Catching-up and the Role of University-Industry Collaboration in Emerging Economies: Case of Turkey

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Abstract

In the last century, universities have played a significant role in stimulating technological change and innovation. The recent decades have witnessed a change in the mission of the universities, namely their social mission in disseminating knowledge and interacting more broadly with the surrounding society, in addition to conduct education and research. This dissemination and interaction is *often* realized in the form of successful university-industry collaborations (UICs) in the developing countries. Nevertheless, this sort of realization still lacks comprehensive view. Besides, such comprehensive view is also required to address gaps and types of barriers to economic development and some possible mechanisms which could lead to catching up on the basis of UICs. Academic studies deviate such possibility of catching up is due to the balance between barriers and resource usage among institutional actors. In order to address this gap, first, we implemented a review on literature on UICs. The review provided an overarching process framework, which are distilled from the analysis. However, as current research on this issue points to, different types of university-industry interaction with government intervention and with a strong emphasis on education programs that may have high pay-offs for developing countries. In this context, we administered the concept of UICs in the case of Turkey as a developing country by which we provide a substantial contribution by creating an integrated analysis of literature and further mitigations for research topics distilled from our analysis.

Keywords

University – Industry Collaboration (UICs), Catch-up, Institutions, Government Intervention, Emerging economies, Turkey, Triple Helix.

I. Introduction

Universities play a central role in the context of the development of knowledge and technology base of societies. On the other hand, creation, distribution and transfer of knowledge and technology is a different and complicated task and needs demanding technology management practices. Since knowledge is distributed within each entity (actor), within each organization and within the economic and social system, it is expected to grow provided that it must also sufficiently be coordinated through increasing interdependencies and welfare economies (Loasby, 1999)

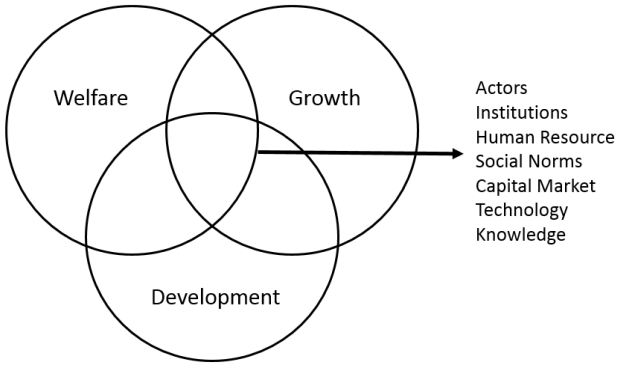
In this paper, we tried to establish an academic literature to set up a basic understanding of transformation of university – industry relationships as reflected in different academic research papers, with regard to certain types and theories of University-Industry Collaborations (UICs). Hence, we analysed the transformation effects for the economic development and catch-up caused by changing collaboration scheme especially for the emerging economies and utilizes the case of Turkey in order to present some realized determinants. Furthermore, we expect our study to contribute to the literature on the economics of university – industry relations by highlighting different forms and objectives of university–industry interaction in emergent countries.

The academic literature on welfare in evolutionary economics mainly focuses on fostering education and innovation as a central means of welfare and growth. In this perspective, it is considered that the transformation and development of societies is *strongly* depended upon the technological development or the emergence of

technological routines. However, one may argue that this strong emphasis on innovation and technology only represents a fragment of an evolutionary welfare economics. Nevertheless, some additional arguments and theories related to other dimensions of economic welfare might highlight the importance of the need for a proper analysis of knowledge creation in societies. In this context, it can also be argued that suggesting a concise concept of evolutionary welfare is a necessary condition for the development of an evolutionary welfare framework.

Supposedly, the evolutionary welfare framework, presented in Figure 1, points out that growth and development has a bidirectional causality and thus, a concurrent feedback. Moreover, current approaches suffer from a vague or limited applied research to determine the *real* strength of welfare economies. Of course, we are challenging a neoclassical welfare or purely Keynesian welfare; but the locus of our research is *implicitly* founded on the theory of evolutionary welfare including gradual improvements of *all* capital infrastructures including actors, institutions, human capital and relational capital through collaboration networks in the context of economics of technology. From this perspective; as one of the most important per-capita for welfare economics; we propose that the university-industry (U-I) interactions (linkages, collaboration, etc.) should further be analysed through the *synopsis* of technological development. In addition, we further propose that the specific analysis for U-I interactions should be accomplished for emerging economies that encounter infrastructural problems or problems at various levels of innovation systems (national, regional, sectoral, technological); but having *relative* advantages in terms of relational capital and technology transfer as well.

Figure 1: The evolutionary welfare framework



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Furthermore, according to *technology policy-oriented* evolutionary studies, it is widely recognised that the interface between U-I interactions are founded on the basis of technology and knowledge transfer. Universities, by any means, are essential players in the process of innovation, technology and knowledge transfer; and the last decades have *clearly* shown us that the emergence of structured mechanisms for knowledge and technology transfer from universities inventions into industry, products and services are also critical in sense of welfare economics. Perkmann and Walsh (2007) clarifies this status by explaining that technology transfer complies with the use of knowledge codified within research papers, patents or prototypes, undoubtedly occurs in some circumstances, the concepts of open, networked and interactive innovation point to the role of collaboration and other types of relationships underpinning and enabling such transfer

Nevertheless, scholars recently have interested in technology and knowledge (but also in policy making) transfer from different points of view involved with the determinants, characteristics and barriers of university - industry (U-I) knowledge transfer activities. Hence, firms' innovative activities are examined in order to distinguish between the impact of knowledge transfer and the impact on overall firms' economic performance. In this sense, most of the analysis that exploit direct measures of knowledge interactions, such as U–I R&D cooperation, or the use of university as an external knowledge source, find positive effects on firms' innovative activities (see e.g. Bozeman 2000; Arvanitis et al., 2008; Becker, 2003; Fritsch and Franke, 2004; Lööf and Broström, 2008).

As an outcome of the above described studies, from the perspective of "university", they are termed to be essential elements for any innovation system. Accordingly, universities are considered as *leverages* for the economic development in the case of search accomplished for emerging countries. This fact is proven many times by the theoretical and empirical framework of the triple helix and, more recently, quadruple helix approaches, where the focus is on how the interplay between university, industry and government and civic society can

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stimulate knowledge-intensive economic development (Etzkowitz and Leydersdorff, 1995; Carayannis and Campbell, 2009; Carayannis and Campbell, 2010).

In this perspective, as one of the important missions of universities, i.e. the *social* mission, signifies that they should engage in external partnerships related to community needs and support economic development. Today, universities are also coupled with new challenges determined by the emergence of the learning economy. Current academic literature identifies certain changes in the context of universities that derives new dynamics in the economic sphere. More specifically, the combination of growing complexity of the knowledge base, as well as the accelerated renewal and obsolescence of knowledge, entails that positioning of the firms and universities in business networks has become a vital factor for their relative success (Hakanson, 1995). Complementarily, the creation of these business networks and alliances are often realized with entrepreneurial universities and triggered successful U-I interactions.

In the next section, the prominent studies and approaches aiming to understand and systematize the university – industry interaction in retrospect; and how these interaction changes are connected to the economic and societal changes are discussed. In the third section, the University-Industry collaboration in emerging economies with respect to the change in the knowledge and technology production is examined. The chapter is followed by a forth section which includes the analysis of organizational forms of UICs in Turkey by further discussing the role of UICs in the catch-up process. Last two sections explore preliminary outcomes and include some related policy recommendations with risk mitigation how UICs have been structured under the influence of all these discussions / controversies.

II. University-Industry Interaction in Retrospect: An Evolving Domain?

Etzkowitz (2002) delineated that the first examples of university-industry interactions are observed in 17th century in German pharmacology sector. These examples are classified as the seeds of academic entrepreneurship. However, the early instances for the intermediary role of researchers between university and industry and consultancy services are witnessed in Harvard and MIT by the end of 19th century. It is only within the 20th century, U-I relations analysis is extended with changing relations between science and industry as related with how knowledge is produced and how social linkages effect the relationship between science and the university (Martin 2003).

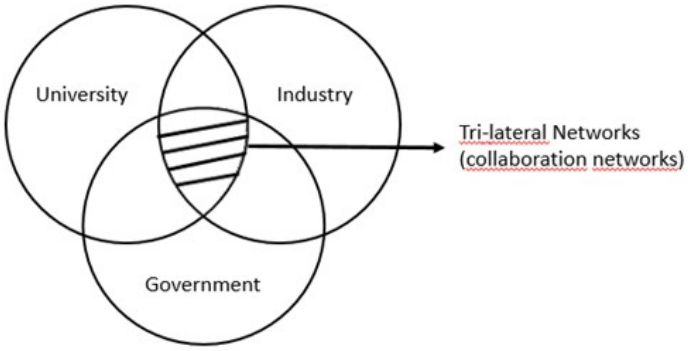
Extended transformation of U-I relations is depicted in the end of 20th century with one of the most common approaches namely as “Triple Helix” (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2008). This approach is based on the assumption that three exists three intrinsic poles in economic terms: university, industry and government. It is evident that, in the 20th century, all these poles have *abruptly* connected with each other.

Etzkowitz (2008) clearly states that Triple Helix model must be considered as an arrangement for capitalizing knowledge in order to pursue innovation to create an economic value added either in direct or indirect ways to the economy. Therefore, it is also notable that the knowledge generated in Triple Helix has an institutional character to emerge catch up at different scales.

One of the important scales is that the Triple Helix model succeeds catch-up by creating new forms of organizations. Academia, industry and government play the intrinsic role of organizational and economic development. Finally, this new means of economic growth has of course an important role to recognize catch-up for emerging economies. In principle, the Triple-Helix model has three main configurations (Ranga & Etzkowitz, 2013) (see Figure 2):

1. Governments pave way to develop new collaboration (university – industry collaboration – UIC) scheme by defining objectives and putting limitations for the interaction between university and industry,
2. Industry becomes the driving force for the collaboration environment where both university and government have limited roles (university acts as provider of academic talents, where government role is to regulate the social and economic mechanisms),
3. All three actors act as partners aiming for the transition of knowledge to society.

Figure 2: Triple Helix Model



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Moreover, in a heuristic sense, changes in the system of U-I interaction effects the course of knowledge production systematically at all three spheres within their conjunction in the trilateral networks to innovate (see Figure 2) (Hessel and Van Lente, 2008).

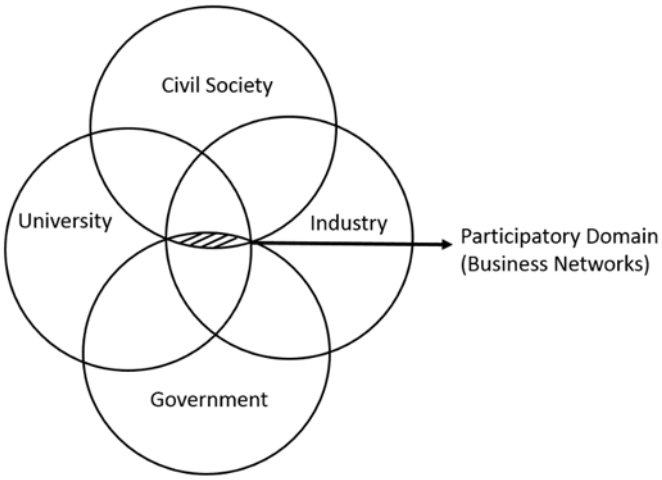
The *old* model of UIC (industry and university alone) was influenced with the linear model of innovation, which describes how ideas move sequentially from research to production through process development, and ultimately diffused into the market (Malecki, 1991). This new reconfiguration of university-industry-government networks are strengthened also with the emerging concept of open innovation in the beginning of the 21st century (Powell et al., 1996; Chesbrough, 2003). In the context of open innovation from the UIC perspective, one should notice that the network linkages with high relational involvement facilitate new inter organizational relationships as the "locus of innovation" (Powell et al., 1996). This concept furthermore clarifies the importance of a new trend in which mainly start-up companies tend to utilize the knowledge produced outside the company; and value the importance of universities in the dissemination of knowledge in the society. In a sense, we might also comment that start-up companies represent the transfer of applied knowledge and technology created in a university into industry for further development and commercialization having risks inadequate financing, etc.

On the following, engaging a wide range of actors has long been fundamental to economic development, the significance of and the need for a new approach has emerged: Quadruple Helix model by proposing to add a fourth group (civil society as innovation users) to a classical Triple Helix model. This model is potentially "open" to support economic development (since these different actors have skills and knowledge); furthermore, this model develops open innovation's dialect with a new development approach in that of innovations are pertinent for users who drive the innovation processes. In line with this perspective, new innovative products, services and solutions are developed with the involvement of users in their role as lead users, co-developers and co-creators (see Figure 3).

Moreover, we should also denote that the interaction between industry and university *mostly* happens to take place within a national Research and Development (R&D) system. The cooperation and collaboration between parties takes place within the tri-lateral networks for the process of technical change in developing countries, as in the case of Triple Helix model. Nevertheless, it is *inseparably* important to define formal structure of national R&D regime in which university and industry functions through the overall R&D system. Hence, different objectives, emphases and regimes in the many countries creates the set of economic gaps.

Closing the gap or *catch-up* terminology relate to the ability of a single country to narrow the gap in economic aspects (productivity and income) and technology (as an intermediary) with a leader country in order to reduce the overall differences as a whole. The issue of catch-up has been crucial for the academic research as growth proceeds such convergence on the long run (Solow, 1974). Of course, it is highly metaphorical that all developing countries tend to converge and succeed in catching-up while others fall behind (Abramovitz, 1986).

Figure 3: Quadruple Helix Model



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Any examination of failure of catch-up between university-industry interactions reveals different approaches. Nevertheless, we claim that the underlying reasoning is the potential failure of the "iteration" process, or "feedback" loops, which characterize the continuing progress of science and technology. As Beckers (1984) depicts in his study, the iterative process involving universities and industry should be complementary to each other in which society progresses ideas, knowledge and applications together.

Above described *iterative* interactions between U-I; addressed from different sets of viewpoints in the academic research papers; partially, explains the closing gaps (*catch-up of*) between the developed and developing countries. Besides, in this article, we tend to analyse different characteristics for each agent in the triple helix model in order to determine the degree of U-I cooperation as well as the societal and economic nature of the developing country. Nevertheless, our approach is different and difficult in the sense of defining objectives and indifferences in economic development that *eventually* create some intrinsic results as the failure of catch up within the many developing countries.

In this article, we are basically trying to reflect the basis of university-industry interactions; as the traditional role and strengths that each partner brings to the relationship in order achieve certain economic achievements and developments. Moreover, in our opinion, this intrinsic status implies the importance of each UIC partner to sustain its fundamental technical capacities so that projects conducted in parallel are to be successful contributions to the science and technology reservoir of that developing country.

Hence, on the essence of U-I interaction, one may say, it is the *desire* to advance simultaneously the universities' role in educating new graduates and to advance new technical and societal achievements. These mechanisms pave way for many other economic functions that can produce the optimum benefits from cooperation schemes. Here, *strategic* importance of this approach may be referred as a *must* if a country or an industry, especially high technology industry, wants to sustain its leading position.

Complementarily, the "Quadruple Helix" model better explains U-I interactions by the development of a society with new technology-based firms (start-up companies) that eventually benefit from proximity to the university. Benefiting from organizational and technologies proximities, we may summarize the fact that firms are eventually created by either academics or (former) students or by companies that moved in from other areas, including international enterprises. Start-ups' emergence in technological districts have also provided a technological development environment, as common to the early stages of 21st century.

In this article, we are discussing some issues whether the successful U-I relations would be sufficient to stay at the leading edge of science and technology hence to lead way to catch-up. To be precise, our predictive empirical

research on UIC policies gives us the incentive that universities (beyond the old traditions) create value to society (value creation for economic and societal development) and universities are essential *pioneers* to cooperate with industry if governed successfully.

III. A Snapshot on University-Industry Interaction in Emerging Economies

Today, we are witnessing an expanding number of technologies, products and services, all combined together in various kinds of institutional networks formed by U-I interactions. Concurrently, we need a robust understanding for economic growth for new applications, products and services. In addition, among developed and emerging economies, a usable framework that captures the essence of economic growth theory is needed. Hence, in this complex and competitive regime of economic analysis, the role of U-I interaction with regard of economic growth and innovation makes *sense*.

Often, economic growth is associated with innovation through new technology or new products. But, in reality, a significant amount of innovation research is also about new ways of producing knowledge and transfer of knowledge. For innovative economies, collaboration between U-I is expanded through norms that lead to the transfer and creation of knowledge among different business networks involving companies and universities. These networks are natural *leverages* for research and development (R&D) that leads to matching of knowledge and technology with new applications by facilitating the creation of new business and market opportunities.

Hence, through the universities and businesses, in order to continue to create new knowledge and business opportunities, newly industrialized countries (NICs) (for instance namely Brazil and Turkey) are increasingly focusing on fostering science–industry interactions and developing high-technology sectors (Gouvea and Kassicieh, 2005). Policy-makers in both developed economies and newly NICs have been focusing on designing policies aimed at building up the *innovative capacities* via different research and training programmes.

In an aim to develop relevant capacities within a suitable innovation environment, the challenge for governments is *how* to sustain a *suitable* innovation environment that supports and facilitates new ideas, knowledge flow and entrepreneurial spirit within tri-lateral networks of innovation. Wong et al., 2007 denotes that making a suitable network for more entrepreneurial environment; and to support the growth of high-technology activities; it is important to develop certain indigenous technological capabilities of NICs in a more dynamic economic network.

In accordance with above prepositions, it is possible to claim that, through the universities, indigenous technological capabilities are transformed to produce value-added output surprisingly with an increasingly innovative pace. In this regard, for knowledge-based or learning economies (NICs), such innovative pace is achieved through collaborative interactions among different actors within the innovation systems to produce, accumulate and diffuse knowledge for promoting competitiveness through technological changes and innovations (Archibugi and Lundvall, 2001).

In certain academic literature, universities have been considered the essential source for knowledge utilization for sustainable competitiveness (Huggins et al., 2012; Etzkowitz, 2002). Nevertheless, through time, the role of universities in developing new knowledge and shaping societies through innovation has become more evident. Moreover, business networks and innovation capacity among university and industry have become more important through “entrepreneurial universities” (Powers, 2004 and Etzkowitz and Leydersdorff, 2000) and “academic entrepreneurs” (Shane, 2004 and Meyer, 2003) that are highly *effective* in the establishment of start-up firms.

In this perspective, similar to findings presented in Perkmann and Walsh (2007), academic research also indicates that partnerships between firms and universities are one of the most intermediary for developing new innovative and technological capacities through new start-ups. As technological innovation is *literally* being transformed, the creation, dissemination, and utilization of knowledge moves from the periphery to the centre of industrial production and university – industry interactions (Etzkowitz, 2012). Furthermore, the concept of *innovation systems* comprises some other institutional arrangements between university and industry that enable the utilization of knowledge in NICs as they tend to be a more research-based country (see Huggins et al., 2012 and Etzkowitz, 2008).

In this perspective of research - based innovative economies, larger firms tend to focus on building non-core competences, whereas start-ups and smaller firms focus on developing core areas (Santoro and Chakrabarti, 2002). It is also argued that the most successful knowledge is transferred through universities through business networks (Lockett et.al., 2009). Universities in these business networks are also considered to be the key actors in the process of industrial technological development and catch-up in specific industrial sectors (Mazzoleni, 2008). Universities can also support the collaborative networks to develop new technological capabilities. They can also sustain *catch-up*, through the provision of training for scientist and engineers, support for personnel exchanges involving international researchers, experts and students, access to collaborative research networks (national or international) and new technologies, and advanced knowledge and skills in relevant science and engineering fields (Pavitt, 1998; Robertson and Patel,2007).

Aforementioned collaborative support through networks also involves external interactions among customers, suppliers, regulators and knowledge providers (Edquist, 1997; Freeman and Louta, 2001). Among the different forms of collaborations, networks and alliances, this study also concentrates on U-I interaction on the basis how these interactions facilitate catch-up between developed and NICs and how companies relate to this scheme.

In this sense, for developed countries, there exist a huge number of case studies exploring the role of the universities in stimulating economic development. For instance, Cohen et al.'s (2002) inclines that university research results play little if any role in triggering new industrial R&D projects.

Such a context is also associated with major contributions to academic research at national levels. In the case of developing countries, Hersberg et al. (2007) denote the few business start-ups associated with a university, yet missing any significant linkages of local businesses to universities. In Japan, for instance, localized spillovers and university-associated clusters are infrequent, although the informal and occasionally formal collaboration among the leading universities and the major corporations that spearhead Japan's technological advances is widespread. Continuously, in their study, authors summarized the fact that they realized few instances of university–industry linkages (UILs); however, when we focus on the studies accomplished for United States, in most of the studies, it is exemplified in Hersberg et al. (2007) that universities encourage companies to establish new business connections. (see Aniello, 2004; Cosh, Lester, & Hughes, 2006; Proudfoot, 2004; Saperstein & Rouach, 2002 for more).

Complementarily, the benefits of university-industry collaboration are also evident in the studies accomplished for developing countries. For instance, for emerging economies (for NICs), Brimble and Doner's (2007) study indicates a very low level of innovation linked up with universities in Thailand. Hershberg et al., 2007 denotes also that the faculties relatively do not conduct *enough* applied research at most of the universities in emerging economies. For example, in their research, they have underlined the fact that, in Korea and Singapore, the leading universities have only recently begun paying attention to research and its commercialization mostly limited to consulting and small-scale contract research. In a different study, Meredith and Burkle (2008) identified a positive attitude among industry and university informants on the joint benefit of building bridges between universities and industry in Mexico. In addition, Marotta et al. (2007), in their study accomplished for Chile and Colombia, show that collaboration with universities substantially increased the propensity of firms to introduce new products and to patent.

Subsequently, from a developing country context, a study by Egbetokun and Savin (2015) also provides a positive insight for the relationship development between interactive learning and the development of innovative capacities in Nigeria. In a more recent study, Huang and Chen (2016) depict that universities in Taiwan facilitate more interaction in business networks with industry thereby contributing to the creation of more partnerships and improved academic innovation. Moreover, in their study, the same findings show us that government funding facilitating new collaboration may have significant impact on the implementation of *correct* regulations and the support for *innovative climate* in universities.

In order to create an innovative environment and scheme in universities, we might discuss the effects of two kinds of challenges: The first one arises from barriers to networking that often accompany the codification of knowledge as imposed by the knowledge sources in universities. The second challenge is posed by the limitations on the use of unrestricted (codified) knowledge by mostly innovative (start-ups or spin-off) firms. From a

developing country's standpoint, the creation or strengthening of university and industry linkages might be structured with technology transfer.

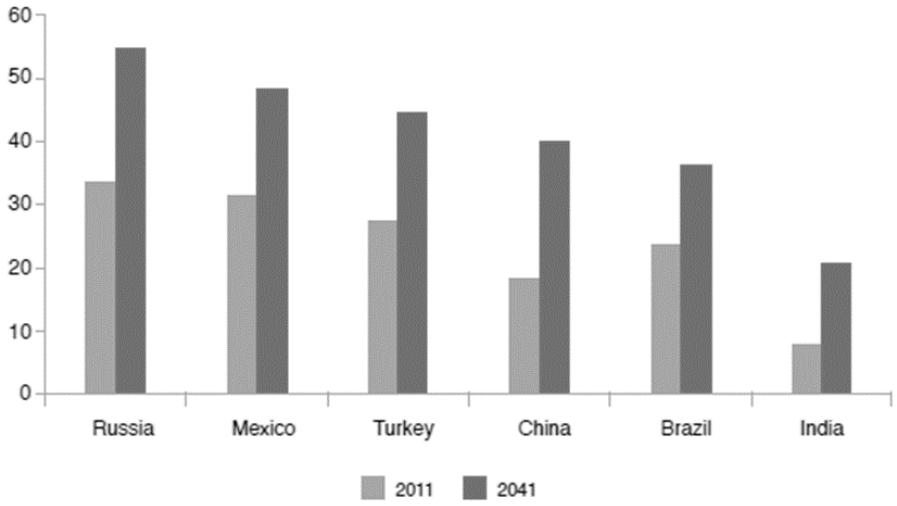
From this perspective, the capabilities to transfer knowledge depend on the intended uses of the knowledge to be acquired (see Castro and Neira, 2005 and Connely et al., 2012). These may range widely, from country to country according to the relative governance settings. We must also denote that there are also sectoral differences effecting the scheme how codified knowledge is transferred (or transformed) or how complex to define a suitable economic model to analyse the differences between university and industry.

The divergent economic performance of developing countries as related UICs may also be characterized by convergence in productivity and income and GDP per capita compared to the industrialized economies (as the most striking evidence on the great variation of performance between countries). However, the efforts for catching-up cann*ot* be solely explained by higher growth in GDP per capita. For instance, according to a recent financial report by PWC (2016), Turkey, *as an emerging economy*, is expected to perform a lower GDP growth as compared to Brazil (with a *fragile* economy). In this report, Turkey is ranked 16th in the world as GDP per PPP in 2011 and expected to be ranked 12th in year 2041 (see Table 1 and Figure 4). On the contrary, Brazil sustains its relative economic and geographic advantages by sustaining a bigger GDP growth as ranked 7th to 4th in 2041. Nevertheless, current academic evidence on economic growth (see IMF World Economic Outlook 2015) and innovativeness index (see The Global Innovation Index 2016 in Cornell University, INSEAD, and WIPO 2016) show us that Turkish rankings are preferably *stable* (ranked 42nd in 2016; was 58th in 2015). But, it can be argued that Turkey is showing relatively *low performance* when compared to other developing countries having higher income like Brazil (ranked 70th in 2016; was 69th in 2015; and Chile (ranked 44th in 2016; was 42nd in 2015). Further argument might be extended in such a manner that economic gap analysis restricted with average GDP growth and catching-up require *more* (analysis and policy development) than average growth in GDP with respect to the target levels of innovativeness growth.

Rank	Country (FY2011)	Rank	Country (FY2041)
1	US	1	China
2	China	2	US
3	India	3	India
4	Japan	4	***Brazil***
5	Germany	5	Japan
6	Russia	6	Russia
7	***Brazil***	7	Mexico
8	UK	8	Indonesia
9	France	9	Germany
10	Italy	10	UK
11	Mexico	11	France
12	Korea	12	***Turkey***
13	Spain	13	Nigeria
14	Canada	14	Korea
15	Indonesia	15	Italy
16	***Turkey***	16	Canada
17	Australia	17	Vietnam
18	Argentina	18	Saudi Arabia
19	Saudi Arabia	19	Spain
20	South Africa	20	Argentina

Table 1 - Top 20 countries by GDP on a PPP basis (constant 2009 US$bn)
Source: PwC Analysis Report 2016 (based on International Monetary Fund World Economic Outlook April 2012)

Figure 4: GDP per capita in PPP terms in 2011 and 2041 (constant 2009 US$ % of US GDP per capita)



Source: PWC Analysis Report 2016 (constructed with IMF WEO)

To analyse patterns of convergence and divergence related with the U-I interactions, it is also necessary to assess organizational changes and economic development that influenced the accumulation of technological and social capabilities in catching-up countries. The role of U-I interactions in catching-up at the country level experiences relatively shows us that the diversity of growth processes among developing countries reflects differences in institutional patterns in which social and technological capabilities have been accumulated through U-I interactions (see UNIDO 2005).

In order to assess the role of universities in catching-up models (one important model is the formation of entrepreneurial and technological capabilities in emerging industries), we might focus on the components of knowledge transfer mechanisms through universities. Different forms of knowledge transfer mechanism can also be experienced through technical and vocational training, academic and technical research, laboratories, technology transfer offices, technology development zones, associations, and technical regulatory bodies and institutions that support the interactions between training and research activities in the quadruple helix domain (social factors assessed literally).

The institutional change in the basis of quadruple helix domain in industrialized countries such as Germany, US and Japan in the 21st century (as well as in China, Taiwan and Korea) relates to the role of collective competence-building in economic catch-up. For all these cases, described above, significant institutional adaptation and innovation noted in macroeconomic studies to take place in response to resulting diversity in contemporary national or industrial policies (OECD 2007). Hence, we might also comment that the success of the respective achievements often relied on achieving a balance between U-I relations based on the rapid accumulation of knowledge; and enhancing the demand from industry for technological skills and capabilities.

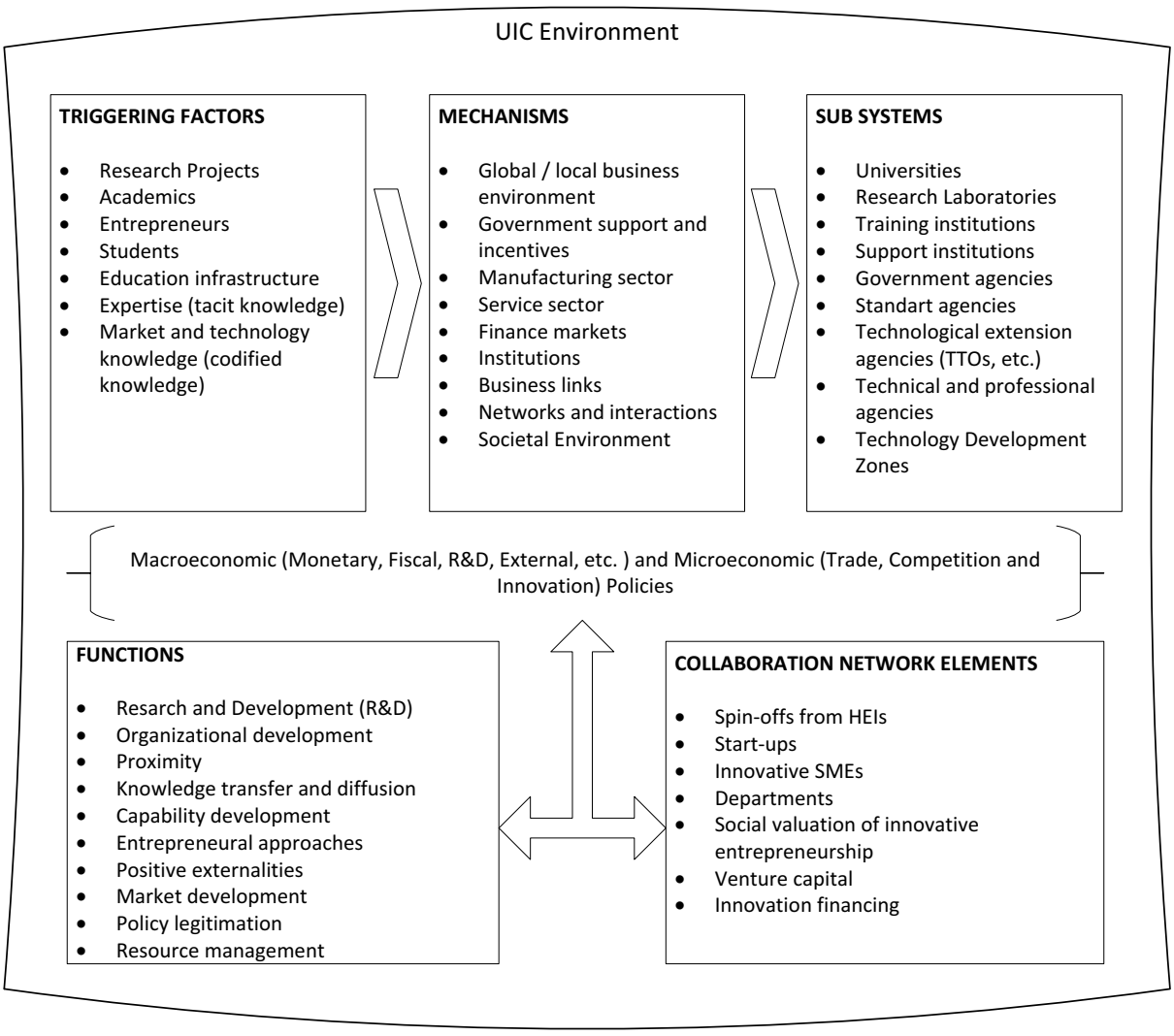
Remaining questions about spillovers and accumulation of knowledge, new skills development as related to relationships between UICs, technological progress, and catch-up needs further applied research. Accordingly, related bodies of literature assume that firms that are located near universities may frequently collaborate with them and benefit from knowledge spillovers (see Bonaccorsi et al., 2013). Nevertheless, the preliminary findings in this article also targets the need for further *econometric* analysis on the relationship between knowledge transfer and economic development with regard to UICs.

Within the strand of literature related to the effect of UICs over economic development, Maietta (2015) summarizes the findings that proximity to a university may positively be associated with innovation as well. Accordingly, in Boardman (2009) and Thuneand and Gulbrandsen (2011), it is denoted that normal UIC management mechanisms are also beneficial for collaborative relationships in order to facilitate the improving

the interaction between universities and industry. Nevertheless, we must underline the fact that *few* academic studies quantify the *real* management and policy perspective.

In this context, we claim that implementing formal UIC management and policy mechanisms within universities can facilitate UIC development. Supportively, Youtie et al. (2006) and Corley et al. (2006) summarized collaborative relationships between university and industry require more formal, standardized, and structured manner. In addition, in need of a formal framework for defining a *suitable* UIC environment, we claim to define a relative policy measure that will eventually develop interorganizational relationships. Therefore, in this study, we propose a framework model for the development of UIC environment to determine formal UIC management mechanisms (see Figure 5)

Figure 5 – UIC Environment



Source: Own construction

Above described UIC environment might help business actors as well as universities to influence the diffusion and transfer of knowledge. Supportively, from the management perspective, a *good* public policy may influence collaborative scheme with universities and the scope of collaborations in many different ways. For instance, an *efficient* public policy may lead institutional actors to sustain the necessary infrastructure through intermediate organizations such as technology transfer offices, science parks (technology development zones), and business incubators (Innovation Policy Platform Report, 2013).

Furthermore, we also claim that governments can stimulate collaboration through other measures, such as providing specific support services to firms / universities in the search for partners and conducting outreach activities to promote networking and raise awareness of the importance of collaboration. Given these challenges, in the case of developing countries, (with regard to limited budgets, and multiple competing priorities), governments might concentrate efforts on the most appropriate policy instruments. The following sections review also some policy options to promote U-I interactions and UICs specifically related to the case of developing countries.

Our preliminary research targets in this article further indicate that the less-developed economies contain a potential of rapid economic growth (see Table 1 and Figure 4) Hence, further applied research might also focus on GDP growth rates that might be *oppositely* correlated to innovativeness levels. To implement this hypothesis, we claim that the determinants for productivity levels has to be regressed with the country's technology production level of capital stocks. As cited in Abramovitz (1986) supporting the constitution of quadruple helix model, as technology of the leader country is always before the other follower countries' time, one of the most important determinants for catching up is termed to be "social capability". In this regard, our basic hypothesis in terms of catch-up and convergence are to be tested to understand why European countries' sociocultural heritage and development potential technologies were the ones to catch up with the more developed countries (e.g. USA, Japan), innovativeness.

On the contrary, in emerging countries (for instance, in Turkey), studies regarding to technological development and innovation are sustaining its importance. However, it is *surprising* there are still *few* field studies that search for the roots of technological development and its potential economic effects. There exist some preliminary studies focus on the role of information technology. Some of these studies focus on the role and effect of research and development in technology domains, and some others just analyse the role of innovation systems in various country cases (see Lundvall et al., 1992; Brundenius et al., 2009). However, in this study, we explicitly tried to determine the factors that are behind of the development process and to list different kinds of driving forces from the U-I relations point of view. Accordingly, the following chapter about Turkey, as an emerging economy, aims to contribute to the literature by providing a better understanding of technology policies, which are applied in order to facilitate the catch-up process with the leading countries in the world.

IV. University-Industry Interaction in Turkey: An Unresolved puzzle

Collaboration between universities and industries is critical for innovativeness and economic growth. This collaborative scheme is founded on the theory and application of knowledge generation and transfer (acquisition, and adoption of knowledge and technology) and the promotion of entrepreneurship (start-ups and spin-offs).

In the accordance with previous sections, we tried to clarify the issue that university-industry linkages are helpful mechanisms to coordinate R&D studies; and to stimulate public and private R&D investment; and to exploit new scientific and technological capabilities. Hence, in order to classify and clarify UICs, we must institutional arrangements and classifications for UICs. In this respect, Santoro and Gopalakrishnan (2000) suggested four main institutional arrangements and classifications for a successful analysis of UICs:

1. Research support (i.e. Endowment/Trust Fund)
2. Cooperative research (i.e. institutional agreements, group arrangements, institutional facilities, informal Intentions)
3. Knowledge transfer (i.e. hiring of recent graduates, personal interactions, institutional programs, cooperative education)
4. Technology transfer (i.e. product development and commercialization activities through university research centers)

According to the above classification, in addition, Kiper (2010) depicts that successful UIC depends on the structure of formation of a set of interfaces (suitable instruments) to create an environment enabling communication between both parties. In addition, for Turkey, we may list the relative interfaces and intermediaries that the considered to be currently effective for a successful UIC environment as follows:

- Technoparks - Scienceparks (TP)
- Scientific Research Programmes (SRP)
- Start-ups (StrU)
- Spin-offs (SPnO)
- Academic Research Centers (ARCs)
- University Laboratories (UL)
- Technology Transfer Offices (TTOs)
- Ministry of Science, Industry and Technology (MoSIT)
    - TÜBİTAK (Scientific and Technological Research Council of Turkey)
    - KOSGEB (Small and Medium Enterprises Development Organization)
    - Development Agencies (DA)
- University Revolving Capital (URC)
- European Union Framework Programme (FP7, etc.)

Moreover, we might depict that the functioning of UICs; to foster the commercialization of public R&D outcomes; implies various forms of institutional arrangements among aforementioned interfaces and intermediaries. In this sense, UIC may also be categorized to be formal or informal (Hagedoorn et al., 2000) (see Table 2).

Institutional Arrangement of UICs	Type of Arrangament (Formal or Informal)	Supporting Interface and/or Intermediary	Definition / Forms of Arrangement
Research partnerships and cooperative research	Formal or Informal	TP, ARCs, TTOs, URC, SRP	Inter-organizational arrangements for pursuing collaborative R&D, including research consortia and joint projects.
Research support and services	Formal	MOSIT, TÜBİTAK, DA, SRP, UL, TTOs, KOSGEB	Research-related activities commissioned to universities by industrial clients, including contract research, consulting, quality control, testing, certification, and prototype development.
Knowledge Transfer	Formal or Informal	MOSIT, TÜBİTAK, DA, SRP, UL, TTOs, KOSGEB	Access to new knowledge that allow achievement of competitive advantage inc. new capability development
Shared infrastructure	Formal	TP, SRP, ARCs, UL, URC, KOSGEB	Use of university labs and equipment by firms, business incubators, and technology parks located within universities.
Technology Transfer	Formal or Informal	TP, SRP, ARCs, UL, UR, TTOs	Achieving a better intermediary involvement, technology management, combine R&D capabilities and scientific and technical cooperation, technology commercialization
Academic entrepreneurship	Formal or Informal	TP, ARCs, TTOs, SpnO, StrU	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own (spin-off companies).
Human resource training and transfer	Formal or Informal	TTOs, TP, ARCs	Training of industry employees, internship programs, postgraduate training in industry and research staff, adjunct faculty of industry participants.
Commercialization of intellectual property	Formal	TTOs, StrU, SpnO, TÜBİTAK	Transfer of university-generated IP (such as patents) to firms (e.g., via licensing).

Scientific publications	Formal	ARCs	Use of codified scientific knowledge within industry.
Informal interaction	Formal or Informal	ARCs	Formation of social relationships (e.g., conferences, meetings, social networks).

Table 2 - Institutional Forms and Arrangement of UIC in Turkey
Source: Own construction (based on Hagedoorn et al., 2000)

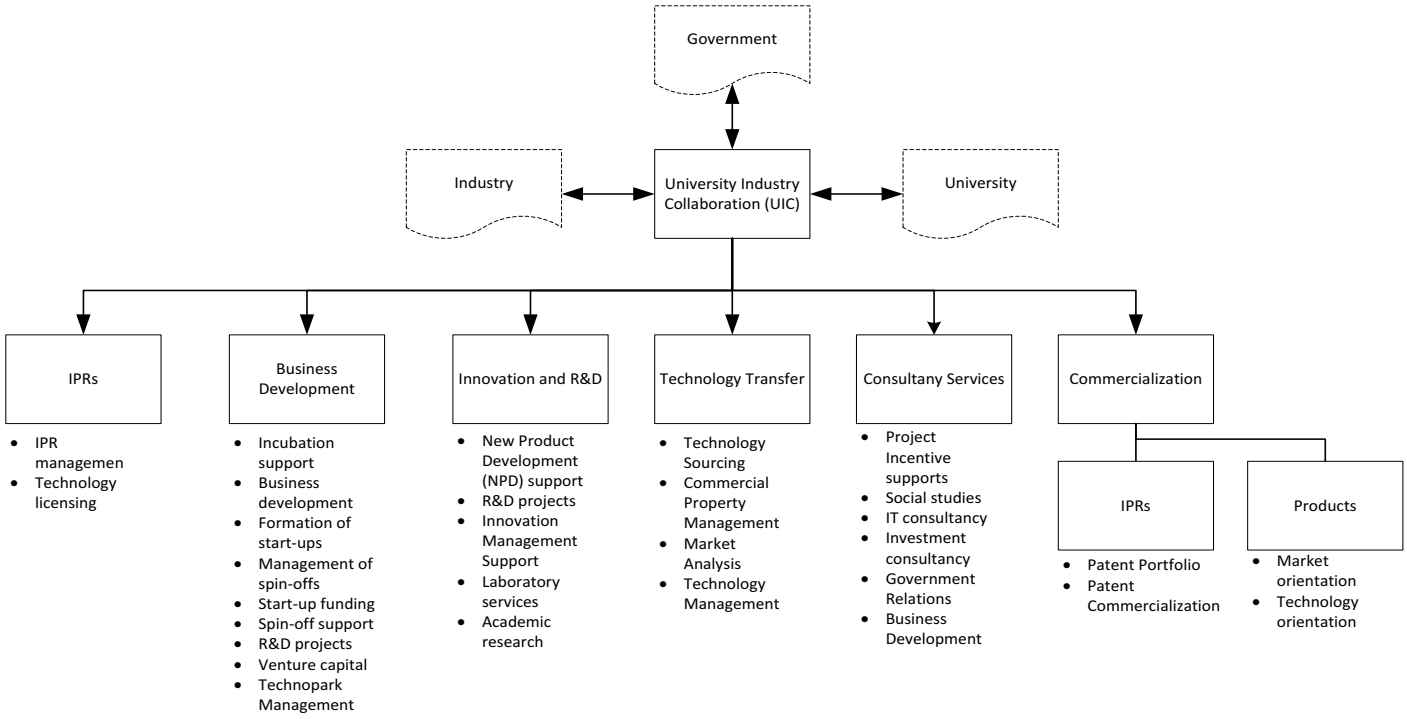
In particular, UIC still plays a major part in economic research in Turkey. The research is rooted by the increasing the stock of knowledge and human capital, triggering technological or methodological spinoffs, and influencing the formation of networks (Salter and Martin 2001; Etzkowitz et al. 2000). Hence, the concept of UIC contains all the systematic works in the field of scientific and technological development by combining the possibilities mainly for innovation, technology transfer, technology management consultancy and commercialization (IP and product) (Yıldırım and Güven, 2008)

In order to characterize UIC structures for Turkey, we draw intention on the work of Ankrah and Al-Tabbaa (2015) which posited 6 (six) different organizational forms as generalizable determinants of inter-organizational relationships: Personal Informal Relationships, Personal Formal Relationships, Third Party, Formal Targeted Agreements, Formal Non-Targeted Agreements, Focused Structures.

Moreover, from a systematic point of view, our evaluations indicate that the motivations for Turkish universities and industry engaged in UICs can easily be exemplified with these above described organizational forms or determinants; which are *originally* defined by Oliver (1990). From this perspective, we might further argue that UICs might strengthen organizational linkages and development. Since the nature of knowledge and its creation process linked with organizational linkages and development are still very complex to exemplify, we further claim that research on social processes involving different levels of modalities of interactions (like tacit knowledge, codified knowledge, financial flows, personal flows and technological flows) is required. In this manner, according to these modalities of interactions described above, we clarified the levels of relationship whether which organizational determinant is correlated with the regarding modalities of interactions. Therefore, we also defined different modalities for each related institutions in order to categorize the support given or knowledge exchange / usage behaviour for a *successful* UIC structure. A brief analysis is presented in Table 3.

Furthermore, academic literature also directed us to analysis of the formation of TTOs; as an important organizational intermediary for sustaining UICs; that have a key position to manage the technology and innovation within UIC. In Turkey, as similar to the findings in Babba et al. (2009), we describe below a basic UIC support scheme formed by university TTOs' the point of view (see Figure 6):

Figure 6 – UIC Approach from a Turkish TTO point of view



Source: Own construction

Determined organizational structure and forms for Turkey (see Table 3), we might argue that the structure and contingencies demonstrated in big cities, like Ankara, İstanbul and İzmir of Turkey, are to be entirely different endowments and *gaps* in terms of Higher Education Institutions (HEIs). Social and cultural differences play an important role in defining this gap between other cities. Nevertheless, we claim to exhibit *cluster-like* features of UICs. For instance, in the case of Ankara, UICs are a critical source of the knowledge and entrepreneurs that have been fuelling up the creation of an IT and defence industry based cluster. Middle East Technical University and Bilkent University in particular have supported this UIC scheme with a remarkable constitution. We should also depict that, today, it is important to create attracting campuses with technoparks in universities; and it is the essential to create a *hive* for growing number of high-technology firms through UICs.

Clearly, the potential of UICs has also pave way to entrepreneurs into *sustainable* existence. In this perspective, the administrative support for researchers in the leading universities *eventually* opens up new opportunities for start-ups or spin-offs. Moreover, many star-up companies, which are increasingly dependent on innovation to sustain competitiveness, take the advantage of new capability development opportunities sustained by the universities, Academic Research Centers (ARCs) and Technoparks (TP) in Turkey. Already, these firms are perceiving additional advantages from a deepening of tri-lateral (triple helix) linkages. Turkish government encourage and subsidizes firms *continuously* ([1]) by offering new incentives to expand the scope and depth of their support. For instance, a *comparably weaker* innovation system is being induced to formalize the links between Turkish university researchers and firms. Besides, Turkish government are also supporting some *elite* universities and research institutions to expand their research and/or to commercialize *aggressively* technologies and products, even as the government works *hard* to increase the demand for R&D through institutional and fiscal incentives.

[1] See http://www.worldstartupwiki.org/page/Turkey-Startup-Ecosystem for more details.

Organizational Forms of UICs	Modalities of Interactions					Supporting Interface and/or	Type of Organizational Forms
	Financial Flows	Technological Flows	Codified Knowledge	Tacit Knowledge	Personal Flows		
Personal Informal Relationships	+	++	+	++	+++	ARCs, UL, TTOs	• Academic spin-offs and Individual consultancy (paid for or free) • Conferences and publications • Personal contact with university academic staff or industrial staff
Personal Formal Relationships	++	++	++	+	++	ARCs, Universities, Industry, Ministry of Education (MoE)	• Scholarships, Fellowships and postgraduate linkages • Exchange programmes (e.g. ERASMUS) • Student internships • Students' involvement in industrial projects • Joint supervision of PhDs and Masters theses • Employment of relevant scientists by industry • Use of university or industrial facility (e.g., lab, database, etc.)
Third Party	+	++	+	+	++	TTOs, TPs, MoSIT, TÜBİTAK, DA	• Technology Transfer Services (in universities or industry) • Government Agencies (including regional technology transfer networks) • Industrial associations (functioning as brokers) • Technopark Consultancy Services • Technology Management Support
Formal Targeted Agreements	++	++	++	+	+	TTOs, TPs, MoSIT, TÜBİTAK, DA, Universities, Industry	• Contract research (including technical services contract) • Patenting and Licensing Agreements (licensing of intellectual property rights) • Cooperative research projects • Joint research programmes • Commercialization Agreements
Formal Non-Targeted Agreements	++	+	++	+	+	TTOs, TPs, MoSIT, TÜBİTAK, DA, Universities, Industry	• Broad agreements for U-I collaborations • Industrially sponsored R&D in university departments • Research grant, gifts, endowment, trusts donations (financial or equipment), general or directed to specific departments or academics
Focused Structures	++	++	+	+	+	TTOs, TPs, MoSIT, TÜBİTAK, DA, Universities, Industry	• Innovation/Incubation Relay Centers (IRCs) • Start-ups, joint verntures, alliances • Research, science and technology parks • University—Industry Consortia • University—Industry research cooperative research centers

Table 3 - Organizational forms of UIC according to different modalities ([2])

Source: Own construction (based on Oliver, 1990)

[2] As presented in the Ankrah and Al-Tabbaa (2015) study, some of the motivation determinants are categorized under the related determinant as considered to be the most appropriate one.

In this respect, there also exists a substantial body of literature about the analysis on the role of several leading universities in Turkey that *eventually* create relative advantage for start-ups and spin-offs (in knowledge-intensive clusters) through techno-parks associated with university research institutions (Hershberg et al. 2007; Lecuyer, 2005; Siegel, Westhead, & Wright, 2003). Complementarily, the universities in Turkey are *mostly* a *major* player but not a direct catalyst compared to other global universities. For instance, ODTU Teknokent (as the first technopark in Turkey), was initiated and substantially propelled by university itself providing significant financial and technical inputs.

For instance, similarly, the emergence of a defence cluster in the Ankara, Turkey, Teknokent Savunma Sanayii Kümelenmesi (TSSK) ([3]), is a good example in order to demonstrate the outgrowth of funding and intermediary support from two different organizations; the Turkish government and Middle East Technical University (METU) Technopark (ODTU Teknokent), separately. In other words, we claim that innovation and technology diffusion, through licensing for example, may only be accomplished properly with the presence of a strong university and government incentives, simultaneously. Of course, for the majority of this case, an empirical study is further needed to be planned in order to prove that business start-ups associated with a university are more successful than the ones in the industrial zones (industrial development zones – IDZs) having significantly weaker linkages to universities.

Finally, as an emerging economy and country, it is important to underline that most of the Turkish universities are encouraged to develop strategic collaborations with other foreign universities and International Research Centers (IRCs) to develop new R&D capacities, particularly those pertaining to new, emerging technologies.

In this regard, we might denote that the Turkish government proposes to achieve the goals of developing new R&D capacities through three main approaches:

- The implementation of more *attached* incentive programs with the industry, which will enable academicians to share their tacit and codified knowledge and ideas and thus raise the quality of their research.
- Strengthening the management of intellectual property developed in universities to improve the governance of research activities.
- Strengthening the function of technoparks and spin-offs at the universities by creating more sustainable ways for business and industrial collaboration in R&D activities
- Formation of new R&D centers and related tax incentives as an essential – inseparable sub-part of industrial actors as a mere policy to sustain competitive advantage.

Moreover, in order to support and accelerate the commercialization of innovations and new technology, Turkish government acts to construct active collaboration between the U-I as this scheme is promoted to generate positive effects on the Turkish economy. Recently, the government has launched a specific development and transformation programme by TÜBİTAK for Turkish universities' TTOs, aiming to subsidize and transform the roles of these offices to be *hubs* for transmitting academic research and Intellectual Property Rights (IPRs) into the industrial actors (entrepreneurs, start-ups, etc.) that will contribute to revenue generation and profitable development by IPR commercialization.

Finally, we argue that as Turkish universities are considered to encounter more cooperative environment into practice that will eventually foster connections between academy and industry, UICs and corporate partnerships will allow all actors to tackle with the transition ongoing in Turkey. The partial review and framework presented in this article for the Turkish UIC scheme is expected to make *valuable* contribution to the literature. Besides, in addition to our empirical analysis, we claim that there is still a need to investigate *deeply* and empirically to measure the effectiveness of UIC; for instance, researchers tend to analyse the extent of new products, patent and publications to reflect the real value of the UIC and justify the mechanisms' effect on catch-up.

V. Challenges for Catch-up and Mitigation

In academic research, collaboration between U-I research and related technical endowments in industry can often be *useful* in terms of different academic reference. The preliminary findings of this paper show that barriers to development exist to catch-up but that they can be overcome by using different mechanism and adequate policies including the development of UICs leading to catching up.

[3] For more information, please refer to TSSK official website: www.tssk.org.tr

The review and proposed framework in this article is expected not only to provide a substantial contribution with a directed analysis of UIC schemes for developing countries but also is expected to indicate areas that require further investigation. First, we might depict that the observed scheme for UIC through our reviews might also indicate that actors from the industry and universities may vary in definition of the success of the interaction and its outcomes (see Barnes et al., 2002). Therefore, similarly as denoted in Ankrah and AL-Tabbaa (2015), we claim that there is a need to investigate more determinants and empirical analysis in order to measure the effectiveness of UICs, in addition to the subjective measure currently employed.

In addition, we propose *by no means* that the process of catching up is not a *sole* outcome of successful UICs nor automatic or homogeneous. Actually, we require critical changes in the policy perspective with regard to the challenges equivalent to those of university – industry interaction. For instance, by encouraging firms to gather *qualified* human capital from the universities (starting from the very beginning of their foundations) must *strategically* be planned by improving the quality of education in universities compensating the industrial needs; or by reducing barriers to entry for firms to collaborative academic research. Unfortunately, in Turkey, such policies are *usually* constructed in *narrow* industrial development point of view.

We also propose *by technical means* that start-ups, new industries, institutions need to be conjunct in a collaborative environment taking also into account its social endowments (basis of quadruple helix model). This preposition, of course, requires up a high degree of capacity building path dependent policy making including all factors and actors in a suitable UIC environment.

Finally, the expected outcomes of this study may lead us to understand the gap and differences in a better sense amongst different emerging countries in spite of common constraints and risks *specifically* listed for Turkey below:

- The limited flow of information in between U-I
- Disjunction of technical needs for industrial development and Higher Education Institutes (HEIs)
- Low levels of universities' involvement and potential conflict of interest with industrial practice
- Weak technology transfer linkages among intermediaries
- The non-engagement of graduate students to start-ups and spin-offs
- Misinterpretation of UIC drives and constraints
- inexperience of academicians affiliated to universities that engaged with the industry
- Weak technological learning structures construed upon different institutional schemes
- Creating false and inefficient agencies
- Weak commercialization support from TTOs or ARCs
- Weak industrial bases at technology parks
- Complex and insufficient government funding and aid programs
- Misleading laboratory infrastructure
- Counter-cultural and societal conflicts

It is also the generic view of this paper that, through appropriate forms of capacity building, it is almost impossible to predict how quickly UICs will affect the economic growth and catch-up; and how much of a difference this might make to capacity building, technology development, its transfer and to the process of commercial innovation. We are aware that it is difficult to predict *how* and *to what degree* actors will benefit and engage with applied research. However, our empirical analysis predicts how certain achievements in leading universities and research institutions are to be developed through a suitable evaluation of required UIC motivations. Similarly, in the case of Turkey, UIC is *still* a weak determinant for developing the required collaboration skills to benefit from academic research (for instance, contracting misleading research to universities or ineffective alliances with research institutes, etc.)

Finally, the preliminary results out of this paper show us that there still exist barriers for development; but this *bottleneck* can be indoctrinated by leading strong UICs; finally leads to catching up by adequate policies. Here, we claim that governments may achieve changes through adequate policy changes (for instance, encouraging firms to use better academic capital (human capital, knowledge capital, etc.) by improving the quality of education or by reducing barriers to entry for start-ups and spin-offs. It is also notable that new industries and universities are to be coordinated and followed with *care* taking into account of its natural and social endowments. Here, in spite of common

global and economic constraints, we might also claim that this sort of UIC environment require a high degree of path dependence and can be expected to lead to different schemes of economic catch-up amongst emerging countries.

VI. Concluding Remarks

From an evolutionary perspective, in this decade, we encounter many developing countries tend to build up a sustainable basis for economic growth. Of course, some of them will succeed, yet the rest are not expected to be successful as the same levels as the suppressor. Hence, from an alternating perspective, we claim that *strong and dense* interactions between U-I might also help to close these gaps between emerging economies. In this sense, several indicators strongly suggest that Turkey has a *relative* financial and technical advantage based on its economic and social welfare settings.

Furthermore, we propose that Turkey might close the gaps in the mid-run by sustaining a wide range of visionary technology and development policies and programs that may be constructed upon a successful UIC regime. In order to achieve this goal, among some other policy and program constitutions, we may also counsel over some key facts in order to sustain a strong basis for a developing-regime UIC scheme:

- Inter-industry (industry-linked) education programs in the UIC environment
- Government incentives and funding for basic and applied research, supplemented at the level by R&D investments by industry
- Know-how and funding for start-ups and spin-offs in order to scale-up of new businesses.
- Advanced institutional basis for UIC environment
- Strong capability building programs and policies for leading research universities to be the pioneer for industrial development
- Robust policies for knowledge and technology transfer for IP protection

In addition, from the developing countries' perspective, we assume that industries are the driving force for the UICs, where both university and government have *limited* roles. In this article, we tried to inspire a deeper understanding of one of the critical research topics: the role of government in UICs. In developed economies, most of the academic research indicate that government is a key player in facilitating the establishment and development of such collaboration ([4]). However, it is still not clear in academic literature that the governments in developing countries, where universities are considered to be at the *center* of economic research, might intervene at all collaboration stages the UICs by defining the appropriate rules and objectives. Same perspective is applicable since there is a need to conduct comparative studies across different countries in relation to UICs.

In the end, since our study reveals only a small part of the majority of UIC studies, we claim that further applied *econometric* research may prove approved insights in this article. In order to define new UIC determinants for applied research, finally, we may propose that researchers might ensure investigating the effect of independent and strong connections to government and *sufficient* knowledge flows from universities through industry *may* help in transforming academic research into *value added* products.

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[4] Refer to Perkmann et al., (2011) for a detailed methodology

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