

The Triple Helix of University-Industry-Government Relations

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Loet Leydesdorff

University of Amsterdam, Amsterdam School of Communication Research (ASCoR),

Kloveniersburgwal 48, 1012 CX Amsterdam, The Netherlands;

loet@leydesdorff.net ; <http://www.leydesdorff.net>

Introduction

Etzkowitz & Leydesdorff (2000) further elaborated the Triple Helix of University-Industry-Government Relations (cf. Etzkowitz & Leydesdorff, 1995; Lowe, 1982) into a model for studying knowledge-based economies. A series of workshops, conferences, and special issues of journals have developed under this title since 1996. In various countries, the Triple Helix concept has also been used as an operational strategy for regional development and to further the knowledge-based economy; for example, in Sweden (Jacob, 2006) and Ethiopia (Saad *et al.*, 2008). In Brazil, the Triple Helix became a “movement” for generating incubators in the university context (Almeida, 2005).

Normatively, a call for collaborations across institutional divides, and the awareness that the roles of partners in such collaborations are no longer fixed in a knowledge-based economy, provides a neo-corporatist model of economic and social development that is compatible with neo-liberalism (Mirowski & Sent, 2007; cf. Rothwell & Zegveld, 1981). The City of Amsterdam, for example, adapted the Triple Helix as its working model for economic development as

recently as 2010.¹ In the Latin American context, the Triple Helix model accords with Sábato's (1975) "Triangle" as a program for endogenous development of technology and innovation. The emphasis on bottom-up learning processes (Bunders *et al.*, 1999) can help to avoid reification of systems (or states and interstate dependency-relations) as barriers to innovation. In an overlay of communications between industrial, academic, and administrative discourses, new options and synergies can be developed that can strengthen knowledge integration at the regional level. In a study about regional innovation systems, Cooke & Leydesdorff (2006), for example, noted the possibility of "constructed advantages."

The Origins of the Triple Helix Model

The Triple Helix thesis emerged from a confluence between Etzkowitz' longer-term interest in the study of university-industry relations (e.g., Etzkowitz, 2002) and Leydesdorff's interest in an evolutionary model that can generate a next-order hyper-cycle—or in terms of the TH, an overlay of communications (cf. Leydesdorff, 1995). After Etzkowitz' (1994) participation in a workshop and a proceedings volume, the metaphor of a Triple Helix emerged in discussions about organizing a follow-up conference under this title in Amsterdam in January 1996 (Etzkowitz & Leydesdorff, 1995; cf. Lowe, 1982).

From a (neo-)evolutionary perspective, a double helix can be expected to generate a relatively stable trajectory when the two subdynamics mutually shape each other in a coevolution. For example, in a political economy, the market and the state can be expected to generate equilibria (cf. Aoki, 2001) which are upset by knowledge-based innovations (Nelson & Winter, 1977,

¹ See at <http://www.iamsterdam.com/nl/economic-development-board/over-edba/visie-ambitie/hoewerken-we> (Retrieved on January 23, 2012).

1982; Schumpeter, 1939). Alternatively, when the state and its knowledge infrastructure constrict market forces (as in the former Soviet Union), a suboptimal lock-in can be sustained for considerable periods of time. The interaction of three (analytically independent) subdynamics, however, can destabilize, hyper-stabilize, meta-stabilize, or eventually globalize a relatively stabilized system, and thus change the system at the regime in terms of lock-ins and path-dependencies (Dolfsma & Leydesdorff, 2009; Dosi, 1982; Viale, 2010).

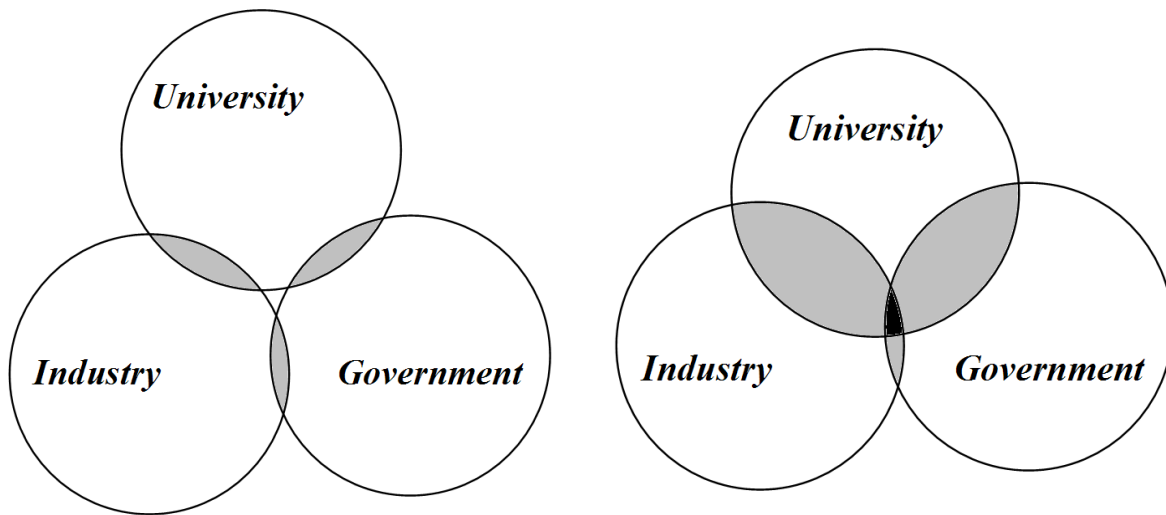


Figure 1: A Triple Helix configuration with negative and positive overlap among the three subsystems.

The Triple Helix model of university-industry-government relations is depicted in Figure 1 as alternating between bilateral and trilateral coordination mechanisms or—in institutional terms—spheres. The systems remain in transition because each of the partner institutes also develops its own (differentiating) mission. Thus, a trade-off can be generated between integration and differentiation, and new systems in terms of possible synergies can be explored and potentially shaped. As the various bilateral translations function, a Triple Helix overlay can also be expected to develop as a system of meaning exchanges among differently coded expectations (Figure 2).

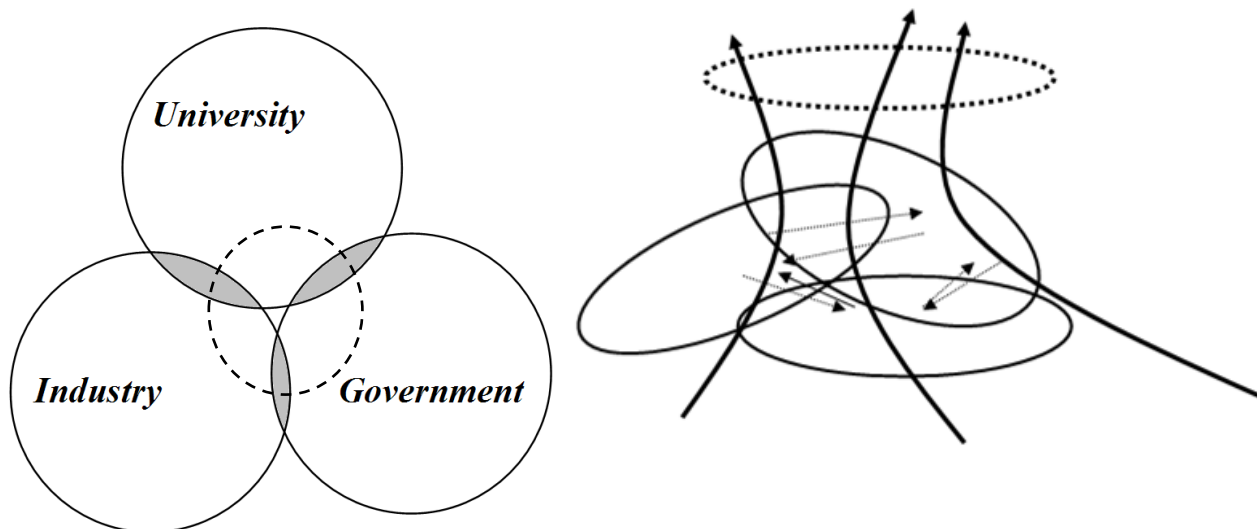


Figure 2: A differentiated Triple Helix with dynamic overlay

If one envisages the overlay (in Figure 2a) as hovering above the sheet, one can imagine a tetrahedron emerging from the bottom with four (three plus one) different types of communications involved. Political, scientific, and economic exchanges are different, but these media (e.g., power, truth, and money; Luhmann, 1995) can also be exchanged. In the overlay, translations among the various media can further be invented and developed.

Etzkowitz & Leydesdorff (2000) specified the top-level overlay as a *subdynamic* and therefore differently from the specification of “Mode 2” by Gibbons *et al.* (1994; cf. Nowotny *et al.*, 2001). “Mode-2” replaces “Mode-1,” but a subdynamic functions among other subdynamics. The complex system can operate “transdisciplinarily” and one can translate contexts of discovery and justification into contexts of application (and *vice versa*), without damaging the integrity of the underlying processes. This imaginative restructuring may loosen existing boundaries at the

institutional level and thus begin to reshape “systems of innovation.” Unlike discussions about national (Lundvall, 1988; Nelson, 1993) or regional (Braczyk *et al.*, 1998) systems of innovation, the Triple Helix model enables us to consider empirically whether specific dynamics (e.g., synergies) among the three composing media emerge at national and/or regional levels. In other cases sectors and/or technologies (e.g., biotechnology) may be more relevant systems of reference for innovations than geographical units of analysis (Carlsson, 2006).

Globalization: a transformation of the Triple Helix?

In the case of Japan, for example, and using a specific operationalization, Leydesdorff & Sun (2009) found that since the opening of China and the demise of the Soviet Union (1991)—both major changes in international competition—the national system of Japan has increasingly become a retention mechanism for international relations. Thus, a further differentiation between the national and the global level emerged in this explanation. In principle, the Triple Helix indicator—that is, the mutual information among three dimensions—can be extended to more than three dimensions (Kwon *et al.*, 2012).

In a study about Hungary, Lengyel & Leydesdorff (2011) found that its national system of innovations fell into three regional systems of innovation following the transition of the 1990s and the accession to the EU in 2004. The authors distinguish: (i) a metropolitan area around Budapest, (ii) a knowledge-based innovation system in the western part of the country which is integrated into other EU countries, and (iii) an eastern part of the country where the old (state-led) dynamics still prevail. The national level no longer adds synergy to these three regional systems.

The roles of the academic, industrial, and governmental contributions are also not given. The central role of universities in many TH studies is based on the assumption that this system is more adaptive than the others because of the continuous flux of students (Shinn, 2002). In a recent study of Norway, however, Strand & Leydesdorff (in preparation) found foreign direct investment via the offshore (marine and maritime) industries in the Western part of the country to be a greater source of synergy in the knowledge-based developments of regions than the university environments of the major centers in Trondheim and Oslo.

Two conclusions can be drawn from these nation-based studies: (i) medium-tech industry is more important for synergy than high-tech, and (ii) the service sector tends to uncouple from geographical location because a knowledge-intensive service is versatile and not geographically constrained. These conclusions accord with the emphasis in the literature on embeddedness (Cohen & Levinthal, 1989) and the footlooseness of high-tech industries (Vernon, 1979). Certain Italian industrial districts, for example, while very innovative, are under the continuous threat of deindustrialization because incumbent multinational corporations may buy and relocate new product lines (Beccatini, 2003; dei Ottati, 2003). In institutional analyses that focus on local and regional development using the Triple-Helix model, the structural effects of globalization are sometimes backgrounded.

Different versions of the Triple Helix model

The Triple Helix (TH) can be considered as an empirical heuristics which uses as *explanantes* not only economic forces (e.g., Schumpeter, 1939; Nelson & Winter, 1982), and legislation and

regulation by (regional or national) governments (e.g., Freeman, 1987; Freeman & Perez, 1988), but also the theoretically endogenized dynamics of transformations by science-based inventions and innovations (Noble, 1977; Whitley, 1984). The TH model does not exclude focusing on two of the three dynamics—for example, in studies of university-industry relations (Clarke, 1998; Etzkowitz, 2002) or as in the “variety of capitalism” tradition (Hall & Soskice, 2001)—but the third dynamics should at least be declared as another source of variation.

TH models can be elaborated in various directions. Firstly, the networks of university-industry-government relations can be considered as neo-institutional arrangements which can be made the subject of social network analysis. This model can also be used for policy advice about network development, for example in the case of transfer of knowledge and the incubation of new industry. The new and potentially salient role of universities in knowledge-based configurations can then be explored in terms of different sectors, regions, countries, etc. (Godin & Gingras, 2000; Shinn, 2002). Over the past ten years, this neo-institutional model has also been developed into a discourse about “entrepreneurial universities” (Etzkowitz, 2002; Mirowski & Sent, 2007). Regions are then considered as endowed with universities that can be optimized for a third mission, and different from higher education and internationally oriented research.

Secondly, the networks span an architecture in which each relation occupies a position. One can thus obtain a systems perspective on knowledge-based innovation in a hypothesized space; this theoretical construct—the knowledge-based economy—can be informed by systematic data analysis (e.g., Leydesdorff & Fritsch, 2006).

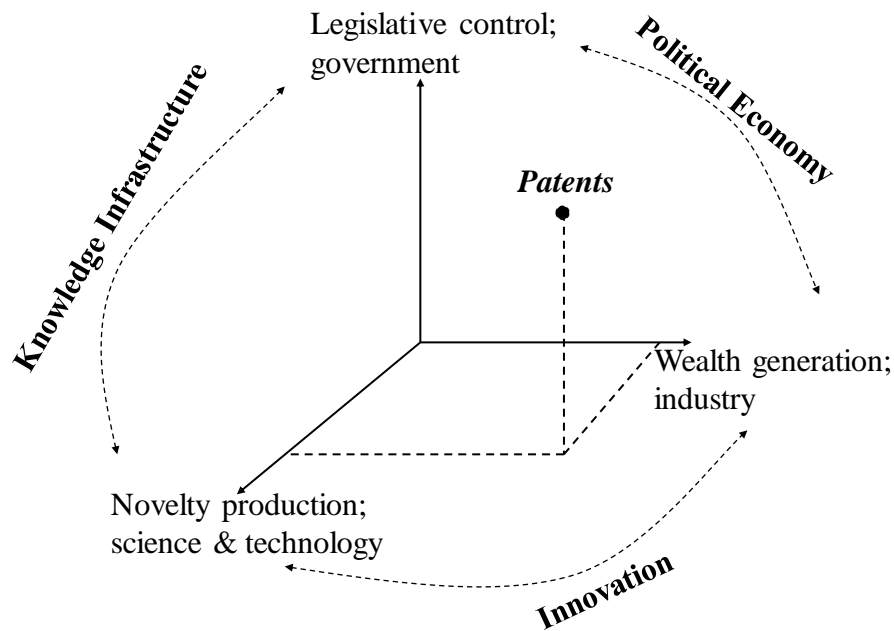


Figure 3: Patents as events in the three-dimensional space of Triple Helix interactions. (Source: Leydesdorff, 2010, at p. 370.)

In Figure 3, patents are considered as positioned in terms of the three social coordination mechanisms of (1) wealth generation on the market by industry, (2) legislative control by government, and (3) novelty production in academia. Whereas patents are output indicators for science and technology, they function as input into the economy. Their main function, however, is to provide legal protection for intellectual property. In other words, events in a knowledge-based economy can be positioned in this three-dimensional space of industry, government, and academia. When events (e.g., patents) can also circulate, a three-way interaction can be expected. This knowledge-based economy contributes to the political economy by ensuring that the social organization of knowledge as R&D is endogenized into the systems dynamics.

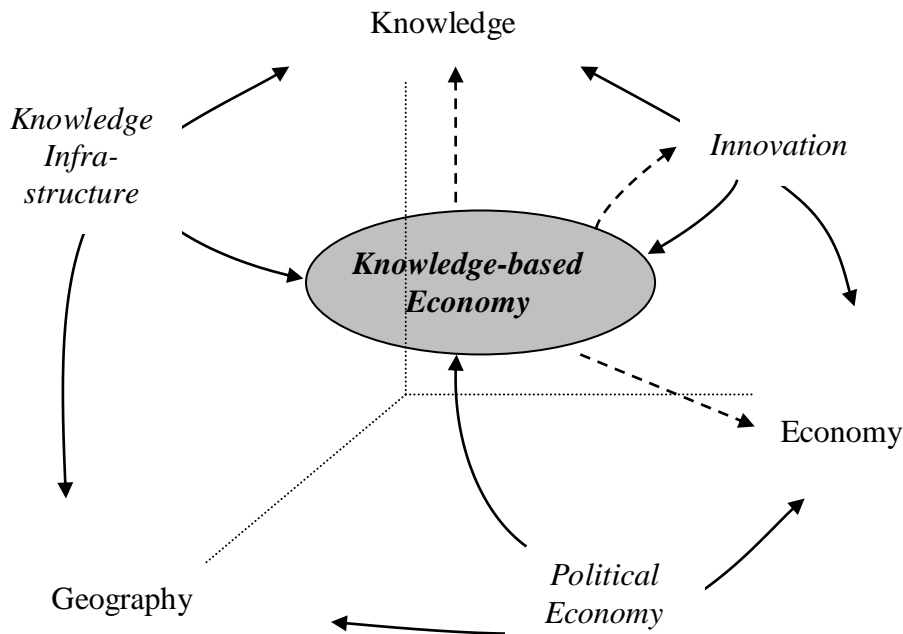


Figure 4: The first-order interactions generate a knowledge-based economy as a next-order system. (Source: Leydesdorff, 2010, at p. 379.)

The three functions in Figure 3 can also be considered as interaction terms among relational exchange processes (e.g., in an economy), political positions in a bordered unit of analysis (e.g., a nation), and the reflexive and transformative dynamics of knowledge. When these interaction terms exhibit second-order interaction, a knowledge-based economy can increasingly be shaped (Foray, 2004; Leydesdorff, 2006).

In my opinion, the crucial research question is under which conditions do the three functions operate synergetically, to what extent or at which level, and at what price? Is a country or region able to retain “wealth from knowledge” and/or “knowledge from wealth” (as in the case of oil revenues)? Such a synergy can be expected to perform a life-cycle. In the initial stage of emergence, “creative destruction” of the relevant parts of the old arrangements is the driving

force. New entrants (scientists, entrepreneurs) can be expected to attach themselves preferentially to the originators—the innovation organizers—of the new developments.

In addition to “creative destruction” as typical for Schumpeter Mark I, Soete & Ter Weel (1999) proposed considering “creative agglomeration” as typical of the competition among corporations. This changes the dynamics of development in the later stage of development, and is sometimes called “Schumpeter Mark II” (Freeman & Soete, 1997; Gay, 2010). In a bibliometric study of the diffusion of the new technology of RNA interference (Fire *et al.*, 1998; Sung & Hopkins, 2006), Leydesdorff & Rafols (2011) found a change of preferential attachments from the inventors in the initial stage to emerging “centers of excellence” at a later stage. In the patent market, however, a quasi-monopolist was found (Leydesdorff & Bornmann, in preparation) located in Colorado, whereas the research centers of excellence were concentrated in major cities such as London, Boston, and Seoul. Drug development requires a time horizon different from that required by the application of the technique in adjacent industries, such as the production of reagents for laboratories (Lundin, 2011).

In other words, the new technologies can move along trajectories in all three relevant directions and with potentially different dynamics. The globalization of the research front requires an uncoupling from the originators and a transition from Mode-1 to Mode-2 research in order to make the technique mutable (Latour, 1987). From this perspective, “Mode-1” and “Mode-2” are no longer considered as general systems characteristics of society and policy making, but as stages in the life-cycles of technological transformations. An analogon of Schumpeter Mark I

and Mark II within the domain of organized knowledge production and control can thus be specified.

Universities are poorly equipped for patenting (Leydesdorff & Meyer, 2010). Some of the original patents may profitably be held by academia. In the case of RNA interference, for example, two original US-patents (“Tuschl-I” and “Tuschl-II”) were co-patented by MIT and the Max Planck Society in Germany (MIT Technology Licensing Office, 2006), but a company was founded as a spin-off to further develop the technology. As noted, the competition thereafter shifted along a commercial trajectory. In summary, whereas one can expect synergies to be constructed, the consequent system “self-organizes” in terms of relevant selection environments, while leaving behind institutional footprints. Three dimensions are important: the economic, political, and socio-cognitive potentials for change. Both local integrations and global pressures for differentiation can continuously be expected.

Research strategies

What is the contribution of these models in terms of providing heuristics to empirical research? First, the neo-institutional model of arrangements among different stakeholders can be used in case study analysis. Case studies can be enriched by addressing the relevance of the *three* major dimensions of the model on an equal footing *ex ante*. Research can then inform us about specifics, such as path-dependencies (e.g., Etzkowitz *et al.*, 2000; Viale & Campodall’Orto, 2002). Thus, the Triple Helix perspective does not disclaim the legitimacy of studying, for example, bi-lateral academic-industry relations or government-university policies. However, one can expect more interesting results by studying the interactions among the three subdynamics.

Secondly, the model can be informed by the increasing understanding of complex dynamics and simulation studies from evolutionary economics (e.g., Malerba *et al.*, 1999; Windrum, 1999). Thirdly, the Triple Helix model adds to the meta-biological models of evolutionary economics the sociological notion of meaning being exchanged among the institutional agents (Leydesdorff, 2011; Luhmann, 1995). Finally, on the normative side of developing options for innovation policies, the Triple Helix model provides us with an incentive to search for *mismatches* between the institutional dimensions in the arrangements and the social functions performed by these arrangements.

The frictions between the two layers (knowledge-based expectations and institutional interests), and among the three domains (economy, science, and policy) provide a wealth of opportunities for puzzle solving and innovation. The evolutionary regimes are expected to remain in transition as they are shaped along historical trajectories. A knowledge-based regime continuously upsets the political economy and the market equilibria as different subdynamics. Conflicts of interest can be deconstructed and reconstructed, first analytically and then perhaps also in practices in the search for solutions to problems of economic productivity, wealth retention, and knowledge growth.

The rich semantics of partially conflicting models reinforces a focus on solving puzzles among differently codified communications reflexively. The lock-ins and bifurcations are systemic, that is, largely beyond control; further developments are based on the variation and the self-organizing dynamics of interactions among the three selection environments. These subdynamics

can also be considered as different sources of variance which disturb and select from one another. Resonances among selections shape trajectories in co-evolutions, and the latter may recursively—that is, selectively—drive the system into new regimes. This neo-evolutionary framework assumes that the processes of both integration and differentiation in university-industry-government relations remain under reconstruction.

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