A Multi-Pillar Analysis of Technological, Organizational, and Managerial Factors of innovation: case of Austrian Firms

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Abstract:
This study investigates key determinants of product and process innovation in Austria using world bank BEEPS datasets, focusing on managerial, organizational, and technological factors. The empirical analysis reveals that innovation is strongly shaped by structural capabilities and strategic choices, with firm size, sector, organizational characteristics, R&D expenditures, technology licensing, human capital, energy management systems, and top manager experience significantly influencing innovation outcomes, while top manager gender and firm age show nuanced effects.
Keywords: innovation, multi-pillar analysis, Beeps data sets, Austria
Jel Classification Codes : O31, O32, D22, L25.

ملخص:
تستكشف هذه الدراسة العوامل الرئيسية المحددة للابتكار في المنتجات والعمليات في النمسا، باستخدام قواعد بيانات برنامج BEEPS التابع للبنك الدولي، مع التركيز على العوامل الإدارية والتنظيمية والتكنولوجية. ويؤكد التحليل التجريبي أن الابتكار يتأثر بشدة بالقدرات الهيكلية والخيارات الاستراتيجية، حيث يؤثر حجم الشركة والقطاع وخصائصها التنظيمية ونفقات البحث والتطوير وترخيص التكنولوجيا ورأس المال البشري وأنظمة إدارة الطاقة وخبرة كبار المديرين تأثيراً كبيراً على نتائج الابتكار، في حين يُظهر جنس كبار المديرين وعمر الشركة تأثيرات متباينة.
الكلمات المفتاح:الابتكار، التحليل متعدد الأركان، قواعد بيانات BEEPS، النمسا .
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I. Introduction:

In the current global economic landscape of 2025, innovation has transcended its role as a mere competitive advantage to become the primary prerequisite for institutional survival and sustainable growth. With the European union, Austria has firmly established itself as a strong innovator, consistently ranking among the top-tier nations with an innovation performance reaching 114% of the EU average in 2025. While the nation leads the EU in intellectual property assets, ranking firms in design, trademark, and patent applications relative to GDP, the internal mechanisms that translate high R&D investment into tangible innovation outputs remain a subject of intense academic inquiry.

The Austrian paradox highlights a persistent gap where substantial innovation inputs do not always result in commensurate high-quality outputs. Addressing this requires a multidimensional analysis that moves beyond traditional R&D metrics to explore the internal architecture of the firm. Existing literature suggests that a firm's innovation capability is not a monolithic trait but a configuration of diverse internal determinants. This paper seeks to investigate the drivers of innovation in Austrian firms by categorizing these determinants into three distinct interdependent pillars: technological, organizational and managerial characteristics.

Despite Austria's strong innovation performance and substantial investment in research and development, significant differences remain in firms' ability to generate product and process innovations. Existing studies have generally examined isolated determinants of innovation, while fewer studies simultaneously analyze organizational, managerial, and technological factors within a unified framework using recent firm-level evidence. This study is confined to firms operating within Austria, using cross-sectional firm-level data drawn from the World Bank's BEEPS (Business Environment and Enterprise Performance Survey) dataset (2025 wave), covering a sample of 601 establishments.

Accordingly, this study seeks to answer the following research question: What are the organizational, managerial, and technological determinants of product and process innovation among Austrian firms?

Building on this three-pillar framework, this paper advances three main hypotheses:

Hypothesis 1: Organizational factors significantly and positively influence product and process innovation in Austrian firms.

Hypothesis 2: Managerial characteristics significantly influence the likelihood of product and process innovation in Austrian firms.

Hypothesis 3: Technological factors significantly and positively influence product and process innovation in Austrian firms.

This study examines the determinants of innovation at the firm level in Austria using the most recent World Bank Business Environment and Enterprise Performance Survey (BEEPS 2025) dataset.

The analysis focuses exclusively on firms operating in three economic sectors: manufacturing, retail, and services. Innovation is examined through two complementary dimensions: product innovation and process innovation, which serve as the dependent variables.

The explanatory variables are organized into three analytical pillars:

- Organizational factors: firm size, firm age, sector of activity, participation in a multi-establishment firm, and internationally recognized quality certification.
- Managerial factors: top manager's experience and gender.
- Technological factors: research and development expenditure, foreign technology licensing, formal employee training, and adoption of energy management measures.

The study is limited to firm-level internal determinants and does not investigate external factors such as macroeconomic conditions, national innovation policies, market competition, institutional quality, or financial constraints. Moreover, because the analysis relies on cross-sectional data, the results identify statistical associations rather than causal relationships.

Therefore, this paper is organized as follows: the following sector is a literature review to give a clear theoretical part about the subject, the main determinants of innovation in addition to definitions and types of innovation. Next, an empirical section stars with a presentation of the innovation in Austria, followed by descriptive statistics about the data and finished by a conclusion.

II. Literature Review:

Following the great importance of innovation, and its relation to all sectors and fields, different variables and characteristics influence it. The variables of the study are regrouped into three categories that are: organizational characteristics, managerial characteristics and technological characteristics.

II.1. Innovation: definition and types

II.1.1. Evolution of innovation definitions

Across history, the meaning of innovation has shifted from a political suspect change to a multi-dimensional driver of economic and social transformation. Before the 18th century, the latin word innovo referred to introducing changes in law or religion (Benoît Godin, 2019). Between 19th to early 20th century, innovation take the meaning of progress and desirable societal change (Oki, 2019). From the early 20th century to the mid-20th century, Schumpeter framed innovation as new combination in product (new product, process, markets and organizations) driving creative destruction and growth (Kogabayev & Maziliauskas, 2017). Late 20th century: the definition of innovation expanded from a product to process, from idea to commercialization, integrating science, technology, markets and management and emphasizing value creation and profitability (Kogabayev & Maziliauskas, 2017). 21st century: innovation is now treated as a learning-based, interactional and social process, including organizational, service, and social innovation oriented to structural and sustainable change (Maldonado-Mariscal & Alijew, 2023).

II.1.2. Types of innovation:

There are different classifications of innovation. Basing on Henderson-Clark model, he gives three classifications of innovation basing on the impact of the changes that are incremental, radical, disruptive or architectural(Kaine & Higson, 2006). There is also modern and systemic types here the authors separate between open innovation, social innovation, sustainable innovation and frugal innovation(Mariani et al., 2023). In this paper, we based on the types presented by OECD in 2018. According to (Kunttu et al., 2021; OECD & Eurostat, 2018), there are two main types of innovation that are:

- Product innovation: introducing a new or significantly improved good or service.
- Business process innovation: implementing a new or significantly improved process with the firm, covering areas such as production, distribution, marketing and administration.

II.2. Determinants of innovation

There are many variables that could have direct or indirect relationship between the innovation. Therefore, the variables below presented in groups of characteristics that are:

II.2.1. Organizational factors and innovation:

The organizational characteristics are characteristics that have a link the organization of the firms. There are:

A- IRQ certification:

Internationally-Recognized Quality certification refers to a formal verification by an independent, accredited body that an organization, process or individual meets globally-agreed benchmarks by experts. These certifications facilitate international trade by ensuring reliability and safety across borders. Large multi-country SME study in 30 transitions economies finds firms with internationally recognized quality certifications are more likely to innovate (both invention and imitation or adoption) than similar uncertified firms, these effects are stronger for smaller firms and where institutional quality is weaker(Ullah, 2022). In ASEAN manufacturing, international quality certification raises the predicted probability of process innovation by around 4.2% points (Doan Thi Ngoc et al., 2025). moreover, across 81 countries, the increases in iso 9001 certificates are positively associated with more patent applications (innovation), especially in developed economies(Wayoro et al., 2024).

B- Belonging to a multi-establishment firm

A multi-establishment firms is a single legal business entity that operate across multiple distinct physical locations, or establishment to conduct its operations. These firms are a core concept in economic analysis , particularly in understanding business structure, productivity and the distribution of firm sizes(Xi, 2023). Being part of a multi-establishment (or a multi-unit) is

generally advantageous for both firm and the workers, mainly through flexibility, learning and risk sharing, though it can also create coordination and adaptability challenges. Belonging to a multi-establishment enhance the creation of rich internal networks for sharing knowledge that will play an innovation asset. According to the study of (Villasalero, 2018), business units in multi-business firms can draw on both external partners and internal sisters units for ideas and technologies, unlike stand-alone firms. From 227 business unites shows, for better product innovation, units should source ideas mainly from outside the firm and then diffuse or license innovations mainly inside the corporate network. In the negative side of belonging to multi-establishment firm, multi-establishment business and multinational structures creates high internal and structural complexity (many units, layers, overlapping HQs), which raises coordination costs and slows decisions-making that will hinder effective innovation work (Gillmore et al., 2023; Larsen et al., 2023).

C- Age of the firms

Age of the firms play different roles with ability to innovate. New firms with new ideas some times are able to innovate more than old firms because old firms don't like to change and take the risks to change, and this ability decline with the advanced ages (Huergo & Jaumandreu, 2004). Sometimes, old firms are more capable to innovate more than the young firms because the old firms accumulate more information's and more knowledge about the market, competitors, new technologies that it allows it to innovate more than others and the rate of the risk will be small comparing with the new firms that don't have any information about the components of the market(Yin et al., 2022).

D- Sector of activity:

Innovation is sector-specific by nature because industries differ in:

- Technological opportunities,
- Knowledge bases,
- Appropriability conditions,
- Production processes,
- And market dynamics

This idea originates from Schumpeterian economies, which emphasizes that innovation depends on the technological and institutional environment in which firms operate (Schumpeter & Swedberg, 1942). Later, evolutionary and neo-Schumpeterian scholars formalized this idea by showing that innovation patters vary systematically across sectors, leading to persistent differences in innovation intensity and type. According to (Malerba, 2002), each sector is characterized by:

- A specific knowledge base
- Distinct learning processus,
- Different actors and institutions,
- And particular technological regimes.

Therefore, manufacturing sectors tend to exhibit higher levels of product and process innovation due to structured R&D, engineering capabilities and cumulative.

E. Size of the firm:

The relationship between firm size and innovation has been one of the central debates in industrial economics since Schumpeter. Schumpeter in his books "the theory of economic development, 1934" and "Capitalism, Socialism and Democracy,1942". At first, Schumpeter said that innovation is driven by small and new firms, which are more flexible, entrepreneurial and willing to take risks.

In the second book, he mentioned that innovation is dominated by large firms, which benefit from economies of cale, financial resources, and stable R&D laboratories.

According to the resource-based view, firms size matters because larger firms have:

- Greater financial resources,
- More specialize human capital,
- Better access to external finance,
- Stronger organizational routines

These advantages increase the capacity of the firm to invest in R&D and to manage innovation projects.

II.2.2. Managerial factors and innovation:

A- Experience of top manager:

From the human capital theory, a top manager's experience is a crucial , accumulated knowledge skills, abilities, and judgement developed through years in their sector often measured by years in the industry, that enhances decision-making, drives innovation and creates firms value, acting as both general (transferable) and specific (industry-focused) capital essential for competitive advantage(Timothy, 2022). Top manager with more years of experience have more ability to innovate rather than top managers with less number years of experiences, because years of experience represent cumulative knowledge capacity to take decision (Okrah & Irene, 2023; Timothy, 2022)

B- Gender of top manager:

Gender of top manager can shape innovation mainly by changing leadership style, team composition, risk preferences and diversity of perspectives. In developing countries, firms with female top manager are more likely to innovate in both product and process innovation than those led by men (Na et al., 2019; Ritter-Hayashi et al., 2019).

II.2.3. Technological factors and innovation:

A- Adoption of energy management measures

Adoption of energy management measures involves a systematic process of monitoring , analyzing, and improving energy use through strategies like upgrading equipment, behavioral changes, and implementing systems like ISO 50001 (ISO 50001 from the measures of energy management systems that require firms to systematically monitor, measure, and improve energy performance) or smart home tech to reduce costs, boost efficiency and meet sustainability goals, driven by financial benefits, environmental responsibility and policy(Nwarueze et al., 2025). According to the study of Marimon and Casadesus, the adoption of ISO 50001 improves operational processes (example: energy tracking, performance evaluation) which can create space and incentives fir firms to explore technological and managerial innovations that reduce consumption and costs(Marimon & Casadesús, 2017).

B- Research and development

Research and development R&D are defined as systematic, creative work aimed at increasing the stock of knowledge to devise new applications. R&D is the primary driver of innovation, acting as the foundation for creating new products, processes and businesses models(OECD, 2015) . For an activity to be classified as R&D, it must meet five specific core criteria. If any of these are missing, the activity is generally considered "routine" or "industrial" rather than true R&D:

- **Novelty:** it must be aimed at new findings.
- **Creativity:** it must be based on original, non-obvious concepts and hypotheses
- **Uncertainty**: there must be uncertainty about the final outcome or the time and resources needed to achieve it.
- **Systematic**: it must be planned and budgeted and documented.
- **Transferable/Reproducible:** it must lead to results that can be reproduced or knowledge that can be shared.

C- Training

Formal training is defined as a highly structured, intentional and regulated educational process occurring within a planned setting (Trentin, 2009)

Training can significantly boost innovation at different levels that are individual, team and firm levels(Bourouaha & Maliki, 2021). But these effects depend on design, context and follow-through. The training can influence innovation in different faces as follows:

- Builds skills and human capital(Dostie, 2018; Mwadzingeni et al., 2025; Na, 2021)
- Strengthens creative behavior and innovative capabilities(Nardo & Aprilyani, 2024; Nekoye et al., 2025; Romain & Agogué, 2021)
- Shape culture, learning climate and commitment(Sung & Choi, 2014; Valenzuela-Muñoz et al., 2024)

Five essential characteristics of formal training are proposed by Michael Eraut (Eraut, 2000):

- Prescribe learning framework
- Organized learning events
- Designated instructor
- Award of qualifications
- External specification of outcomes.

D- Foreign technology licensing:

Foreign technology licensing or international technology licensing is defined as a contractual arrangement in which a firm in one country (the licensor) grant a firms in another country (the licensee) the legal right to utilize its proprietary technology in exchange for compensation(Atuahene-Gima, 1993). Foreign technology licensing can strongly support innovation, especially in developing/emerging economies, but its impact depends on absorptive capacity, complementary R&D and industry/technology context. According to (Musandiwa & Ngwakwe, 2020), licensing foreign technology is positively and significantly related to new product innovation.

III. Empirical study:

In the empirical part, we will start with the presentation of the innovation in Austria. After, we will present the data of the study:

III.1. Overview about the innovation in Austria:

Austria is recognized as a strong innovator, ranking among the top-tier European nations for research and development intensity and intellectual property assets. The country consistently exceeds the European Union's R&D expenditure target of 3% of GDP, reaching a record high of 3,35% in 2024 and maintaining this leadership into 2025(euraxess, 2025).

Austria's innovation ecosystem is characterized by strong public-private partnership and a high volume of scientific output. Starting with the European innovation scoreboard EIS 2025, Austria ranks 8th overall in the European union, with a performance at 114% of the EU average (patentamt, 2025).

Following the global innovation index 2025, Austria holds the 19th position globally, noted for its high quality infrastructure and business sophistication(World Intellectual Property Organization, 2025). More precisely, Austria ranks first in the European union for the intellectual assets, specifically leading in design application where it ranks second place and patent filings where is tanks sixth places. For the human capital, Austria, ranks 2nd among the 27european countries for STEM graduates, providing a critical pipeline of specialists for technology-based industries(Martin Polaschek et al., 2024). In 2025, Austria is prioritizing a dual approach known as the "Twin Transition," focusing on both Green and Digital innovation.

About the green innovation, Austria is a European frontrunner in eco-innovation, with nearly all domestic firms taking steps to cut emissions and over half-investing directly in energy efficiency in 2025(European Investment Bank, 2025). Even in the field of scientific research publication, Austria is a pioneer in quantum research, ranking the second in the EU for scientific publications per million inhabitants in the field of technology and innovation(Bettega, 2024).

Innovation in Austria is driven by a mix of federal support and intensive business activities. First, total R&D expenditures reached €16.13 billion in 2024(Simeon Woo, 2025). Where approximately 66% of this funding is provided by the business sector (including foreign subsidiaries), while the public sector contributes roughly 34% (Martin Polaschek et al., 2024).

Moreover, public universities have been allocated a budget of €16 billion for the 2025-2027 period, a 31% increase aimed at offsetting inflation and bolstering research. Viena remains the most innovative region due to its high concentration of universities and research institutes. Despite this strong performance, Austria faces structural hurdles in 2025 such as venture capital where Austria continues to struggle with a lack of risk capital for startups, seeing that 25.8% decline in venture capital deals between 2023 and 2024(International Monetary Fund European Dept, 2025). Also, the Austrian firms suffer from the lack of skilled workforce.

Therefore, the empirical part of this paper guide us to understand the main determinants of both types of innovation (product and process) in Austria.

III.2. Descriptive study:

The second part of the empirical contain descriptive study that present the main variables of the study. The variables of the study are divided into three groups that are organizational characteristics, managerial characteristics and technological characteristics in addition to two types of innovation that are product innovation and process innovation as dependent variables. The data of this study is from the beeps datasets published by the world-bank in 2025.

Starting with the continuous variables, the table below presents the main variables of the study:

Table (1): variables of the study

Variables	Obs	Mean	Std.Dev	Min	Max
Top manager Experience	601	24,20	9,388	2	50
Gender of top manager	601	0,16	0,370	0	1
Age of the firm	601	37,31	31,181	1	225
Size of the firm	601	1,77	0,766	1	3
Sector of activity	601	2,05	0,930	1	3
Part of multi-establishment	601	0,23	0,421	0	1
Having IRQ certification	601	0,46	0,499	0	1
Using foreign-owner technology license	601	0,28	0,449	0	1
Establishment spent on R&D	601	0,35	0,477	0	1
Establishment adopt energy management	601	0,66	0,475	0	1
Formal training program	601	0,36	0,480	0	1
Competing against informal competitors	601	0,04	0,192	0	1
Product innovation	601	0,50	0,500	0	1
Process innovation	601	0,28	0,448	0	1

Source: authors construction using beeps datasets.

III.2.1. Managerial factors

In this part of the paper, the first table presents the distribution of the top managers of the firms per gender.

Starting with the experience of top manager, from the table 1, the mean of the experience of top managers is 24.2 years with a standard deviation equal to 9.38. These results mention that the top managers of the sample have at least 24 years of experience. This latest will help them in taking decisions. Following the value of the standard deviation that is 9.38, this latest mention that there is a considerable deviation in the experience.

Table (2): Gender of top manager

	Frequency	Percent
Woman	98	16,3
Man	503	83,7
Total	601	100,0

Source: authors construction using beeps datasets.

According to the results of the table 2, 83.7% of the top manager of the firms are male. This result confirms the theory “Glass Ceiling Theory” that women are not interested by the creation or management of firms.

III.2.2. Organizational factors

The descriptive study of the characteristics of firms, the table 3 below presents the distribution of the sample on the size of the firms.

Table (3): Size of the firms

	Frequency	Percent
Small	261	43,4
Medium	217	36,1
Large	123	20,5
Total	601	100,0

Source: authors construction using beeps datasets.

From the data presented above, 43.4% of the firms of the study are small firms following by medium firms with 36.1%, however large firms take the third rate with 20.5%. This distribution follows also the global data of the state where the majority of the firms are small and medium sized enterprises(BMWET, 2025b).

The distribution of the sample per sector presented in table below. According to these data, service sector takes the first place with 46.1% of the firms of the study. This result confirm also the data presented in the OECD report (OECD, 2022) that Austria's economy is service-dominated followed by firms in manufacturing sector with 40.6%. However, retailing takes the third place with 13.3% of the sample of the study.

Table (4): Sector of activity

	Frequency	Percent
Manufacturing	244	40,6
Retailing	80	13,3
Services	277	46,1
Total	601	100,0

Source: authors construction using beeps datasets.

These results mention that the Austrians firms operate in the service sector due to the characteristics of the state in addition to the long-term economic policies to shift-away from the other sector such as agriculture and industry an and to build a sustainable activity (lloydsbanktrade, 2025).

Table (5): Establishment part of a multi-establishment Firm

	Frequency	Percent
Yes	138	23,0
No	463	77,0
Total	601	100,0

Source: authors construction using beeps datasets.

Belonging a part of multi-establishment firms has different advantageous as it was cited above, however just 23% of the firms of the sample from Austrian firms are part of multi-establishment firms. Because the majority of the firms operate in service sector, they prefer to work alone than belonging to multi-establishment firm. Also, different risks from this belong such as structural complexity that will raise the coordination costs and reduce adaptability within the groups. These for, 77% of the firms of the sample prefer to work alone rather than belonging to multi-establishment firms.

The table below presents the rates of the firms having Internationally-Recognized Quality Certification. Is it shown, 45.9% of the firms of the sample in Austria have this certification, that is near the half of the sample.

Table (6): Having an Internationally-Recognized Quality Certification

	Frequency	Percent
Yes	276	45,9
No	325	54,1
Total	601	100,0

Source: authors construction using beeps datasets.

These data reveal that the Austrian firms are interested by having these certifications. For the other firms, they face several common obstacles to obtaining the certification, primarily centered around resource constraints, resistance to change and the perceived complexity and bureaucracy of the certification process (Sfakianaki & Kakouris, 2020)

III.2.3. Technological factors:

The table below present the descriptive statistics of the firms using technology licensed from foreign owned company:

Table (7): Using Technology Licensed from a Foreign-Owned Company

	Frequency	Percent
Yes	168	28,0
No	433	72,0
Total	601	100,0

Source: authors construction using beeps datasets.

The data presented in table above demonstrate that 72% of the firms of the sample do not use technology from a foreign owned technology. Focusing on the strategic “digital sovereignty 2025”, the top managers respond to the political and economic push to reduce reliance on non-European technology provider especially the US providers(Charlotte, 2025).

Table (8): Formal Training Programs for Permanent employees

	Frequency	Percent
Yes	216	35,9
No	385	64,1
Total	601	100,0

Source: authors construction using beeps datasets.

Following the data presented in the table above, just 35.9% of the firms offer formal training programs for their permanent employees, however, 64,1% do not offer these programs. From the main barriers, are as follows;

The operational time constraints: the high workloads and limited available time is the major reasons for not participating in training because taking employees away from their primary job responsibilities can disrupt production or service delivery.

The recruitment-first strategy: the Austrian firms prefer to recruit individuals who already possess the required skills rather than investing in training exiting staff. In addition to that, the Austrian firms are Satisfied with current skill levels (Tatel & Mulherin, 2025)

Table (9): Adoption energy management measures

	Frequency	Percent
Yes	395	65,7
No	206	34,3
Total	601	100,0

Source: authors construction using beeps datasets.

The data presented in **Erreur ! Source du renvoi introuvable.** reveals that around 66% of the firms of the sample adopt energy management measures. This latest reflect the interest of these firm to reduce CO2 emission and following the policies of Austria's energy management to achieve climate neutrality by 2040, this latest is followed by focusing on 100% renewable electricity by 2030. Therefore, the government enhance the firms to innovate in the field of energy and switching to renewable heating and promoting efficient technologies by implementing supportive legislative like the Renewable Energy Expansion Act EAG and the Energy Efficiency Act EEFFG (BMWET, 2025a).

For these reasons and others, the Austrian firms respond to the acts of the government such as focusing on decarbonization via massive expansion such as hydro, solar or wind in addition to promoting green gases as hydrogen (European Environment Agency, 2025).

The data presented in **Erreur ! Source du renvoi introuvable.** reveal that just 34,9% of the firms of the sample spend for research and development, however 65,1% of the sample do not spend for R&D. These data shows that not all the Austrian firms are interested by the research and development.

Table (10): Establishment Spent On R&D

	Frequency	Percent
Yes	210	34,9
No	391	65,1
Total	601	100,0

Source: authors construction using beeps datasets.

III.2.4. Innovation:

For the data that represent innovation, **Erreur ! Source du renvoi introuvable.** give the rates of the product innovation in the sample of the study. As it is presented in the table, about the half of the firms of the sample have new or improved product or service that represent product innovation.

Table (11): product innovation

	Frequency	Percent
Yes	299	49,8
No	302	50,2
Total	601	100,0

Source: authors construction using beeps datasets.

For the process innovation, just 27,8% of the firms have a new or improved process. These results reveals that the process innovation is a bit difficult to have comparing with the product innovation.

Table (12): process innovation

	Frequency	Percent
Yes	167	27,8
No	434	72,2
Total	601	100,0

Source: authors construction using beeps datasets.

III.3. Cross tables:

To select the relationship between the two types of innovation and the characteristics of the firms, the Table (1 below presents the frequencies of two types of innovation with different characteristics of the firms.

Starting with the couple size of the firms and both types of innovation, the highest rates of the innovative firms in both types of innovation is for large firms 57,72% (71 firms from 123 large firms) following by medium sized firm (50,7% and 29% for both types of innovation), however the small firms take the last place for both types of innovation. These results confirm that the size of the firm have a positive relationship with the innovation. These results suggests that larger firms benefit from greater resources, scale economies and organizational capabilities, which facilitate both product development and process improvement. These findings is consistent with the Schumpeterian view that firm size enhances innovation capacity especially for process innovation (Mazzucato, 2000).

For the second factor of the study, manufacturing firms exhibit the highest innovation rates, particularly in product innovation (63,93%) and process innovation (35,25%). Retailing shows relatively lower product innovation (35%) but moderate process innovation (32,5%), while other services display weaker innovation outcomes overall. This reflects sectoral technological opportunities, manufacturing is more R&D intensive and technologically structures, whereas services-especially non-knowledge-intensive ones tend to innovate less formally.

For the third factor that is belonging to a multi-establishment firm, firms that are part of a multi-establishment group show higher innovation rates than standalone firms, especially for product innovation (56,52% vs. 47,73%). This indicates that organizational networks, internal knowledge transfer, and shared resources within multi-establishment firms may stimulate innovation activities.

Table (1): Cross tables between types of innovation and characteristics of the firms

		Product innovation		Process Innovation	
		N	%	N	%
Size of the firm	Small	118	45,21%	62	23,75%
	Medium	110	50,69%	63	29,03%
	Large	71	57,72%	42	34,15%
sector of activity	Manufacturing	156	63,93%	86	35,25%
	Retailing	28	35,00%	26	32,50%
	Other services	115	41,52%	55	19,86%
Belonging to a multi-establishment Firm	Yes	78	56,52%	40	28,99%
	No	221	47,73%	127	27,43%
Gender of top manager	Woman	55	56,12%	27	27,55%
	Man	244	48,51%	140	27,83%
Having an Internationally-Recognized Quality Certification	Yes	165	59,78%	93	33,70%
	No	134	41,23%	74	22,77%
Using Technology Licensed from a Foreign-Owned Company	Yes	101	60,12%	54	32,14%
	No	198	45,73%	113	26,10%
Establishment Spent On R&D	Yes	177	84,29%	87	41,43%
	No	122	31,20%	80	20,46%
Adoption energy management measures?	Yes	223	56,46%	139	35,19%
	No	76	36,89%	28	13,59%
Formal Training Programs for Permanent employees	Yes	145	67,13%	91	42,13%
	No	154	40,00%	76	19,74%

Source: authors construction using beeps dataset

For the gender of top manager, innovation rates are remarkably similar across gender, with women-led firms showing slightly higher product innovation (56,12% vs.48,51%) and nearly identical process innovation rates. This suggest that managerial gender per se is not a limiting factor for innovation outcomes, reinforcing the view that structural and organizational factors matter more than demographic characteristics.

For the quality certification, quality certified firm are significantly more innovative, particularly in process innovation (33,70% vs. 22,77%). Certification likely reflects formalized procedures, continuous improvement practices, and compliance with international standards, which are closely aligned with process innovation and indirectly with product innovation.

Firms using technology licensed from foreign-owned companies display higher innovation rates in both product (60,12%) and process innovation (32,14%). This highlights the role of international technology transfer and external knowledge spillovers as important drivers of innovation.

For research and development, as it is presented in the theoretical parts, the R&D shows the strongest association with innovation. Firm investing in R&D report extremely high rates of product innovation (84,29%) and process innovation (41,43%) compared to firms without R&D activities. This provides robust descriptive support for the central role of internal R&D capabilities as a cornerstone of innovation performance.

For the factor of adopting energy management measures, the Austrians firms adopting energy management measures are substantially more innovative, especially in process innovation (35,19% vs. 13,59%). This suggest that environmental practices and eco-efficiency strategies are closely linked to process improvements and operational innovation. However, for the variable "formal training program", training emerges as a key enabling factor, with trained firms showing much higher product innovation (67,13%) and process innovation (42,13%) rates. This rate confirms human capital theory: skills development enhances absorptive capacity, enabling firms to transform knowledge into innovative outputs.

IV. Conclusion:

The aim of this study is to investigate the main determinants of both types of innovation that are product and process in Austria using beeps datasets from world bank. In this paper, we focus on different factors such as managerial, organizational and technological. The empirical analysis provides a preliminary result by examining a comprehensive set of firm-level. Using product and process innovation as two distinct but complementary dependent variables allow for a more nuanced understanding of firm's innovation behavior.

The empirical results show that innovation is not randomly distributed across firms look but is strongly shaped by structural capabilities and strategic choices. Firm size emerges as a significant factor with medium and large firms being more likely to introduce both product and process innovations than small firms. These findings support the resource-based view, according to which larger firms benefit from greater financial, human, and organizational resources that facilitate innovation activities. Sectoral differences are also evident. Manufacturing firms display higher innovation propensities than service-oriented firms, particularly with respect to process innovation. This confirms the existence of sector-specific technological opportunities, where manufacturing activities are more R&D-intensive and technologically structured than most service activities. Organizational characteristics further play a decisive role. Firms belonging to multi-establishment groups exhibit higher innovation rates, suggesting that internal networks shared knowledge and economies of scope enhance innovation performance.

Similarly, the presence of internationally recognized quality certifications is positively associated with both product and process innovation, highlighting the importance of standardized procedures, continues improvement practices, and organizational discipline. From a technological perspective, R&D expenditures constitute the most powerful determinants of innovation, especially for product innovation. Firms investing in R&D demonstrate substantially higher innovation probabilities, underlining the central role of internal knowledge creation. Moreover, the use of technology licensed from foreign-owned companies significantly increases innovation outcomes, emphasizing the importance of international technology transfer and absorptive capacity, particularly in context where domestic technological capabilities may be limited.

Human capital variables also matter. Firms offering formal training programs to permanent employees are more innovative, especially in process innovation, reflecting the role of skills upgrading in improving operational efficiency and innovation implementation. In addition, the adoption of energy management systems is positively linked to process innovation, suggesting that environmental and energy-efficiency practices act as complementary drivers of technological upgrading rather that as constraints.

Regarding managerial characteristics, the experience of the top manager positively contributes to innovation, indicating that accumulated managerial knowledge and decision-making capacity support innovation strategies. In contrast, the gender of the top manager does not exhibit a systematic effect on innovation, suggesting that innovation outcomes are driven more by firm capabilities and strategies than by demographic characteristics.

Finally, firm age shows a differentiated effect, reflecting the tension between learning advantages in older firms and the greater flexibility of younger firms. This finding confirms that innovation dynamics are shaped by both experience and adaptability.

The empirical results support the proposed research hypotheses. Organizational factors significantly influence both product and process innovation, confirming the importance of firm characteristics and organizational capabilities in enhancing innovation performance. Managerial factors also contribute to innovation, particularly through the experience of the top manager, while the effect of manager gender remains limited. Technological factors show the strongest association with innovation, emphasizing the importance of research and development expenditures, foreign technology licensing, formal training programs, and energy management measures. Overall, the findings confirm that organizational, managerial, and technological factors jointly explain innovation performance among Austrian firms, thereby validating the proposed multi-pillar framework.

Overall, the study provides strong empirical evidence that product and process innovation are driven by a combination of firm resources, organizational practices, technological openness, and human capital investment. By distinguishing between the two types of innovation, the study contributes to the innovation literature by showing that while their determinants overlap, their intensity and channels of influence may differ. From a policy perspective, the results suggest that innovation-support policies should not be limited to R&D subsidies alone but also encourage training, quality certification, technology transfer, and energy management practices especially for small and medium-sized enterprises. Future research could extend this analysis by exploring interaction effects, longitudinal dynamics or sector-specific innovation pathways.

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