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RESEARCH

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Knowledge-based development as a new economic culture

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Abstract

This is a theoretical research paper that aims to make the case for the major cultural evolution underlying the transition from industrial to knowledge societies. The approach followed consists of a theoretical analysis of the re-definition of production factors as well as the output variables to characterize and measure social worth. A major emphasis is placed upon economy as culture, one where not just financial and material capital, but all worthy value dimensions are given due consideration. As a result, knowledge-based value is characterized through represented experience, i.e., acquired symbols and preference criteria. The nature of k-based as opposed to material-based economics is central to this discussion. The paper concludes that a new economic culture shall evolve in parallel to the emergence of knowledge cities and societies. The 'knowledge' attribute of knowledge cities relies on the capacity to balance all societal values into an equitable and sustainable dynamic equilibrium. The background section provides an introduction to the evolving concept of knowledge-based, in contrast to the prevailing material-based paradigm of industrial culture. The approach section explores the behavioral and social bases of such distinction. The discussion section concentrates on the economic foundations of knowledge-based value generation. Finally, the conclusions draw on the implications of the above discussion for economic science and the emerging knowledge-based culture.

Keywords: Material-based; Industrial culture; Knowledge-based; Knowledge-based value systems; Capital systems; Knowledge city; Knowledge-based development (KBD); Knowledge culture; Knowledge society; Knowledge economy

Background

Whereas concepts such as knowledge economy, knowledge societies and knowledge cities are widely used nowadays, the lack of solid definitions is apparent. Even in specialized circles, the core concept of Knowledge-based Development has a number of interpretations (Carrillo, 2014). This is particularly evident in the construction of the idea of Knowledge Cities.

The concepts of knowledge city and knowledge-based development

In contemporary media, the association of the terms *knowledge* and *city* conveys the conglomeration of technological, academic, cultural, scientific, and innovation capabilities in cities and regions operating as engines of economic growth. Thus, the technological district, university campus, creative neighborhood, cultural precinct, innovation

hub or science park are seen as knowledge-intensive areas catalyzing urban and national competitiveness. The spatiality of knowledge and innovation intensive sectors has been widely studied. California's Silicon Valley, Barcelona's @22, North Carolina's Research Triangle, London's East End, Moscow's outskirts Solkovo, New York's Roosevelt Island, and Paris' new outer circle development exemplify such knowledge-intensive spaces (Katz and Wagner, 2014).

Indeed, science, education and innovation contribute to territorial knowledge-based profile. This idea is captured by the European Institute of Innovation and Technology *Knowledge Triangle* model. However, the concept of knowledge-based development (KBD) can also be applied to city attributes such as *resilience*, *cohesion* or *identity*. It can even be applied to non-urban communities such as *Indigenous Cultures* (Indigenous Peoples' Restoration Network, Indigenous Peoples' Restoration 2012), *Aboriginal Communities* (Northern Territory of Australia, 2003) or *Indian Villages* (Batra et al. 2013). Hence, KBD obviously has a wider meaning than cutting-edge technology-intensity. It is able to encompass all these urban dimensions. Many current development initiatives bring together the multidimensionality of urban knowledge, such as peer-to-peer dealing, sharing economies, social entrepreneurship and innovation, open dealing, happiness economics, green growth, crowd dealing, collaborative consumption, frugality and voluntary simplicity, etc.

Another common view of knowledge cities appeals to a high concentrations of highly productive and educated people in realms such as industry, politics and the arts). This concept, exemplified by the *creative class* (Florida, 2004), centers on individuals making a difference to a city's global competitiveness. However, such idea relies on a existence and continuity of a privileged population sector and is distant from the above non-high-technology communities, often more sustainable ones. Whereas poles of highly creative individuals have been used to characterize knowledge cities, this concept fails to convey the distinctiveness of knowledge-based urban development. In fact, a privileged class is less characteristic of knowledge cities than the democratization of knowledge and innovation. The recent book by Nobel Laureate in Economics Edmund Phelps *Mass Flourishing* provides a fresh account of modern economic history. Phelps collective leverage of knowledge and innovation closely resonates with the approach to KBD developed in this paper. International awards such as *Most Walkable City*, *Most Admired Knowledge City* and *Sustainable City* or urban attributes such as *livability* or *quality of urban life* imply a comprehensive development scheme, where no citizen is excluded.

Yet another popular view is based on the knowledge-city association with intensive information and communication technology (ICT). Some variations include *smart cities* and *digital territories*. These rely on big data analysis and extensive grid management. Through intensive ICT, these developments contribute to improve transit, security, public transportation and public service management in general. Digital grids have certainly opened up new possibilities to urban planning, analysis, and management through distributed, real-time systems enabling effective and fast response. Besides, Internet-based solutions has contributed to knowledge democratization, reducing information asymmetries and empowering both groups and individuals to mobilize their ideas and initiatives. Digital leveraging of social processes is an ingredient of knowledge markets. Hence, state-of-the-art digital infrastructure may substantially contribute to

building knowledge-based societies. However, digital infrastructure per se is not sufficient or even strictly necessary, however desirable. KBD requires a multidimensional transformation process aimed at social value balance.

The distinctive leveraging potential of KBD benefits from but is not restricted to high-end scientific, educational and innovation sectors. It also includes but is not reducible to precincts of highly creative people. It may be fortunate to count on, but it can eventually do without, state-of-the art digital grids.

Three KBD generations

An important clarification is convenient at this point. In this work and the approach it represents, the 'knowledge' component of KBD is characterized neither in terms of *knowledge contents* nor of *knowledge flows*. It is not defined in terms of content or exchange intensity or volume. This distinction stems from identifying three necessary and sufficient conditions for knowledge events. These are: first, knowledge *object*: that which is known. Secondly, knowledge *agent*: her/him who knows. Third and critically, knowledge *context*: the axiological and semiotic references that provide value and meaning and therefore, economic and cultural significance (Carrillo, 1998).

The distinction between three generations of KBD may help here. First generation, object-centered KBD approaches focus on object attributes, such as medium nature (caved stone, manuscript, printed paper, magnetic recording, digital screen, augmented reality display) and content molarity (data, information, knowledge). The second KBD generation deals mostly with agent attributes, like structure (roles and hierarchy) as well as relevant agent competencies (code or language proficiency, procedural know-how). Both approaches have been extensively discussed in the literature from different perspectives and do have a major contribution to KBD. For instance, object molarity determines KBD level of analysis and management at data, information or knowledge levels. In the first case, it may enable energy grid analysis for smart cities. In the second, traffic systems for intelligent cities. In the third it may enable e-citizenship collaboration for knowledge cities.

Through social network analysis research on technology clusters and regional innovation, k-agent base is receiving increasing attention. Certainly, k-object and k-agent dimensions, insofar necessary conditions for KBD deserve due consideration as these relate to important aspects of urban life. In this regard, this paper agrees with Arrow (1994) in characterizing the social base for information and knowledge value generation.

At this point is critical to emphasize the *knowledge context* dimension since it provides KBD with cultural significance and economic relevance regardless of what we undertake on its behalf. A 3rd KBD generation, focusing on meaning and value, brings to the forefront the received distinction between tangible or traditional capital (physical + monetary) and intangible value or intellectual capital (other significant dimensions). Such emphasis applies to knowledge-intensive goods, but also to all knowledge society distinctive outputs and services (De Long & Froomkin, 2000). KBD aims at portraying and developing urban life from an holistic value perspective, where all sustainable and equitable living factors are given due considered. This KBD approach has also been characterized as integrative or radical KBD (Carrillo, 1998, 2006b, 2014; Allee, 2002; von Mutius, 2005).

From this viewpoint, KBD certainly deals with objects and agents insofar engaged in knowledge-intensive transactions. Yet, it also deals more distinctively with value dimensions that have been outside the regular scope of economics. Hence, KBD has more to do with human capacity for cultural evolution. It aims at the correction of major environmental, social, and gender unbalances. The distinctive leverage of the knowledge city lies on the disruption of the social contract on the basis of a human cultural upgrade (Carrillo, 2006a).

KBD aims at a dynamic identification, measurement and balance of all value elements shared by urban communities. It multiplies the overlap between knowledge and city, knowledge and economy, knowledge and society, beyond current boundaries.

Finally, KBD concerns the continuity of human civilization. It involves the capacity to balance production, consumption, distribution and vital sources of matter and energy. It requires the capacity to identify, agree, implement and evaluate collective preferences; a set of common value dimensions for ethics, politics, economics and culture (Gudeman, 1986). The *knowledge-based* attribute refers to a new cultural, political and economic order giving as much priority to *intangible value* or *intellectual assets* as it has so far done to the material and monetary. The most recent World Development Report by the World Bank focuses on the behavioral and social elements that shape the economy and society at large (World Bank, 2015). From this perspective, this paper aims at identifying the axes on which a transition from industrial to knowledge-based economic culture might be evolving, and where political action might leverage human development (Lin, 2012; Carrillo, 2014).

Approach

A historical deconstruction of the relationship between the values of a community, its cultural products, its social organization and its knowledge base becomes necessary after the former reinterpretation of economic and knowledge acts. Such reinterpretation follows the evolution from experience dominated by material reality to experience where represented or knowledge-based reality becomes prominent (Table 1). Rather than *material objects* (matter and energy manifestations generating sensory or instrumental records) both *representations* and *interpretations* of these objects (emotions and ideas based on perceptions and their psychological elaborations) dominate daily life. This involves a shift in emphasis from the realm of *things* to the realm of *representation of things*. The substitution process involved is at the core of knowledge-based behavior, psychological life, and civilization (Carrillo, 1998). On these bases lie the association of values where economics unfolds and the association of meanings where semiotics emerges. Social value-addition and social sense-making take place: culture emerges (Gudeman, 1986). Eight decades ago, John Commons diagnosed: "Economic science has not, to my knowledge, incorporated within itself a theory of reasonable value. It separates ethics, public welfare, or national public interest as a postscript, different from economic theory. But a theory of reasonable value, which shall include these postscripts, has become obligatory..." (quoted by Rutherford & Samuels, 2002, p. 467). The World Bank report cited above underscores the currency of such prescient views (World Bank, 2015).

Table 1 Key factors in major production systems

	Production type	Input	Process		Output
			Agent	Instrument	
Physical Era	Hunting – gathering	Natural habitat	Human and animal	Hands and primitive tools and techniques	Game, fish and collected natural goods
	Agricultural	Land, water, seeds, fertilizers	Human and animal	Agricultural equipment and techniques	Agricultural goods
	Extractive	Natural deposits	Human and animal	Mining equipment and techniques	Stones, metals, minerals
	Industrial	Raw materials and energy	Human and automata	Industrial machinery, equipment and techniques	Manufactured goods and industrialized products
	Physical-based production	Matter and energy	Muscular strength and sensory-muscular dexterity	Physical tools, equipment and techniques	Physical goods
Knowledge Era	Knowledge-based production	(Relative) lower-level knowledge input	Rationality and emotion	Knowledge processing tools, systems and networks	(Relative) higher-level knowledge outputs & services

Culture and production

The prominent behavioral scientist B. F. Skinner, captured the essence of the sensory/symbolic substitution process in a simple expression: “responding to x in the absence of x”. This is the basic learning mechanism through which a formerly neutral stimulus gains control over a given response. It provides the building blocks of most acquired behavior. Through this mechanism, rudimentary ideas and therefore the building blocks of further behavioral processes such as motivation, emotion, memory, learning, thinking and language are formed.

Often, when making reference to the dawn of the knowledge society, the fact that knowledge-based behavior exists since the very origins of mankind it is rightly raised. This might also be true about sophisticated cognitive and emotional abilities in other species. But the scale and depth of the current shift to knowledge-intensity in human activities is unprecedented. The behavioral upgrade from the industrial 20th Century where most people still earned their living through manual work, to 21st Century where knowledge workers add value mainly through on sensibility and intelligence than on muscular strength and dexterity, is leap-frogging. Human individual development follows a series of emotional and cognitive stage-consolidation that might be analogous to current cultural evolution. A variety of human actions are transforming radically as the shift from material-based to knowledge-based pervades. Table 1 shows the evolution of successive cultural bases based on their production elements (input/process/output). These elements set the dynamics of economic life, as much as cultural foundations such as values, roles, practices and institutions.

Cultural patterns transition from nomadic hunter-gatherers societies, through agricultural and industrial societies, to the emerging knowledge societies can be observed from such perspective. While major cultural transformations have happened throughout history, it might be at the current shift from matter-based to knowledge-based production when human life is qualitatively leveraged and with it the space of possibilities for civilization. The European Commission *Knowledge Economy Indicators* study states: “the fundamental changes taking place at the level of the economy will have wide-ranging impacts throughout society that could result in major changes to how people live and work”. These deep transformations were foreseen decades ago by visionaries Frederick Soddy in Britain, Taichi Sakaiya in Japan and Fritz Machlup in the US.

Gender provides a good example of an elementary human condition being deeply transformed by the transition to knowledge societies. Gender roles were, in most civilizations, culturally shaped, by specialized physical requirements of hunting-gathering, agricultural, extractive or industrial activities, amongst other factors. Muscular strength was a major determinant of task specialization until the 20th Century. It needs not be anymore. The majority of today’s knowledge-intensive work levels the value-generation field. As a consequence, an increasing gender balance in economic production is being achieved. To some extent, women might have an edge in entering the knowledge society as it requires deploying certain social and emotional competencies. Surely, a vast cultural inertia is getting in the way of full gender balance regarding, job opportunities, political representation and power exercise. However, the nature of knowledge-based production and the cultural construction of gender is giving way to unprecedented gender

politics, roles definition, family characterization, and workplace dynamics (Rosin, 2010; Walby, 2010). As Joel Mokyr, the economic historian, has pointed out: “The central phenomenon of the modern age is that as an aggregate we know more ... Every aspect of our material existence has been altered by our new knowledge” (Mokyr, 2002, p. 2).

In Table 1, our current time position would be right at the horizontal line separating the physical era from the knowledge era, at the early 21st Century. This is also the timing for the largest and definitive urbanization in human history: on the one hand, city dwellers have just passed the 50 % mark of global population. On the other human activity has become largely knowledge-based.

This critical moment in human civilization, was summarized in an earlier work: “Few aspects of today’s world may characterize better the dawn of the new millennium than the transformation of regions and cities into knowledge societies. The evolutionary significance of both the definite urbanization of the world’s population and, above all, the *experience upgrade* of urban life in post-industrial economies is only beginning to be realized: *the 21st Century Society is Post-industrial, the Knowledge City its horizon*”. “On the one hand, the 21st Century is being identified as the *Century of Cities* ... On the other hand, the 21st Century has also been identified as the *Century of Knowledge*... [and as a consequence]... the convergence of these two emerging conditions of human civilization – cities and knowledge – at the dawn of the new millennium: *The Century of Knowledge Cities*.” (Carrillo, 2006a, p. xi).

Discussion

Value creation of the knowledge-based kind

A key assumption has thus been established: that of a qualitative difference between natural principles for the behavior of objects (mostly physical, chemical and physiological processes) and natural principles describing the behavior of ideas and emotions (mainly neurological, psychological and cultural processes). A corollary being the impact such difference makes on the economic and social dynamics of each realm. For example, insofar products of human activity upon matter and energy are determined by space-time conditions, legal and social norms regulating production, ownership and distribution are constrained by physical possession, thus generating property laws.

In a similar vein, the wasting of industrial production lines is thermodynamically determined, resulting in diminishing returns. Insofar as work involves an energy cost, each successive unit in mechanical production lines carries a cumulative waste of and moving parts, lubricants, etc. The relative cost of each successive cycle experiences a marginal increase. Due to a relentless entropy, each single factory is inextricably subject to this constraint and has to re-invest continually in eventually replacing every mechanical component of production lines. This is unlike the latest operating system version by a software company, or hit by a pop singer, or trending topic in social networks, or breaking news by a media channel, or viral video, which may be delivered at no additional production cost thousands or millions of times. In k-based production the return of each successive unit remains constant. Such simple fact has deep implications and has drastically transformed business models. Apple’s iTunes Store, for instance,

carries well over a million apps, has paid more than 13 billion to developers and by the end of 2014 set a new 75 billion downloads mark.

It is generally recognized that knowledge is a leverage to economic growth and that it has special properties such as partial excludability, non-rivalry and increasing returns (Romer, 1990; Amidon et al., 2005; Commonwealth Department of Education and Training (2012)). However, we still might be far from understanding its nature and harnessing knowledge-based value dynamics potential. Since 1986, Brian Loasby had realized: "It is now becoming widely recognized that many of the central unresolved problems in economics turn on questions of knowledge" (Loasby, 1986, p. 41). Even if overwhelming counterexamples to received economics views abound, only a few hints and conjectures about the new realities are available.

The poorly understood properties of represented economic objects is exemplified by cloud computing. Professor Chris Reed, from Queen Mary, London claimed: "The problem is that our understanding of property is based on material objects", when discussing the case of an entrepreneur whose property rights over all his cloud-stored files were legally challenged, once the servicing company was confiscated by US Government (Heaven, 2013, p. 35). Reed noted that, "While the government's defense may sound ridiculous, it is on pretty firm legal ground" so long as ... "Possession, which is sort of what property is all about, is irrelevant" (Heaven, 2013, p. 35). Cloud storage services, unlike physical storage, it may reside partially in several locations at once, be constantly shifting amongst server locations and be downloaded and re-uploaded continuously by many individuals far beyond the author. With such a rapid growth that it is expected to become the main world digital repository by 2020, cloud storage often leads to unforeseen scenarios (Anderson & Rainie, 2010). One such scenario has unfold regarding the legal status of acquiring (limited) use rights but not necessarily property rights in e-books and music re-selling (Streitfeld, 2013). Heaven (2013, p. 36) concludes: "Untangling relationships with your possessions in the cloud quickly gets confusing". Ownership is a major issue being re-defined in the knowledge economy.

The ongoing dispute over Internet state sales taxes in the USA provides another such confusing scenario. The legal definition of "nexus" has proved to be a key element in a lengthy federal regulation ordeal. Nexus denotes the extent to which a company has physical presence in a state becoming proportionally subject to local taxes on sales and income. The distinction has proven so slippery that Amazon, in a long dispute, sustained it had no physical presence in Texas, despite the fact of owning and operating for 15 years of a 630,800 square-foot distribution center. The distinction between brick-and-mortar and internet-based business became central to this dispute and forthcoming legislation. Barnes & Noble, the once dominant bookstore chain, has meanwhile lost market to Amazon, that stopped claiming to be "Earth's Biggest Bookstore", since it is now more than that.

Thus, the universe of possibilities that determines the nature of material-based value dynamics is contained by physical reality. By far, economic theory, management practices, accountancy systems and policy making have been dominated by physical realities. As noted earlier, knowledge-based realities are with us since the dawn of mankind—i.e., since the origin of human psychological life. Management, both private and public, have been puzzled by the pervasive and often neglected role of intangibles.

Frederick Soddy, the 1921 Nobel laureate in chemistry, who anticipated the distinction required to understand the interplay between wealth and debt, between material-based and knowledge-based production, has offered one of the most perceptive insights into the distinctive bases of economics. His naturalistic monism is consistent with a complex systems perspective: “The principles and ethics of human law and convention must not run counter to those of thermodynamics” (quoted by H. Daly, 2009, p. 3). The interplay between knowledge-based and material-based value creation needs to be culturally acknowledged and assimilated. Such achievement may require a three-phase distinction between physical capital, monetary capital and intellectual capital, synthesized in a unified theory of value (Carrillo, 1998; Graeber, 2011).

So far knowledge-based realities, despite their ubiquity, have not been granted an ontological status as that of material and monetary units. Precisely because of this fact these dimensions are deemed “intangible”. The way measuring intellectual or knowledge-based capital has been tackled reflected such ambivalence. Hubbard (2014) defaces “The Illusion of Intangibles”, showing how intangibles measurement is at the core of current misconceptions concerning the role of measures in our received industrial culture. The limits to development of knowledge societies will be set by the capacity to understand and represent collective value (Carrillo, 1998, 2006b; Stiglitz, Sen & Fitoussi, 2009; Lin, 2012; Carrillo & Batra, 2012).

Actually, money –of the printed and above all digital kind that makes by far the bulk of global wealth- is not less ethereal than ideas or beliefs. In fact, it is a promise sustained by a belief, and less substantial than software or technical procedures. Nevertheless, money has been at the core of economic life and the shaping of culture. Michael Reiss puts it succinctly: “It is not much of an exaggeration to say that the history of economics has been a history of mankind’s attempts, and mostly dismal failures, at establishing and sustaining a stable monetary system” (Reiss, 2011, p. 20). It is obvious that national accounts and the productivity these rely on are still restricted to physical assets and monetary base. The extent to which this restriction constrains the universe of management and strategic development is less obvious. Remaining by far the limits to organizational and political language, physical and monetary dimensions remain, in Wittgenstein’s criterion, the limits to the world (Gudeman, 1986).

So long as these limits are challenged by contradictions from within and realizations from outside, alternative paradigms will emerge. The worlds of formal economics, management and politics are bound to be subverted by the ever-increasing role of behavioral or knowledge-based realities and their natural weight in human affairs (Carrillo, 1998; World Bank, 2015).

As mentioned before, human production stemming from ideas and emotions, by lacking the constraints of physical production, has natural a dynamic of its own. However, no proper theory of the knowledge economy is yet available. Subsidiary theories have been advanced at the organizational level such as the Knowledge-Based Theory of the Firm. At the societal level, Development Theory has attempted to capture the novel role of knowledge, as in Endogenous Growth (Romer, 1990). Yet, most of these attempts have been isolated and short-lived. Contributions have been made at both the organizational (Sveiby, 2001; Grant 2002; von Krog & Grand, 2002) and societal levels

(Romer, 1990; Asian Development Bank, 2007) to substantiate the need and prescribe specifications but there is a long way to go towards a Theory of Knowledge-Based Value Production.

Kuhnian scientific revolutions involve an increasing acknowledgment of counterexamples to prevailing paradigms, those boundary cases defying received views or new conjectures challenging prevailing theories. While a formal knowledge-based production theory has yet to be produced, some novel elements are beginning to emerge.

A deconstruction of the market economy deeply rooted in industrial capitalism was undertaken by De Long and Froomkin (2000). They pointed out the increasingly obvious limitations of conventional market attributes to deal with knowledge-intensive production along three axes: excludability (sellers capacity to prevent access to a good), rivalry (depletion of a good caused through an agent using it) and transparency (individuals ability to choose what they want to buy). Once these three axes are disrupted through new production and distribution processes, market failures and externalities unleash (Romer, 1990; Carrillo, 1998, 2014; Amidon et al., 2005).

In a broader attempt, the following distinctive features of knowledge based value production were recently identified by Australia's Commonwealth Government, Department of Education, Science and Training (Commonwealth Department of Education and Training 2012): non-subtractive (several agents can use it at a given time), non-scarce (renewal capacity is the only limit to use), use independency of cost (cost remains the same no matter how many people use it), easily replicable (once having an item, as many copies as desired are possible), creation cost independency (high value outputs rendered by low cost inputs and process), rapid obsolescence (knowledge can depreciate very quickly), ease of transfer and globalization (knowledge can travel quickly and efficiently through frontiers).

Table 2 compiles distinctive attributes of knowledge-based production (Carrillo, 2006a).

Value production principles and its impacts through culture and social organization are bound to explode as the new millennium unfolds. The continuity of human civilization might depend upon human capacity to grasp such principles and redesign coexistence terms, across nations as well as with the planet.

Hence, KBD needs not be constrained to drivers of economic growth such as R&D, innovation, competitiveness, education and intellectual property. Such constrain should be lifted also on initiatives so far regarded as knowledge-intensive: technology transfer centers, science parks, business incubators and accelerators, techno-poles, industry clusters, innovation regions and so forth. Being the current forefronts of the knowledge economy, each has a distinctive purpose and applies to well-defined realms. All were already in use by the 1980s, before knowledge-based development took off at the dawn of the new century. If KBD can be reduced to any of these concepts or even to the sum of all, then it should be abandoned since it would prove redundant (Carrillo, 2006b, 2014).

The search for an coherent model of human value is driven by the urge to capture and codify the systemic unity of net human-created worth as much as by as the realization of the growing limitations of the economic establishment. KBD must be the foundation of an economic system allowing the visualization and management of total human activity value. While science and technology, infrastructure and innovation, should be included, also should societal attributes relatively disregarded such as

Table 2 Knowledge-based production attributes

Non-rivalry	Possession and use of a good by an agent does not consume it and therefore does not prevent possession and use of the same good by another agent
Non-excludability	Access to a good by an agent does not prevent access by another agent
Non-scarcity	A good can be replicated indefinitely at no extra cost
Non-decrementality	The rent value of successive product units x_1, x_2, \dots, x_n , may not diminish as a function of iterations of the production cycle
Capital/labor convertibility	Labor may simultaneously operate as capital and become the most critical factor (e.g., talent-intensive companies)
Ubiquity	A good may be simultaneously available to anyone, anywhere
Time and context dependency	A good may decrease in value as a function of time and sometimes may become obsolete soon after it is being released
Connectivity	The sum value of a network increases as the square of the number of members
Intangibility	The market value of a firm can (largely) surpass that of its book value
Externalities	Unintended consequences, both positive and negative, can (largely) surpass the value of producing a good

identity, intelligence, cohesion, resilience, transparency, equality, diversity, tolerance, renewal, attractiveness, etc.

Paradigmatic roles and institutions of the industrial culture need to be revised within this context. It becomes necessary to redraw the tacit 20th Century contract inherited from industrial societies under these considerations. A new breed of organizations redraw the political and economic world map while the economic categories in force depreciate. Emerging species such as knowledge markets, distributed work and learning, value networks, competencies and technology brokerage, knowledge citizenship, talent auctions, expertise pools, illustrate this ongoing evolutionary process.

Conclusions

KBD as cultural disruption

There is a long way to go in seeking a new economic paradigm able to deal with behavioral and knowledge-based phenomena (World Bank, 2015). Knowledge economics has yet to be founded on scientific grounds. The road from KM and KBD towards a theory of individual and social knowledge-based behavior looks like a long one. Hence, would it be not easier to adapt or expand some current economic theory? Would it not be easier to take established economic science into KBD? To start with, why is it so relevant, economic theory for urban development?

Two immediate answers are a hand: because in cities we are dealing with sets of people making choices (starting with settling on the same territory) and also because we are dealing with people sharing (intangibles to a large extent). These two aspects have deep economic implications and lie at the heart of KBD. These two critical issues are the pillars of the knowledge economy: knowledge markets as operational models of exchanging intangibles and capital systems as language to contain knowledge-based value. So long as cities have become the engines of socioeconomic development and culture, and the experience of the biggest part of humanity is urban, and so long as most of that experience is knowledge-based, then the relevance of an economic science of urban KBD becomes obvious. The remaining of this section attempts to provide an answer to the first two questions from the former paragraph.

The approach to be followed stems from behavioral psychology. Back in the late 1970s, experimental analysis of behavior (EAB) started to deal with choice through experimental research. Choice was at the time the leading topic in EAB, as researchers in the field became familiar with micro-economic topics such as consumer behavior, microeconomic analysis, decision-making, Game Theory and other related issues. The connection occurred not mainly through formal modeling, but through experimental analysis of decision-making. Under the radical behaviorism perspective, EAB insisted on limiting resource to theoretical structures only to the basic explanatory mechanisms and the formulation of further empirical research. A constant theoretical reference was the work by Amos Tversky on decision-making under uncertainty and risk perception impact. Leading EAB researchers like Richard Herrnstein (the matching law) and Howard Rachlin (self-control) contributed to the later development of behavioral economics. That was the context for the associations between scientific behavior and the psychology of science (Carrillo, 1983a, b, c), later transferred into KM and KBD.

Economic science is founded on assumptions about how humans behave, some of these assumptions being centuries-old. Embedded in economic theory, in particular, are assumptions about individual self-interest and rationality. These assumptions are then commonly extrapolated to collective choice. Most of economic theory was founded until very recently, on a number of such assumptions, embedded in the myths of *homo economicus* and rational markets. These remained unchallenged over many years. Mainstream economics developed mainly through conceptual elaboration, mathematical sophistication and ideological consolidation. Progress was swift but as it advanced it became farther removed from empirical grounds (Sen, 1977).

The study of human behavior and particularly of individual choice and group collaboration contributed in recent years to amend such bias. Once the central assumption of the rationality of economic agents was scrutinized taking into account cognitive and emotional factors, it became difficult to hold. Converging inputs from experimental psychological research provided fresh insights. For example, Herbert Simon's works on Bounded Rationality, established how rationality was relative to both the information available to and cognitive limitations of decision-makers (Simon, 1957). For a contribution drawn mostly from non-economic disciplines like social and computer sciences, Simon was awarded the 1978 Nobel prize in economics. Another example is David Kahneman a psychologist with no curricular economic training. A close collaborator of Tversky, he was also recipient of the 2002 Nobel prize in economics. The award rationale reads: "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty" (Kahneman, 2002). He shared that award with the founder and president of the International Foundation for Research in Experimental Economics, Vernon Smith, "for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms" (*ibid.*).

These developments help to justify the perspective adopted in the current section of this paper, summarized as follows:

- i) economic systems are based on assumptions about human nature, particularly when characterizing the attributes of economic agents. Such explanation belongs to behavioral science.
- ii) those assumptions have rendered subject to experimental research and should from now on be expressed as empirically testable conjectures.
- iii) most disciplines benefit eventually from fresh inputs from other disciplines. Economic science can now assimilate inputs from behavioral and social science, amongst other.

These developments add weight to the observation by Thomas Kuhn: “Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change” (1962, p. 68).

An economic KBD paradigm, therefore, seems to have some specific prerequisites, including:

- i) *Empirical Economics*. An empirically grounded economic discipline drawing on recent developments by behavioral and social sciences would help to demystify long-held beliefs such as *homo economicus* and market self-regulation as well as to overcome methodological constraints like model over-theorization. Such renewal would include, as much as for any scientific discipline, a systematic revision of ideological biases as well as a clearer awareness of social and ethical implications.
- ii) *Systems viability*. Evidence has been mounting on the material unsustainability of our current economic culture, be it in production, distribution or consumption. The viability of life on Earth requires a balancing act for aligning economies to a sustainable growth policy. This might be the necessary level for adapting to socio-technical development, age demographics and population size, with a strong emphasis on localization (as opposed to globalization) approaching zero-growth or even de-growth. It is hard to see how monetary expansion and interest-based credit can continue to be part of a sustainable economic culture.
- iii) *Full-cost pricing*. Undertaking proportional responsibility for production, distribution and consumption practices should follow an ethical awareness the consequences of our current economic culture. The basis for human rights and the rule of law, and the norms for corporate social responsibility and individual consumer behavior should be the social and political accountability of negative externalities.
- iv) *Affirmative Equality*. Corrective actions may be necessary beyond steady-state policies to correct the growing imbalances inherited from industrial culture and sustain a new dynamic equilibrium. Major changes will perhaps be necessary at environmental, social and cultural levels for several generations.

The search for an economic approach to KBD becomes a more focused and encouraging undertaking from this standpoint. The perspective of urban life already obtained from traditional urban studies, political science as well as engineering fields dealing with infrastructure and physical city layers of the shall be enriched through interdisciplinary collaboration with anthropology, geography, sociology, economics, neurology and psychology as well as computer and systems sciences. Social sciences are

particularly well suited to operationalize the intangible dimensions of knowledge cities, used as they are to dealing with constructs such as cohesion, identity, belonging, etc.

A new ground for interpreting and promoting human value transactions is the field of resolution for KBD. The emerging research agenda could start by tackling two foundational issues:

- i) demand aggregation: how bounded rationality at the individual level unfolds into the emerging properties of collective decision-making. This problem underlies most of this paper.
- ii) intangible goods exchange: describing and explaining the unique value dynamics of knowledge markets.

While behavioral brought about economics a long-term research program for connecting KBD and economics, which has been catalyzed by the financial crisis, this is still in its infancy. But, world reality is not waiting. Evidence on the inner contradictions and structural constraints of current economic practices and ideas is mounting up, on the one hand. On the other hand, alternative economic practices and mindsets are sprouting all over the world in the form of knowledge markets.

To sum up the disruptive consequences of the transition from industrial to knowledge-based societies: a major shift in ideas, values, attitudes and behaviors is taking place. This shift might be accelerated by overwhelming signs of the socio-economic establishment limitations exhibited through its environmental impacts, financial dis-functionality and human costs. Yet, this shift also brings an increasing awareness that an emerging culture based on value balance is doing away with the industrial-capitalist paradigm. Alternative approaches to cultural evolution (Brockman, 1995; Acemoglu & Robinson, 2012; Sachs, 2012), economics (Brown 2012; Meadway 2013; Woodford, 2012), politics (Lasn, 2000; Chomsky, 2011) and certainly urbanism as knowledge cities (Carrillo, 2006a) herald an alternative culture, based on new and more balanced ways of production, organization, distribution and transaction.

The knowledge city is by far still uncharted territory. New intangible layers of relational, identity, human, and cultural capital as well as other forms of increasingly acknowledged value categories are leveraging urban innovation, upon the traditional layers of economic activity, territory, urban landscape, and infrastructure that shaped modern industrial cities.

There is yet so much to be understood about the unique value dynamics of knowledge-based production and about the cultural avenues it open. Nevertheless, the direction of change—and with it the new possibilities for urban planning—can be reasonably anticipated. In short, is a move from the net present value paradigm implied by maximum economic growth to a net future value paradigm consistent with sustainable value balance.

Urban utopias throughout history, foresaw a steady-state ideal city reminiscent of the heavens, the nirvanas and the paradise promises for the afterlife, largely determined by religious frameworks whether explicit or tacit. The knowledge city is founded on a political call to identify, debate, understand, measure, develop, balance, assess and adjust

the unique value system on which any given community may found a viable future. In his aforementioned work *Mass Flourishing*, Phelps (2014) finds intensive cross-fertilizations of ideas at the core of the most prosperous moments throughout the modern age. Each city must engage in self-discovery, since there is no paved road to this end. Since such process shall include historic liabilities, structural contradictions and current conflicts as much as unique assets and opportunities, the openness requirement is maximum. Nevertheless, amongst social attributes facilitated by knowledge societies, transparency and accountability are prominent. Constantly striving to attain dynamic balance on public capital accounts, rather than maintaining an ideal equilibrium, seems to be the basis for KBD policy. The knowledge City is the convergence of human hopes and contradictions, the encounter with the other and the possibilities that unfold (Carrillo, 2006a).

A new language is required to capture, all relevant wealth dimensions. Several advances have been made to capture total value bases at the organizational level such as Capital Systems (Carrillo, 1998, 2002) Value Networks (Allee, 2002) and Integrated Reporting (International Integrated Reporting Committee, 2011). At the wider social level, developments include the Most Admired Knowledge City Awards—MAKCi (Carrillo & Garcia 2012), the Gross Domestic Happiness Study, the Subjective Well-being report (L. Daly, 2011) and the Happy Planet Index. At the leading edge, leisure and discretionary time is becoming the new currency. “A healthy economy involves using our time efficiently and getting enjoyment out of our time” (Stiglitz et al. 2009, p. 144). New cultural patterns and citizen competencies are required for such potential reconciliation between human life and the economy.

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