

Essays on the role of knowledge, R&D, and Technology-based firms in the evolution of socio-techno-economic system

Citation for published version (APA):

Shafique, M. (2016). *Essays on the role of knowledge, R&D, and Technology-based firms in the evolution of socio-techno-economic system*. [Doctoral Thesis, Maastricht University]. Universitaire Pers Maastricht. <https://doi.org/10.26481/dis.20160419ms>

Document status and date:

Published: 01/01/2016

DOI:

[10.26481/dis.20160419ms](https://doi.org/10.26481/dis.20160419ms)

Document Version:

Publisher's PDF, also known as Version of record

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy

If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

VALORIZATION OF KNOWLEDGE

[K]nowledge that tendeth but to satisfaction is but as a courtesan, which is for pleasure and not for fruit or generation... [I]n the courts and services of princes and states it is a much easier matter to give satisfaction than to do the business; so in the inquiring of causes and reasons it is much easier to find out such causes as will satisfy the mind of man and quiet objections, than such causes as will direct him and give him light to new experiences and inventions.

Sir Francis Bacon (1561-1626): *Valerius Terminus*

Technological change that transforms the structure of socio-techno-economic system (STES) is important from the perspective of public policy and business strategy because its scope is vast and its impact is profound. TTC involves the emergence of clusters of new technologies and industries and migration of the locus of inventive and innovative activities from the established technologies and industries to the emerging ones. It is an inevitable outcome of the evolution of the STES and poses great challenges for management. It offers new opportunities for development and growth which demand new routines and structures that often necessitate the destruction of established ones. Its depiction and prediction is important because in the absence of this knowledge actors tend to adapt to their local environments without considering the consequences of local adaptation in the larger context of the evolutionary changes in the STES. Such ignorant adaptation to evolutionary changes may culminate into the necessity of revolutionary changes or threat of demise as explicated by the famous fable of the frog that gets boiled alive due to her adaptation to the increasing temperature of water surrounding her.

This thesis posits that the nature and direction of TTC can be depicted as well as predicted by looking at the substantive changes in the nature and purpose of *useful knowledge* produced in the society during any given period. TTC occurs in the knowledge space well before it manifests in the product space that constitutes the world that we can 'see'. TTC begins to sprout when new knowledge begins to emerge in order to help solve some interrelated scientific and technological problems in the creation of new *technologies* that, in turn, seek to help solve some practical problems of the society at the time. Since every technology is a particular configuration of knowledge that produces a particular effect, the kind of effects needed by the society in a given era determine the kind of technologies it will value and demand, which in turn determine the kind of scientific and technological knowledge needed. Thus, from the standpoint of economics and management of technological change, TTC occurs as a result of the interaction between the *demand* for and *supply* of useful knowledge which, in turn, are determined by the actors, structures, and processes concerning knowledge production, dissemi-

nation, and utilization. The interaction between the demand and supply of knowledge and the aggregation of their effects that form the TTC take place due to the interaction among social, technical, and economic forces that shape the "collective wisdom" (cf. Landemore & Elster, 2012).

Collective wisdom emerges in various parts, and at various levels, of the STES due to the aggregation of the pursuits of boundedly rational actors within their respective spheres of action and influence. Two well-known social forces that bring about coherence and aggregation of individual and collective pursuits are *zeitgeists* and *paradigms*. A *zeitgeist* represents the overall mood or ambience prevalent in the society in a given era regarding major problems of the society while a *paradigm* is a broad approach to a given problem that is shared by most of the actors engaged with the problem. Knowledge is the prerequisite to solve the societal problems because the actors need to know why do/undo something, what to do/undo, how to do/undo that could solve a given problem. Since the needs and problems of the society continue to change systematically and new needs and problems continue to arise, the need for new knowledge and the drive for its production continue to remain there. Particularly, technical problems of the society require scientific and technological knowledge that could help produce particular technical effects that can solve the chosen problems.

Since the amount of problems facing a society at any given time is indeterminable, the society needs to prioritize the problems in order for utilizing the resources available to it efficiently and effectively. Collective wisdom is the selection mechanism through which individual actors, and hence the society, prioritize their needs and problems. Thus *zeitgeists* and *paradigms* shape the collective wisdom that determines and prioritizes the kind of knowledge to be created. However, the evolution of collective wisdom through 'natural' process of aggregation and its culmination in TTC tends to be slow because boundedly rational actors remain largely unaware of it due to their focus on their respective spheres of action and influence. Selective adaptation to local environments is by far the predominant force that shapes the collective wisdom of actors. Thus the collective wisdom that manifests in TTC is by and large the product of deterministic evolution rather than voluntary determination of the structure of STES. Consequently, deterministic adaptation to the technological changes in their locales tends to keep the actors ignorant of the potential fruits and ultimate destruction of TTC. Due to this reason, this thesis posits that voluntary determination of technological change is preferable than deterministic adaptation by the actors and hence the collective wisdom shaped by the *ex ante* resolution is preferable than the *ex post* aggregation, depiction, and explanation of the phenomenon.

Voluntary determination and *ex ante* resolution are needed to reap the fruits of TTC and minimize the destruction caused by it. This requires that the actors serving the domains of science and technology create the knowledge that is

useful in catering to the needs and solving the problems of the society. However, linking the knowledge-base of the society with the problem-suite of the society and minimizing the costs of blind experimentation and ignorant adaptation require that the collective wisdom is enhanced and deliberately shaped through public policy and business strategy. Public policy is an influential tool in shaping the zeitgeists in the contemporary world whereas business strategy is the principal mechanism through which resource-base of the society is shaped and harnessed.

This thesis posits that voluntary determination and *ex ante* resolution are possible by adopting a *technological ecosystem approach* facilitated by an *integrated global intelligence system*. The dominant paradigm in contemporary policy and strategy is to use the nature of *products* as the frame for reference for identifying and classifying the actors and activities. For instance, activities are often grouped into sectors and industries on the basis of the nature of the output as the basis of policy and strategy. Technological ecosystem approach provides an alternative, and possibly complementary, perspective of thinking about activities. It suggests that *knowledge* is not only the quintessential input but also the principal output that determines the quantity and quality of solutions to the societal needs and problems. This perspective suggests that the nature or *kind* of knowledge being produced and used may be more useful frame of reference for identifying and classifying actors and activities, regardless of the products they are producing. This perspective links the knowledge-base of the society with its problem-suite and may help better allocation of resources besides creating greater value. For instance, if a firm identifies itself as the user and producer of a particular kind of knowledge, who are other producers and users, and what alternative applications this knowledge has, the firm is more likely to identify new opportunities for exploitation of their existing resources and find new avenues for invention and innovation through exploration and excursion. Similarly, if policy indicates which kind of new knowledge has begun to emerge and what are the potential uses of that knowledge in relation to the problem-suite of society, the production of that kind of knowledge is likely to be further stimulated and expedited. Such directive use of policy may be more helpful in societal development and growth than purely regulative use. Above all, this approach can help all stakeholders be more informed about the developments, including but not limited to the scientific and technological advancements, that may affect their role in the long run and save them from the perils of ignorant adaptation to their local environments.

Technological ecosystem approach can be adopted better if there is an integrated global intelligence system that continuously monitors and appropriately classifies the scientific and technological knowledge. A great deal of experience has already been accumulated in relation to scientific indexing, patent classification, and concordances among various classification schemes. However, these efforts have been disconnected and followed different purposes and rationales. It may be fruitful to revisit and integrate all such schemes with the help of infor-

mation technology and the information gathered is made accessible to the public. The proposed approach and the intelligence system are expected to stimulate the actors to span their silos, minimize the costs of duplication, increase the linkages across science and technology domains, expedite the otherwise slow process of convergence, and lower the costs of ignorant adaptation and destruction from unanticipated TTC.

References

Landemore, H., & Elster, J. (Eds) (2012). *Collective wisdom: Principles and mechanisms*. Cambridge University Press.