World Patent Information 54 (2018) 1–17

Contents lists available at ScienceDirect

World Patent Information

journal homepage: www.elsevier.com/locate/worpatin

A study on the time-dependent changes of the intensities of factors determining patent lifespan from a biological perspective

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ARTICLE INFO

Keywords:
Patent
Survival analysis
Lifespan
Biology
Cox
Genetic

ABSTRACT

The lifespan of a human is determined by inborn factors including genetic factors and acquired factors, such as social-environmental factors and individual-behavior. From this point of view, this study classified factors determining the economic lifespan of patents into inborn "genetic factors," acquired "social-environmental factors," as well as "individual-behavioral factors," and analyzed the change in the influence intensity of factors with patent age along with application year. The results showed that the intensities of factors determining patent lifespan differed by industry and changed with the maintenance period and application year. Moreover, while "social-environmental factors" (such as a patent litigation), together with "individual-behavioral factors" (such as the number of patent family) had a stronger influence on patent lifespan than "genetic factors" (such as the number of claim), patents maintained longer period had stronger influence of behavioral and environmental factors rather than genetic factors. Furthermore, recently applied patents had a stronger influence due to the external environments than patents applied a relatively long time ago.

1. Introduction

Every living thing or product with a limited life has a different lifespan across eras and regions. This is because the lifespan of such items could be either longer or shorter than the average due to differences in original conditions, methods of use and the environment. Additionally, since the influential intensities of factors determining lifespans change over eras and periods of usage, and since patented technologies also have a limited lifespan, that lifespan must change over time.

However, previous research has analyzed such lifespan without considering these factors as variables that change over time, meaning that the reliability of the intensities of influence determined based on those results are questionable. Therefore, in this study, we have classified factors into inborn factors and acquired factors, while approaching the problem from a biological perspective by regarding these factors as variables that constantly change over time. We do this to demonstrate more accurate intensities of factors influencing patent lifespans.

A patent is an exclusive right preventing others from using one's patented technology. Patents protect technological innovation from being copied and guarantee a patentee to make profits from innovative activities. However, the one must pay a patent renewal fee to the relevant patent office to maintain this legal right. The economic value of such technology constantly changes due to the development and decay of technology, as well as through the social environment, since the patent is merely a legal protection on a technology. Therefore, it is very important to reduce the cost of holding patents by performing annual economic valuations on technologies and eradicating unnecessary patents.

One approach to valuing patents is by estimating a patent lifespan based on renewal-data, which assumes patentees' behavior [13]. The renewal of a patent implies that such patent is still economically useful [20,32,34]. This is because a rational patentee would not pay for rights, which are not economically useful [13]. Thus, estimating a patent lifespan can be interpreted as estimating the economic value of a patent.

Estimating a patent lifespan is very useful in the valuation and vitalizing of technology transfers, as well as in reducing holding costs resulting from maintaining unnecessary patents. Since lapsed patents are no longer exclusive, but rather become common property, third parties could be able to improve and develop such lapsed patents freely. This is highly important since it maximizes economic utility and develops industries, which are fundamental purposes of the patent law.

Meanwhile, since a patent is a protection over certain technology, it is highly related to the lifespan of that technology. As a new technology emerges, it rapidly develops, enters maturity, and then retains its position for a certain period of time before starting to decline until it fades

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https://doi.org/10.1016/j.wpi.2018.05.006
Received 27 November 2017; Received in revised form 19 April 2018; Accepted 15 May 2018

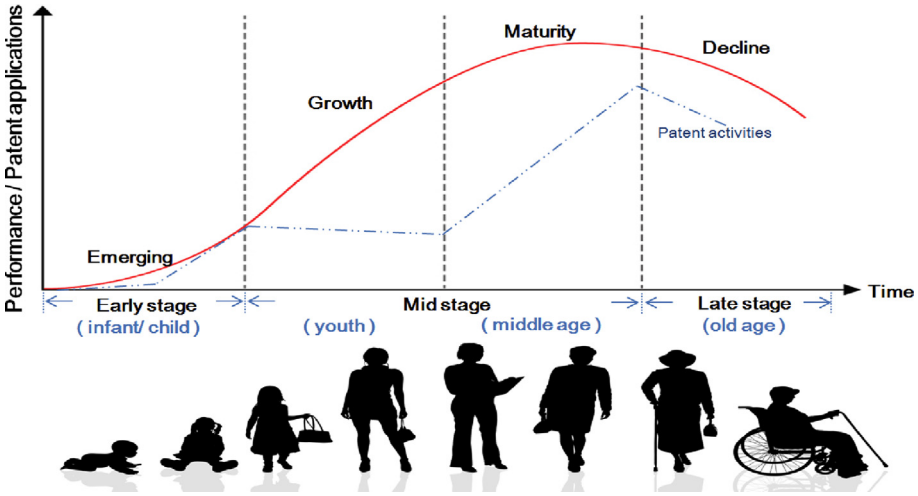

Fig. 1. S-curve concept of technology life cycle and human aging.
Note: Partial Quotation [4,29].

away from the market. It has some similarities with the pattern of human lifespan (see Fig. 1).

The theories on human lifespan (that is to say, the causes of aging) can be classified into two main branches: “inborn factors” and “acquired factors.” The acquired factors are further classified into social-environmental factors and individual behavioral factors [27].

The most significant factors that have affected the expansion of human lifespan are acquired factors, such as medical improvement and economic prosperity. This implies that among the factors that have impacts on lifespan, the most significant factors affecting individuals are acquired factors. Recent causes of the expansion of lifespan are attributable to acquired factors, which determine 70–80% of the lifespan [3,14,18].

Similarly to human lifespan, a patent's peculiar property – which would equate to genetic factors in the case of a human – would also be important, although it can be expected that environmental factors such as the speed of technological change, litigations provoked by competing firms, the intellectual property protection environment of each country and patent renewal fees would have stronger influences on a patent lifespan. Furthermore, as we as now entering the era of industry 4.0 characterized by hyper-connectivity, artificial intelligence and great convergence, we would expect huge changes in the development speed of technological innovation, as well as in the economy, and social system. Additionally, these environmental change will become important factors in determining the economic lifespan of patents.

Classifying each factor determining the economic lifespan of patents as genetic, behavioral and environmental – in relation to a human lifespan – and analyzing their change of intensity over time, allows us to judge the degree of hazard concerning the survival of possessing a patent from a variety of angles, in the same way as for the analysis of living things. This process is very important in deciding whether to maintain a patent or not. This result will be one of the significant indicators in deciding the economic value of possessing a patent, as well as important in constructing a lifespan anticipation model, technology valuation and technology transfer.

2. Literature review

2.1. Limits of previous research

So far, many quantitative methods to forecast technology lifespan had been studied. Normally, market share and the emergence of alternative technologies are used to measure technological lifespan. Theoretically, when a new technology replaces an existing one, or when a technology becomes obsolete, the lifetime of the old technology is considered to have come to an end [16]. Practically however, a technology lifespan is regarded to have come to an end if its patent is no longer cited. Alternatively, backward citation, forward citation as well as TCT[1] from patents of similar technologies are used to indirectly estimate technological lifespan [45]. The income approach is widely considered to be an accepted theory for technological valuation. In the approach, technological lifespan estimation, sales figures, discount rate, and the extent of its contribution [15,26] are significant contributing factors to the valuation.

Using patents to forecast technology lifespan is a much simpler and more objective way of doing so compared to other methods. However, the prediction of patent lifespan using citations is limited to US patents due to the introduction of mandatory patent registration, so the approach cannot be generalized since it does not reflect characteristics of all countries. It is also reasonable to use TCT as an indicator of the rate of technological change, rather than an indicator representing patent lifespan [45].

Although there have been broad studies on the renewal of patents, most are simply valued by adopting a linear correlation analysis or multiple linear regression approach to analyze citations, patent families, litigations, patent reassignment information with patent lifespans or commercial transaction values [20,37,41,43]. However, patent lifespans, in most cases, are not normally distributed but rather, are non-linear functions. Therefore, it is not desirable to adopt the general linear model.

Moreover, many controversies have arisen since the results from previous research indicated different conclusions about factors influencing the renewal of patents. It is not clear, however, whether this is because of the differences between samples or the excessive size of variation of a patent's quantitative data [33,43]. Thus, further study in this direction is necessary.

In the case of humans, although genetic factors at birth are important, other factors such as medical standards, pollution, workplace safety, weight, exercise, and lifestyle have a much stronger influence on lifespan [3]. Likewise, patent lifespan constantly changes as its value is not fixed, but is consistently influenced by existing environmental factors.

Similarly to the theory of natural selection in evolution,

[1] TCT provides the information on the speed of technology advance, that is to say the speed of innovative activity. It refers to the median age of a technology, which is the difference between the issued year of a patent based on citation, and when the patent is being cited.