Transforming Algerian "University / Enterprise relations" into sustainable projects: an empirical study for the decade 2010-2020 through Principal Component Analysis (PCA) method

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Abstract

The materialization of university-business partnerships in Algeria requires a convergence between academic laboratories and economic entities to establish robust exchange networks. This research analyzes the transition of these relationships into joint projects across the innovation spectrum, from fundamental research to operational R&D. Utilizing Principal Component Analysis (PCA), the study compares four laboratory families—Social Sciences; Agronomy/Biology; Engineering/Physics; and Human Sciences/Arts—across the 2010-2020 decade.

The results identify a nearly absolute positive correlation (99%) between the volume of contacts and their transformation into formalized projects. Conversely, a strong negative correlation (-0.8) exists between contact volume and project sustainability. These findings suggest that while quantitative interaction drives project creation, current institutional frameworks fail to support long-term viability, necessitating a shift toward managerial and entrepreneurial motivations within research entities.

Keywords: relationship; projects; research laboratories; economic enterprise; university.

JEL Classification Codes: I23.

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1. INTRODUCTION

Universities have evolved into dominant agents for innovation through Research and Development (R&D), the cultivation of highly skilled human capital, and the provision of technical support to the industrial sector. In a landscape of intensifying international competitiveness, these institutions must maintain robust partner networks. For instance, in 2007, Canadian universities accounted for 36% of national R&D expenditures (10.4 billion dollars), with subsequent national reports identifying university-business collaboration as the primary catalyst for competitive advantage.

The research strategy explored herein involves bridging university laboratories and economic entities to foster "exchange networks" where partnerships are structured around joint projects targeting diverse innovation levels—from fundamental exploration to practical exploitation. The objective is to compare four laboratory families in the Algerian context during the 2010-2020 decade to determine how the volume of relationships influences both project transformation and long-term sustainability.

2. RESEARCH COLLABORATIONS BETWEEN UNIVERSITIES AND COMPANIES: A LITERATURE REVIEW

2.1 Historical Context and the Nation-State:

Modern universities matured during the 19th and 20th centuries as symbols of social liberation and national development within the nation-state framework (Neave & Van Vught, 1994; Van Damme, 2001). Nation-states leveraged universities to improve civil service efficiency and economic standing (Kerr, 1990). The German model, described by Clark (1994), prioritized research-centered institutes where ministerial support favored knowledge production over student throughput, establishing the blueprint for the modern research university.

2.2 Transition to Mass Higher Education:

Post-WWII, higher education transitioned from an elite to a mass system to satisfy the demands of modern industrialized society. This expansion introduced social mandates, such as integrating students from disadvantaged backgrounds (Scott, 1998). However, this massification often

coincided with severe budgetary constraints, particularly in the developing world, leading to deficient educational services and rigid management structures (World Bank, 2002).

2.3 The Changing State-University Relationship:

The 1980s neoliberal shift promoted the privatization of public services, reframing students as consumers and subjecting universities to corporate accounting metrics (Becher, 1995). While some argue that academic and managerial values can achieve a robust synthesis (West, 2006), others caution that importing business models can undermine institutional innovation (Cohen et al., 2002). Torres (2002) identifies a shift from an alliance of "class and culture" to one of "capital and culture," where corporate interests increasingly penetrate academic governance.

2.4 Participation in the Knowledge Economy:

UNESCO and the World Bank emphasize higher education's role in accumulating human capital for the global economy. Divergences persist in their implementation: the World Bank promotes market-driven individualism in developing nations, whereas the OECD encourages "institution-based liberalism" for developed member states to manage the complexities of the knowledge economy (Robertson, 2005).

2.5 Collaborative R&D and Exploration/Exploitation:

Strategic alliances are governed by the logics of "exploration"—prospecting new horizons, basic research, and risk-taking—and "exploitation"—standardizing and marketing existing knowledge (March, 1991; Koza & Lewin, 1998). In collaborative R&D, exploration focuses on internalizing new knowledge within patents or prototypes, while operational R&D emphasizes the "D" (Development) to achieve commercial standardization (De Bandt, 1991). This global paradigm shift toward the Triple Helix model serves as the theoretical backdrop for the Algerian regulatory reforms initiated during the 2010-2020 decade.

3. UNIVERSITY-BUSINESS IN ALGERIA: AN INVENTORY

3.1 Mutual Necessity:

The relationship is predicated on reciprocal needs:

- **Business Requirements:** Access to specialized researcher skills; utilizing universities as "technological markers" or scouts to anticipate scientific shifts; and resolving technical bottlenecks that require fundamental scientific breakthroughs. Furthermore, labs provide SMEs access to high-cost instrumentation.
- **University Requirements:** Aligning curricula with labor market demands; adopting industrial methodologies to manage complex research programs; and utilizing concrete industrial problems as catalysts for new theoretical development.
- **The Formatting Effect:** "Intramural" research participation produces a "formatting effect" among R&D engineers, allowing them to reappropriate scientific rigor through proximity to laboratory environments.

3.2 Institutional and Human Challenges:

Structural barriers include the conflict between public accounting rules (budgetary annuality) and the private sector's need for long-term investment and profitability. Human resource mobility is hindered by wage disparities. Furthermore, a philosophical divide exists: academics prioritize rapid publication ("publish or perish"), while businesses demand secrecy to protect competitive advantages.

3.3 The Regulatory Dimension:

Recent frameworks attempt to bridge these sectors:

- **MTESS-MESRS Framework (2017):** Promotes entrepreneurial spirit through the generalization of **Entrepreneurship Houses** (and later Innovation Centers). It encourages a "bank of ideas" derived

from student dissertations and laboratory work to fuel investment projects.

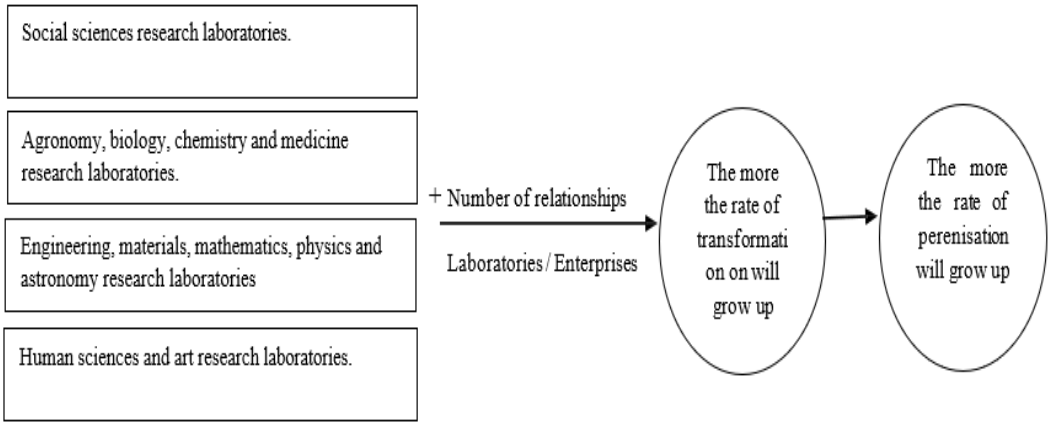
- **Inter-ministerial Order (2016):** Fixes the list of R&D activities in companies, allowing for tax deductions (IBS). Appendix III specifically identifies 18 university research activities eligible for this framework, including renewable energy, health, and agro-food.

4. Methodological protocol of the empirical study

In order to study the three-dimensional relationship of the university-economic company relationship (number or volume of relationships; transformation of relationships into joint projects and finally sustainability of projects), we opted for the documentary study: a research strategy, a choice objects to study Stake (1995), which includes multiple data sources, mainly institutional. Indeed, our study consists in determining the factors of the birth of a lasting relationship between the university and the company through research laboratories. To this end, we carried out a "DESK RESEARCH" from the database published by the DGRST. The research laboratories have, thus been grouped into four families of laboratories according to their nature: 1). Social Sciences. 2). Agronomy & biology- chemistry- medicine. 3). Engineering-Materials Science-Mathematics-Physics & Astronomy. Finally 4). Human sciences and arts. The study focused on data covering the period between 2010 and 2020 relating to the period between 2010 and 2020. The recommended method is that of Principal Component Analysis (PCA).

Our conceptual model is as follows:

Fig.1. The conceptual method



Source: Prepared by the author

In this conceptual model, we advance the following postulate: by increasing, partnership relations between research laboratories and economic enterprises should lead to an increase in the rate of transformation of relations into concrete projects between these two parties.

Then, we put forward the idea that achieving a project sustainability rate is conditioned by the existence of an equally high transformation rate. In other words, we suppose that the dynamic of collaboration between universities (via research laboratories) and economic enterprises obeys a sequenced logic which begins with the amplification of contacts between these two entities and develops to first reach a rate of transformation of relationships into sufficiently substantial projects so that, at the end of the sequence, a sustainability rate for the projects resulting from this collaboration is reached.

4.1 Methodology and Data Collection:

This study utilizes "DESK RESEARCH" based on the DGRSDT database. Four laboratory families are identified:

1) Social Sciences; 2) Agronomy/Biology/Chemistry/Medicine; 3) Engineering/Materials/Math/Physics/Astronomy; 4) Human Sciences/Arts.

4.2 Laboratory Distribution:

Since 2000, Algeria has seen exponential growth in research laboratories (Graphic 1). Graphic 2 illustrates a diverse distribution of vocations, though technical sciences remain dominant.

Table 1. Repartition of laboratories over Algerian university institutions

Institution	Labs	Institution	Labs	Institution	Labs
U. Annaba	90	U. Tlemcen	78	U. Oran 1	72
USTHB	70	U. Constantine 1	67	U. S.B. Abbés	54
U. Sétif 1	45	U. Mostaganem	43	U. Oran 2	43
U. Batna 1	39	U. Biskra	39	USTO	39
U. Bejaïa	37	U. Alger 1	36	U. Alger 2	35
U. Ouargla	35	U. M'sila	34	U. Blida 1	33
U. Jijel	31	U. Tizi Ouzou	31	U. Chlef	29
U. Laghouat	29	U. Batna 2	28	U. Boumerdès	27
U. Guelma	27	U. Alger 3	26	U. Constantine 2	24
U. Oum El Bouaghi	24	U. Tiaret	22	U. Béchar	20
U. Constantine 3	20	U. El Oued	20	U. Mascara	20
U. Blida 2	19	U. Tébessa	19	U. Djelfa	18
U. Khémis Méliana	18	U. Médéa	18	U. Saïda	18
U. Sétif 2	17	U. Skikda	17	U. Bouira	16
E.N.S Kouba	14	U. Adrar	14	ENP (ex ENP)	13
U. Souk Ahras	12	U. B.B. Arreridj	11	C.U. Tipaza	10

E.N.S Agro	10	ENP Oran	09	U. Khenchla	09
U. Sc. Islamiques	09	U. El Tarf	08	U. Ghardaïa	08
U. Ain Témouchent	07	U. Relizane	07	U. Tisselsilt	07
ENS Bouzéréah	06	U. Tamanghasset	06	C.U. Naama	05
ENP Constantine	05	C.U. El Bayadh	04	C.U. Mila	04
ENS Constantine	04	C.U. Tindouf	03	ENS Sc. Politiques	03
ENS Archit.	03	ENS SCF	03	ENS V	03
INFS STS	03	C.U. Aflou	02	ENS Biotech	02

Source: Author from DGRSDT data.

4.3 Conceptual Model and Hypotheses:

The collaboration follows a sequenced dimensionality reduction logic: **Contacts (*X*1) → Transformation (*X*2) → Sustainability (*X*3).**

- **H1:** An increase in the number of relationships (*X*1) leads to a higher transformation rate (*X*2) of relations into projects.
- **H2:** An increase in the number of relationships (*X*1) correlates positively with the project sustainability rate (*X*3).

4.4 Statistical Data (The Input):

Table 2. Statistical data about Research labs and Enterprises (2010-2020)

Lab Family	Contacts (*X*1)	Transformation (*X*2)%	Sustainability (*X*3)%
Social Sciences	300	2	6
Agronomy/Biology/Chem/Med	450	2	4
Engineering/Math/Physics	950	8	2
Human Sciences & Arts	700	7	5

Source: Prepared by the author based on statistics

4.5 PCA Calculation Protocol :

Table 3. Mean and Standard Deviation

Variable	Mean	Standard Deviation
Number of Contacts ($X1$)	600	247.50
% Transformation ($X2$)	4.75	2.77
% Sustainability ($X3$)	4.25	1.48

Source: Prepared by the author based on statistics

The mathematical protocol involves the construction of the **Reduced Centered Matrix (RCM)** and the **Variance-Covariance Matrix**.

- **Correlation Matrix Results:**
  - $r(X1;X2)=0.99$: **H1 Confirmed.** Nearly absolute positive correlation.
  - $r(X1;X3)=-0.80$: **H2 Invalidated.** Significant negative correlation.
- **Eigenvalues and Inertia:**
  - **Axis 1:** 78% of information (Total inertia).
  - **Axis 2:** 22% of information.
- **Contribution of Individuals and Variables:**

Table 4. Contribution of Individuals and Variables

Individuals/Variables	$X1$	$X2$	$X3$	Contribution (Individuals)
Social Sciences	0.12	0.08	0.17	**0.37**
Agronomy/Med	0.05	0.08	0.01	**0.14**
Engineering	0.17	0.11	0.19	**0.47**
Human Sciences	0.10	0.05	0.02	**0.17**
Variable Contrib.	**0.44**	**0.32**	**0.39**	

Source: Prepared by the author based on statistics

The Engineering family acts as the primary driver of the variance (47%), while relationship volume (*X*1) explains 44% of the observed phenomenon.

4.6 Interpretation of Results:

Using orthogonal eigenvectors and projections of individuals on principal components, we observe that for Axis 2, the determining point is **0.82 (82%)**. Axis 1 and 2 converge specifically on the **Agronomy & Biology-Chemistry-Medicine** cell. Despite this family recording a moderate contact volume (450), its position in the reduced subspace makes it the most representative pivot for understanding the "dimensionality reduction" from volume to sustainability.

5. CONCLUSION

This is a study on the relationship between research laboratories and economic companies. The initial table for the following calculation includes 03 numerical variables and 4 categorized variables.

The three (03) numerical variables are: the **number of contacts** made between research laboratories and economic companies between 2010 and 2020; **the rate (%) of transformation** of contacts into formalized projects and finally **the rate (%) of sustainability of projects transformed** into sustainable projects.

The four (4) categorized variables are **Social science research laboratories; Agronomy & biology- chemistry- medicine research laboratories and Engineering-materials sciences- mathematics-physics & astronomy research laboratories; Human Sciences & Arts Laboratories**. The study carried out demonstrated that the number of contacts initiated between university research laboratories and economic companies had a very significant and positive correlation with the rate of transformation of relationships into concrete projects. We are talking about a **correlation of 99%**, therefore almost absolute. The interest of this is to say that if we aspire to transform the initial relationships between research laboratories and economic enterprises, then it is fundamentally essential to increase the number of contacts (both institutional and personal contacts). We also obtained a significant correlation rate of **80%** but with a negative effect

between the number of relationships between research laboratories and economic companies in terms of the sustainability of transformed projects. In other words, the efforts made by the research laboratories of Algerian universities affect the creation of collaborative projects but have no effect on the sustainability of these projects. In addition to these results, the study highlighted a number of realities regarding the nature, ins and outs of this collaboration.

So, and to conclude, the failure of this quantitative logic lies in the fact that we try as best we can to institutionalize the relations between research laboratories and economic enterprises, may have little or no interest at all is granted to the question of "entrepreneurial initiative". In other words, the research laboratories within our universities should be transformed into companies, and consequently, driven by managerial and economic motivations. The Director of the laboratory should act as an entrepreneur, and human resource researchers. The university business-economic relationship cannot operate with dualistic perceptions: scientific interest for the research laboratory and profitability for the business.

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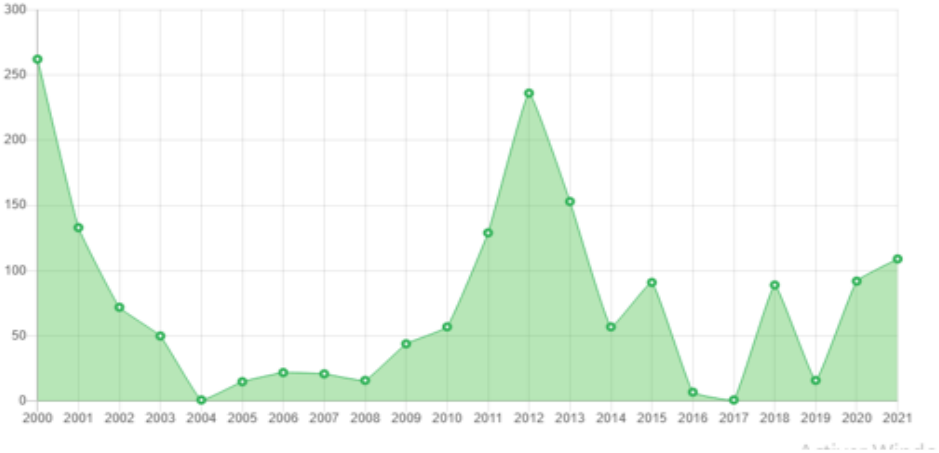
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7. Appendices

Graphic 1: Displays an exponential upward trend in research laboratory accreditation since 2000, illustrating the national commitment to research density.

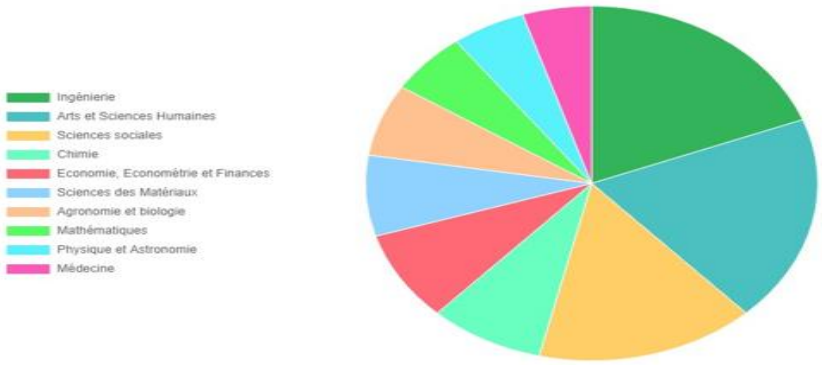
Graphic 1:Curve of agreedresearch labs per year of creation



Source: DGRST

Graphic 2: Presents the proportional distribution of laboratories by research vocation, highlighting a concentration in technical and medical sciences.

Graphic 2: Repartition of laboratories based on research field.



Source: DGRSDT