life-cycle» (p. 631)

Stage I

Timing: «[it] begins with the commercial introduction of a new product by its first producer (though in rare instances there is a concurrent introduction of the product by more than one producer) and ends with a sharp increase in the rate of entry of new competitors into the industry»

Hypothesis: «the **length** of this stage is related to the ease of copying the initial innovator(s), the size of the market for the new product soon after it is first introduced, and the number of potential entrants into the market. In addition, the speed with which technological information is communicated in the economy is an important factor affecting the length of Stage I» (p. 631)

Stage II

Timing: «period of sharp increase in the number of producers» (p. 631)

Question: why entry occurs?

Q1: «why the market is not captured entirely by existing producers»?

Q2: «what ultimately brings about an end to the rapid growth in the number of producers»?

Stage III

Timing: «period in which the number of entrants is roughly balanced by the number of exiting firms, leaving net entry approximately zero» (p. 631)

Main issue: «zero net entry does not, however, reflect an equilibrium but rather is associated with structural changes in the market»

Stage IV

Timing: «period of negative net entry» (p. 631)

Stage V

(not analyzed)

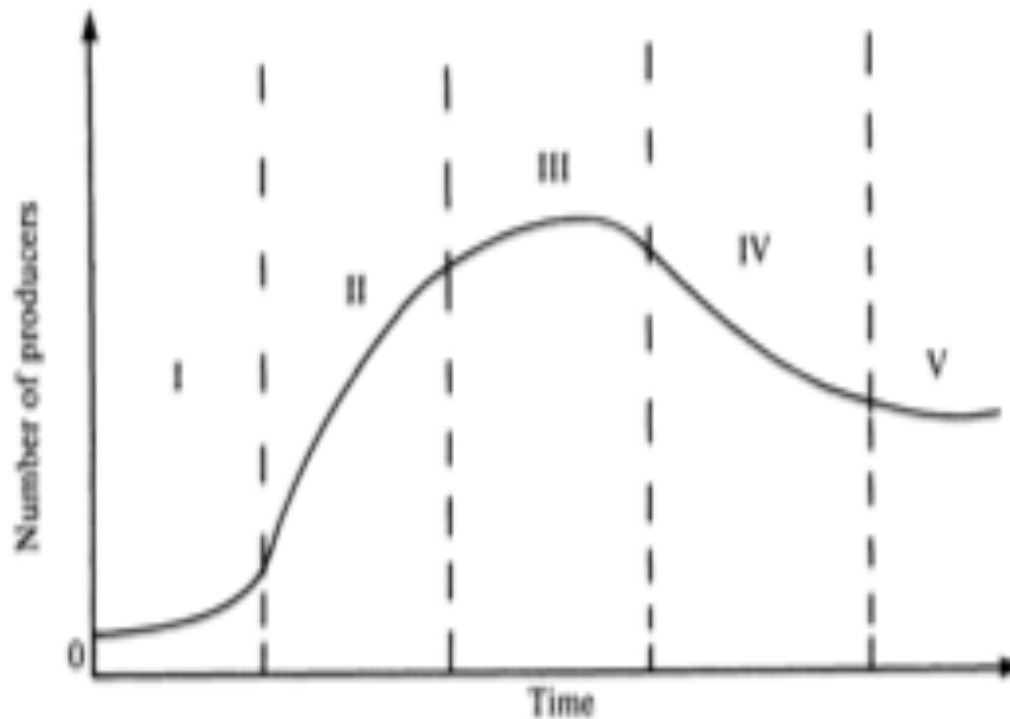
Timing: «second period of approximately zero net entry [continuing] until the eventual shrinkage of the market, induced by obsolescence of the product, or until fundamental changes in technology launch a new product cycle»

Main issue: «the approximate absence of net entry or exit does not result, however, from equality of the number of producers with a unique equilibrium level defined by market size and economies of scale» (p. 631)

Stages: summing up

<i>Stage</i>	<i>Start</i>	<i>End</i>	<i>Features</i>
I	Commercial introduction of a new product	Sharp increase of the number of producers	- ease of copying the initial innovation - size of the markets for the new product - number of potential entrants - speed of technological information
II	Sharp increase of the number of producers	Zero net entry	- the existing firms are not able to capture the entire market - market dynamics led to a balance between the number of entrants and producers
III	Zero net entry	Negative net entry	- changes in the market structure
IV	Negative net entry	Zero net entry (again)	- [market structure as “given”] - [strategic behaviour of incumbents] - [prevention of entry]
V	Zero net entry (again)	Eventual shrinkage of the market or introduction of relevant technological changes	- the market is going to expire quitting the cycle or alternatively - a new product is introduced starting the cycle again

Stages: figuring out



The five stages of new product industries (p. 639)

Remarks (1)

- “traditional” theories of market structure generally capture only a portion of all the market dynamics beside the cycle
- no symmetry assumption on firms and technology characteristics
- in each stage firm’s strategies have to fit specific market features
- market features are shaped by several factors:
 - nature of innovation (product),
 - complexity in imitation (technology and information),
 - size of the potential market (demand),
 - number of potential entrants (supply),
 - behaviour of existing producers (strategy)
- market structure is not given
- the final outcome of the cycle is not given

General process

$$F_t = P_t (N - n_{t-1})$$

F_t = expected number of entrants in t

P_t = probability of entry in t for each potential entrant

N = population of potential entrant

n_{t-1} = number of firms having already entered the market in $t-1$

«The central issue, of course, is what determines **P_t , the probability of entry**. [...] it basically depends upon the ways in which returns can be maximised on a component of organisation capital, namely, information on new product technology» (p. 632)

Organization capital

«We distinguish organisation capital from human capital in that the returns to the latter can be appropriated by the individual employees who possess such capital. In contrast, **organisation capital belongs to the firm** either because it has legal title to it, as in the case of a patent, or because it depends upon the interdependent actions or information of more than one employee» (p. 632)

Information on new products

«Information on new product technology may take a wide variety of forms, including **knowledge and skills** relating to production processes and **market characteristics** for the new product» (p. 632)

Sources of product information:

1. firms already **in** the market (I_1)
2. **outside** the set of current producers (I_2)

Information inside the market (I_1)

«new information emanating from **experience** in production by existing firms. This type of information has **both transferable and non-transferable components**»

Transferable component: «information that cannot be appropriated and is available for adoption by other firms»

Non-transferable component: «[it] remains the property of its producer and tends to cumulate over time. The accumulated stock of non-transferable information represents what is commonly referred to in the literature as “learning by doing” and, in the context of a model of entry, operates as a **barrier to entry** contributing to its eventual decline» (p. 632)

Information outside the market (I_2)

«technological information emanating from sources outside the set of current producers, [that] has a positive effect on entry. Such innovation reduces the value of experience accumulated through past production and, thereby, **facilitates entry**» (p. 632)

Innovation

«A central feature of [...] entry is that **systematic changes** occur in the **sources of innovations over the product cycle**. Innovation [...] is not a single event but a continuing process encompassing all product improvements and modifications in production techniques» (p. 632)

Innovation over the cycle

«In the early phase of a product cycle (Stage II), [...] most innovations are of the I_2 variety. That is, they originate outside the set of current producers (from firms in technologically related markets, from independent inventors, from equipment manufacturers, etc.). In contrast, later in the product cycle (**Stages III, IV, and V**), we expect that the balance of innovations shifts to the I_1 variety, and **the cumulative stock of such innovations begins to operate as an entry barrier**» (p. 633)

Probability of entry

$$P_t = f(I_{2t}, L_t, \pi_t)$$

P_t = probability of entry for each potential entrant

I_{2t} = number of innovation at time t emanating from sources external to the industry

L_t = accumulated stock of experience of existing producers at time t (it partially depends on I_{1t})

π_t = profits of existing producers at time t

«The variables I_{2t} and L_t represent the **influence of technological change** on the probability of entry»

$$\partial f / \partial I_{2t} > 0$$

$$\partial f / \partial L_t < 0$$

«The variable π_t represents the potential rewards of entry. [...] larger the **potential rewards of entry**, the greater the probability that a potential entrant who possesses valuable information will enter the market» (p. 633)

Stages: innovation and entry

Stage	Dynamic
I	New product
II	Diffusion: «the entry rate accelerates at the beginning [...], propelled by the two forces I_2 and π_t. As technology matures and opportunities for the most dramatic product improvements are realised, the rate of important innovations declines, leading to a reduction in the entry rate. This is reinforced by: (a) the accumulation of experience by existing firms (itself a function of I_1) operating as an entry barrier; (b) the eventual decrease in π_t resulting from the increase in the number of producers; (c) a gradual reduction in $N - n_{t-1}$, the population of potential entrants that have not as yet entered the market» (p. 633)
III	Zero net entry , «however, is not an equilibrium but rather reflects structural changes in the industry that, when they mature, precipitate Stage IV» (p. 634)
IV	Maturity: «as prices and profit margins approach normal competitive levels under pressure from imitators, there is renewed pressure to raise the rate of innovation. Now, however, the induced rise in innovation takes mainly the form of I_1 (innovations internal to the set of current producers). This not only reinforces the barriers to new entry but, in addition, compresses the profit margins of the less efficient producers who are unable to imitate the leaders from among the existing firms. Consequently, the exit rate rises sharply until the less efficient firms are forced out of the market» (p. 634)
V	Decline

Innovation strategy

Stage II – Diffusion

«a much larger fraction of the innovations have major consequences for costs of production or for product quality»
(p. 633)

«From the standpoint of entry, however, what is critical is not simply the reduction in the rate of technical advance but the concurrent shift in its origin»
(p. 633)

Stage IV – Maturity

«there is a retardation in technical change [...] This retardation may be reflected primarily in the importance of the innovations rather than in their number. As contrasted with I_2 , innovations of the I_1 type are much more frequently associated with minor modifications in production and marketing techniques, in methods of quality control, and in product improvements of lesser importance»
(p. 633)

Remarks (2)

- entry is propelled by the expected profits and the sources of innovation that are outside the industry
- entry is related to relevant innovations
- relevance of innovation and entry decline in time (stages II – IV)
- experience and internal sources of innovation reinforce barriers to entry
- market structure is more sticky in the maturity stage (IV)

As a consequence:

- **a unique equilibrium number of firms does not exist**
- **technology affects the rate of entry and the number of existing firms**
- **technological proximity of industries can influence the entry rate**

Empirical evidences (1)

- entry rate appears to be higher in Stage II
- entry rate apperars to decline in the later stages, especially in Stage IV

<i>Product</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
Computers	2,8	14,3	6,6	-13,0	–
Electric shavers	0,2	15,0	–	-2,9	-0,1
Pens, ballpoint	0,1	1,4	–	–	–
Shampoo	0,8	4,9	-1,0	–	–

Table. Mean annual entry rate by stage [selection] (p. 642)

Empirical evidences (2)

- «the number of major innovations appears to peak slightly in Stage II and remains roughly level in the subsequent stages»
- «the number of minor innovations appears to peak in Stage III and remain roughly level in Stages IV and V»

<i>Product</i>	<i>Pens, ballpoint</i>		<i>Average</i>	
Innovation	M	m	M	m
I	0,50	0,40	0,24	0,24
II	0,28	0,17	0,29	0,25
III	—	—	0,28	0,47
IV	—	—	0,24	0,22
V	—	—	0,26	0,18

Table. Mean annual number of innovations, classified by importance and stage: *M* = major; *m* = minor [selection] (p. 647)

Final remarks

(selection, p. 651)

1. the markets for most new products appear to pass through at least five distinguishable stages in the course of their evolution;
2. new industries generally pass through a stage in which the number of producers declines significantly;
3. there appears to be an association between rises and declines in the rate of innovation and the rate of entry into new markets;
4. the character, importance, and sources of innovations appear to change over the product cycle;
5. the results support the conclusion that the structure of markets (in terms of number and composition of producers) is shaped, to an important degree, by discrete events such as technical change and the flow of information among existing and potential producers.