Socioeconomic Impacts of University–Industry Collaborations

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University–industry collaborations create socioeconomic impacts for the areas where they are undertaken. Although these collaborations have recognized importance and a high potential to generate economic and social benefits, there is no consensus in the literature on a consolidated conceptual model for assessing their socioeconomic impacts.

Keywords: university–industry ; economic development ; innovation ; socioeconomic development

1. Introduction

Firms must continually adjust and change to thrive in a competitive, globalized economy. Despite the constant shift, firms drive markets by exploiting and strategically managing knowledge. Markets are driven by creative, efficient, and strategic knowledge management. Universities using knowledge to generate competitive advantage makes them fundamental elements in the science, technology, and innovation ecosystems [1].

The open innovation paradigm points out that firms must carry internal and external knowledge management in order to enhance the internal innovation process of companies, making it faster through the application of both internal and external ideas, with the improvement of its technology [2].

The university is a valuable resource in the open innovation dynamics, as well as a great source of ideas for companies. In addition, academic specialists are trained and have the required resources for technical feasibility evaluation of new technologies implementation. Thus, for the open innovation study area, it is extremely strategic, the analysis and understanding of the socioeconomic impacts of university–industry collaborations.

The triple helix thesis proposes that universities are increasingly vital to discontinuous innovation in knowledge-based societies, superseding companies as the primary source of future economic and social development. The three members of the triple helix are these: industry (as the locus of production); government (as the source of contractual ties that ensure secure interactions and exchange); and universities (as the source of new information and technology, the generative concept of knowledge-based economies) [3].

In the innovative university–industry–government triple helix, three institutional spheres interact to achieve innovation. Any one of them can take the lead as the organizer of innovation. The broad goals of the three actors are uniform: they all strive for innovation, even they follow different strategies to achieve that goal. Thus, the university–industry–government triple helix is in alignment [4]. There has been a growing recognition of the triple helix's potential contribution to economic development, especially in the relationship between universities and companies [5].

Entrepreneurial ecosystems, organized environments that promote the success of new ventures, come in many forms, including academia [6]. Entrepreneurial universities play critical roles in various triple helix configurations, jump-starting regional innovation by creating a new academic function, economic development [5][7].

The general theory of the economics of entrepreneurial ecosystems differs from the traditional neoclassical theory of economics. Entrepreneurial ecosystems are multifirm and multiproduct markets that might exist in the future; the traditional neoclassical theory of economics cannot capture the combinations of multifirm and multiproduct markets [6].

The metrics to measure the successes and impacts of technology transfer outputs have not yet been well defined [8]. There are several ways universities can positively impact local economies' development beyond technology transfer. However, university-led knowledge-based economic development needs time and patience, which are not always in sync with political schedules [9].

Despite the incentives and an increasing commitment to developing entrepreneurship practices at universities, better information management is still needed, including tools to analyze the entrepreneurial activities' performance. We need broader analysis methods for university entrepreneurship that go beyond specific indicators (e.g., financial returns on intellectual property) and consider the broader social and economic benefits (e.g., knowledge dissemination, creation of intangible assets, employment, socioeconomic and cultural development) [10]. We must develop better metrics to measure the impact and performance of technology transfer [8]. The effectiveness of technology transfer activities can be expressed through such parameters as the social impact on the community, job creation, and poverty reduction, which are all associated with long-term financial benefits [8]. Most university–company collaborative research focuses on specific elements, resulting in fragmented and inadequate research [5].

2. Context

In the CIMO perspective, the contexts analyzed are the internal and external environments that influence behavioral change [11][12]. This systematic literature review identified both external and internal contexts: (1) the external contexts were the socioeconomic conditions and the national and regional laws and policies; (2) the internal contexts were the universities' characteristics, the firms' characteristics, and the researchers' characteristics. A region's capacity to absorb knowledge is most often associated with its socioeconomic conditions [13]. The ability of universities to invest in research and development (R&D to generate knowledge and apply it in industries generating innovations depends on political, economic, and social conditions [9].

Technology transfer policies support a commitment that considers knowledge spillovers to be public and offers property rights to guarantee the commercialization of developed technologies and a return on additional private investments. In the innovation system, the political and legal environment influences the type of knowledge generated, prioritizing the areas of greatest interest and directing investments, affecting the rate of technological transformation [9]. Therefore, consolidating entrepreneurial universities created national and regional programs and public policies to encourage university–industry collaborations; this benefited local companies and opened a new market for academic innovation R&D [14].

Universities and companies follow distinct paradigms and have different interests and objectives, the latter totally focused on profits and financial returns, and the former with their own interests. However, universities are under increasing pressure to generate economic benefits for society [13]. Universities invest financial and intellectual capital in startups in exchange for part of the businesses created from scientific research. They also establish collaborations with technology companies, based on R&D in exchange for participation in the generated intellectual property and benefits to the status of their faculty [15].

Commercial companies have the same relatively simple goal: earning profits. In contrast, universities have multiple objectives beyond the obvious ones of educating students; they also serve the greater society by developing and sharing knowledge and nurturing their faculty, scientists, and researchers to support the scientific community in general [9]. Research in collaborations between universities and industries should focus on areas of mutual interest, both academic and business. For a collaboration to be sustainable, the research results must add long-term value for the university and the industry or company. The value will depend on the perceptions of the research's impact on enhancing companies' and universities' strengths [16].

Several authors have reported on how various firm characteristics influence the establishment of university collaborations: size [16][17]; time of existence [18]; geographic location [15][19][20]; operating sector [13]; and specialization in the operating sector [21]. Ahrweiler et al. [22] investigated the role of university–industry links for innovation generation and diffusion in networks in two contexts: large, diversified companies and small technology companies. The latter context has been studied by several authors, such as Audretsch et al. [23] and Doh and Kim [18].

Although favorable external contexts (socioeconomic conditions, national and regional laws and policies) and favorable internal contexts (companies' and universities' characteristics) are necessary, they are not sufficient to ensure technology transfer. Furthermore, although cutting-edge research universities are critical assets for urban and regional economies, their presence does not guarantee regional economic development [19].

Ahrweiler et al. [22] found no direct and instant link between increasing knowledge inputs and financial returns with increasing profitability; nor did they find that companies with collaborative projects with universities were any better at adapting to changes in environmental conditions than their nonaffiliated counterparts. The average life of companies that interacted with universities was no longer than that of those that did not; additionally, increasing the knowledge quantity input automatically did not elevate the innovation generated or economic benefits.

The context presented by Bramwell and Wolfe [19], Bercovitz and Feldman [9], and Ahrweiler et al. [22] showed that despite the existence of robust structures with favorable conditions for the transfer of technology and the establishment of university–industry collaborations, the objectives of the collaborations were not always realized. This evidences the need for and importance of another factor in collaborations: the people and personal characteristics critical for technology transfer. The participants must connect academic research and its industrial and marketing applications, transforming scientific knowledge into financial profit. Effectively managing the available resources is essential for competitive advantage. Researchers and those involved in collaborations with access to cutting-edge technological research must identify the opportunities for pioneering innovations in the market efficiently and competitively.

Bradley et al. [24] outlined the various challenges for technology transfer: (1) university entrepreneurs are often older and generally lack many relevant business skills; (2) product research faculties are not always willing to adapt or align their research to technologies that can be transferred; (3) universities often lack the strong and consolidated social network necessary for successful technology transfer; and (4) university policies (e.g., promotion and tenure, financial and intellectual property) often do not offer the necessary subsidies and motivations for faculties to participate in technology transfer activities.

Figure 1 shows the context of university–industry collaborations.

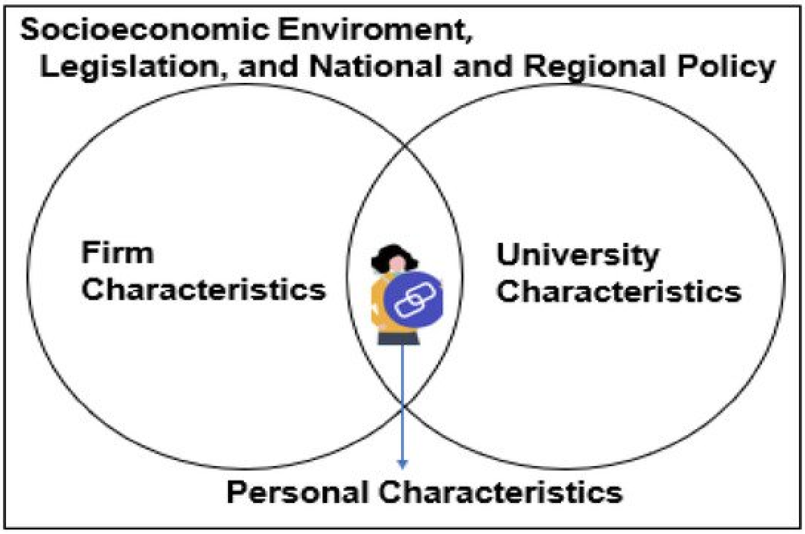

Figure 1. Context of university–industry collaborations.

3. Interventions

Interventions are inserted in a broader system, the social system [25]. They are influenced by interpersonal links, the institutional configuration, and the broadest infrastructural system [11][26]. Managers have interventions at their disposal to influence behavior [25].

University–industry interactions are multifaceted, complex, and diverse. Commercialization can include a wide variety of transactions between universities and industries [9]. Although the flow of knowledge drives innovation, knowledge transfer from university to company is fluid, complex, and iterative [19]. Many authors have found formal and informal links in university–industry interactions: Budyldina [14], Bercovitz and Feldman [9], Bramwell and Wolfe [19], Ahrweiler et al. [22], Dutrénit and Arza [27], Perkmann et al. [28], Hope [29], Lendel and Qian [30], Azagra-Caro et al. [31], Kochetkov et al. [32], and Owusu-Agyeman and Fourie-Malherbe [33].

Numerous formal and informal empirical works have investigated the possible ties between universities and firms. Universities are expected to provide the permanent growth, development, and diversification of knowledge for potential transfer to the industry that drives innovation. Furthermore, universities are strong network partners that are considered highly reliable because they are tied to public investments that largely isolate them from market fluctuations [22].

University–industry collaborations associate formal and informal interactions and are affected by industries' characteristics and business strategies, universities' rules, and the operational mode of the technology transfer activities and government policy interests [9]. The interactions between universities and industries frequently start as informal relationships that develop into more formal relationships with detailed descriptions of planning, roles, and expectations [33]. Formal channels involve the contractually supervised use of universities' and firms' skills, resources, and facilities. In the absence of a formal contract, informal channels provide access to a pool of knowledge reflected in skills, resources, technological and scientific capacities and requirements, and the preparation, procurement, and distribution of skilled personnel [31].

Commercialization generally occurs outside of formal academic channels, and universities seldom keep track of it [28]. Local economic effects are generally the result of a complex, dynamic, temporally unfolding series of interactions between formal and informal channels of knowledge transfer [31]. Knowledge created during formal interactions can be transferred through informal networks [31].

4. Mechanisms

Mechanisms produce outcomes [34]. In the context of university–industry collaborations, the mechanisms are the channels for technology transfer. We analyzed the links between contexts, interventions, and outcomes to establish the mechanisms.

The mechanisms identified were intellectual property, spin-offs, hybrid organizations, sponsored research, consulting and hiring professionals with academic knowledge, and publications and conferences. Table 4 shows the dominant mechanisms. Intellectual property (47.87%) and spin-offs (45.75%) stood out from the rest of the dominant mechanisms. The relevance of intellectual property has been noted by Perkmann et al. [35], Mets et al. [36] Jones and De Zubielqui [37], and Secundo et al. [38]. Licensing intellectual property provides legal rights that give companies access to technological solutions in the universities' intellectual property [9]. Spinning off companies and hiring professionals with academic knowledge enables more straightforward technology transfers through human resources movement [39].

Chiesa and Piccaluga [40] called academic spin-off enterprises one of the most promising ways to get scientific findings to the market.The triple helix concerns the relationships among universities, industries, and governments and the creation of such hybrid organizations as incubators, science parks, and technology transfer offices. The original business support structure of incubation has been reconsidered to emphasize its focus on the educational mission in training organizations [3].

According to Guadix et al. [41], considering the regional economic, business, and industrial context, science and technology parks have a high strategic value for the regions where they are located and carry out operations that promote research, development, innovation, and technology transfer. Universities transfer internally developed technologies to the public domain via technology transfer offices [42]. Audretsch et al. [43] emphasized the importance of technology transfer offices in universities' technology licensing. Bercovitz and Feldman [9] maintained that the setting of technology transfer offices represents an independent variable that partially accounts for the evaluated differences in patenting, licensing, and sponsored research between institutions.
Technology transfer offices differ considerably in their commercialization capacity. The license income distribution is highly localized, with a few big commercial hits yielding strong profits for a few universities [9]. Many high-impact start-up projects have emerged from academic studies in many developed countries, with the majority of these firms originating with a limited group of strongly entrepreneurial universities [44]. Sponsored research is a contract between a university and an industry. A sponsored research project supports university-commissioned studies and offers funding for facilities, graduate students, course launches, and faculty summer care [9]. Examples include collaborative research [45][46], contract research [47],[48][49][50][51][52], and the establishment of R&D organizations [47][53][54][55].

Several authors considered consulting and hiring professionals with academic knowledge an important mechanism, such as Bramwell and Wolfe [19] , Breznitz and Feldman [13] , Chen et al. [53], and Hope [56]. Universities do not usually have individual consultancy agreements with the faculty member(s), as companies nearly always own all the created intellectual property and directly remunerate the faculty member; in these cases, the university does not have access to new investments and potential generation of intellectual property [9].

Dutrénit and Arza [57] argued that publications and conferences are traditional technology transfer mechanisms. They classified mechanisms into four types: (1) traditional (hiring professionals with academic knowledge and publication and conferences); (2) services (providing science and technical resources in exchange for funds, such as consulting, use of quality management facilities, tests, instruction, and so on); (3) commercialization of scientific results already obtained (academic spin-offs, licensing, patents, and incubators); and (4) bidirectional mechanisms motivated by long-term aims of knowledge (contract research, joint R&D projects, and scientific–technological parks). Their model was also used by Orozco and Ruiz [58] and Fernandes et al. [59]. Serendipity is considered an unconventional mechanism that could possibly start relationships that later unfold through different mechanisms [9].

University offices are often regarded as displays for companies and treated as cooperation platforms for marketing their R&D results. The mechanisms vary depending on the context in which a university and a company are engaged (e.g., the country, region, and prevailing incentive policies). Hayter and Link [60] listed numerous university-affiliated proof-of-concept centers (PoCCs) in the United States that contributed to a rise in that country's academic spin-offs. Chang et al. [61] presented a model created in China of a university–industry cooperation platform in which companies could seek partnerships with any higher education university in the country or vice versa. The China cooperation platform has improved the economic performance of that country's high-tech companies; this suggests a positive connection between economic performance and the number of cooperating parties. Different cooperation mechanisms impact the economic performance of high-tech companies at different levels [57][61].

4. Socioeconomic Impacts

We classified the outcomes into three dimensions: (1) economic, (2) social, and (3) financial. We further subdivided each dimension as follows: (1) economic: infrastructure, production and processes, and scientific development; (2) social: jobs, skills, and qualification; and (3) financial: purchases, taxes, investments, and income generation. Figure 2 shows the proposed model for measuring the economic impact of university–industry collaborations.

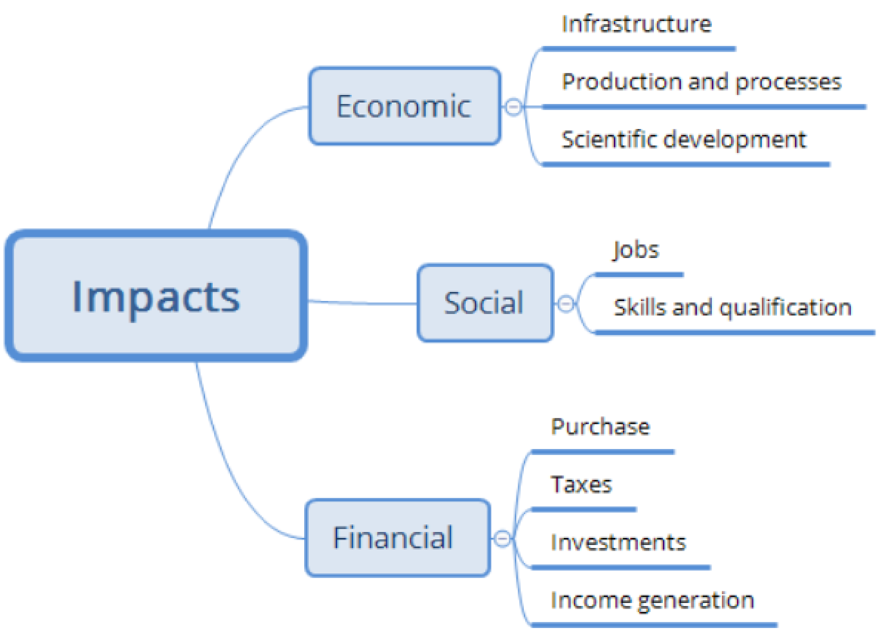

Figure 2. Evaluation model for the socioeconomic impact of university–industry collaborations.

Several authors have addressed some of the socioeconomic impacts of university–industry collaborations on the technology transfer mechanism, such as the emerging of companies (startups and spin-offs), patents and licensing, and relevant scientific publications. Ahrweiler et al. [62] and Urbano and Guerrero [63] claimed that these collaborations could lead to new business opportunities.

Etzkowitz [64] contended that universities have emerged as leading actors in a society predicated on knowledge owing to their nature as creators of original ideas. University–industry collaborations often result in new scientific and technological development partnerships that generate intellectual properties and market opportunities, such as industrial applications and new enterprises. Scientific novelty is of interest to academics, too, because it can generate new avenues for research. An enhanced mechanism from a university–industry collaboration can directly lead to such positive results as higher productivity, new products, increased sales, and commercial and societal value creation. Most of the authors in the systematic literature review regarded job creation as a socioeconomic impact of university–industry collaborations that could be quantified and influences people's quality of life.

Entrepreneurial universities can contribute through an advisory role in public policy formulation [13][46][65]. In this role, universities engage with local communities on a variety of themes. Nevertheless, most of the services and activities supplied by institutions cannot be easily quantified [13]. A university–industry collaboration can have several socioeconomic impacts on the actors in [66] triple helix; therefore, we propose a conceptual model of socioeconomic impact based on the main benefits from the actors in the triple helix. Figure 3 illustrates our Socioeconomic Triple Helix Conceptual Model.

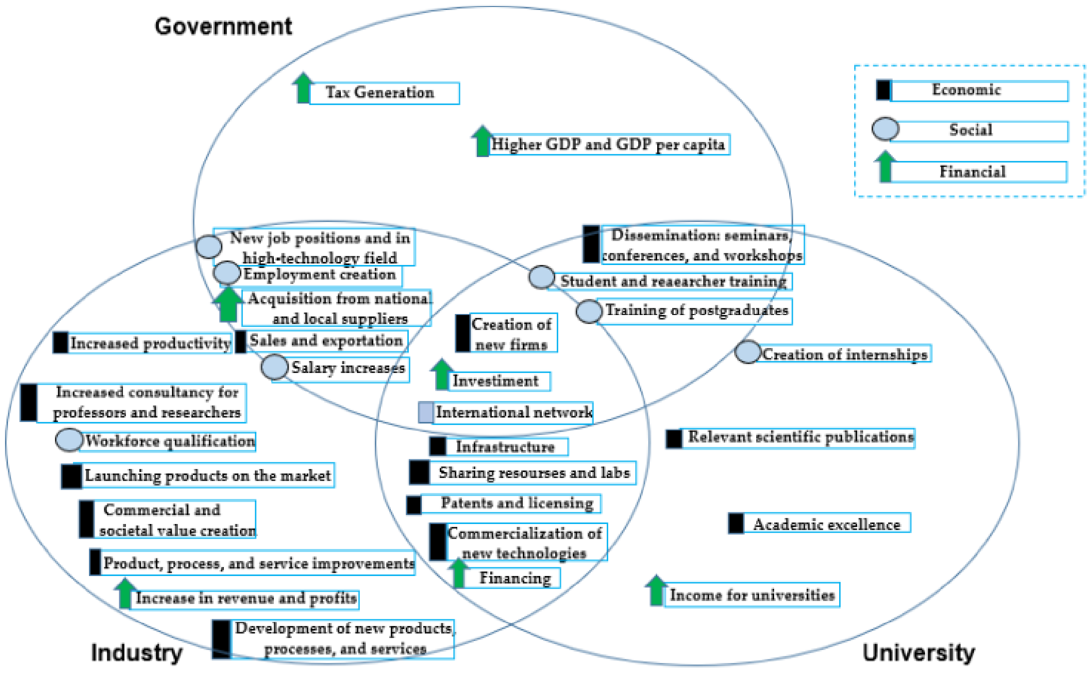

Figure 3. Socioeconomic triple helix.

The triple helix model puts the institutional spheres into perspective. An understanding of the most significant impacts and the stakeholders who benefit from such impacts facilitates negotiation between the constituents and enables strategies to be defined with the objective of enhancing the socioeconomic impacts based on interests and priorities.

The advantage of organizing the model according to the triple helix thesis is that the model has a visual and didactic advantage that makes it possible to quickly map the impacts and the main stakeholders, allow cuts or partial indicator applications for more specificity, and evaluate the impact of particular actions or public policies.

5. Final Discussion and Conclusions

University–industry collaborations can have appropriate economic and social advantages. We developed the socioeconomic triple helix, a conceptual model of socioeconomic impacts identified in the systematic literature review based on Etzkowitz and Leydesdorff's [66] triple helix model. Our model has significant academic and managerial contributions.

The triple helix model puts the institutional spheres into perspective. An understanding of the most significant impacts and the stakeholders who benefit from such impacts facilitates negotiation between the constituents and enables strategies to be defined with the objective of enhancing the socioeconomic impacts based on interests and priorities. The advantage of organizing the model according to the triple helix thesis is that the model has a visual and didactic advantage that makes it possible to quickly map the impacts and the main stakeholders, allow cuts or partial indicator applications for more specificity, and evaluate the impact of particular actions or public policies.

Any authors, including Galan-Muros and Davey [5], Audretsch et al.[6] , Alessandrini et al. [8], Bercovitz and Feldman [9], and Etzkowitz et al. [10], have claimed that traditional metrics and indicators cannot capture the socioeconomic benefits of university– industry collaborations. Our work enables a deeper analysis of the socioeconomic impacts of university–industry collaborations, highlighting the existing effects in the literature through synthesizing high-value insights into the theory of socioeconomic development based on strategic knowledge management, R&D, and technological innovation. Our model complements the triple helix model with a socioeconomic perspective of the interactions among government, universities, and industries, thus adding knowledge and elaborating on the theory. This work provides a guide for researchers and scholars who are interested in university–industry collaborations.

In addition to its academic contributions, this research and our new conceptual model benefit all the actors in the triple helix: (1) universities and companies can use the model to assess the socioeconomic impacts of individual collaborations; (2) public agents can use it to evaluate the impacts of their investments; and (3) government agencies can use it to inform their development of public policies for innovation and technology management.

Based on the results and the discussion on the socioeconomic impact of university– industry collaborations, we offer a few suggestions for future research: (1) an application of an evaluation model to university and companies and (2) a development of methods for the indirect impact assessment in local communities.

Future research should pursue applications of the proposed model, which will require developing metrics for each indicated variable. These additional metrics will enable the assessment of the socioeconomic impact of collaborative activities of university–industry partnerships by creating indicators that can be controlled and enhanced based on actions focused on the technology transfer mechanisms. Research has shown that conventional and quantitative metrics are not sufficient to measure the socioeconomic impact of university–industry collaborations fully [9][67]. In addition, a more qualitative assessment is suggested that addresses the indirect impact of university–industry collaborations—for instance, the creation of public policies [13][46], regional human capital attraction, and community and city development.

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