Sustaining innovation: How financial investment shapes patent creation in leading economies?

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Sustaining innovation: How financial investment shapes patent creation in leading economies?

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Abstract: This study aims to analyze the role of liquidity in promoting patent-based innovation in the 10 countries with the highest innovation rates during the period 2012-2021. Using secondary data from the World Development Indicators (WDI), World Intellectual Property Organization (WIPO), and World Integrated Trade Solution (WITS), this study applies panel data regression method with Seemingly Unrelated Regression (SUR) approach to identify the influence of economic variables on the number of patents. The independent variables analyzed include equity x high technology, credit x high technology, industrial value added, exports, and liquidity. The results show that high-tech-based equity and credit have a significant influence on increasing the number of patents, while exports and liquidity do not show a meaningful influence. Value-added was also shown to have a significant contribution to innovation. These findings indicate that funding stability and long-term investment in research and development (R&D) determine innovation success more than the level of liquidity of the firm. Therefore, government policies and funding strategies should focus on improving access to high-tech-based financing as well as incentivizing R&D activities to foster a sustainable innovation ecosystem.

Keywords: Liquidity; Innovation (Patent); High Tech Equity; High Tech Credit; Panel Data Regression
JEL Classification: D63; E51; G33; O11; 014; O31

Introduction

Innovation is a key factor in driving economic growth and competitiveness of a country. In the context of globalisation and the era of the industrial revolution 4.0, innovation protected by patents is one of the main indicators of a nation's progress. Countries that are able to create an environment that supports innovation tend to have a higher competitive advantage in global economic competition (Kuang et al., 2021). The Global Innovation Index report shows that countries such as Japan, China, and South Korea occupy the top positions in terms of innovation, as measured by the number of patents filed and accepted

(Segal et al., 2015). Nonetheless, challenges in terms of liquidity and access to funding are still an obstacle for many companies, especially in the small and medium enterprise sector (Belas & Rahman, 2023).

In a constantly evolving business environment, companies are required to not only maintain their existence, but also be able to innovate in order to remain competitive and meet increasingly complex market needs (Tang et al., 2022). Sustainable innovation is a major requirement in the face of intense global competition, rapid technological change, and increasingly dynamic economic challenges (Appiah et al., 2020). To create sustainable innovation, companies need stable financial resources, especially in the form of sufficient liquidity to finance research and development (R&D) in the long term (He & Estébanez, 2023).

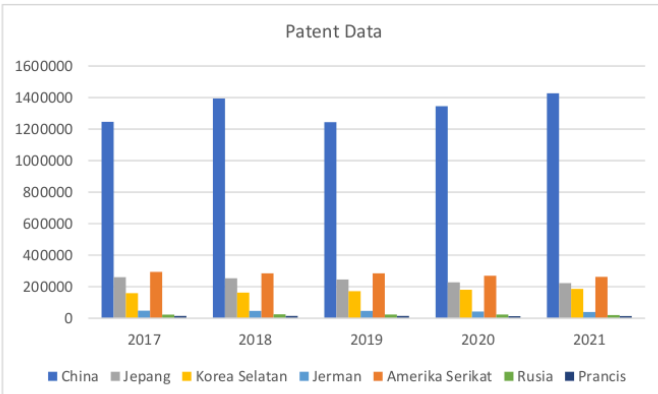

Figure 1 Patent Data

Overall, based on figure 1 reflects China's dominance in technological innovation, followed by the United States and Japan, while European countries show a slower or declining trend in the number of patents. This underscores the importance of continued investment in research and development to boost global competitiveness. Innovation (patents) not only improves efficiency and productivity, but also creates new opportunities in various sectors of the economy.

Liquidity plays a strategic role in supporting a firm's innovation activities. The limitation of previous studies lies in the lack of research that examines the influences that make patents the leading economies. Firms with sufficient liquidity tend to have better financial flexibility to invest in the development of new technologies that can lead to patents (Agénor & Canuto, 2017; Berentsen et al., 2012). In addition, successful innovation can improve a firm's liquidity through increased revenue, cash flow and asset value (Chen et al., 2022; Illmeyer et al., 2017; de Rezende, 2011). However, although liquidity theoretically has a positive influence on innovation, some studies suggest that its impact is not yet fully comprehensively understood, especially in the context of a diverse global economy (Aassouli et al., 2018).

The novelty of this study lies in the selection of topics and analytical approaches that are still rarely used in similar studies, namely by examining the effect of liquidity on innovation (patents) in the 10 countries with the highest level of innovation. Unlike previous studies that tend to use the Generalized Method of Moments (GMM) method, this study adopts the Seemingly Unrelated Regression (SUR) method which is more efficient in handling the correlation between disturbances in the model and provides more stable parameter estimates. In addition, the focus on liquidity variables as determinants of innovation highlights a significant research gap, given the lack of empirical evidence on the role of liquidity in supporting long-term, high-risk innovations such as R&D. This research provides a new perspective in understanding the dynamics of corporate finance towards patent creation and offers a practical contribution to the development of innovative funding policies in the technology sector.

Research Method

This study uses a quantitative approach with panel data regression method to analyse the relationship between liquidity and innovation (patents). The model used is Seemingly Unrelated Regression (SUR) which allows for more accurate identification of cross-relationships between variables compared to conventional regression methods. This approach was chosen because it is more efficient in handling the correlation between disturbances in the model, resulting in more accurate estimates (Berentsen et al., 2012; Beck et al., 2023).

The data used in this study is secondary data obtained from the World Development Indicators (WDI), World Intellectual Property Organization (WIPO), and World Integrated Trade Solution (WITS). This study covers the period 2012-2021 and focuses on the 10 countries with the highest number of patents in the world based on the Global Innovation Index report (Segal et al., 2015). The variables used in this study consist of dependent and independent variables. The dependent variable in this study is innovation (patents), which is measured based on the number of patents filed and approved annually in each country (Kuang et al., 2021). Meanwhile, the independent variable consists of several main factors that are believed to affect innovation, namely equity x high technology, credit x high technology, value added, exports, and liquidity. High-tech equity and credit reflect how access to finance contributes to innovation in the technology sector (Cao & Zhao, 2013; Nguyen et al., 2020; Yeh et al., 2014). Value added is measured by the contribution of the industrial sector to economic growth, which is attributed to investment in research and development (Babica & Sceulovs, 2019; Jamshidi, 2019; Fortinguerra et al., 2021; Jommi & Galeone, 2023). Exports represent the country's involvement in global trade that can drive innovation (Bıçakcıoğlu-Peynirci et al., 2019; Chen et al., 2022; Roper et al., 2006; Añón Higón & Driffield, 2011; Piñera-Salmerón et al., 2023; Cassiman & Golovko, 2007), while liquidity reflects the financial stability of banks and access to finance for firms (Almashhadani & Almashhadani, 2023; Agénor & Canuto, 2017; (Berentsen et al., 2012).

In analysing the data, this study uses a panel data regression model, which considers both individual and time effects in measuring the effect of liquidity on innovation (Baltagi 2005). The Seemingly Unrelated Regression (SUR) model was chosen because it is superior to the Generalised Method of Moments (GMM) in handling relationships between economic variables and produces more stable and efficient estimates (Aassouli et al., 2018). Several statistical tests were conducted to ensure the validity of the model, including stationarity test (Unit Root Test) with Levin-Lin-Chu (LLC) and Augmented Dickey-Fuller (ADF) methods to avoid bias due to non-stationary data. In addition, model selection tests were conducted through the Chow Test and Hausman Test to determine whether the Common Effect Model (CEM), Fixed Effects Model (FEM) or Random Effects Model (REM) is more appropriate.

Analysis with dynamic panel data using SUR (Seemingly Unrelated Regression) is an estimation technique in a system of regression equations that allows for correlation between errors from several seemingly unrelated equations. SUR was developed by Arnold Zellner (1962) to improve estimation efficiency by considering the relationship between errors in a system of simultaneous equations (Dong et al., 2017; Saeed & Hussein, 2022). According to Berti et al (2019), Galindo (2024), Kennedy et al (2022), Páez et al (2020) and Hayat et al (2023) the following equation is for panel data as follows:

$$y_{1t=} \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \beta_3 x_{3,t} + \beta_4 x_4 + \beta_5 x_5 + \epsilon_{it} \quad \text{............................} \quad (1)$$

Where y is the innovation using number of patent for each countries; x_1 is the equity*high technology; x_2 is the credit*high technology; x_3 is the value added; x_4 the total value of export in each countries; x_5 is the liquidity; β_0 is the constanta; $\beta_1 - \beta_5$ is the coefficient of independent variables; ϵ is the error term; i is the notation for cross-section and t for time-series. The selection of SUR method in this study is based on several considerations. First, this method is able to overcome the problem of heteroscedasticity, thus providing more stable estimates than conventional regression. Second, SUR can handle the correlation between disturbances in the model, which increases efficiency in analysing the relationship between innovation and economic factors (Chen et al., 2022). Third, this method is more optimal in processing information from panel data, thus providing more accurate results in the context of global economics and finance. The equation for SUR methods based on Zellner (1962) and Khasanah & Kurniawan (2024) as follows:

$$\gamma_j = X_j \beta_j + \mu_j$$

Where γ_j and μ_j is the vector of n dimension; β_j is vector of parameters and X_j is n x p_j of covariat matrixs. The matrix equation as follows:

$$\begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \vdots \\ \gamma_m \end{bmatrix} = \begin{bmatrix} X_1 0 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & X_m \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_m \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_m \end{bmatrix}$$

The error term has the assumption that value of mean = 0 for each independent variables and homokedastic and μ_j has several assumption that mean of error term is 0 or $E(\mu_j|X) = 0$; the variance of error term is equal on j or $E(\mu_j \mu'_j|X) = \sigma_{jj} I_N$. Although this study uses robust methods, there are some limitations that need to be noted. Firstly, this study only focuses on the 10 countries with the highest patents, so the results may not be generalisable to countries with lower levels of innovation. Secondly, this study does not consider institutional and regulatory factors, which may play a role in supporting or hindering innovation. Thirdly, this study uses secondary data, so there are limitations in the quality and availability of data from the sources used. With the methods used, the results of this study are expected to provide recommendations for the government and financial sector to improve policies that support investment in innovation. In addition, this study also aims to provide an academic contribution in understanding the role of liquidity in encouraging high-tech-based innovation and to guide industry and investors in making decisions related to innovation financing.

Result and Discussion

The purpose of this study is to determine the effect of equity x high technology, credit x high technology, value added, exports, and liquidity on the number of patents produced by the 10 countries with the highest innovation in the world. The data used in this study is secondary and obtained from reliable sources such as World Development Indicators (WDI), World Intellectual Property Organization (WIPO) and World Integrated Trade Solution (WITS). The time span analysed in this study covers ten years, starting from 2012 to 2021. The following are the results of the data description analysis for each variable:

Table 1. Descriptive Statistic

Variable	Unit	Obs	Max	Min	Mean	Std. Dev
Inovation(Patent)		100	1426644	4641	191048.9	330505.6
Equity x *High Technology*	US$	100	2.88e+09	9351615	3.85e+08	6.67e+08
Credit x *High Technology*	US$	100	35.95302	24.49374	29.39664	3.30359
Value Added	%	100	3.816018	2.797015	3.219446	0.2847251
Export	US$	100	5.043532	4.412938	4.696846	0.1236567
Liquidity	%	98	287.8542	47.31981	121.2493	57.36986

The results of descriptive analysis show that innovation (patents) as the dependent variable has an average of 191,048.9 with large variations, as seen from the standard deviation of 330,505.6. The independent variables show significant differences between companies. Equity x High Technology averages 385 million US$ with a standard deviation of 667 million US$, while credit x High Technology averages 29.4 US$ with a standard deviation of 3.3 US$, indicating a gap in access to capital. Value added ranged from 2.79% to 3.81% with a standard deviation of 0.28%, reflecting moderate variation. Exports averaged 4.69 US$, with a small standard deviation (0.12 US$), indicating a fairly uniform distribution. Liquidity, with an average of 121.2%, shows high variation with a standard deviation of 57.4%. Overall, the data reflects significant differences in innovation, equity and liquidity between companies.

Table 2 First Difference Stationary Test Results

Variable	First Difference		
	Philips Perron (PP)	Augmented Dickey-Fuller (ADF)	Levin Lin Cu (LL)
Inovation (Patent)	70.6286 (0.0000)***	19.6018 (0.4831)	-0.90007 (0.1840)
Equity x *High Technology*	70.5681 (0.0000)***	19.5562 (0.4860)	-0.89135 (0.1864)
Credit x *High Technology*	68.8780 (0.0000)***	19.4586 (0.4922)	-0.68108 (0.2479)
Value Added	25.2595 (0.1917)	37.5638 (0.0100)***	1.05067 (0.8533)
Export	26.0633 (0.1637)	43.2930 (0.0007)***	1.99264 (0.9768)
Liquidity	75.8329 (0.0000)***	24.8768 (0.2062)	0.44613 (0.6722)

Notes: ***=1%(0.01); **=5%(0.05); *=10%(0.10)

Table 1 Two Difference Stationary Test Results

Variable	Two Difference		
	Philips Perron (PP)	Augmented Dickey-Fuller (ADF)	Levin Lin Cu (LL)
Inovationi (Patent)	92.0840 (0.0000)***	34.1799 (0.0249)**	-4.22014 (0.0000)***
Equity x *High Technology*	92.1090 (0.0000)***	34.1599 (0.0251)**	-4.20397 (0.0000)***
Credit x *High Technology*	91.3748 (0.0000)***	44.1489 (0.0014)***	-4.56412 (0.0000)***
Value Added	41.2376 (0.0035)***	37.8473 (0.0092)***	-8.67817 (0.0000)***
Export	15.3814 (0.6356)	23.1564 (0.1846)	-7.77689 (0.0000)***
Liquidity	64.7581 (0.0000)***	24.0541 (0.0883)*	-2.47100 (0.0067)***

Notes: ***=1%(0.01); **=5%(0.05); *=10%(0.10)

Based on the Table 3, the results of the unit root test with the first difference level using the Philips Perron (PP), Augmented Dickey-Fuller (ADF), and Levin Lin Cu (LL) methods, there are several variables that are not stable. This can be overcome by changing the first difference level to two differences. After testing at the two difference level, the results show that through the Levin Lin Cu (LLC) approach the six variables have a significant effect with a probability level of < 0.05, when using the Philips Perron (PP) and Augmented Dickey-Fuller (ADF) approaches there is one variable that is not stationary. So it can be concluded that this research can be continued because the data shows stationary data at the two difference level through the Levin Lin Cu (LL) approach.

Table 2 Best Model Selection Test Results

Variable	CEM	FEM	REM	SUR
Equity x *High Technology*	0.0004955 (0.000)***	0.0004942 (0.000)***	0.0004955 (0.000)***	0.0004955 (0.000)***
Credit x *High Technology*	41.42103 (0.061)	126.7371 (0.314)	41.42103 (0.058)	41.42103 (0.000)***
Value Added	257.6924 (0.152)	319.6194 (0.679)	257.6924 (0.148)	257.6924 (0.041)**
Export	-678.2701 (0.051)*	-254.6312 (0.342)	-678.2701 (0.048)**	-678.2701 (0.042)**
Liquidity	-0.6944278 (0.414)	-8.345689 (0.000)***	-0.6944278 (0.412)	-0.6944278 (0.121)

Notes: ***=1%(0.01); **=5%(0.05); *=10%(0.10)

Based on the calculation using the Common Effect Model (CEM), equity x High Technology and export variables have a significant influence on innovation (patents) because the probability value is < 0.05. While the variables of credit x High Technology, added value and liquidity do not have a significant effect on innovation (patents) because the probability value > 0.05. The calculation results using the Fixed Effect Model (FEM) explain that the equity x High Technology and export variables have a significant effect on innovation (patents) because the probability value is < 0.05. While the variables of credit x High Technology, added value and liquidity do not have a significant effect on innovation (patents) because the probability value > 0.05. The results of calculations using the Random Effect Model (REM) explain that the variables of equity x High Technology, credit x High Technology, value added and exports have a significant effect on innovation (patents) because the probability value is < 0.05. While the liquidity variable does not have a significant influence on innovation (patents) because the probability value > 0.05.

Table 3 Chow Test Results

Test Summary	Prob
F(5.83) = 2.25e+06	0.0000

Based on the Table 5, the Chow test results show that the probability value is 0.0000, which is smaller than 0.05. Therefore, it can be concluded that H0 is rejected, so H1 is accepted, which means that the most appropriate model in this Chow test is the Fixed Effect Model (FEM).

Table 4 Hausman Test Results

Test Summary	Chi-Sq.Statistic	Prob>Chi2
Cross-section random	20.45	0.0004

Based on the Table 6, it shows that the probability value is 0.0004, which means that the probability value < 0.05, the null hypothesis (H0) is rejected, which means that the Fixed Effect model is more suitable for use because there is a correlation between the independent variables and individual effects.

Based on the results of the Chow test and Hausman test, the most suitable model is the Fixed Effect Model (FEM) approach. However, when compared with Seemingly Unrelated Regression (SUR), the results show that the coefficient values and standard errors in SUR are smaller, which indicates that this model is more efficient than FEM. In addition, the lower probability values in the SUR model further strengthen the rationale for using it. Not only that, the selection of SUR is also based on the amount of data used in this study that fulfils the SUR test criteria, namely more years than observations. The selection of SUR is preferred because this method is able to overcome heteroscedasticity and correlation between errors in panel regression, thus producing more accurate and efficient estimates in data analysis.

Table 5 Seemingly Unrelated Regression Test Results

Variable	Coeffisien	Std.Error	z-statistik	Prob
Equity x *High Technology*	0.0004955	1.87e-07	2645.92	0.000
Credit x *High Technology*	41.42103	15.70939	2.64	0.000
Value Added	257.6924	126.1862	2.04	0.041
Export	-678.2701	333.7191	-2.03	0.042
Liquidity	-0.6944278	0.4477927	-1.55	0.121
Constanta	1367.244	1483.181	0.92	0.357

The analysis shows that Equity x High Technology and Credit x High Technology have a significant effect on innovation (patents) with a significance level of 0.000. A one US$ increase in equity increases the number of patents by 0.0004955 US$, while a one US$ increase in credit increases patents by 41.42103 US$. Value Added also has a significant effect (p = 0.016), with a one per cent increase increasing innovation by 10.34171 per cent. Meanwhile, Exports has a negative coefficient (-678.2701) and a significance level of 0.042, indicating that an increase in exports slightly suppresses innovation, although the impact is not significant. Liquidity also has no significant effect on innovation (p = 0.121) with a negative coefficient (-0.6944278). This suggests that funding and value-added factors play a greater role in driving innovation than exports and liquidity.

In high-tech industries, innovations are costly and take a long time to produce marketable products (Jin, 2023). Firms with strong equity are better able to finance long-term research, bear innovation risks, and support the development of potentially patentable products (Shi & Lai, 2019). The stability of funding from equity also helps companies attract top talent, which is important in creating high-quality patents (Yang & Zhou, 2022). Firms with large equity can invest more aggressively in R&D, increasing the chances of creating new technologies (Zhang et al., 2019). Access to cutting-edge research methods enables the development of high-value innovations (Power et al., 2022). In addition to creating patents, firms can protect and commercialise their innovations through litigation or technology licensing. Strong equity encourages investment in high technology and R&D, which increases the number and quality of patents (Zhang et al., 2019; Shi & Lai, 2019; Yang & Zhou, 2022). This relationship creates a sustainable innovation ecosystem, where large capital and high technology are key factors in the growth and dominance of firms in innovation-based industries.

Credit as an external funding source enables firms to finance research and development (R&D), which is crucial in high technology-based industries(Alya, 2022; Wiriya et al., 2023). Innovations in these sectors require substantial costs for testing, sophisticated equipment, and skilled labour, so easy access to credit can increase research capacity, speed up product development, and increase the number of patents(Asqalany, 2024; Marlina, 2024; Bala & Lastuti, 2021; Hanif et al., 2020). Sectors such as AI, biotechnology, nanotechnology and quantum computing rely heavily on continuous investment. Credits allow companies to access cutting-edge equipment, build state-of-the-art labs and accelerate experiments, which increases the chances of creating high-value patents (C. Han et al., 2017; Jia, 2015). Greater efficiency in R&D also helps to reduce costs and improve the accuracy of predicting research results. Companies that obtain credit under specialised funding schemes can increase investment in high technology, accelerate innovation cycles, and create patents of economic value (Rodríguez, 2014; Vicente et al., 2012; (Hochberg et al., 2018; H. Wei et al., 2024). Moreover, credit also supports the commercialisation of patents through mass production or technology licensing. Thus, easier access to credit increases the chances of high-tech-based firms to innovate and gain competitive advantage (Vicente et al., 2012; H. Wei et al., 2024).

Value-added plays a significant role in innovation and patent creation, reflecting the increased economic value of a product or service through technology and creativity (Riyani, 2024; Setiawan & Harmasanto, 2019). Investment in R&D enables companies to produce innovative products with higher added value than conventional products, which are often secured in the form of patents to protect and monetise their innovations (Fadhilah, 2018). Value-added-focused companies tend to develop products with unique features, better performance, or higher production efficiency (Sunandi, 2024). High technologies such as automation and artificial intelligence play an important role in this process, increasing product competitiveness and opening up monetisation opportunities through licensing or market expansion (Sugeng, 2022). Patents also increase company credibility and investor confidence, easing access to funding for further innovation (Wihartiko et al., 2021). Thus, the greater the added value of an innovation, the higher its chances of being patented and providing economic benefits to the company and the industry as a whole.

The link between exports and innovation (patents) occurs through technology transfer, global competitiveness, and incentives for high-quality products. However, the effect is often insignificant due to dependence on natural resources, low R&D investment, and weak intellectual property protection in some countries (NURHIDAYAH, 2022). In countries such as Brazil, Russia and India, exports are dominated by natural resource-based sectors or low value-added manufacturing, which does not encourage innovation (Garrone et al., 2018; Kizilkaya et al., 2016). The UK and France rely more on domestic R&D investment than export encouragement (Wurlod & Noailly, 2018). Other factors such as government policies, large domestic markets, and trade barriers also limit the influence of exports on innovation. Many export-oriented firms prefer adopting existing technologies rather than creating new innovations due to high costs and great risks. Export market regulations also make them focus on meeting international standards rather than developing new patents (Imaduddin, 2024). In the manufacturing and agricultural industries, companies prefer technological adaptation over long-term research (Judijanto, 2024). Although the effect of exports on patents is not always significant, in some cases, global competition can encourage innovation to increase the added value of products. However, its impact on the number and quality of patents is smaller than other factors such as R&D investment, government policies, and domestic technological infrastructure (Aryanti & Utami, 2022).

Liquidity reflects a company's ability to fulfil short-term obligations, but often has no significant effect on innovation and patent creation. Investment in R&D is long-term and high-risk, while liquidity focuses more on daily operational needs. Companies with high liquidity tend to be cautious in the allocation of funds and prefer investments that provide quick returns over R&D that has high uncertainty (Fang et al., 2014; Xu & Yang, 2018). In the UK and France, innovation is driven more by R&D funding from the government and venture capital, rather than from firm liquidity(Han et al., 2021). In Brazil, India, and Russia, firms with high liquidity remain reluctant to allocate it to innovation due to economic uncertainty, complex regulations, and lack of a supportive ecosystem (Shao, 2024). In developed countries, companies prefer to use liquidity for business expansion or dividend payments rather than long-term research (Xie et al., 2022). While liquidity can provide financial flexibility, many companies prefer to use it for other purposes such as share buybacks or dividends, rather than innovation. In contrast, liquidity-stressed firms can still innovate through credit or equity (Evers et al., 2020). However, in some cases, liquidity can support innovation if it is managed well and some of its assets are allocated to R&D and patent protection. Even so, its influence remains smaller than factors such as R&D investment, access to credit, or government policy support (Malamud & Zucchi, 2019). Therefore, liquidity is not a major factor in innovation, as investment decisions are more influenced by long-term business strategies and the availability of risk capital.

Conclusion

This study underscores the significant role of financial variables particularly equity, credit, and value-added production—in fostering sustainable innovation, especially in high-technology sectors. Firms with strong equity positions and access to credit demonstrate greater capacity to invest in research and development (R&D), attract skilled talent, and develop patentable technologies. Conversely, export activities and liquidity were found to have no significant influence on innovation. In many cases, highly liquid firms prioritize short-term financial goals such as business expansion or shareholder returns over long-term innovation investments. These findings suggest that innovation is more strongly driven by strategic financial planning and access to risk capital than by immediate financial flexibility.

Based on these insights, policymakers are encouraged to design financial and fiscal frameworks that promote innovation-oriented funding. This includes offering tax incentives for equity-based investments, facilitating affordable credit schemes for technology-driven firms, and supporting value-added production through targeted subsidies. Additionally, governments should strengthen the innovation ecosystem by fostering partnerships between industries, research institutions, and capital markets. For future research, the author recommends examining how firm-level financial behavior interacts with innovation across different industries and economies. Longitudinal and comparative studies, as well as qualitative case analyses, could provide a deeper understanding of how financial strategies contribute to innovation over time and under varying institutional conditions.

Author Contributions

Conceptualisation, A.P.G., F.R.A.L. and A.S.; Methodology, A.P.G.; Investigation, A.P.G. and A.S.; Analysis, A.P.G. and F.R.A.L; Original draft preparation, M.L.A.K and A.S.; Review and editing, A.P.G., R.K., and N.A.A; Visualization, R.K.; Supervision, F.R.A.Land R.K.; Project administration, R.K.

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Conflict of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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