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The Role of Bank Funding, Institutional Quality and Bank Competition

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nInnovation Activities and Sustainable firm growth in Arab Countries: The Role of Bank Funding, Institutional Quality and Bank Competition

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Abstract:
The objective of this study is to explore the curvilinear relationship between innovation and sustainable firm growth, as well as the moderating role of bank funding on R&D, institutional quality and bank market power on this nexus. To do this, we selected a sample of 424 companies over the period 2010-2022. Using a systemic GMM model, the results show that there is a curvilinear (inverted U-shaped) link between innovation and sustainable firm growth. In addition, the outcome shows that bank funding on R&D, institutional quality and bank market power moderate the curvilinear nexus between innovation and sustainable business growth. This study offers valuable insights into strategic innovation planning and elaboration of important implications by highlighting the role of bank funding on R&D, institutional quality and the power of the banking market in promoting firm sustainability.

Keywords: Firm Innovation, Sustainable firm growth, Arab Countries, Bank funding, Institutional Quality, Bank market power, System GMM

1. Introduction

Despite the progress Arab countries have made so far, they still lag far behind the leading countries in spending on research and development (R&D). A key strategy for Arab countries to contribute to the global effort in science and technology is to strengthen the technological innovation capacity of enterprises. In 2022, Arabs countries had 634 766 full-time equivalent research and development personnel[1], which equals 1,374 researchers per million inhabitants. This is a relatively low level of staffing compared with other regions of the world, but it is not the lowest level. Additionally, in 2022, the total gross spending on R&D across countries in the Middle East was projected to be over $54.3 billion[2]. As for the percentage of GDP, the average R&D expenditure in the Arab world was around 0,73% of GDP in 2021[3]. The Global Innovation Index 2023, published by the World Intellectual Property Organization, shows that some Arab countries appear in this international ranking. It reveals that Morocco (ranked 70 in global classification and 8 in Lower middle-income (LMI) intergroup with score of 28,4) and Tunisia (ranked 79 in global classification and 9 in LMI intergroup with score of 26,9) are considered to be performing

[1] ALECSO, Statistical Bulletin N°8, 2022.
[2] Statista, Annual report, 2022
[3] World Bank, World Development Indicator, 2021

above expectations for their level of development in the lower middle-income group. Nonetheless, Arab countries are striving to become a significant force in science and technology in the longer term. To do so, firms that operate in Arab countries must increase their involvement in technology innovation initiatives and close the gap in their ability to innovate.

Efficient innovation by enterprises is a vital precondition for building a strong scientific and technical country, as is seen from the development practices of many countries. Several global experiences demonstrate that some countries have become innovative leaders through leveraging their firms' efficiency in innovation and research and development (R&D). Its success can be attributed to the fact that 90% of the innovative companies are local businesses, which also employ 90% of the R&D staff and provide 90% of the R&D expenditure (Liu X & Zhao Q (2024). Because Arab firms have limited resources for technological innovation, increasing the effectiveness of scientific and technology innovation is essential to boosting firm's capacity for independent innovation.

- **What drives innovation ?**

Innovation provides firms with a competitive advantage in their domestic and foreign markets (Porter (1992) and Agazu & Kero (2024)) and is an important driver of economic growth (Doe and Smith (2023)). In a more open, integrated and competitive global economy, innovation is a key driver not only of productivity and performance, but also of sustainable firm growth. Indeed, technological progress, through better assimilation and integration of artificial intelligence, represents an opportunity for Arab countries to reverse the downward trend in factor productivity. This should also accelerate potential growth, triggering a more inclusive and sustainable growth dynamic. It is therefore essential to understand the factors that influence innovation. There is a rich literature on the nature of the relationship between innovation and various firm and market variables. Empirical studies differ in their conclusions. Sometimes the same relationship is found to be positive, sometimes negative.

A further dimension that could affect this relationship is the way in which these activities are financed. Indeed, the type of financing of the firm's technological activities, e.g. through bank financing, the issue of securities (debt or equity) and private equity, is likely to affect the firm's technological competitiveness and financial performance in different ways. In fact, innovation activities need a market for loanable funds that is specifically able to allocate scarce resources and reduce the cost of risk. This market for loanable funds must also be sufficiently competitive and of sound institutional quality. As a result, the type of financing (bank versus market) and institutional quality play a dynamic role in innovation activity and hence in firm performance. In other words, improvements in factor productivity, and hence economic growth, are inextricably linked to support from the financial sector. Firms need substantial long-term financial support to carry out their innovation activities, and it is difficult to meet their needs by relying solely on internal financing.

Various theoretical postulates have pointed out the importance of innovation in driving firm growth (Nelson and Winter, 1982, Dosi et al., 1995, Aghion et al., 2005). Empirically, the effect of innovation activities on firm growth has been the subject of several studies. However, the results are mixed. Some studies have shown a positive relationship (e.g., Coad and Roa, 2008; Coad et al., 2016; Altuzarra, 2024), while others have shown a negative relationship (e.g., Pourkarimi and Kam, 2022). However, few studies have explored the non-linear relationship between innovation and firm performance (Li et al., 2021). Hence, this study will fill this gap, by examining the curvilinear relationship between innovation and sustainable firm growth.

In addition, another wave of literature has examined the moderating effect of certain factors (i.e., industry orientation (Mavroudi et al., 2023), firm life cycle (Yoo et al., 2019). However, these studies neglected the moderating effect of the bank funding for R&D, institutional quality and bank market power. This highlights a second gap that this study will fill.

For this reason, the aim of this study was to examine the curvilinear nexus between innovation activities and sustainable firm growth, as well as the moderating effect of the bank funding of R&D, institutional quality and bank market power on this relationship.

To achieve these objectives, this study endeavors to bridge this gap by investigating the subsequent research questions: (i) To what extent does the innovation enhance the sustainable growth of Arab countries? (ii) Is the correlation between innovation and sustainable growth likely to be strengthened or weakened by bank funding, institutional quality and bank market power?

Considering this context, the current paper aims to offer three key contributions to the existing body of literature. First, it represents a pioneering effort to investigate the nonlinear relationship between innovation and sustainable firm growth. Second, this study enhances the scholarly discussion by providing additional insights regarding the moderating role of bank funding of R&D, institutional quality and bank market power in this nexus. Third, while numerous studies have explored the impact of innovation on firm growth across various global contexts, this paper is the first to focus on the correlation between innovation and sustainable firm growth in the Arab countries.

The structure of the paper is as follows: Section 2 presents the theoretical framework and outlines the research hypotheses, while Section 3 focuses on the methodology and data utilized. In Section 4, the results are analyzed and discussed, leading to the conclusions presented in Section 5.

2. Literature review and hypotheses

2.1. Innovative activities and firm growth

The concept that elucidates the growth patterns of firms, referred to as Gibrat's law of proportional effects (Gibrat, 1931), posits that the firm growth is independent of its initial size. Consequently, this indicates that a firm's growth occurs in a random manner. In this context, various theoretical postulates have pointed out the importance of innovation in driving firm growth. First, innovation is critical to enable firms to differentiate themselves and survive in competitive environments. However, the costs of experimentation and adaptation implicit in innovation can become limiting on the resources available for rapid growth initiatives; sometimes there is a tension between innovation and growth (Nelson and Winter, 1982). Second, innovation follows technological trajectories that enable firms to develop a sustainable competitive advantage, which enables them to grow. However, in cases when firms significantly deviate from traditional frameworks or commit resources to highly experimental technologies, they put themselves at risk for potential short-run difficulties (Dosi et al., 1995). Third, innovation contributes to growth by increasing business competitiveness in turbulent conditions, often through Schumpeter's process of creative destruction. However, in hyper-competitive markets, innovative firms often face increased competition, which limits their ability to capture the returns needed to support long-term growth (Aghion et al., 2005).

From an empirical viewpoint, there seems to be no consensus on the impact of innovation activities on firm growth (Coad, 2009). Several studies have shown a positive relationship between innovation and firm growth (Monte and Papagni, 2003). For instance, using data from the US high-tech industries, Coad and Roa (2008) showed that innovation enhances firm growth. Additionally, using a sample of Spanish firms, Coad et al. (2016) indicated that young firms with high sales growth are positively affected by R&D investment. Regarding innovation persistence, Altuzarra (2024) suggested that the role of persistence in R&D activities is not significant. However, persistence in producing innovative outputs, such as products, processes, and patents, drives growth in firms with moderate to low sales growth rates. However, other studies provided a negative correlation between innovation activities and firm growth (e.g., Rosenbusch et al., 2011; Spescha, 2018).

Recently, certain studies examined the relationship between innovation and firm performance. For instance, using a sample of China firms, Peng and Toa (2022) showed that digital transformation has greatly enhanced financial firm performance. Using a survey of Tehran firms, Moradi et al. (2021) proved that open innovation positively impacted firm performance. Babina et al. (2024) showed that artificial intelligence enhances the firm's growth.

In terms of sustainability growth, sustainable growth theory (SGT) provides a framework for determining the maximum rate at which a company can grow its sales, assets, and equity without needing to increase its financial leverage (Higgins, 1977). In addition, sustainable growth is the highest possible annual sales-growth rate that a firm can achieve while maintaining specified ratios (Van Horne, 1987). Under the SGT, innovation is a critical factor in achieving long-term corporate growth. By making it possible to develop new products, services, and processes, innovation pushes the efficiency of operations and reduces costs, thereby bringing improved profitability (Saxena et al., 2024), which are two significant drivers of SGR. It further enhances asset utilization by developing more effective operations and increasing productivity, thereby resulting in higher sales per unit of asset and increased asset turnover ratio (Ferlito and Faraci, 2022). Moreover, innovation supports internal funding through improvement in sales and margins that allows the firms to save retained earnings for growth without refunding external financing (Skare and Porada-rochon, 2022). Innovation enables this through continued improvement that brings about a competitive advantage, relevance, and adaptability in dynamic markets. This eventually supports growth with financial stability, where innovation facilitates organic growth through better efficiencies and is not dependent on external funding (Labella-Fernández et al., 2021).

Although in recent years, sustainable firm growth has been determined by certain factors (financial inclusion (Khémiri et al., 2023); tangible investment (Khémiri et al., 2024)), the literature has not examined the impact of innovation activities on sustainable growth. Moreover, to the best of our knowledge, there are just a few papers that examine the non-linear relationship between innovation and growth. Aristizabal-Ramirez et al. (2015) investigated the threshold effect of innovation on economic growth (at county-level) showed that there is a nonlinear relationship between innovation on economic growth. In addition, Li et al. (2021) identifies an inverted U-shaped correlation between innovation and firm performance, with latent mechanisms suggesting that varying levels of exploration and exploitation influence performance, moderated by the number and strength of cluster relationships. Given this literature, our first hypothesis is as follows:

Hypothesis 1. *There is a curvilinear nexus between innovation and sustainable firm growth.*

H1(a). *Innovation positively affects sustainable firm growth.*

H1(b). *Innovation negatively affects sustainable firm growth.*

2.2. Moderating effect

2.2.1. Bank funding technological innovation in times of crisis.

Various studies show that innovative companies face significant difficulties in accessing external funding, particularly bank funding (Savignac, 2007). The lack, or limited access to financing firm innovation is accentuated in times of crisis and with the introduction of prudential reforms that banks must comply with (Haouat Asli, 2013).

Bank credit is a source of external financing that influences firm innovation (Ayyagari et al., 2011; Amore et al., 2013). The relationship between bank funding and innovation remains a subject of debate, although several studies have addressed it from different perspectives: the effect of competition (Gu et al, 2020; Liu and Zhao, 2024), deregulation (Amore et al, 2013), banking development (Benfratello et al., 2008), financial crisis (Haouat Asli, 2013; Nanda and Nicolas, 2014) and the Covid sanitary crisis (Trunschke et al., 2024). But recent studies have also focused on the risk culture and risk appetite of lending banks (Agarwal et al., 2019; Abu-Abbas and Hassan, 2024; Xu and *Al* (2024).

Several empirical studies show that R&D investment is procyclical due to uncertainty and insufficient liquidity during the economic recession period (Altig et al., 2020; Giebel and Kraft, 2020; Trunschke et al., 2024). The 2008 financial crisis challenged risk management practices in the banking system. Thus, banks have faced huge regulatory challenges in complying with the new prudential requirements related to maintaining financial stability, in response to their risk strategies (Agarwal et al., 2019). They must therefore adopt strategies that are consistent with regulatory constraints and ensure a better allocation of resources, which may be a burden for the innovative firms.

Basel III reform introduced new measures aimed essentially at increasing the quality and ratios of bank equity capital, which led to an increase in the cost of financing for the riskiest companies and a rationing of credit, particularly for long-term credits (Standard & Poor's, 2011). Many studies, both in the academic literature and in the banking profession, have analyzed the impact of prudential regulations on the levels of credit granted to companies and the interest rates applied to them, and agreed on the fact that tighter financial constraints and a tightening of the supply of credit weigh primarily on companies with a risky profile and insufficient guarantees.

According to the literature, bank funding for R&D therefore not only enhances innovation but also boosts its potential for sustainable firm growth by overcoming financial and operational challenges. Considering the prior discussions, the second hypothesis is articulated as follows:

Hypothesis 2. *Bank funding for R&D moderates the relationship between innovation and sustainable firm growth.*

2.2.2. Corporate finance constraints, prudential rules and bank's risk culture

Innovative companies are characterized by a relatively high level of risk, given their R&D investment activities, which require long-term credit, the uncertainty of generating a return on investment, and guarantees that are deemed insufficient to cover credit risk under prudential rules. According to Savignac (2007), French companies that qualify as JEI (*jeune entreprise innovante*) under the 2004 Finance Act face a 'triple-barrel' obstacle in accessing bank finance because of their intrinsic characteristics*: 'they are young, small and innovative'.* Firstly, innovative companies face a problem of asymmetric information vis-à-vis lending banks due to a lack of historical accounting and financial data to assess their risk profile, particularly for young companies, or due to the confidentiality surrounding the development of innovative projects. Moreover, Basel prudential regulations and the international accounting standard IFRS9 require banks to have a depth of historical and granularity of data on their debtors to assess their risk exposure and improve the quality of default prediction models (Kharoubi and Thomas, 2016).

Furthermore, an innovative project faces uncertainty, which is even higher in the start-up phase, regarding technical feasibility, the ability to develop and improve new products and its capacity to generate future economic benefits for the company (Hall and Lerner, 2010). These conditions must be met if expenses can be considered as investments and such reported as assets in respect of IAS 38 requirements. In addition, assessing the potential success of some innovative projects and the associated investment risk is a burden for the lending bank as it requires technical expertise and specialized know-how (Planès et al., 2002).

The financing restrictions that this kind of project may encounter are likely to be amplified by the nature and limited value of the guarantees provided by the innovative company to its bank. The guarantees intended to mitigate the risk perceived by the bank for a risky client or project are mainly represented by intangible assets that are difficult to evaluate and realize in the event of default. These assets largely correspond to expenditures on developing the innovative company's human capital (Hall and Lerner, 2010; Brown et al., (2012).

In economies where prudential rules are less restrictive, bank financing of innovative companies is more structured and accessible. The deregulation of banking activities in the US during the 1980s and 1990s improved the quantity and quality of innovative activities and stimulated the financing of innovative companies by banks and with more favorable conditions (Amore et al., 2013). In developing countries, where the economies are mainly based on SMEs, the role of banks is fundamental in financing and supporting the growing and innovative entities (Ayyagari et al., 2011). However, it is essential to adopt credit risk management policies that are in line with international best practices and to respect the recommendations of the International Monetary Fund and the World Bank to keep the non-performing loans (NPL) rate under acceptable levels.

Access to finance for firms engaged in technological innovation also depends on banks' risk culture. Some banks are reluctant and face a dilemma: adopting new proactive approaches and adjusting their risk appetite policies to support innovation or limiting access to finance for innovative companies by imposing more restrictive pricing conditions. Other banks are seeking solutions to better understand the risk profile of innovative companies and the characteristics of innovative projects to better assess the opportunities for financing them by offering appropriate schemes. It involves a mixture of financing based on the risk profile of the borrower. A bank must balance its risk appetite when lending together with maintaining its profitability. The assessment of risk appetite depends on several factors, including the economic health of the business, the profitability of the project and compliance with regulatory requirements. Amore et al, 2013 suggest that deregulated banks adopt bolder credit policies and lend to innovative firms with more favorable conditions. Xu and *Al* (2024) examined the impact of banks' risk culture on innovation on a sample of companies listed on the Chinese market over the period 2016 to 2020. The study concluded that financing from banks with a more developed risk culture promotes corporate innovation.

Hypothesis 3. *Risk culture moderates the innovation-sustainable firm growth nexus.*

2.2.3. Institutional quality and firm innovation.

In economic literature, institutional quality focuses on the interaction between firms and the factors that shape firm behavior (North, 1990; Williamson, 2000). In terms of innovation, Technological dynamism is the speed and extent of technological progress, which varies from one sector to another: (i) high dynamism sectors, (ii) low dynamism sectors (Li and Calantone, 1998). The first category experiences rapid progress and frequent adoption of new technologies. Indeed, companies in these sectors must continually improve by collaborating and accessing resources and knowledge. This enhances their competitiveness and performance. However, the second category is characterized by stability, infrequent change and longer technological life cycles (Zahra, 1996).

Regarding emerging countries, according to Kafouros & *al.* (2024), higher institutional quality can assist certain companies in emerging economies to become more competitive and enhance their performance, compared to others. In addition, to increase competitiveness and performance, emerging firms often face adverse conditions, intense competition and shortages of necessary technological resources (Wang and *al.*, 2020). As a result, three mechanisms have been argued to better explain this idea: (i) the ease and cost of identifying and establishing business partnerships and collaborations, (ii) the effectiveness of the legal framework and (iii) non-contractual exchange (Kafouros et al., 2024). Under the first mechanism, high-quality institutions are vital for collaborations and contracts in technologically dynamic industries (Gelbuda et al., 2008). These industries heavily depend on external partnerships. For comparison, high technology dynamic industries (e.g. pharmaceuticals and information technology firms) perform better in terms of strategic alliances than low technology dynamic industries (Hagedoorn, 2002). This distinction has its origins mainly in emerging countries, where firms rely on diverse networks of collaborators (Stojcic, 2021). According to the second mechanism, due to unpredictable technological evolution, firms diversify their portfolios to pursue new opportunities, which makes protection from imitation challenging (Zahra, 1996). A strong legal framework is crucial for emerging economies to protect firms and facilitate economic rents. Institutional quality is especially beneficial for firms in rapidly evolving industries (Aliyev and Kafouros, 2023). Under the third mechanism, in rapidly evolving industries, new technologies lead to the obsolescence of existing technologies and knowledge (Bessen and Maskin, 2009). Companies in these sectors must continuously enhance capabilities and adapt product offerings. They heavily rely on external markets to address challenges and improve internal capabilities (Nelson, 2009). This dependence is stronger in emerging economies. To cope with rapid changes, companies need to seek external expertise and access resources that they do not possess or cannot develop cost-effectively and timely (Swan and Allred, 2003).

Recently, certain studies suggested that countries that recognize innovation as a key driver of economic development create an environment that fosters innovative activity. Such an environment is linked to the quality of the institutions, which in turn relies on governance and the level of corruption in the country (Focacci et al., 2023). Wu and Wang (2024) suggest that innovation strategies and corruption are significantly moderated by institutional quality which also includes a stable regulatory environment and an effective legal system to ensure that intellectual property rights are protected, thereby boosting the confidence of investors who can benefit from their innovations without fear of counterfeiting (Donges et al., 2023).

Given this literature, institutional quality is vital in moderating the link between innovation and sustainable firm growth, affecting how firms utilize their innovative capabilities. In rapidly changing sectors, high institutional quality facilitates smoother interactions and lowers transaction costs. A solid institutional environment, characterized by stable governance, low corruption, and strong intellectual property protection, encourages innovation investment and enhances stakeholder trust. This is crucial in emerging economies, where firms face technological gaps and limited resource access. By improving external resource access, ensuring innovation returns, and fostering resilience against technological uncertainty, institutional quality strengthens the impact of innovation on sustainable growth. Thus, it is a key moderator that enhances the innovation-sustainable growth relationship, especially in complex institutional contexts. The fourth hypothesis follows:

Hypothesis 4. *institutional quality moderates the innovation-sustainable firm growth*

2.2.4. **Banks Market power hypothesis and corporate innovation**

When it comes to the relationship between banking competition and innovation, there are two distinct and generally opposing theoretical approaches. The first, based on the information hypothesis, suggests that banks with an informational advantage in a monopoly market efficiently select high-potential firms and establish long-term customer relationships to channel credit to creditworthy customers. According to this approach, banks operating in competitive markets are more reluctant to lend to firms whose financial strength is weak or whose financial information is incomplete (Liu X & Zhao Q, 2024). This approach favors the formation of monopoly markets so that banks can exploit the private information they have about their customers and effectively select innovative firms. On the other hand, the second approach, based on the market power hypothesis, argues that a competitive banking market allows for better segmentation of firms and reduces adverse selection. Innovative firms are thus less dependent on a single dominant bank and have greater bargaining power. This makes it easier for them to obtain bank financing.

According to Zaho and Jee (2024), several empirical studies have found evidence in support of information theory (Ratti, Lee, and Seol's (2008), Petersen and Rajan (1995)). It should be noted, however, that the market power hypothesis is more strongly supported by recent empirical work. It has been shown that a banking monopoly inevitably leads to an excessive increase in lending rates (Carbo-Valverde, Rodriguez-Fernandez, & Udell (2009)). Also, banks will extend loan terms aiming to maximize profits. This practice raises the cost of debt for businesses and hinders their access to credit. However, a competitive banking market structure can effectively reduce the financing constraints on firms' R&D investment activities. This effect is particularly significant for non-state firms, science and technology firms, and small and medium-sized micro-enterprises. Similarly, Jiang, Cai and Li (2019) show that increased competition in the banking sector reduces the information asymmetry between banks and their corporate counterparties, thereby easing the financing constraints faced by firms.

Most studies have focused on the impact of banking competition on firm innovation, highlighting how it fosters technological growth and incentivizes firms to engage in innovative research and development. According to Chen, Sinha, Hu and Shah (2021), increased competition in the banking sector can lead to lower financing costs, lower lending criteria and easier access to credit facilities for small and medium-sized enterprises. Innovative ideas can help firms to increase their revenues. According to Benfratello et al. (2008), bank loans are the most important source of financing for firms with technological innovations. They also suggest that increased banking competition helps firms innovate products and streamline internal procedures, which is particularly beneficial for small and medium-sized enterprises (SMEs) and those requiring large external financing. Deepening the banking sector is also likely to encourage technological and innovative firms to innovate, as shown by Li and Du (2021). Increased bank competition leads to more lending to high-quality firms, which also reduces their financing constraints and encourages investment in innovation.

Several studies have shown that increased competition among banks reduces the information asymmetry between the bank and its corporate clients, thereby easing the financing constraints of the latter (Jiang et al., 2019). From this point, a competitive banking market structure is likely to reduce firms' financing constraints on R&D investment. This effect is particularly pronounced for private firms and technology firms. Considering the research by Fan et al. (2021), it has been shown that the liberalization of financial activities and the competitive determination of interest rates are likely to reduce the constraints related to the external financing of innovative and technological firms. Indeed, a competitive interest rate could lead to a decrease in lending rates and an increase in the supply of credit to the benefit of these firms.

Faced with this literature, bank market power plays a crucial role in the relationship between innovation and sustainable business growth by affecting financing for R&D. Banks with significant market power have better information access, allowing them to identify innovative firms and provide long-term financing options (Liu & Zhao, 2024; Petersen & Rajan, 1995). However, this dominance can lead to higher borrowing costs and extended loan terms, negatively impacting the innovation capabilities of small and medium-sized enterprises (SMEs) (Carbo-Valverde et al., 2009). Conversely, a competitive banking environment reduces information asymmetries and financing constraints, allowing innovative firms to access diverse credit sources and better conditions, such as lower interest rates and fewer credit hurdles (Jiang, Cai, and Li, 2019; Chen et al., 2021). This is especially relevant for technology and private sector firms reliant on external financing for innovation. Additionally, competition among banks may encourage better resource allocation based on project quality, enhancing innovation's impact on sustainable growth (Benfratello et al., 2008). Figure 2 explains this conceptual model. Therefore, we hypothesize that

Hypothise 5. *Bank market power moderates the link between innovation and sustainable firm growth.*

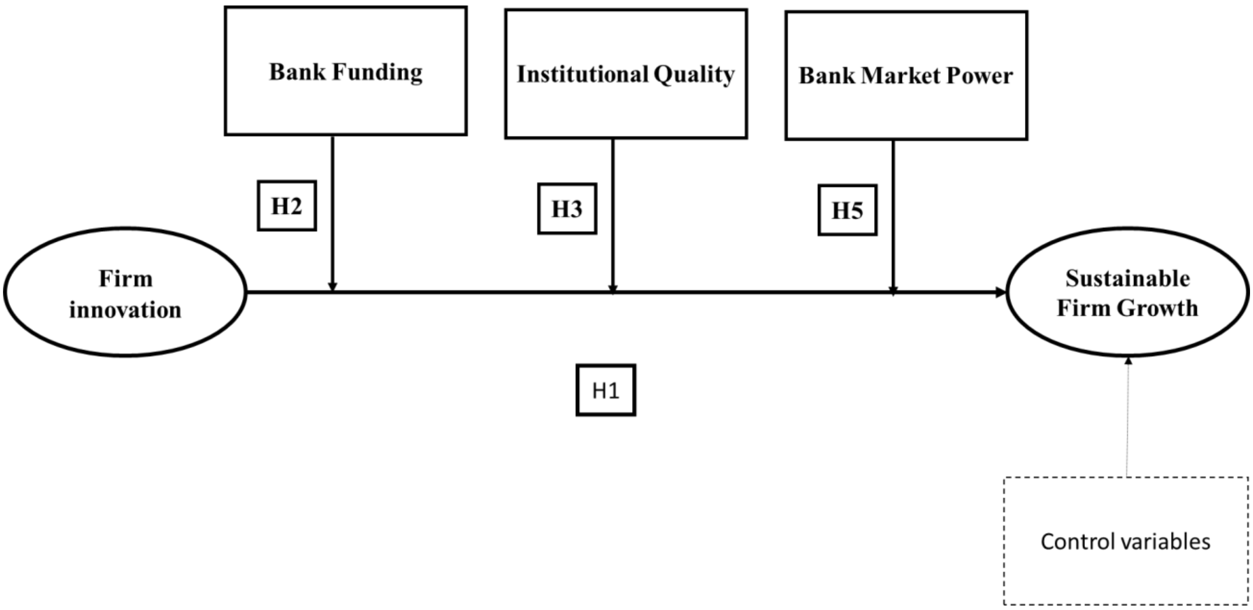

Figure 1. Conceptual framework

3. Research design.

3.1. Data

This research involved 424 companies listed on ten stock exchanges in Bahrain, Egypt, Jordan, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, and the United Arab Emirates. The study covers the years 2010 to 2022 and used data from multiple sources, including Refinitiv Eikon for firm-level information and the World Bank's World Development Indicators for macroeconomic indicators. According to the Thomson Reuters Eikon database, our initial sample includes 1184 listed firms in the MENA region. However, we exclude firms from the financial sector because of their different governance features. Furthermore, we have removed organizations that do not have three successive years of data in the period under consideration, and firms that do not have information on intangibles assets. After applying these criteria, our final sample consists of 424 firms. These firms are categorized based on Thomson Reuters Eikon database procedure, which results in a total of 5512 firm-year observations. To reduce the impact of outliers on our examination, we applied winsorization to all firm-level variables at the 1st and 99th percentiles.

These countries were selected because they represent different economic and innovation contexts, thus providing a comparative basis for analysis. The resource-rich GCC countries use ambitious national policies to foster innovation as part of broader economic diversification strategies. For instance, the UAE has emerged as one of the world's leading startup hubs in technology; on its part, Saudi Arabia is investing massively in artificial intelligence and renewable energy. In contrast, the non-oil-producing countries like Egypt, Jordan, Morocco, and Tunisia concentrate on innovation in agriculture, manufacturing, and information technology sectors—often through technopoles and in cooperation with multinationals. Across the sample, there are policies supportive of innovation: the UAE has established technology free zones like Dubai Internet City, while Qatar and Saudi Arabia use sovereign wealth funds to invest in cutting-edge technological projects. These initiatives highlight the strategic role that innovation can play in advancing competitiveness with respect to energy, transport, logistics, and finance. Second, regional interoperability —enhanced by the likes of the GCC and multilateral agreements—promotes cooperation and competition among firms operating in integrated markets. Third, this sample represents diverse models of innovation: from government-driven approaches (as seen in Saudi Arabia and the United Arab Emirates) with high levels of public investment, to private sector-driven models based on the initiatives of private companies with foreign capital (Jordan, Kuwait, Morocco, and Tunisia). Innovation policies in these countries are more oriented towards market-led growth and industrialization driven by foreign companies, whose technological decisions remain under their control.

Table 1. Distribution and breakdown of firms

Panel A: Distribution			
Countries	Number of firms	Number of observations	Percentage
Bahrain	25	325	6%
Egypt	66	858	15%
Jordan	73	949	17%
Kuwait	58	754	14%
Morocco	24	312	6%
Oman	37	481	9%
Qatar	19	247	4%
Saudi Arabia	71	923	17%
Tunisia	22	286	5%
UAE	29	377	7%
Total	424	5512	100%

Panel B: Breakdown	
Number of firms	1184
Less financial sector firms	362
Less firms that do not have three successive years of data available during the period are under consideration and firms that do not have innovation information	398
The final sample	424

3.2. Measurement of variables

3.2.1. Dependent variable

To measure sustainable firm growth, we follow several empirical studies (e.g., Huang et al., 2019; Akhtar et al., 2022; Khémiri et al., 2024) using sustainable firm growth (SFG) rate based on the Higgins model (Higgins 1977). This rate is measured as follows:

$$SP = \text{Net profit ratio} \times \text{Asset turnover ratio} \times \text{Retention rate} \times \text{Equity multiplier} \tag{1}$$

where, net profit rate: net income to net turnover; turnover rate: net turnover to total assets; retention rate: retained earnings to net profit; and equity multiplier: total assets to total equity.

3.2.2. Independent variable

According to the financial literature, there is no consensus on how to measure corporate innovation. Some studies use research and development (R&D) expenditure (e.g., Geo et al., 2025). Other studies used the number of patent applications (e.g., Li and Peng, 2024). This paper uses the intangible assets divided by total assets to measure the firm innovation, in line with some studies such as Bagna et al., (2021) and Kramer et al. (2011).

3.2.3. Moderator variables

The second objective of this study is to analyze the moderating effect of bank financing, institutional quality and bank market power on the relationship between innovation and sustainable growth. Consequently, three moderating variables are considered: (i) Bank fundings, (ii) Institutional quality and (iii) Bank market power.

To measure the bank funding, R&D expenditure is first subdivided between the public and private sectors. Expenditure in the private sector is then split between self-financing and bank financing. In the absence of information on the external financing rate of companies in the given country, it is assumed that companies self-finance 90% of their R&D expenditure. Then, bank funding for R&D expenditure (*BfI*) is measured by this formula: private R&D expenditure x (1 - self-financing ratio).

To measure the institutional quality, we follow Khémiri et al., (2024) using a composite variable. To measure the county governance, Kaufmann et al. (2011) used six indicators: Voice and Accountability, Political Stability, Government Quality, Regulatory Quality, Rule of Law, and Control of Corruption. These indicators are estimated to be between -2.50 and +2.50. Higher values represented more robust institutions and better governance. To combine these indicators, we employ principal component analysis (PCA). In addition, to facilitate analysis, we normalize the composite variable, using the min-max normalization technique, assigned to each country on a scale of 0 to 1.

To measure the bank market power, we follow Rajhi and Salah (2011), Salah and Chafai (2021), and Li and Peng (2024) using the Lerner index. This index indicates the level of monopoly control in the market by quantifying the extent of difference between price and marginal cost. It measures as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{2}$$

Where P_{it} denotes the standard output price of bank i at year t measured by the ratio of total income to total assets; MC denotes the marginal cost. The Lerner index ranges between 0 and 1 and would show the deviation between price and marginal cost. A higher Lerner index indicates a higher monopoly power and lower competitiveness. In a perfectly competitive market, the Lerner index is zero. However, the marginal cost cannot be directly observed. Therefore, to estimate it, we will derive it from a cost function. Following Li and Peng (2024), we construct a translog cost function to derive the bank's cost function, and then take its first-order derivative to obtain the bank's marginal cost. In practical market contexts, financial institutions may deviate from the efficiency frontier and confront difficulty in achieving production levels consistent with the optimal frontier. For this reason, this study applies to the panel stochastic frontier model to estimate the bank's cost function. The translog cost function (TCF) used by the bank is expressed as the following:

$$\begin{aligned} \mathrm{lncost}_{it} = {} & \beta_0 + \beta_y \mathrm{lnta}_{it} + \sum_{n=1}^{3} \beta_n \mathrm{lnw}_{nit} + \frac{1}{2}\beta_{yy}\left(\mathrm{lnta}_{it}\right)^2 + \frac{1}{2}\sum_{n=1}^{3}\sum_{m=1}^{3} \beta_{nm} \mathrm{lnw}_{nit} \mathrm{lnw}_{nit} \\ & + \sum_{n=1}^{3} \beta_{ny} \mathrm{lnta}_{it} \mathrm{lnw}_{nit} + \delta_i + \varepsilon_{it} - \nu_{it} \end{aligned} \tag{3}$$

Where, $Cost_{it}$ is the total cost of bank i in year t; ta_{it} denotes the total assets (i.e., output) of bank i in year; w_{it} signifies the three-input price: (i) capital (non-operating expenses to fixed assets), (ii) labor (management expenses to fixed assets), and (iii) funds (interest expenses to total deposits). δ_i stands for the year fixed effect, ε_{it} is the random error term, and ν_{it} represents the production inefficiency term. However, in TCF, the principles of symmetry, cost exhaustion and homogeneity must be respected by input prices. Therefore, it is important to satisfy these constraints in equation

3. These constraints are followed by $\sum_{n}^{3}\beta_{n}=1$; $\sum_{n}^{3}\beta_{nm}=0, \forall m$; $\sum_{n}^{3}\beta_{ny}=0$. In this case, the marginal cost of banking is calculated by inserting these constraints into equation 2 as follows:

$$\text{M.cost} = \frac{\partial \text{cost}_{it}}{\partial \text{ta}_{it}} = \frac{\text{cost}_{it}}{\text{ta}_{it}} \times \frac{\partial \ln\text{cost}_{\text{it}}}{\partial \ln\text{ta}_{\text{it}}} = \frac{\text{cost}_{it}}{\text{ta}_{it}} \times \left(\beta_y + \beta_{yy}\ln\text{ta}_{\text{it}} + \sum_{n=1}^{3}\beta_{ny}\ln\text{w}_{\text{it}} \right) \tag{4}$$

Although the marginal cost has been estimated, the Lerner index for each bank can be calculated from equation 2. Finally, to construct the Lerner index at the country level, we follow Li and Peng (2024) using this formula:

$$Lerner_t = \sum_{i}^{n} \frac{Lerner_{it} \times Branch_{it}}{\sum_{i}^{n} Branch_{it}} \tag{5}$$

Where, $Lerner_{it}$ is the Lerner index calculated for bank i in year t, and $Branch_{it}$ is the number of branches of bank i in year t. To estimate the Lerner index, we use 85 Arab listed banks for the teen Arab countries.

3.2.4. Control variables

Following previous studies (e.g., Khémiri et et al., 2023; Khémiri et et al., 2024), we employ several control variables which affect sustainable firm growth. These control variables include leverage, firm size, asset tangibility, risk, non-debt tax shields, liquidity, inflation, and GDP growth. Table 2 summarizes the definition of variables.

Table 2. Definition of variables

Variables	Symbol	Definition	Source
Sustainable firm growth	SgR	Net-profit ratio x Asset-turnover ratio x Retention ratio x Equity multiplier	Refinitiv Eikon
Firm innovation	Inov	Intangible assets to total assets	Annual reports, data stream
Bank funding	BfI	private R&D expenditure x (1 - self-financing ratio)	WDI & other reports
Institutional quality	Iq	Composite variables using PCA	WGI
Bank market power	MP	Lerner index	Refinitiv Eikon
Leverage	LeV	Total debt to total assets	Refinitiv Eikon Refinitiv Eikon
Firm size	SiZE	Natural logarithm to total assets	Refinitiv Eikon
Asset tangibility	TaNG	Fixed assets to total assets	Refinitiv Eikon
Firm risk	RiSK	Altman’s Z-score	Refinitiv Eikon
Non-debt tax shields	NdTS	Depreciation to total assets	Refinitiv Eikon
Liquidity	LiQ	Current assets to current liabilities	Refinitiv Eikon
Inflation rate	InF	Consumer prices index (annual %)	WDI
GDP growth	GdPG	GDP growth rate (annual %)	WDI

3.3. Econometric model

3.3.1. Baseline model

The relationship between Firm innovation activities and sustainable firm growth could be nonlinear. To examine their relationship, this study first sets up a Twostep system GMM. The econometric model is shown in Equation (6).

$$\begin{aligned} SgR_{cit} = \alpha_i + \beta_1 SgR_{cit-1} + \beta_2 Inov_{cit} + \beta_3 Inov_{cit}^2 + \beta_4 LeV_{cit} + \beta_4 SiZE_{cit} + \beta_4 TaNG_{cit} \\ + \beta_4 RiSK_{cit} + \beta_4 NdTS_{cit} + \beta_4 LiQ_{cit} + \beta_4 InF_{cit} + \beta_4 GdPG_{cit} + \varepsilon_{it} \end{aligned} \quad (6)$$

Where, SgR_{cit} is the sustainable growth ratio of country c, of firm i, at the time t, $\mathrm{SgR}_{\mathrm{cit-1}}$ is the lagged one-year sustainable growth ratio, Inov_{cit} is the R&D expenditure, Inov_{cit}^2 is the square term of R&D expenditure, LeV_{cit} is the leverage, $SiZE_{cit}$ is firm size, $TaNG_{cit}$ is firm tangibility, $RiSK_{cit}$ is Altman's Z-score, $NdTS_{cit}$ is the non-debt tax shields, LiQ_{cit} is the liquidity, InF_{cit} is inflation rate, $GdPG_{cit}$ is the GDP growth rate (annual %).

Several studies (e.g., Akhtar et al., 2022; Khémiri et al., 2024), have adopted the systemic GMM (SGMM) technique (Blundell and Bond, 1998) to analyze sustainable firm growth, which allows us to overcome the problems of heterogeneity and endogeneity in dynamic panels. This approach is particularly effective when the time dimension of the panel is smaller than its cross-sectional dimension. To deal with unobserved heterogeneity, we computed the first difference of all variables, which revealed a first-order autocorrelation in the residuals, confirmed by AR (1) tests rejecting the null hypothesis of no autocorrelation. On the other hand, AR (2) tests did not reject this hypothesis, indicating the absence of second-order autocorrelation and thus validating the dynamic structure of the models. The use of valid instruments is crucial for dynamic GMM estimation, so we applied Hansen's J test, which confirmed the validity of the instruments in our models (Arellano and Bond, 1991).

3.3.2. Moderating effect

To explore additional consequences, this study aims to examine how bank financing, institutional quality and bank market power moderate the relationship between firm innovation and sustainable firm growth. To assess our second hypothesis, we will adjust the baseline model. Specifically, we will include interaction terms in Equation (6) as follows:

$$\begin{aligned} SgR_{cit} = \beta_0 + \beta_1 SgR_{cit-1} + \beta_2 Inov_{cit} + \beta_3 Inov_{cit}^2 + \beta_4 FBFI_{ct} \\ + \beta_5 Inov_{cit} \times FBFI_{ct} + \beta_6 Inov_{cit}^2 \times FBFI_{ct} \\ + \beta_7 LeV_{cit} + \beta_8 SiZE_{cit} + \beta_9 TaNG_{cit} + \beta_{10} RiSK_{cit} \\ + \beta_{11} NdTS_{cit} + \beta_{12} LiQ_{cit4} + \beta_{13} InF_{cit} + \beta_{14} GdPG_{cit} + \varepsilon_{it} \end{aligned} \quad (7)$$

$$\begin{aligned} SgR_{cit} = \beta_0 + \beta_1 SgR_{cit-1} + \beta_2 Inov_{cit} + \beta_3 Inov_{cit}^2 + \beta_4 Iq_{ct} \\ + \beta_5 Inov_{cit} \times Iq_{ct} + \beta_6 Inov_{cit}^2 \times Iq_{ct} \\ + \beta_7 LeV_{cit} + \beta_8 Size_{cit} + \beta_9 TaNG_{cit} + \beta_{10} RiSK_{cit} \\ + \beta_{11} NdTS_{cit} + \beta_{12} LiQ_{cit4} + \beta_{13} InF_{cit} + \beta_{14} GdPG_{cit} + \varepsilon_{it} \end{aligned} \quad (8)$$

$$
\begin{aligned}
SgR_{cit} = {} & \beta_0 + \beta_1 SgR_{cit-1} + \beta_2 Inov_{cit} + \beta_3 Inov_{cit}^2 + \beta_4 MP_{ct} \\
& + \beta_5 Inov_{cit} \times MP_{ct} + \beta_6 Inov_{cit}^2 \times MP_{ct} \\
& + \beta_7 LeV_{cit} + \beta_8 SiZE_{cit} + \beta_9 TaNG_{cit} + \beta_{10} RiSK_{cit} \\
& + \beta_{11} NdTS_{cit} + \beta_{12} LiQ_{cit4} + \beta_{13} InF_{cit} + \beta_{14} GdPG_{cit} + \varepsilon_{it}
\end{aligned} \tag{9}
$$

Were, $FBFI_{ct}$ is bank financing, Iq_{ct} is the institutional quality and MP_{ct} is the bank market power.

4. Empirical results and discussion

4.1. Statistical analysis

In order to determine the stationarity of the variables in our balanced panel, several unit root tests were conducted, including the Levin-Lin-Chu (Levin et al., 2002) and Im-Pesaran-Shin (Im et al., 2003) tests. The null hypotheses of these tests suggested that all the panels had a unit root. The findings of these tests are detailed in Table 3, indicating that all variables were stationary at the level, specifically I (1).

Table 3. Unit root tests

Variable	LLC	IPS
	1st difference	1st difference
SgR	-4.962***(0.000)	-10.782***(0.000)
Inov	-13.438***(0.000)	-33.413***(0.000)
BfI	-24.578***(0.000)	-8.847***(0.000)
Iq	-44.857***(0.000)	-42.428***(0.000)
BmP	-3.570***(0.000)	-11.229***(0.000)
LeV	-19.074***(0.000)	-2.682***(0.003)
SiZE	-30.179***(0.000)	-4.479***(0.000)
TaNG	-16.523*** (0.000)	-21.757***(0.000)
RiSK	-12.883***(0.000)	-3.877***(0.000)
NdTS	-12.198***(0.000)	-5.1623***(0.000)
LiQ	-48.613***(0.000)	-10.068***(0.000)
InF	-10.750***(0.000)	-12.642***(0.000)
GdPG	-22.539***(0.000)	-18.124***(0.000)

Note: *** reflects the s

Table 4 summarizes the descriptive statistics for all the variables used in this study. The descriptive statistics show that the average sustainable firm growth (SgR) of the sample over the period 2010-2022 is 0.886. Furthermore, the average value of firm innovation disclosure is 0.212 in terms of total assets. This suggests that Arab firms invest significantly in R&D relative to their assets. This may reflect a strategy focused on innovation. As for bank funding (BfI), it recorded an average value of about 16.424. In addition, the average level of institutional quality is estimated at 0.453. This suggests that, on average, the institutional quality in Arab countries is below the median point of the scale used for measurement. This indicates that there is significant room for improvement in areas like governance, legal frameworks, and anti-corruption measures. The average level of market power (MP) is estimated at 0.343. It suggests that, on average, firms in Arab countries have moderate market power. This means they can set prices somewhat above their marginal costs, but not to the extent of a monopoly.

Table 4. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
SgR	5512	0.886	14.899	-19.961	881.932
Inov	5512	0.212	0.188	0.010	0.650
BfI	5512	16.424	2.689	11.915	20.836
Iq	5512	0.453	0.246	0	1
MP	5512	0.343	0.076	0.177	0.512
LeV	5512	0.228	0.203	0.001	1.059
SiZE	5512	12.451	2.450	7.713	18.383
TaNG	5512	0.322	0.259	0.002	0.898
RiSK	5512	1.337	1.850	-2.713	12.609
NdTS	5512	0.032	.031	0.003	0.174
LiQ	5512	0.385	0.272	0.005	0.929
InF	5512	0.047	0.110	-0.260	0.338
GdPG	5512	-0.004	0.037	-0.152	0.067

Figure 2 illustrates the evolution of the firm's level of innovation and sustainable firm growth rate. The innovation curve shows a steady progression, reflecting a continuous increase in R&D investment relative to operating income, indicating a sustained commitment to innovation by Arab firms. At the same time, the SGR curve follows an upward trend with more pronounced variations, particularly around 2020. These fluctuations suggest the influence of factors such as reinvested earnings or the financial structure of firms on their ability to maintain sustainable growth. The two indicators are potentially correlated, suggesting that investment in R&D could contribute to sustainable growth. In fact, these two indicators will fall sharply in 2020, probably because of the Covid-19 pandemic.

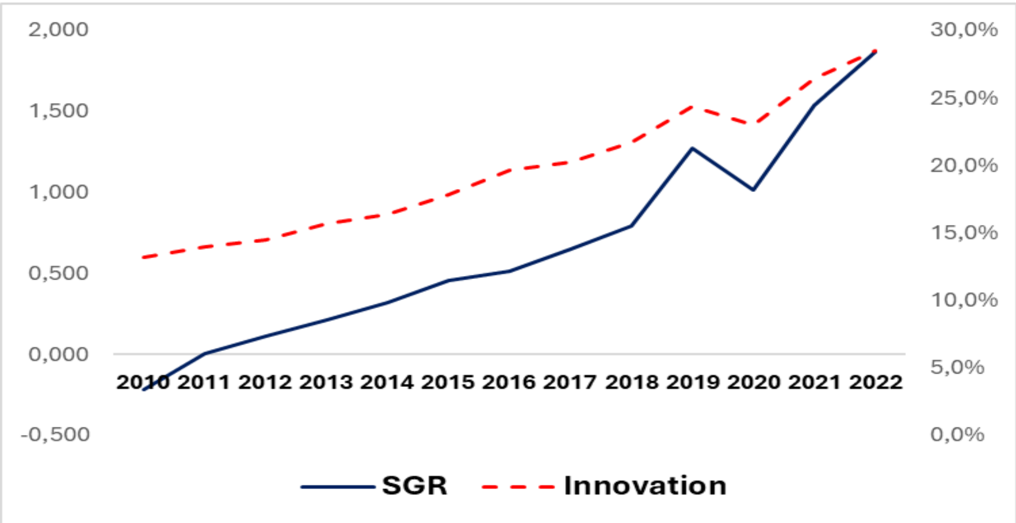

Figure 2. Sustainable firm growth and innovation activities across Arab countries.

The results of the Pearson correlation matrix are reported in table 5, showing that there are no problems of multicollinearity between the variables (estimated coefficients do not exceed 0.80).

Table 5. Correlation matrix coefficients and VIF results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	VIF
(1) SP	1.000													
(2) Innov	0.022*	1.000												1.15
(3) BfI	-0.021*	0.011	1.000											1.02
(4) Iq	0.021	0.180*	-0.086*	1.000										1.45
(5) MP	-0.010*	0.014	-0.044*	0.338*	1.000									1.29
(6) LeV	0.010	-0.052*	-0.035*	0.065*	-0.041*	1.000								1.10
(7) SiZE	0.013*	0.003	-0.040*	-0.011	-0.076*	0.035*	1.000							1.03
(8) TaNG	0.016*	-0.076*	-0.063*	-0.028*	-0.003	0.123*	0.098*	1.000						1.22
(9) RiSK	0.010	-0.247*	0.024	-0.121*	-0.129*	-0.014	-0.085*	-0.223*	1.000					1.25
(10) NdTS	0.078*	-0.034*	-0.042*	0.046*	-0.114*	0.260*	0.038*	0.187*	0.187*	1.000				1.19
(11) LiQ	0.040*	-0.119*	-0.013	-0.342*	-0.147*	-0.016	-0.006	-0.212*	0.116*	-0.009	1.000			1.21
(12) InF	-0.039*	-0.158*	0.048*	-0.311*	-0.064*	-0.030*	-0.012	-0.040*	0.097*	-0.048*	0.091*	1.000		1.25
(13) GdPG	-0.040*	-0.114*	0.080*	-0.295*	-0.334*	-0.054*	0.021	-0.009	0.104*	-0.005	0.115*	0.361*	1.000	1.31
Mean VIF														1.21

* Denotes statistical significance at the 1% level.

4.2. Baseline results

In this subsection, we aim to explore the non-linear (curvilinear) relationship between firm innovation and sustainable growth within Arab listed firms using the two-stage SGMM technique. The results of the J-Hansen test in Table 6 confirm the validity of the null hypothesis for the instrumental variables. Additionally, the AR (1) test supports the null hypothesis that there is no autocorrelation in the first-differenced errors. Furthermore, the result of AR (2) further proves the strength of the null hypothesis by indicating no second order correlation. Based on these findings, it can be concluded that the SGMM estimator is suitable for this study.

The results reported in columns (1) and (2) of Table 6 reveal that the coefficients related to the lagged sustainable firm growth (SgR_{t-1}) are positive and statistically significant at the 1% level on sustainable firm growth (SgR_t) (columns 1 and 2). Specifically, the coefficient of the SgR_{t-1} influences SgR_t positively and significantly. However, since the coefficient is equal to 0,134, well below one, it indicates a dynamic relationship. In addition, while past SgR significantly influences current SgR, this inertia tends to decrease over time. Knowledge gained in the previous efforts will help implement new sustainable strategies more effectively, which, in turn, will lead to reinforcing initial effort through technology appropriation, supporting current growth. The positive effect of previous growth was identified by certain studies (e.g., Akhtar et al., 2022; Khémiri et al., 2023, Khémir et al., 2024).

Furthermore, regarding the linear impact of innovations on sustainable firm productivity. The outcomes indicated that *Inov* has a positive and significant impact on *SgR* (column (1)). More precisely, raising the *Inov* by 10% leads to a 1.94% increase in the *SgR*.

To better comprehend the findings, it is valuable to explore the connection between *Inov* and *SgR* using a U-shaped test. Including the quadratic term of *Inov* indicates a negative impact on *SgR*, indicating an inverted U-shaped curve. However, this observation alone is not enough to confirm the presence of this curve. It is crucial to assess both the lower and upper bounds of the correlation, as well as the critical point. To do so, we follow several studies (e.g., Chafai et al., 2024, Khémiri et al., 2024) using the U-shaped curve test of Lind and Mehlum (2010). The results of this test are reported in table 7, which indicates that there is an inverted U-shaped relationship between *Inov* and *SgR*. These outcomes confirm hypothesis 1. This finding is consistent with Li et al. (2021), showing that there is an inverted U-shaped between innovation and firm performance.

Specifically, firms on the left side of the graph in Figure 1 will see their sustainable productivity improve as their innovation activities increase, while those on the right side of the graph will see their sustainable firm growth decrease significantly as their innovation activities decline after reaching a certain threshold. More precisely, the *FbI* coefficients move from positive to negative. When *Inov* reaches 47.6%, there is an inflection point beyond which sustainable growth begins to decline. Specifically, firms' productivity increases in the early stages of technological innovation development, peaks, and then declines as the innovation is further developed. This raises concerns about inefficiency in R&D spending, which is a significant issue for business leaders. In terms of a comparison, this inflection point is above the inflection point of 0.398 proved by Li et al. (2021) in the context of Chinese firms.

The positive impact can be explained by the fact that innovation drives growth and development in Arab firms, promoting competitiveness, effectiveness, and sustainability. More specifically, in the initial growth phase, Arab companies focus primarily on productivity growth, often to the detriment of effective R&D spending. As the industrialization strategy progresses and the use of advanced technologies increases, the company's intangible assets grow until a tipping point is reached. This tipping point is estimated at 0.47, meaning that intangible assets represent 47% of the balance sheet total. Beyond this tipping point, the company can no longer increase its sustainable productivity as easily. It is then forced to rationalize its R&D spending and consolidate its intangible assets. Concerns about technological efficiency have become more significant, and stricter policies are implemented to reduce all forms of inefficiency and resource waste. Also, it allows high quality goods and services, increasing market share and customer loyalty. It enables market expansion, attracting a wider customer base. Innovation improves operational efficiency, reducing costs and increasing productivity. It creates employment opportunities, increases income levels, and improves living standards. It promotes sustainability and aligns consumer demand for eco-friendly products. Innovation is transformative in shaping the Arab business and economic landscape. This outcome is in line with the findings of Dosi et al. (1995), Coad et al. (2016), and Babina et al. (2024). Hence, hypothesis 1(a) is confirmed.

However, although it is a driver of business growth in the Arab region, innovation could also negatively impact firm growth when the profitability and efficiency of R&D expenditures are low, due to the high costs of implementing new technologies or the limited scope of innovations. In addition, the risk of failure is a real concern, as not all innovative ventures deliver the expected returns, potentially resulting in significant financial setbacks. While technological progress is beneficial, it could also lead to job displacement through automation, resulting in a greater need for highly skilled workers compared to low-skilled workers. This shift could involve higher wages and reduced firm performance if productivity is not sufficiently high. Market disruption is another issue, as innovation may make existing business models outdated, putting companies that fail to adapt at a competitive disadvantage. Finally, regulatory challenges can create barriers, especially in industries with strict compliance requirements, as navigating these regulations can be both expensive and time-consuming. These factors highlight the intricate environment that Arab firms must navigate to successfully innovate. This result consists with Aghion et al. (2005) and Spescha (2018). Hence, hypothesis 1(b) is confirmed.

This result can be better appreciated by assessing the results of company- and country-specific control variables. Leverage had a negative impact on sustainable firm growth. This outcome could be explained by the fact that financial systems in Arab countries are generally dominated by banks, and alternative financing options (such as equity or venture capital) are limited. Strict repayment terms and high interest rates imposed by banks can be problematic for highly indebted firms, limiting their ability to make profitable investments and thus slowing their sustainable growth (Akhtar et al., 2022). The firm size negatively impacts the sustainable firm growth. The negative impact indicates that Gibrat's law does not apply. This outcome is consistent with those obtained by Akhtar et al. (2022) and Khémiri et al. (2024).

However, asset tangibility has a positive impact on sustainable firm growth. This outcome suggests that firms in Arab countries have sufficient tangible assets to ensure their sustainability. In particular, the absence of collateral hinders firms from obtaining external funding, dissuades lenders from offering loans for their growth initiatives, and secures their longevity. Moreover, firm risk had a positive association with sustainable firm growth. The findings suggest that Arab companies with high risk levels may face challenges in attracting investors or obtaining financing, thus hindering their capacity to fund new initiatives or grow their business. In addition, NDTS has a positive effect on sustainable firm growth. This positive correlation suggests that Arab firms are utilizing tax advantages as a substitute to support their growth. This aligns with findings from Akhtar et al. (2022) and Khémiri et al. (2024), indicating that firms are capitalizing on tax benefits to sustain their expansion. The presence of LIQ also has a beneficial impact on sustainable firm growth, indicating that firms rely on internal funding for their investment and expansion. This outcome is consistent with those obtained by Khémiri et al. (2024).

As for macroeconomic factors, we observe that inflation and economic growth have a negative impact on sustainable firm growth. The negative impact of inflation on sustainable firm growth suggests that an increase in the level of inflation negatively impacts the cost of borrowing and hinders access to capital, posing a threat to sustainable growth (Akhtar et al., 2022). The negative effect of economic growth is explained by the various events that have occurred in the Arab region, such as the subprime crisis, the Arab Spring, political transitions, and the Covid-19 pandemic. These results consist of those reported in (Khémiri et al., 2024).

Table 6. Main results

VARIABLES	(1) SgR	(2) SgR
SgR_{t-1}	0.134***	0.134***
	(0.001)	(0.001)
Inov	0.194***	0.614***
	(0.120)	(0.009)
$Inov^2$		-0.645***
		(0.001)
LeV	-0.141***	-0.605***
	(0.010)	(0.147)
SiZE	-0.031***	-0.008**
	(0.007)	(0.001)
TaNG	0.123***	0.337**
	(0.007)	(0.165)
RiSK	0.090***	0.116***
	(0.012)	(0.022)
NdTS	0.160***	0.722***
	(0.095)	(0.001)
LiQ	0.095***	0.321**
	(0.008)	(0.145)
InF	-0.126***	-0.392***
	(0.007)	(0.087)
GdPG	-0.524***	-0.262***
	(0.031)	(0.005)
Constant	-0.166***	-0.120***
	(0.013)	(0.003)
Observations	5088	5088
Number of firms	424	424
Number of instruments	112	110
AR (1) (p-value)	0.000	0.000
AR (2) (p-value)	0.111	0.149
Hansen test (p-value)	0.147	0.175
Endogeneity test (p-value)	0.000	0.000

Notes: Standard errors are displayed in brackets. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

Table 7. U-shaped curve test

Group	Lower bound	Upper bound
Interval	0.010	0.650
Slope	6.138***	-7.410***
	(6.446)	(-5.899)
Overall test		
t-value	5.90	
	0.000	
p-value	0.476	
Extreme point		

Notes: t-values are in parentheses. **, *** indicate significance at 5% and 1% levels respectively.

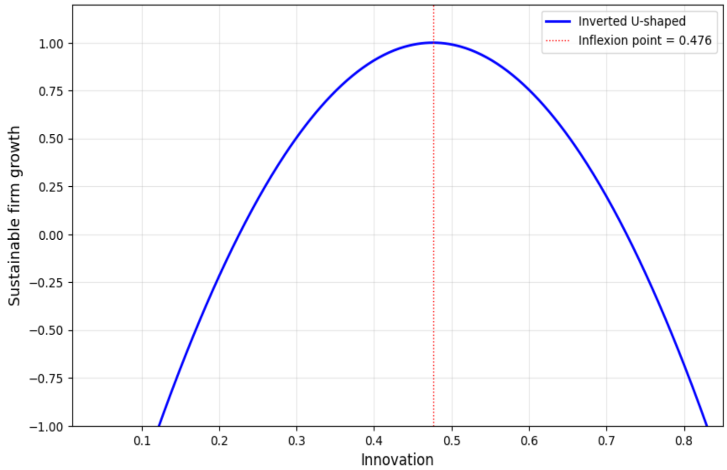

Figure 3. The curvilinear nexus between firm innovation and sustainable firm growth.

4.2. Moderating effect outcomes

This subsection discusses the results of the moderating effect of bank funding, institutional quality, and bank market power on the innovation and sustainable firm growth relationship. The results are reported in Table 8. Although three moderator variables have been identified, our analysis is conducted separately for each of these variables.

Let's look at the moderating effect of bank financing on this relationship. As for the direct effect of bank funding on sustainable firm growth, the outcome shows a positive relationship (column 1). A 10.0% increase in *BfI* leads to a 7.95% rise in *SgR*. This positive effect could be explained by the fact that bank financing also contributes to financing innovation, thus providing a competitive advantage. Similarly, bank financing enables firms to create new products and improve their operating efficiency. As a result, revenues grow, and firms become more valuable. These innovations attract investors and enhance the firm's reputation in the market. R&D efforts also generate highly skilled jobs, increase workforce retention and create knowledge spinoffs for the economy. Bank financing is essential to overcome barriers to innovation and promote sustainable growth. On the other hand, the introduction of bank financing of R&D as a moderating factor transforms this relationship into a U-shaped curve, with the new inflection point reduced to 0.369 (versus 0.476 without the moderating effect) (see figure 4). This change indicates that bank support alleviates the constraints associated with innovation by reducing risks and costs, while reinforcing the positive effects of *Innov* on *SgR*. As a result, Arab firms can achieve sustainable growth at higher levels of innovation, thanks to a more efficient use of financial resources devoted to R&D. This explains the positive moderating effect of *BfI*, i.e., the shift from a positive to a negative relationship between *Innov* and *SgR*. Hypothesis 2 is therefore accepted.

As for the moderating effect of institutional quality, it has a positive impact on the sustainable growth of Arab firms as follows: a 10.0% increase in *Iq* leads to a 5.73% increase in *SgR*. By fostering a sound business climate and a stable and transparent regulatory framework, the *Iq* supports sustainable growth. Strong institutions help firms to pursue sustainability through an improved framework of public-private partnerships. Furthermore, we observe that the relationship remains curvilinear but has changed form, becoming U-shaped. The optimal point, located at 0.312 (figure 5), suggests that *Iq* lowers the threshold at which *Innov* begins to produce favorable results for *SgR*. This result underlines the central role of efficient spending on intangible assets. This may be explained by the fact that better *Iq* attenuates the negative effects generally associated with excessive innovation. This indicates a positive moderating effect of *Iq*, i.e., the move from a positive to a negative association between *Innov* and *SgR*. Hypothesis 4 is therefore accepted.

Turning now to the moderating effect of bank market power. *BmP* has a negative effect on *SgR*, i.e. the two variables move in opposite directions. A 10.0% decrease (increase) in *BmP* leads to a 5.15% increase (decrease) in *SgR*. A decrease in *BmP* therefore means an increase in competition. This generally leads to better access to bank financing, lower lending rates and reduced financing costs for innovative firms. For all Arab firms, the moderating effect of *BmP* shows that the overall shape of the relationship remains similar, but the inflection point shifts to a lower value of 0.387 (figure 6). This adjustment suggests that the increase in *BmP* has a positive impact on *Innov* dynamics. This suggests a negative moderating effect of *BmP*, i.e., the move from a negative to a positive correlation between *Innov* and *SgR*. Hypothesis 5 is therefore confirmed.

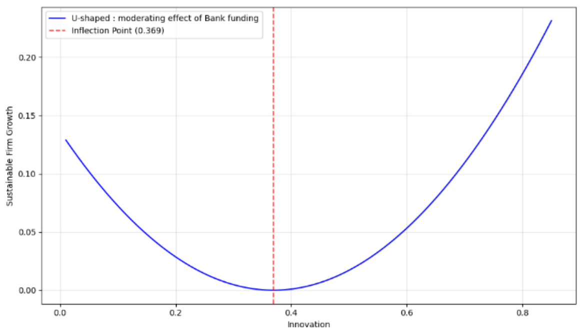

Figure 4. Curvilinear nexus between *Innov* and *SgR*, moderated by *BfI; Source: Authors' calculation*

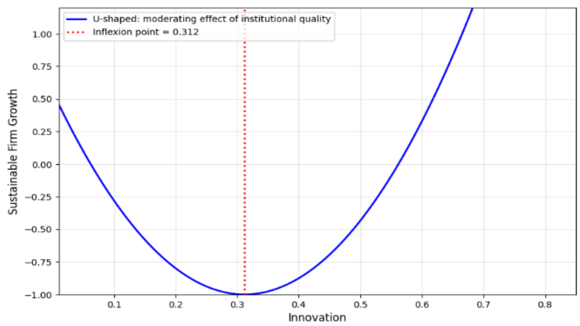

Figure 5. Curvilinear nexus between *Innov* and *SgR*, moderated by *Iq; Source: Authors' calculation*

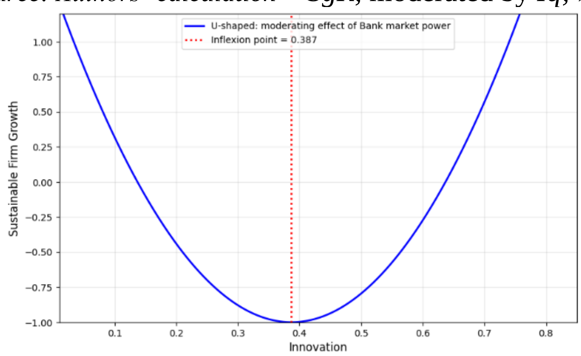

Figure 6. Curvilinear nexus between *Innov* and *SgR*, moderated by *BmP; Source: Authors' calculation*

Table 8. Moderating effect results

Dependent Variable: SgR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		ME: BfI			ME: Iq			ME: BmP	
SgR_{t-1}	0.133***	-0.193***	0.131***	0.132***	0.101***	0.133***	0.134***	0.092***	0.134***
	(0.004)	(0.003)	(0.001)	(0.001)	(0.008)	(0.001)	(0.001)	(0.009)	(0.002)
Inov		-0.571**	0.265***		-0.727***	0.153***		-0.588***	-0.833***
		(0.270)	(0.011)		(0.015)	(0.001)		(0.065)	(0.126)
$Inov^2$			-0.257***			-0.246***			0.108***
			(0.011)			(0.002)			(0.016)
ME	0.795***	-0.551***	0.212***	0.573***	-0.370	0.610**	-0.515***	-0.142***	-0.141***
	(0.133)	(0.044)	(0.010)	(0.087)	(0.484)	(0.243)	(0.096)	(0.015)	(0.027)
Inov*ME		0.144***	-0.163***		0.634***	-0.104***		0.834***	0.134***
		(0.021)	(0.068)		(0.214)	(0.002)		(0.091)	(0.002)
$Inov^2$*ME			0.149***			0.271***			-0.170***
			(0.062)			(0.002)			(0.002)
LeV	-0.188***	-0.575***	-0.182***	-0.143***	0.714***	-0.107***	-0.932***	0.656***	-0.329
	(0.091)	(0.128)	(0.016)	(0.001)	(0.117)	(0.132)	(0.141)	(0.256)	(0.252)
SiZE	0.048***	0.047***	0.072***	0.039***	0.066***	0.035***	0.004	0.073***	0.039
	(0.006)	(0.008)	(0.013)	(0.006)	(0.013)	(0.010)	(0.010)	(0.017)	(0.026)
TaNG	0.110***	0.774***	0.144***	0.967***	0.501***	0.130***	0.454***	0.663***	-0.012
	(0.068)	(0.096)	(0.016)	(0.060)	(0.124)	(0.001)	(0.110)	(0.167)	(0.271)
RiSK	0.060***	0.052***	0.112***	0.062***	-0.144***	0.171***	0.016	-0.141***	0.036
	(0.011)	(0.016)	(0.022)	(0.010)	(0.023)	(0.020)	(0.014)	(0.032)	(0.034)
NdTS	0.191***	0.391***	0.216***	0.173***	0.256***	0.134***	0.929***	0.308***	0.765***
	(0.097)	(0.012)	(0.013)	(0.009)	(0.016)	(0.001)	(0.001)	(0.018)	(0.002)
LiQ	0.108***	0.317***	0.181***	0.874***	0.129***	0.123***	0.286***	0.153***	0.523*
	(0.079)	(0.090)	(0.014)	(0.083)	(0.017)	(0.001)	(0.102)	(0.017)	(0.270)
InF	-0.189***	-0.320***	-0.155***	-0.103***	-0.209***	-0.816***	-0.928***	-0.117***	-0.197
	(0.010)	(0.022)	(0.011)	(0.009)	(0.042)	(0.066)	(0.103)	(0.047)	(0.150)
GdPG	-0.663***	-0.155***	-0.584***	-0.476***	-0.880***	-0.489***	-0.400***	-0.132***	-0.178**
	(0.035)	(0.088)	(0.048)	(0.003)	(0.013)	(0.003)	(0.004)	(0.017)	(0.008)
Constant	-0.150***	-0.186***	-0.552***	-0.153***	0.041	-0.302***	0.270***	0.871***	0.783***
	(0.011)	(0.016)	(0.027)	(0.001)	(0.337)	(0.002)	(0.001)	(0.011)	(0.002)
Observations	5088	5088	5088	5088	5088	5088	5088	5088	5088
Number of firms	424	424	424	424	424	424	424	424	424
Number of instruments	112	110	111	112	110	123	121	121	123
AR (1) (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) (p-value)	0.251	0.250	0.537	0.107	0.241	0.136	0.121	0.267	0.446
Hansen test (p-value)	0.211	0.223	0.219	0.237	0.107	0.202	0.150	0.110	0.189
Extreme point			**0.369**			**0.312**			**0.387**

Notes: Standard errors are displayed in brackets. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

4.3. Additional analysis

4.3.1. Subsample Tests

In this analytical discourse, the objective is to verify whether the findings derived from the earlier phases are applicable to the entire region or whether they are constrained to a particular subset of countries. To facilitate this investigation, we have categorized our sample into two distinct groups: GCC countries and non-GCC countries. The data illustrated in Table 9 substantiates the existence of a curvilinear (inverted U-shaped) relationship between *Innov* and *SgR* for both groups, as evidenced by the results found in columns (1) for GCC countries and columns (4) for non-GCC countries. These outcomes indicate that hypothesis 1 is supported in both contexts.

An analytical assessment of the inverted-U relationship between *Innov* and *SgR* in GCC versus non-GCC countries illustrates marked disparities in their respective inflection points, estimated at 0.494 for GCC countries and 0.319 for non-GCC counterparts. Comparing the non-GCC region with the total countries, we can see (figure 7) that the inverted U-shaped curve is shifted to the left, with an inflexion point at 0.319, lower than that of firms in the total sample (0.476). This suggests that the optimal level of innovation to achieve maximum sustainable growth is reached in the non-GCC countries with less expenditure on R&D or patent acquisition. In other words, these calculations indicate that non-GCC firms operate in sectors where innovation is more effective or yields quicker benefits for sustainable growth. Thus, less innovation is needed to achieve the same level of optimal sustainable growth. Moreover, this can be explained by contextual, industrial, or geographical differences compared to other Arab countries. For example, it is possible that the tipping point is lower in the non-GCC group because innovations are more easily adopted, or the infrastructure is more supportive of new technologies. In addition, non-GCC firms can be characterized targeted approach to innovation, particularly by foreign firms operating in these countries (notably Tunisia and Morocco). These firms, often oriented towards cost optimization and specialization, could exploit increment rather than radical innovation, which favors immediate and tangible returns.

In addition, we find that the *BfI*, *Iq* and *BmP* play a moderating role on the *Innov* and *SgR* nexus in both groups of countries, confirming the main results. These outcomes indicate that hypotheses 2, 4, and 5 are supported in both contexts. Specifically, if we compare the moderating effect of the bank financing for non-GCC countries with that of Arab countries, we see that the curve is U-shaped (figure 8), like that of the total sample, but with an inflexion point at 0.333 (0.506) for non-GCC (GCC) countries versus 0.369 for Arab countries. This indicates that the volume of bank financing seems more substantial and has contributed more effectively to optimal innovation for non-GCC countries.

As for the moderating effect of *Iq*, we observe that the curve is also U-shaped, but with an inflexion point at 0.376 (0.545) for GCC (non GCC) countries compared to 0.312 for Arab countries (figure 9). These changes reflect disparities in *Iq*. In the GCC countries, effective institutions enable firms to benefit quickly from innovations, lowering the innovation threshold necessary for *SgR*. However, in the non-GCC countries, less efficient institutions impose more constraints, forcing firms to invest more in innovation to achieve increasing returns. This highlights the need to strengthen institutions in the non-GCC region to maximize the effectiveness of innovation.

Regarding the moderating role of *BmP*, we note that the curve is also U-shaped, but with an inflexion point at 0.284 (0.474) for non GCC (GCC) region compared to 0.387 for Arab countries (figure 10). This indicates that the lower *BmP* in the non-GCC group facilitates the dynamic innovation to reach its optimum with fewer resources, thereby achieving greater efficiency. Unlike the GCC banks, the banks' non-GCC group appear to have been more successful in reducing adverse selection problems and relatively increasing the volume of loans granted to firms with moderate risk and innovative projects with high growth potential. Consequently, credits are better distributed, encouraging the private sector to invest more in intangible assets, including R&D spending. This also highlights the constraining role of *BmP* in maximizing the benefits of innovation by hindering the optimal targeting of investments.

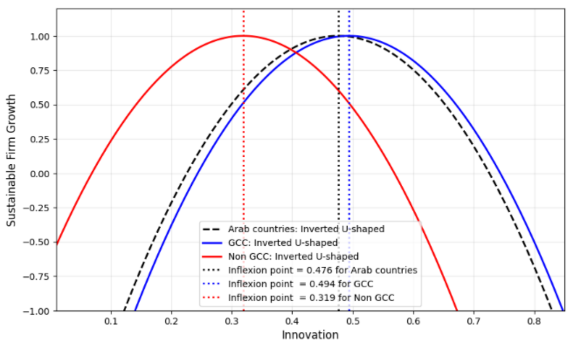

Figure 7. Curvilinear nexus between *Innov* and *SgR*, GCC vs Non GCC.

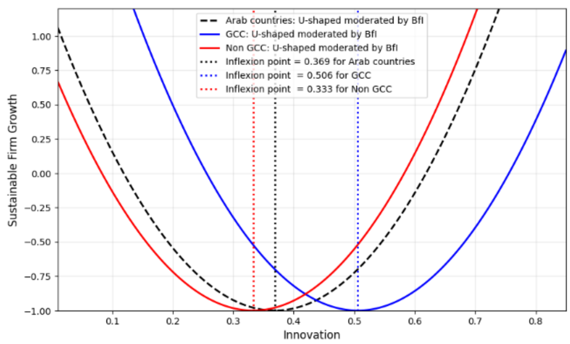

Figure 8. Curvilinear nexus between *Innov* and *SgR*, GCC vs Non GCC, moderated by *BfI*.

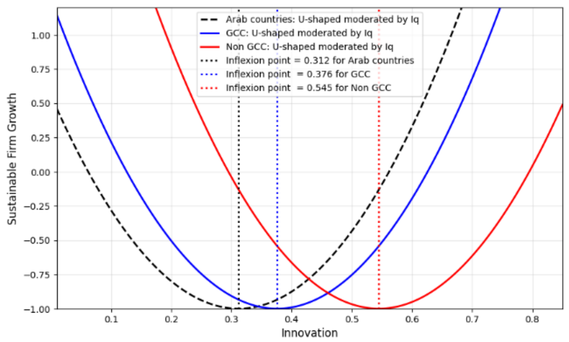

Figure 9. Curvilinear nexus between *Innov* and *SgR*, GCC vs Non GCC, moderated by *Iq*

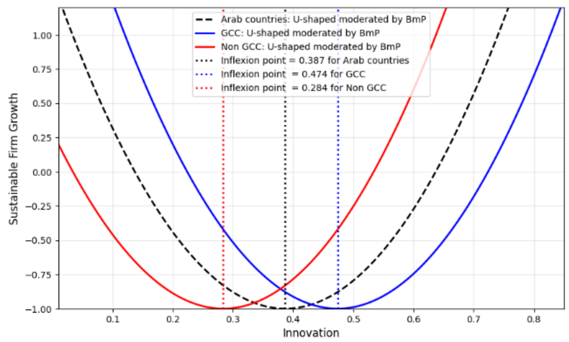

Figure 10. Curvilinear nexus between *Innov* and *SgR*, GCC vs Non GCC, moderated by *BmP*

Table 9. GCC countries vs. non-GCC countries.

	GCC Countries				Non GCC Countries			
Dependent Variable: SgR_a	(1)	(2)	(3)	(4)	(4)	(5)	(6)	(7)
Variables	Curvlinear	ME: BfI	ME: Iq	ME: BmP	Curvlinear	ME: BfI	ME: Iq	ME: BmP
SP_{-1}	0.133***	0.130***	0.133***	0.134***	0.133***	0.128***	0.128***	0.132***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.005)	(0.003)
Inov	0.823***	0.373***	0.532***	-0.136***	0.223***	0.835***	0.600***	-0.121***
	(0.053)	(0.065)	(0.034)	(0.013)	(0.024)	(0.022)	(0.025)	(0.037)
$Inov^2$	-0.833***	-0.369***	-0.708***	0.143***	-0.350***	-0.125***	-0.550***	0.214***
	(0.051)	(0.064)	(0.045)	(0.013)	(0.033)	(0.041)	(0.025)	(0.051)
ME		0.463***	0.916***	-0.255***		0.180***	0.274***	0.282***
		(0.010)	(0.010)	(0.027)		(0.029)	(0.097)	(0.079)
Inov*ME		-0.311***	-0.643***	0.198***		-0.221***	-0.208***	-0.146***
		(0.070)	(0.051)	(0.018)		(0.017)	(0.074)	(0.052)
$Inov^{2}$*ME		0.296***	0.925***	-0.210***		0.551***	0.1435***	0.260***
		(0.065)	(0.069)	(0.019)		(0.026)	(0.071)	(0.067)
LeV	-0.217***	-0.382***	-0.153***	-0.211***	0.032***	0.128***	0.017	0.077***
	(0.017)	(0.012)	(0.026)	(0.026)	(0.008)	(0.011)	(0.017)	(0.016)
SiZE	0.072***	0.149***	0.121***	0.011	-0.011***	-0.008***	-0.004***	-0.016***
	(0.017)	(0.011)	(0.025)	(0.033)	(0.001)	(0.001)	(0.001)	(0.001)
TaNG	0.145***	0.251***	0.200***	-0.088	-0.014*	0.040***	-0.037***	0.002
	(0.014)	(0.101)	(0.026)	(0.262)	(0.008)	(0.008)	(0.010)	(0.012)
RiSK	0.068***	0.224***	0.078**	-0.026	0.012***	0.006***	0.031***	0.016***
	(0.024)	(0.019)	(0.035)	(0.040)	(0.001)	(0.000)	(0.003)	(0.002)
NdTS	0.299***	0.354***	0.259***	0.237***	-0.120***	-0.934***	-0.479***	-0.121***
	(0.018)	(0.010)	(0.022)	(0.032)	(0.023)	(0.064)	(0.040)	(0.029)
LiQ	0.154***	0.304***	0.229***	0.896***	0.021***	0.048***	0.079***	0.079***
	(0.015)	(0.011)	(0.028)	(0.320)	(0.004)	(0.005)	(0.006)	(0.005)
InF	-0.153***	-0.272***	-0.624***	-0.603***	-0.542***	-0.142***	-0.761***	-0.270***
	(0.014)	(0.009)	(0.129)	(0.156)	(0.016)	(0.012)	(0.043)	(0.025)
GdPG	-0.559***	-0.915***	-0.470***	-0.542***	-0.384***	-0.743***	-0.239***	-0.256***
	(0.050)	(0.030)	(0.068)	(0.079)	(0.028)	(0.058)	(0.043)	(0.041)
Constant	-0.332***	-0.898***	-0.106***	0.171***	0.043***	0.025**	-0.482***	-0.169***
	(0.027)	(0.020)	(0.090)	(0.018)	(0.012)	(0.011)	(0.030)	(0.056)
Observations	1482	1482	1482	1482	1001	1001	1001	1001
Number of firms	114	114	114	114	77	77	77	77
Number of instruments	91	89	92	92	52	57	52	52
AR (1) (p-value)	0.000	0.000	0.000	0.000	0.006	0.016	0.005	0.000
AR (2) (p-value)	0.153	0.418	0.206	0.470	0.176	0.066	0.184	0.127
Hansen test (p-value)	0.120	0.241	0.140	0.140	0.120	0.223	0.119	0.115
Extreme point	0.494	0.506	0.376	0.474	0.319	0.333	0.545	0.284

Notes: Standard errors are displayed in brackets. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

4.3.2. Firm Size-Based Analysis

In this section, we analyze our basic assumptions according to firm size. To do this, a segmentation was carried out using the K-means method. This technique was applied to our sample using total assets as the main segmentation criterion. This method enables firms to be grouped into homogeneous clusters, reflecting similarities in the size of their assets. After optimizing the model and selecting the appropriate number of clusters, the firms were divided into three groups: 233 small, 127 medium-sized and 64 large firms. This classification facilitates a comparative analysis based on asset size, offering perspectives tailored to each category. The outcomes are reported in table 10.

The examination of the nexus between *Innov* and *SgR* across varying firm sizes reveals a notable distinction for larger firms. More specifically, large firms exhibit a U-shaped curve with an inflection point at 0.533 (figure 11). Beyond this threshold, sustainable growth tends to increase exponentially with innovation for large firms, which endowed with enhanced robust organizational capabilities and improved access to diversified markets. Indeed, due to their size, large firms tend to invest heavily in innovation, which requires substantial financial resources. Although they have a greater financial capacity to meet the challenges of innovation, large firms tend to be less concerned with sustainable growth in the early stages of development. In contrast, SMEs expose a U-shaped curve with an inflection point at 0.304 and 0.415 respectively (figure 12). Beyond these thresholds, innovation negatively affects sustainable firm growth. The curves for SMEs illustrate that innovation have an immediate effect on sustainable growth, but that it quickly reaches its peak, beyond which any new innovation has a negative impact on sustainable growth. Therefore, considerations regarding the effectiveness of innovation spending have become crucial for the managers of these firms during the advanced stage of innovation investments.

In addition, we observe that the *BfI*, *Iq* and *BmP* play a moderating role on the *Innov* and *SgR* relationship with three groups of firms, confirming the main outcomes. These outcomes show that hypotheses 2, 4, and 5 are also supported (see figures 12, 13, and 14).

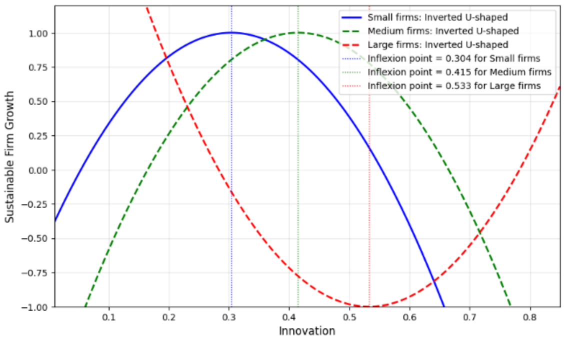

Figure 11. Curvilinear nexus between *Innov* and *SgR*, by size

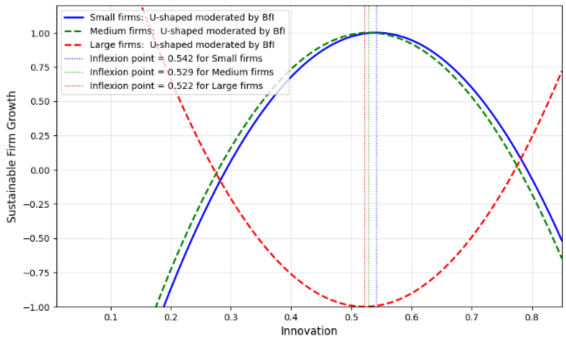

Figure 12. The curvilinear nexus between *Innov* and *SgR*, by size, moderated by *BfI*

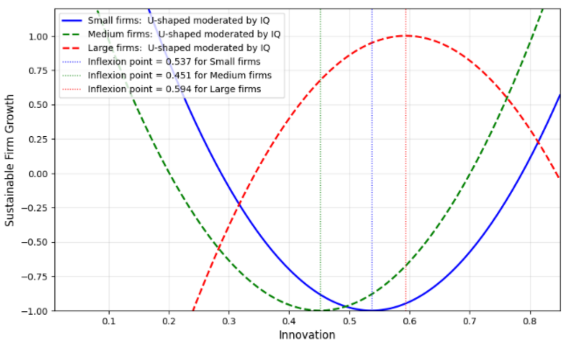

Figure 13. The curvilinear nexus between *Innov* and *SgR*, by size, moderated by *Iq*

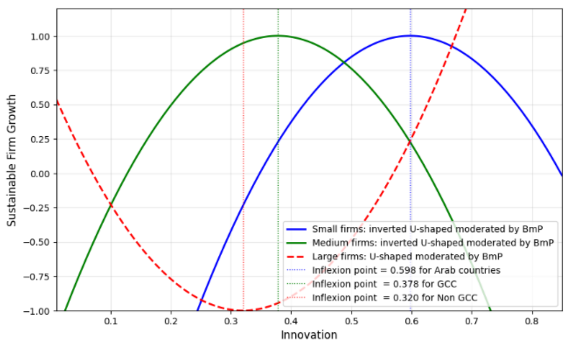

Figure 14. The curvilinear nexus between *Innov* and *SgR*, by size, moderated by *BmP*

Table 10. Firm size-based results

	Small firms				Medium firms				Large firms			
Dependent Variable: SGR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	Curvlinear	ME: BfI	ME: Iq	ME: BmP	Curvlinear	ME: BfI	ME: Iq	ME: BmP	Curvlinear	ME: BfI	ME: Iq	ME: BmP
SP_{-1}	0.339***	0.1330***	0.348***	0.338***	0.872***	-0.278***	0.973***	0.718***	0.509***	0.635***	0.540***	0.495***
	(0.001)	(0.070)	(0.002)	(0.004)	(0.065)	(0.103)	(0.044)	(0.082)	(0.012)	(0.015)	(0.013)	(0.014)
Inov	0.121***	0.424***	0.250***	-0.792***	0.137***	0.205***	0.589***	-0.213***	-0.205***	-0.204***	-0.434***	0.201***
	(0.024)	(0.051)	(0.015)	(0.018)	(0.073)	(0.033)	(0.036)	(0.011)	(0.008)	(0.023)	(0.075)	(0.071)
$Inov^2$	-0.200***	-0.391***	-0.233***	0.662***	-0.165***	-0.193***	-0.653***	0.282***	0.193***	0.199***	0.365***	-0.314**
	(0.029)	(0.045)	(0.015)	(0.016)	(0.058)	(0.031)	(0.040)	(0.015)	(0.008)	(0.026)	(0.095)	(0.069)
Iq		0.122***	0.551***	-0.163***		0.137***	0.139***	-0.325***		-0.471**	-0.759***	0.258*
		(0.078)	(0.042)	(0.042)		(0.017)	(0.010)	(0.019)		(0.183)	(0.150)	(0.154)
Inov*ME		-0.761***	-0.540***	0.118***		-0.127***	-0.920***	0.346***		0.382***	0.484***	-0.276**
		(0.049)	(0.032)	(0.025)		(0.011)	(0.066)	(0.018)		(0.124)	(0.015)	(0.011)
$Inov^2$*ME		0.497***	0.505***	-0.102***		0.162***	0.100***	-0.445***		-0.362*	-0.405**	0.289**
		(0.037)	(0.030)	(0.023)		(0.013)	(0.068)	(0.232)		(0.182)	(0.018)	(0.011)
LeV	-0.129***	-0.534***	-0.673***	0.027	-0.351***	-0.371***	-0.366***	-0.420***	-0.391***	-0.212***	-0.204***	-0.466***
	(0.035)	(0.006)	(0.013)	(0.089)	(0.023)	(0.034)	(0.034)	(0.028)	(0.025)	(0.058)	(0.061)	(0.030)
SiZE	-0.016***	-0.022***	-0.050***	0.010	0.245***	0.219***	0.230***	0.190***	0.023***	0.022***	0.024***	0.022***
	(0.004)	(0.002)	(0.002)	(0.016)	(0.012)	(0.020)	(0.018)	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)
TaNG	-0.165***	-0.560***	-0.341***	-0.600***	0.529***	0.604***	0.493***	0.574***	0.225***	0.134**	0.215***	0.240***
	(0.025)	(0.011)	(0.006)	(0.077)	(0.024)	(0.055)	(0.022)	(0.026)	(0.020)	(0.065)	(0.056)	(0.029)
RiSK	-0.014***	-0.110***	0.039***	-0.087***	0.811***	0.791***	0.944***	0.784***	-0.010***	-0.011***	-0.021***	-0.005
	(0.005)	(0.002)	(0.001)	(0.011)	(0.050)	(0.102)	(0.070)	(0.061)	(0.003)	(0.003)	(0.004)	(0.004)
NdTS	-0.257***	0.339***	-0.449***	0.103***	0.597***	0.587***	0.463***	0.633***	0.579***	-0.135	0.836**	0.674***
	(0.182)	(0.051)	(0.069)	(0.035)	(0.021)	(0.032)	(0.024)	(0.028)	(0.162)	(0.365)	(0.366)	(0.169)
LiQ	-0.213***	-0.288***	-0.908***	0.106**	0.394***	0.484***	0.362***	0.500***	0.051**	-0.035**	0.045	0.026
	(0.022)	(0.011)	(0.011)	(0.051)	(0.018)	(0.044)	(0.023)	(0.023)	(0.022)	(0.015)	(0.036)	(0.027)
InF	-0.212***	-0.813***	-0.879***	-0.333***	-0.577***	-0.803***	-0.381***	-0.529***	-0.160***	-0.189***	-0.284***	-0.158***
	(0.020)	(0.007)	(0.005)	(0.060)	(0.031)	(0.035)	(0.023)	(0.034)	(0.022)	(0.038)	(0.032)	(0.021)
GdPG	-0.259***	-0.322***	-0.246***	-0.390***	-0.2004***	-0.271***	-0.114***	-0.250***	-0.680***	0.070	-0.109***	-0.759***
	(0.108)	(0.047)	(0.022)	(0.202)	(0.083)	(0.0167)	(0.013)	(0.011)	(0.065)	(0.281)	(0.029)	(0.079)
Constant	0.397***	0.232***	-0.102***	0.111***	-0.105***	-0.106***	-0.157***	0.111***	-0.147***	-0.132***	0.149*	-0.335***
	(0.049)	(0.021)	(0.025)	(0.036)	(0.043)	(0.017)	(0.074)	(0.088)	(0.049)	(0.049)	(0.081)	(0.113)
Observations	2796	2796	2796	2796	1524	1524	1524	1524	768	768	768	768
Number of firms	233	233	233	233	127	127	127	127	64	64	64	64
Number of instruments	89	81	81	81	41	36	41	38	11	12	19	19
AR (1) (p-value)	0.000	0.000	0.000	0.000	0.006	0.016	0.005	0.000	0.006	0.016	0.005	0.000
AR (2) (p-value)	0.741	0.528	0.149	0.396	0.201	0.415	0.317	0.279	0.356	0.266	0.164	0.356
Hansen test (p-value)	0.220	0.192	0.187	0.163	0.172	0.196	0.179	0.210	0.180	0.223	0.185	0.215
Extreme point	0.304	0.542	0.537	0.598	0.415	0.529	0.451	0.378	0.533	0.522	0.594	0.320

4.4. Robustness check

.4.4.1. Alternative Measure of SFG

To ensure our findings' validity, we conducted an assessment revising the SgR measurement methodology. Following Khémiri et al. (2024), we implemented Van Horne's static SgR model (SgRA). The SgRA is calculated as: retained earnings × net profit rate × (1 + debt/equity ratio) × {1/(total assets/total sales) − 1}. The results are reported in table 11. The results exhibit similarity to the findings in Table 6, illustrating an inverse U-shaped relationship between *Innov* and *SgR*. This observation further substantiates hypothesis 1. Furthermore, the data indicates that *BfI*, *Iq*, and *BmP* serve as a moderating effect in the relationship between *Innov* and *SgR*, thereby reinforcing hypothesis 2, 4, and 5.

Table 11. Changing dependent variable

Dependent Variable: SgRA	(1)	(2)	(3)	(4)
Variables	Curvlinear	ME: FBFI	ME: iq	ME: CP
$SgRA_{t-1}$	0.600***	0.588***	0.596***	0.598***
	(0.001)	(0.001)	(0.001)	(0.001)
Inov	0.412***	0.865***	-0.340***	-0.770***
	(1.859)	(0.034)	(0.020)	(0.018)
$Inov^2$	-0.455***	-0.944***	0.239***	0.134***
	(0.002)	(0.410)	(0.020)	(0.023)
Iq		0.462***	-0.156***	-0.184***
		(0.041)	(0.049)	(0.039)
Inov*ME		-0.384***	-0.107***	0.176***
		(0.027)	(0.032)	(0.028)
$Inov^2$*ME		0.376***	0.137***	-0.265***
		(0.026)	(0.034)	(0.036)
LeV	0.274***	0.199***	0.436***	0.383***
	(0.002)	(0.022)	(0.072)	(0.024)
SiZE	0.087***	0.098**	0.046***	0.105***
	(0.027)	(0.038)	(0.012)	(0.033)
TaNG	0.105***	0.905***	0.101***	0.104***
	(0.002)	(0.199)	(0.011)	(0.028)
RiSK	0.324***	0.216***	0.009	0.312***
	(0.062)	(0.067)	(0.018)	(0.070)
NdTS	-0.327***	0.442***	0.890***	0.094
	(0.007)	(0.121)	(0.025)	(0.971)
LiQ	0.163***	0.169***	0.373***	0.195***
	(0.002)	(0.302)	(0.012)	(0.027)
InF	0.130***	0.729***	0.135***	0.168***
	(0.002)	(0.202)	(0.086)	(0.024)
GdPG	-0.252***	-0.307***	-0.471***	-0.332***
	(0.006)	(0.096)	(0.337)	(0.087)
Constant	-0.754***	-0.124***	0.564*	0.415***
	(0.005)	(0.074)	(0.323)	(0.026)
Observations	5088	5088	5088	5088
Number of firms	424	424	424	424
Number of instruments	112	111	115	111
AR (1) (p-value)	0.000	0.000	0.000	0.000
AR (2) (p-value)	0.317	0.316	0.317	0.316
Hansen test (p-value)	0.133	0.120	0.115	0.112

Notes: Standard errors are displayed in brackets. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

4.4.2. Alternative measure of Innovation

To assess the robustness of the outcomes, we employ another proxy of firm innovation. In fact, we use the natural logarithm of intangible assets. The outcomes are presented in Table 11. The findings reveal consistency with those shown in Table 6, demonstrating an inverse U-shaped relationship between Innov and SgR. This pattern provides additional support for hypothesis 1. Additionally, the analysis suggests that BfI, Iq, and BmP act as moderating variables in the relationship between Innov and SgR, thereby lending credence to hypotheses 2, 4, and 5.

Table 12. Changing dependent variable

Dependent Variable: SP_a	(1)	(2)	(3)	(4)
Variables	Curvlinear	ME: FBFI	ME: iq	ME: Lerner
SP_{t-1}	0.360***	-0.180***	-0.097***	0.358***
	(0.006)	(0.006)	(0.005)	(0.010)
Inov	0.118***	0.517***	-0.461***	-13.479***
	(0.019)	(0.030)	(0.049)	(2.675)
$Inov^2$	-0.046***	-0.220***	0.207***	0.520***
	(0.008)	(0.013)	(0.021)	(0.113)
Iq		0.102***	-0.794***	-127.265***
		(0.013)	(0.569)	(21.017)
Inov*ME		-0.180***	0.145***	20.947***
		(0.024)	(0.100)	(3.762)
$Inov^2$*ME		0.711***	-0.636***	-0.805***
		(0.091)	(0.043)	(0.160)
LeV	-0.129***	-0.974***	-0.753***	-1.074***
	(0.015)	(0.149)	(0.133)	(0.202)
SiZE	0.077***	0.070***	0.080***	0.065***
	(0.009)	(0.012)	(0.010)	(0.013)
TaNG	0.366***	0.123***	0.796***	0.112
	(0.078)	(0.010)	(0.092)	(0.111)
RiSK	-0.006	0.049***	0.059***	-0.036**
	(0.013)	(0.018)	(0.013)	(0.018)
NdTS	0.283***	0.379***	0.329***	0.257***
	(0.094)	(0.160)	(1.260)	(0.136)
LiQ	0.192***	0.344**	0.242***	0.171***
	(0.099)	(0.012)	(0.0110)	(0.014)
InF	-0.253***	-0.250***	-2.066***	-0.154***
	(0.029)	(0.026)	(0.242)	(0.037)
GdPG	-0.833***	-0.146***	-12.314***	-0.811***
	(0.087)	(0.110)	(0.954)	(0.105)
Constant	-0.885***	-0.308***	0.224***	0.800***
	(0.108)	(0.174)	(0.265)	(0.015)
Observations	5088	5088	5088	5088
Number of firms	424	424	424	424
Number of instruments	113	125	123	119
AR (1) (p-value)	0.000	0.000	0.000	0.000
AR (2) (p-value)	0.243	0.318	0.244	0.248
Hansen test (p-value)	0.117	0.150	0.110	0.120

Notes: Standard errors are displayed in brackets. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

5. Conclusion and implications

In this paper, we investigated the effect of *Innov* on *SgR* in Arab countries. Specifically, we examine, for the first time, the inverted U-shaped relationship between *Innov* and *SgR*. In addition, we aim to extend our study by examining the moderating effect of *BfI*, *Iq*, and *BmP* on this relationship using the SGMM technique. The results showed that there is an inverted U-shaped between *Innov* and *SgR*, supporting hypothesis 1. In addition, they indicated that *BfI*, *Iq*, *BmP* moderate the *Innov-SgR* nexus, confirming our hypotheses 2, 4, and 5.

5.1. Implications

Our outcomes have important implications for policymakers in Arab countries. These implications are structured according to four main dimensions:

- **More Bank Financing for Technology and Innovation Firms**
  - Provide Green Finance Options: Encourage banks to offer green financing options that support sustainable innovation through subsidies, tax incentives, or reduced interest rates on loans for green projects.
  - Financing Start-ups and Innovative SMEs: Banks can offer loans and credit lines specifically designed for start-ups and small and medium-sized enterprises (SMEs) developing innovative technologies. This may include favorable loan terms or risk-sharing mechanisms to help companies achieve sustainable productivity.
  - Mentoring and Incubation Programs: Banks can create mentoring programs and incubators to support innovative entrepreneurs by providing advice, resources, and networks to develop their ideas.
- **Banking Instruments Adapted to the Financing of Technological Innovation.**
  - Adopt Equity Loans: Encourage banks to opt for equity loans for technology start-ups to promote innovation activities and facilitate the adoption of artificial intelligence technologies.
  - Establish Targeted Funding Lines: The government should introduce targeted funding lines for banks that seek to support businesses in their transition to digital technology.
  - Improve Access to Finance for Start-ups and SMEs: Implement measures such as loan guarantees and venture capital support to help start-ups and SMEs invest in innovative activities.
- **The Bank Market Power and the Financing of Innovation**
  - Reduce the Bank Market Power: Encourage Digital Technologies and partner with the private fintech sector to reduce financing constraints for Arab companies with high potential for sustainable growth.
  - Reduce Bank Market Share: Facilitate the entry of new banks by reducing regulatory barriers and offering tax incentives and strengthening anti-trust regulations.
  - Encourage Regional and Local Banks: Support regional and local banks so they can compete with large national and international banks.
- **Strengthening Institutional Quality**
  - Reinforce the Fight Against Corruption: Establish transparency and accountability mechanisms to reduce corruption. These include regular audits, strong anti-corruption laws, and independent agencies to monitor government practices.
  - Implementation of Competition Policy: Promote a *level playing field* where all financial institutions, whether large or small, public or private, local or international, are subject to the same rules and regulations.

- Promote Transparency: Ensure full and transparent disclosure of economic and financial information. This helps to create an environment of confidence for investors and entrepreneurs.

5.2. Limitations and Future Research

This research presents certain limitations that highlight potential avenues for further investigation. To enhance the relevance and applicability of the findings, subsequent research should expand its geographical scope to encompass a wider array of Arab economies. Additionally, while intangible assets have served as a significant measure for assessing firm innovation, it is essential to recognize that numerous other indicators (e.g., R&D expenditure, Patent) warrant further investigation. Finally, the paper used certain economic factors as moderator variables. Future research could explore the moderating effect of risk culture on this relationship.

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