# Integrating the Techno-Economic Cycle with Population Ecology Theory to Explain the Evolution of Organization Forms

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## Abstract

*This conceptual paper explores the interaction between the emergence of each new technological paradigms and the subsequent behaviors of economic long waves as attributing factors for the origin, retention, and survival of diverse organization forms within the assertions of the population ecology theory. This study is based on a broad overview of extant literature and discusses the interrelationship of three major fields of study that includes the theories of technology change, macro-economic fluctuations and trends and population ecology. More specifically, analysis of the dichotomous population ecology concepts of determinism-voluntarism, generalists-specialists and narrow-wide niches within the framework of resource flows over time at different phases of an integrated techno-economic cycle indicated that different organizational forms are more successful at different phases of the techno-economic cycle. This paper advocates that a more integrative macro level approach should be adopted to deepen our understanding of the origin, growth and atrophy of organizations.*

**Key Words**: Kondratiev Economic Long Waves, Techno-economic cycle, Population ecology, Organization forms.

## *1. Introduction*

In recent years there has been a growing interest in how organizations are formed, grow, transformed, decline or fail based on organization theory (Scott, 2011; Niu, 2009). Support for the use of Organizational Theory is well established in the literature and can be viewed from either micro or macro level perspectives (Scott, 1992). The primary difference between these perspectives stems from the fact that the micro level perspective looks at organizational diversity arising from managerial policy decisions and practices which determine how the organization's resources and capabilities are utilized (Baudry and Chassagnon, 2010). These differences result in diversity which is further impacted by differences in organizational culture, strategies and internal social relationships adopted by the organization in response to the dynamic environment within which they operate.

Conversely, organization theory when viewed from a macro level perspective, yields significantly different perspectives. As such, organization theorists must wrestle with questions such as: Why are there different forms of organizations? What are the factors that impact the formation of such clusters? Are these forms the result of evolution, hence deterministic or are they the result of strategic choice hence voluntaristic? In an attempt to answer these questions researchers have used a variety of theories and concepts. Some of the most commonly adopted theoretical perspectives include population ecology theory (Salimath and Jones, 2011; Astley, 1985), resource dependency theory (Pfeffer and Salancik, 1978), contingency theory (Lawrence and Lorsch, 1967) and institutional theory (Tushman and Anderson, 1986).

Not surprisingly, these differing perspectives frequently lead to contradictory interpretations of the same phenomena. Given these difficulties, the purpose of this conceptual paper is to provide a holistic alternative interpretation of organization diversity through the integration of a technology change model utilizing Kondratiev waves to explain the process of the origin, retention and survival of organizations based on population ecology theory (Salimath and Jones, 2011; Hannan and Freeman, 1977). This study contributes to the extant literature in that it integrates two major theories from technology life cycle (technology paradigm) and the dynamic theory of economic growth and decline (Kondratiev long wave theory) to enable readers to better understand how technological and economic changes impact the natural selection, adaptation and survival of populations of organizations within the conceptual framework of population ecology theory.

In the following sections, we will first discuss the techno-economic cycle within the context of economic long wave theory and the technology paradigm phenomenon. Second, we provide a brief review of population ecology theory. Third, we integrate the techno-economic cycle with population ecology theory and offer a model that addresses the influence that determinism versus voluntarism, wide versus narrow niches, and generalist versus specialist organizations have on the life cycle and forms of organizations. The authors then provide a model to advance research propositions and future research.

## *2. Background*

### 2.1 Long-Wave Theory and Technological Paradigm

For several decades, neoclassical economists such as Solow (1956 ) observed that economic growth comes from economies that support a perfectly competitive market that is in constant state of equilibrium (Schlauch and Palmisano, 2013). However, economic long wave pioneers such as Tinbergen (1959) and Kondratiev (1935) observed alternating periods of fluctuations and stability and thus surmised that economies are actually dynamic and move in cycles in an attempt to reestablish equilibrium when changes occur within the market place. They observed that long term economic growth is a dynamic phenomenon that typically lasts for between 25 to 30 years and is followed by periods of slow or stagnating growth.

The long wave cycles that Kondratiev (1935) proposed were first linked to technological innovation by Schumpeter (1939), who analyzed irregular clusters of innovation and considered them crucial to the explanation of upper and lower turning points in economic development. Mandel (1980) provided a more macroeconomic interpretation of what Schumpeter (1939) observed at the firm level. He noticed that, the rate of profit, production volume and the intensity of capital accumulation increased during the peak periods of economic growth but decreased during a depression or downturn. Other research suggests that each technological innovation contributes to periods of economic expansion (Guloglu and Tekin, 2012; Mensch, 1979; Van Duijin, 1984). In 1979, Gerhard Mensch proposed a metamorphosis model by superimposing the technology cycle onto the Kondratiev waves based upon the observation that new technology is the cause of economic expansion in each Kondratiev wave. Van Duijin (1984) supported this finding based on a study of 80 major innovations which looked at the relationship between economic long wave fluctuations and the introduction of basic or major innovations. Van Duijin (1984) also suggested that basic innovations give rise to new industrial sectors.

These sectors develop according to the familiar S-shaped life cycle pattern. The creation of new sectors requires infrastructures that support innovation. As more and more capital stock is built up within a sector there is a corresponding excess of capital stock. The long wave downturns are caused by the build-up of excess capital stock and levelling off of demand, which leads to a reduction in resource flow into the cycle. One way to conceptualize the influence of each new introduction of innovation on the variations and wave like fluctuations of the economy, is the concept of techno-economic paradigms (Perez, 2010). Each techno-economic paradigm is manifested in a techno-economic cycle with the characteristics of a trough and rise feature of the economic wave. It embodies a core technology around which all further innovations and economic activities take place. A new techno economic paradigm emerges with the replacement of the old core technology by a new core technology (e.g. steam engine technology is replaced by internal combustion engines). Not only are old core technologies replaced by newer technologies but the infrastructures that support them are also replaced which creates a need for new skills, abilities and knowledge. An example of this concept is provided by the Industrial Revolution which enables us to identify the introduction of each change in techno-economic paradigm or core technologies that have such a pervasive influence over the social and economic behaviors and activities. To date there have been five techno-economic cycles.

The first techno-economic cycle began in 1787 extended through 1842. This cycle was driven by two technological developments which include the application of steam engine technology to textile manufacturing and the discover of the Bessemer Process used in the production of iron (Freeman, 1982). The second techno-economic cycle resulted from the rapid growth of the railroads and the technology they used. Supporters of techno-economic cycle theory generally agree that this technological paradigm began around 1843 and lasted through 1885. The third wave (1898 to 1929) was driven by the electrification of large parts of North America and the invention of the internal combustion engine. The fourth wave which began with the close of World War II was based primarily on chemicals, jet aircraft and nuclear power and this lasted until early 1980s (Clark et al., 1981). The fifth wave followed soon thereafter in the mid 1980s and brought with it the age of computers and telecommunication and currently dominates all commercial, industrial and social sectors (Ayres, 1990). While this wave still holds a dominant position it is in danger of passing as potentially disruptive technologies such as genetic engineering, biotechnology and green energy technology appear to be on the horizon.

The rise and fall of each techno-economic cycle is related to the pattern of resource flow. In the initial stage of each techno-economic cycle there is the potential for supra-normal profits which attract resources from older technologies to newer ones. This transfer of resources continues until a still newer techno-economic paradigm looms in the horizon. Such patterns of resource flows are critical in explaining the existence of populations of organizational forms and the dichotomous concepts of determinism versus voluntarism, specialist versus generalist and narrow versus wide niches in population ecology theory.

### 2.2 Population Ecology

Population ecology theory seeks to explain the birth, growth and demise of organizations through the natural process of variation, selection, retention and competition (Baum, 1997). This dynamism is based upon the criterion of environment-organization fit (Volberda et al., 2012; Aldrich 1979). In a similar vein, Hannan and Freeman (1977) asserted that focus on strategic choice must be balanced by a theory that considers the power of the external environment in order to explain the diversity of organizational forms. More recently a growing number of population ecologists appear to support the concept of environmental determinism which prevents organizations from instituting change through strategic choice. This perspective is commonly referred to as the Darwinian perspective (Datta and Banerjee, 2012). In the preceding section the authors will provide an overview of the central debates in population ecology regarding the presence or absence of strategic choice (e.g., determinism versus voluntarism change), differentiation of organizational forms (specialist versus generalist) and niche width.

#### 2.2.1 Deterministic versus Voluntaristic Organizational Change

The debate between determinism and voluntarism stems from the dichotomous explanations adopted by organizational theorists in order to better understand the process of variation, selection, retention and inevitably the survival and growth of a given population (Abatecola, 2012; Breslin, 2011). The concept of determinism stems from the Darwinists' concept of "natural selection" which population ecologists use to explain the reactive adaptation that organizations with similar organizational structures, business policies, practices and strategies take in order to better "fit" with their external environmental constraints. The extent of success in adaptation or legitimatization of the successful organization form is measured by the density or number of firms in a specific population at a given time.

Conversely, the deterministic concept of organizational adaptation does not adequately explain diversity of organization forms, as it failed to take into consideration the power of managerial choice. Cyert and March (1963) observed that organizational adaptations are result of pro-active managerial decisions and actions, hence managerial voluntarism. The presence of diversity of organization forms are therefore argued as not the result of natural selection or determinism but the exercise of managerial choice.

In the midst of this dichotomous debate of environmental dynamism versus strategic choice however, there is a leaning towards the acceptance of both determinism and voluntarism as not mutually exclusive influences over organizational forms but as relative states which are interchangeably dominant during the different phases of the legitimatization process. Pfeffer and Salancik (1978) observed that although firms do possess the ability to proactively control and reduce environmental pressures but they do not possess the absolute capability to change or cancel all environmental factors.

### 2.2.2 Specialist versus Generalist Organizations

Hannan and Freeman (1989) defined a population of organizations as a set of organizations engaged in similar activities and with similar patterns of resource utilization and outcomes. Within different populations, Hannan and Freeman (1997) divided organizations into two categories, generalists and specialists in order to explain their differential survival capabilities using niche-width theory. They believed that specialist organizations generally have few slack resources, specific customers, and a narrow range of customized products or services. Hannan and Freeman (1997) also believed that generalist organizations are large and hold slack resources which enable them to serve a broad market through the offering of a wide range of products or services.

As a result, organizations that can be viewed as generalists need a wide range of environmental resources to ensure their survival whereas organizations that are specialists require a much narrower range of environmental resources. In application this concept suggests that markets with a low concentration will support a large number of generalist firms leaving fewer resources for specialists. Support for this view is found in Carroll's (1985) resource partitioning theory in which he hypothesized that as an industry matures generalist firms dominate the market and draw in large reserves of resources to the market's center. This movement of resources to the center in turn opens up pockets of resources on the market's periphery for specialists (Salimath and Jones, 2011).

### 2.2.3 Niche Width

Niche theory, a foundation of population ecology, is an important concept used for relating resource transactions with the presence of diverse organizational forms (Geroski, 2001). The niche concept in population ecology refers to a way "to express how environmental variations and competition affect the growth rate of populations" (Hannan and Freeman, 1989). Hannan and Freeman (1989) also pointed out that different types of niches support different organizational forms. Narrow niches, with constrained resources, tend to support specialist organizations (Swaminathan, 1998) whereas wide niches which have more resources tend to support generalist organizations (Hall, 1991). Specialist organizations in narrow niches tend to draw from a limited array of resources for survival (Freeman and Hannan, 1983; Carroll, 1985).

On other hand, wider niches wherein the generalist type of organizations exists possess broad arrays of resources, and hence organizations enjoy more slack, which they use to accommodate changes in the environment (Beck, 2008). However, contrary to contingency theory which posits that environmental uncertainty favors the survival of generalists form of organization because they have the capacity to spread their risk, it is actually the specialists organizations which possess few slack resources and are better able to respond quickly to large scale environmental changes. Generalists on the other hand are generally thought to be unable to respond to large scale environmental changes quickly because they are encumbered by heavy investments necessary to support existing strategic commitments.

In summary, the debates of these three dichotomies have arisen out of population ecology theory's focus on rates of birth, growth and death of organizations. The three issues can be summarized as: 1) determinism versus voluntarism in organizational change 2) niche dominance by either specialist or generalist forms of organizations, 3) and the flow of resources and capability of the wide versus narrow niches to support diverse organizational forms. It is out of this contention that these dichotomies may be reconciled by incorporating population ecology theory concepts into an integrated and dynamic techno-economic model.

### 2.3 Integration of the Techno-Economic Cycle with Population Ecology

The integration of technology paradigm and economic cycles is supported by past research (Cvetonovic et al., 2012; Perez, 2004; Sterman, 1986). By integrating the techno-economic cycle with population ecology (see Figure 1), it is possible to identify those stages during which organizations are able to exercise strategic choice and those stages wherein the environment is deterministic. Based on this evidence the authors contend that wide and narrow niches width can be explained by integrating them with the concept of core or radical technological changes and the subsequent occurrence of technology trajectories depicted in the techno-economic cycle.

The techno-economic life cycle is based upon an integration of van Duijin's (1979) innovation life cycle with population ecology concepts. Similar thinking about innovation life cycles was proposed by Schmookler (1966) and Kurnet (1978). According to van Duijin (1979), the life cycle of a major innovation can be depicted over time in an S-shaped curve. Van Duijin (1979) also proposed the four phases of the innovation life cycle, characterized by demand structure and type of innovative activity.

The cycle starts with the introduction phase, which is distinguished by the presence of large numbers of product innovations that have not been proven in the market. This provides organizations with different technological options in a high-risk type of environment, as little is known about the nature of the potential of actual demand. This is followed by the growth phase, where customers do not discriminate in their demand, thus leading to a decreasing number of product innovations. The third, or maturity phase, is when output rate slows down and intensified competition requires product differentiation and customization. Market niches become increasingly distinct as organizations focus on innovation in operational processes. Labor-saving processes are churned out increasingly. The market becomes saturated or overcapitalized, as noted earlier in the economic cycle analysis portion of this paper. Organizations attempt to escape market saturation through changes in technology, and labor saving process innovation continues. At this stage of the cycle, collapse of the cycle is avoided and the actual depression is overcome by the appearance of new basic innovations which create a new wave or cycle which in turn repeats itself.

The techno-economic model presented in this manuscript is conceptualized by two interlocking curves. This interlocking curves (see figure 1, curve1 and 2) show that there is no total collapse of the current innovation cycle due to increased mortality of organizations, but rather the effort is compensated by the number of new organizations that emerge in the new techno-economic cycle. Not all organizations of the old cycle have the capability to shift to the new cycle. Some will remain within the old cycle even as the new cycle begins due to prior strategic commitments and technological barriers. However, the mortality rate of firms in the old cycle will continue to increase as resources diminish and or shifted to support the new cycle. Therefore, the techno-economic model presently proposed, is an incorporation of the resource flow concept of economic long waves with the concept of radical-innovation change.

Astley (1985) linked technology as a source of environmental change and observed that technological innovations are the main source of change in organizational communities or populations of diverse organization forms. These are clusters of multiple, diverse organizational forms existing within a community can be configured around a core technology (Wade, 1996). This conforms to the techno-economic cycle's main assumption that radical innovation pervades each cycle and is the common bond among all populations within it.

## *Research Propositions*

### 2.1 The Techno-Economic Cycle: Phase I.

Tushman and Anderson (1986) concluded that changes in technology lead to changes in the environment, which, in turn, lead to organizational change (Ciarli et al, 2008). Technological change is an external and central force that drives organizational change (Karvonen and Kässi, 2011;.Van den Ende and Dolfsma, 2005) As mentioned earlier, technological change can either be radical or incremental, and each has different ramifications for organizations.

The cycle begins with the introduction of a radical innovation (Phase I, Figure I). According to Schumpeter (1935), very few entrepreneurs are involved at this stage in this high-risk endeavor. In addition, Wade (1996) found that new technologies are introduced by new organizations. Thus, it is very likely that organizations existing within the current community will shift their operations to this initial phase of a new techno-economic cycle.

Organizations that are in this new cycle typically enjoy a relatively competition-free environment; hence, Schumpeter (1939) asserted that these organizations enjoy supernormal profits. The supernormal profits attract other organizations into the new niche created by the radical innovation, thus drawing in more resources. Organizations that are in this niche face relatively little competition, hence, can exercise greater control over the technological options open to them due to the continuous inflow of resources. The abundant inflow of resources eventually gives rise to a wide niche that provides organizations the ability to exercise greater strategic choice than a niche with scarcer resources and stiffer competition. This means that organizations are more voluntaristic in response to environmental changes as long as resources are abundant. At this stage, organizations that dominate the niche are mainly generalists because there are abundant resources with little competition. This phenomenon has been confirmed by observations made by Carroll (1985) and Freeman and Hannan (1983), who asserted that wider niches tend to support more generalist organizations whereas narrow niches support organizations that are specialized. Hence, in the beginning phase of the techno-economic cycle, resources are abundant, the niche is wide, and the dominant organizational form is generalist.

*Proposition 1: A distinct, new community of populations of organization will be established based upon the core technology of the new techno-economic cycle. In the initial phase of this cycle, the abundant resources environment of this new community will tend to support populations of generalist organizations existing in wide niches. These organizations will be more voluntaristic at this phase of the new cycle than those organizations in the current techno-economic cycle.*

### 2.2 Transitions between Phase I and II

Competition increases as other organizations begin to enter the niche drawn by the possibility of earning high profits. Tushman and Anderson (1986) observed that radical innovation gives rise to technological fermentation. Organizations begin to compete for market leadership by initiating a dominant design war. This is the transition from Phase I to Phase II of the techno-economic cycle, where organization forms are becoming increasingly standardized as product design begins to congregate around the products that indicate the possibility of it wining the dominant design war. There is also increasing competition from organizations that continue to enter the niche, and this is emphasized by the economic long–wave cycle that points out that at this phase there is increased inflow of capital investments. Therefore, organizations that are already inside the niche are continuously adjusting to changing environmental conditions. This has been called Lamarckian view (Usher and Evans, 1996). Organizational adjustments are possible because generalist organizations have the necessary slack resources to adjust to the changing environment (Hannan and Freeman, 1989). This means that organizations can still exercise their strategic choice.

*Preposition 2: In the transition between Phase I and Phase II of the techno-economic cycle, the community expands as new populations or niches emerge, supported by the availability of excess resources. The competitive environment will cause organizations in these niches to search for and adopt a dominant design that will cause these niches to become narrower and increasingly distinctive.*

### 2.3 Phase II

The emergence of a dominant design has many implications to community members. It signals the beginning of stability within the economic cycle and is parallel to the concepts of selection and retention in population ecology. Also, once a dominant design emerges, it becomes legitimate to use the dominant design as the standard for their continued survival, organizations imitate and mimic structures, strategies, business policies and practices of successful organizations (Suarex and Utterback, 1995). Though this phase is still voluntaristic, it reflects a reduction in the organization's voluntaristic ability. Hence there is a gradual shift from the Lamarckian processes to Darwinian processes. At this phase, stability is established based upon the dominant design.

*Proposition 3: Once a dominant design is established within a population of organizations, these organizations will become increasingly less voluntaristic due to the perceived legitimacy of using the standard dominant design.*

### 2.4 Phase III.

Organizations will remain in this stable environment by adopting the dominant design until a new radical innovation begins a new techno-economic cycle that draws resources away from this niche. Incremental developments in technology, which build on existing structures can modify the dominant design phase (Anderson and Tushman, 1990; Lawless and Anderson, 1996). Organizations begin to focus their responses on specific trajectories. Astley (1985) points out that in this phase organizations experience intense competition and cost minimization is the core competence that organizations seek. This phase is equivalent to the maturity phase of the innovation cycle observed by Mensch, where there is intense competition through product differentiation and organizations concentrate on incremental innovation to push down the cost of production. Soon, the community has populations focusing on specific technological trajectories, and the niches created by these innovations become distinctive. These niches support populations that are increasingly becoming specialized and customized, thus becoming narrower. Therefore, the organizations evolve from generalist to specialist as competition increases. Resources become scarce, leading to the erosion of the slack that the organizations had depended on to exercise their strategic choice, thus creating a more deterministic environment.

*Proposition 4: Specialization and customization activities in Phase 3 of the techno-economic cycle will lead to the creation of a diversity of narrow niches which will begin to partition off the resources available in the community. The environment of these narrow niches will become increasingly intolerant of the generalist type of organization. These specialist types of organization will exist in increasingly narrow niches that are highly deterministic.*

### 2.5 Phase IV

The scarcity of resources in the current niche can be due either to overcapitalization, as observed by advocates of economic long cycles or due to the diversion of resources to the new innovations in the upcoming techno-economic cycle. Organizations that are in the current cycle must move to a relatively more risky but more lucrative new niche or face increasing competition for resources, not only from those organizations in the existing niche, but also from members of the new niche. Anderson (1988) found that organizational mortality rates were higher during periods of technological discontinuities. This means that as organizations become increasingly specialized as a result of adopting innovations and incremental improvements, their mobility between niches will be increasingly constrained. Hence the environment becomes deterministic. This is consistent with the structural inertia concept proposed by Hannan and Freeman (1977).

The new techno-economic cycle will draw resources from old niches and new resources away from the existing niche. Organizations that remain in the existing niche face a very competitive and hostile environment, yet too rigid to shift to a new one due to structural inertia and prior strategic commitment. Astley (1985) emphasized that all organizations in the earlier niches will eventually become extinct.

*Proposition 5: In the final phase of the techno-economic cycle, resources will become scarce for the community. The selection process of the highly specialized niches will become increasingly intolerant of variations from organization-environment fit. Organizations will either move to a new niche or adopt competitive strategies to survive. The deterministic environment will make it extremely difficult for organizations to move to the community niche.*

## *3. Implications*

The proposed model attempts to integrate population ecology with techno-economic cycles in order to clarify some of the debate raised against population ecology. The authors then addressed the issues of determinism and voluntarism, narrow versus wide niches, and specialist versus generalist organizations within the dynamics of the various phases of the techno-economic cycle. This study also incorporated technology and economic variables as sources of variation in the population ecology model.

Based on this information the authors offer the following conclusions:

1. Depending on the phase of the techno-economic cycle, different forms of organizations dominate the niches. Simultaneously, the size of the niches varies in different phases of the cycle, thus supporting different forms of organizations. Organizations exist in niches that are dynamic, and these niches can be wide or narrow depending on resources and phases of the techno-economic cycle. Within this dynamic environment, organizations can exercise their strategic choice, at certain phases, but as niches become narrower and resources shrink, such organizations will become more deterministic and will have to "fit" within the environment.
2. From the practitioner's perspective, this model has some utility. Organizations, in technologically advanced industries need to be aware of technological innovation and able to recognize when these innovations are incremental or radical. Boundary-spanning strategies of the organization should be focused on technological change. Practitioners and organizational designers should realize that at certain stages of the techno-economic cycle, organizations are voluntaristic, as they exercise control over the organization, but as the technology of organizations become more and more specialized, locus of control of the organization becomes external and deterministic due to technological and economic trend changes.

3. The propositions of relationships among the studied variables identified in this conceptual manuscript have been strongly supported by a thorough review of extant literature. However, they can gain higher credibility when supported by empirical data. As in most macro level studies that seek to analyze variables in a dynamic setting, certain constraints have to be overcome such as the difficulty of isolating causal factors from the multitude of confounding variables, the immensity of data that has to be collected and analyzed, among others. Taking cognizance of the above, this conceptual manuscript could benefit from future research by attempts to reduce the model's complexity through focusing on specific techno-economic paradigm or an analysis of the density of populations of organization and resources flows at the industry or national level. These research directions could reveal interesting trends that confirm the relationships between each techno-economic paradigm and the origin, retention and atrophy of organizational forms.
4. In conclusion, the birth, growth, and death of organizations is a dynamic process that should take into account macro-level economic and technological changes. We hope the model proposed in this paper will encourage such integrative macro thinking by current and future organization theorists.

## *References*


Abatecola, G. (2012), Organizational adaptation: An update. *International Journal of Organizational Analysis,* Vol: 20 No. 3, pp. 274-293

Aldrich, H.E. (1979). *Organizations and Environments.* Englewood Cliffs, NJ:

Anderson P. (1988). The population dynamics of Schumpeterian competition. *Academy of Management Best Papers Proceeding:* pp. 150-154.

Anderson, P., & Tushman, M.L. (1990). Technological discontinuities and dominant designs: A cyclical model of technological change *Administrative Science Quarterly.* Vol: 35: pp. 604-633.

Antai, I. (2011). Supply chain vs supply chain competition: A niche-based approach. *Management Research Review, Vol: 34*(10), pp. 1107-1124.

Astley, W. G. (1985). The two ecologies: Population and community perspectives on organizational evolution. *Administrative Science Quarterly,* Vol: 30: pp. 224-241.

Astley, W. G. & Van de Ven A. H. (1983). Central perspectives and debates in organization theory. *Administrative Science Quarterly*, Vol*:* 28: 245-273

Ayres, R.U. (1990). Technological transformations and long waves, part 1. *Technological Forecasting and Social Change*, Vol: 37: 1-37.

Baudry, B. & Chassagnon, V. (2010). The close relation between organization theory and Oliver Williamson's transaction cost economics: A theory of the firm perspective. *Journal of Institutional Economics,* Vol. 6, No. 4, pp. 477-503

Baum, A. C. J. (1997). Organizational Ecology. In *Handbook of Organizationasl Studies* pp. 77-114.

Beck, N. (2008). Organizational ecology as a theory of competition, in Ebner, A. and Beck, N. (Eds), *The Institutions of the Market: Organizations, Social Systems, and Governance,* Oxford University Press, New York, NY, pp. 202.

Breslin, D. (2011), Reviewing a generalized Darwinist approach to studying socio economic change, *International Journal of Management Reviews*, Vol. 13 No. 2, pp. 218-235.

Carroll, G. R. (1985). Concentration and specialization: dynamics of niche width in populations of organizations. *American Journal of Sociology*, Vol. 90: pp. 1262-1283.

Ciarli, T., Leoncini, R., Montresor, S., & Valente, M. (2008). Technological change and the vertical organization of industries. *Journal of Evolutionary Economics,* Vol. 18 No. 3-4, pp. 367-387.

Clark, J; Freeman, C. & Soete, L. (1981). Long waves Inventions and Innovations. Futures Vol. 13 No. 4, pp 308-322.

Cvetanović S., Despotović D. & Mladenović, I. (2012) The concept of technological paradigm and the cyclical movements of the economy, Economic and Organization, Vol. 9 No. 2, pp. 149-159.

Cyert R.M. & March, J. G. (1963), *A behavioral theory of the firm*, Englewood Cliffs, N.J: Prentice-Hall.

Datta, P.R. & Banerjee, P. R. (2012). Innovation and business dynamism: An evolutionary perspective. The Academy of Business and Retail Management (ABRM). Vol. 2 No. 1; pp. 245-251.

Dess, G. G. and Beard D.W. 1984. Dimensions of Organizational Task Environments" *Administrative Science Quarterly*. Vol. 29, pp. 52-73.

Dosi, G. 1988. Sources, procedures, and microeconomics effects of innovation. *Journal of Economic Literature.* Vol. 26: pp. 1120-1171.

Freeman, C. (1982). *The Economics of Industrial Innovation.* (Frances Pinter Publishers London.

Freeman, J.H. & Hannan M.T. (1983). Niche width and the dynamics of organizational populations. *American Journal of Sociology*, Vol. 88: pp. 1116-1145.

Geroski, P. A. (2001). Exploring the niche overlaps between organizational ecology and industrial economics. *Industrial and Corporate Change*, Vol. 10 No. 2, pp. 507-540.

Gersick, C. J. G. (1991). Revolutionary change theories: A multilevel exploration of the punctuated, equilibrium paradigm. *Academy of Management Review,* Vol.16, pp.10-36.

Guloglu, B. & Tekin, R. B. (2012). A panel causality analysis of the relationship among research and development, innovation, and economic growth in high-income OECD countries. *Eurasian Economic Review*, Vol. 2 No. 1, pp. 32-47.

Hannan, M. T. & Freeman J. (1984). Structural inertia and organizational change. *American Sociological Review* Vol. 49, pp.149-164.

Hannan, M. T. & Freeman J. (1977). The population ecology of organizations. *American Journal of Sociology,* 82: 929-964.

Karvonen, M., & Kässi, T. (2011). Patent analysis for analysing technological convergence. *Foresight : The Journal of Futures Studies, Strategic Thinking and Policy*, Vol. 13 No. 5, pp. 34-50.

Kondratiev, N. D. (1935). The Long Waves in Economic Life. *Review of Economic Statistics*, pp. 105-115.

Kurnet S. (1978). *Technological innovations and economic growth.* San Francisco Press 1978.

Lawless M. W. & Anderson P. C. (1996). Generational Technological change: Effects of innovations and local rivalry on performance. *Academy of Management Journal.* Vol 39

Lawrence, P. R. & Lorsch, J. W. (1967). *Organizations and Environments : Managing Differentiation and Integration.* Boston, M. A. Harvard Business School Press.

Mandel, E. (1980). *The longwaves of capitalist development.* London: Cambridge University Press.

Mensch, G. (1979). *Stalemate in Technology.* Cambridge, M. A. Ballinger.

Niu, K.H. (2009), "The involvement of firms in industrial clusters: a conceptual analysis", *International Journal of Management*, Vol. 26 No. 3, pp. 445-55.

Perez, C. (2004) *Finance and Technical Change: A Long-term View, The Elgar Companion to Neo-Schumpeterian Economics*, Hanusch, H. Pyka, A. (eds.), Cheltenham, Edward Elgar.

Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, *34*(1), 185-202.

Pfeffer, J & Salancik, G R. (1978). *The external Control of Organizations.* New York: Harper and Row.

Salimath, M.S. & Jones III, R. (2011). Population ecology theory implications for sustainability. *Management Decisions*, Vol.49 No. 6, pp. 874-910.

Schlauch, M., & Palmisano, G. (2013). The transition from the neoclassical growth model to ecology. *Journal of environmental Management & Tourism, Vol. 4No.* 1, 29-36.

Schmookler (1966). *Invention and Economic Growth*, Harvard University Press, 1966.

Schumpeter J. A. (1939). *Business Cycle,* McGraw- Hill.

Scott, A. J. (2011). Emerging clusters: Theoretical, empirical and political perspectives on the initial stage of cluster formation. *Public Organization Review*, Vol. 11(4), 433-434

Scott, W. R. (1992). Organizations: Rational, natural and open systems (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Solow R.M. (1956) A contribution to the theory of economic growth. *Q J Econ* , pp. 70:65

Sterman, J. (1986). The economic long wave, theory and evidence. *System Dynamics Review*, Vol. 2, pp. 87-125.

Suarez F. F & Utterback J. M. Dominant Designs and the Survival of Firms. *Strategic Management Journal, Vol.* 16, pp. 415-430.

Swaminathan, A. (1998). Entry into new market segments in mature industries: endogenous and exogenous segmentation in the U.S. brewing industry. *Strategic Management Journal (1986-1998),* Vol. 19 No. 4, pp. 389.

Tinbergen J. (1959). Kondratiev Cycles and So called Long Waves. In *Long Waves in the World Economy* ed. Freeman, Christopher Frances Pinter publishes and Dover H.

Tushman, M. & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly,* Vol. 31.

Usher J.M. & Evans, M. G. (1996). Life and death along gasoline alley: Darwanian and Lamarckian processes in a differentiated populations. *Academy of Management Journal*, Vol. 39, pp. 1428-1466.

Van Dujjin, J. (1984). Fluctuations in Innovations over time. In *Long Waves in the World Economy* ed. Freeman, Christopher (Frances Pinter and Dover H. H. .

Van, den Ende, J. & Dolfsma, W. (2005). Technology-push, demand-pull and the shaping of technological paradigms - patterns in the development of computing technology. *Journal of Evolutionary Economics*, Vol. 15 No. 1, pp. 83-99.

Volberda, H. W., Van, D. W., Verwaal, E., Stienstra, M., & Verdu, A. J. (2012). Contingency fit, institutional fit, and firm performance: A metafit approach to organization-environment relationships. *Organization Science, Vol. 23 No.* 4, pp. 1040-1054.

Wade, J (1996). A community-level analysis of sources and rates of technological variation in the microprocessor market. *Academy of Management Journal,* Vol. 39, pp. 1218-1244.

**Table I: Summary Different Phases of the Techno-Economic Cycle**

| Phase I Proposition | Transition between Phase I and Phase II | Phase II | Phase III | Phase V |
|---|---|---|---|---|
| *Establishment of a distinct community of populations of organization based upon the core technology of the new techno-economic cycle.* | *The community of populations of organization expands as new populations or niches emerge.* | *Stability after the adoption of the dominant design. Selection and retention forces organization to imitate and mimic successful organizations.* | *Stability exist due to adoption of the dominant design but impending new techno economic cycle lurking at the horizon.* | *New innovations are introduced, possessing potential for the beginning of a new techno-economic cycle.* |
| *There is abundant resources to support populations of generalist organizations existing in wide niches.* | *Resources are still abundant but competition is focused on the search for and adopt a dominant design that will cause these niches to become narrower and increasingly distinctive.* | *Resources are intensely competed for by existing and new organizations.* | *Resources are beginning to be diverted to new technological trajectories which can potentially become the new techno economic cycle.* | *Resources are diverted to support the next techno economic cycle. Existing organizations will chose to move to the new techno economic cycle or remain with the current cycle.* |
| *Organizations are generalists and are more voluntaristic compared to organizations in the current techno-economic cycle.* | The Lamarckian view prevails and generalists have slack resources to exercise their strategic choice to adjust to the changing environment. | *Organizations become increasingly less voluntaristic and specialists organizations exist at the peripherals of the market.* | *Intense competition and product differentiation leads to distinctive and narrow niches which support specialists. Deterministic environment prevails.* | *Organizations are increasingly specialized and mobility between niches or populations of organizations are constrained. Environment is more deterministic.* |

**Figure I : Integrated Techno-Economic Cycle**