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UNLOCKING GROWTH: THE ROLE OF GREEN FINANCE, INNOVATION, AND ECONOMIC DRIVERS

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Abstract: *The research explores the relationship among green finance, innovation, and economic growth in relation to financial development. It utilizes OLS and MMQR methods to assess the impact of green finance, the number of patents, economic growth, gross fixed capital formation, and public expenditure on research and development on the progress of financial development. The results indicate that both patent innovation and economic growth positively influence financial development. However, green finance, government investment in fixed capital, and research and development hinder financial development. The study highlights the importance of institutional quality and emphasizes the need for targeted investment.*

Keywords: *innovation, green finance, economic development, public spending, institutional quality.*

1. Introduction and Literature Review

Globalization, alongside environmental consciousness and digital advancement, is increasingly becoming a focus of academic inquiry. The financial system is now shaped not by conventional ideas, but by innovation and sustainability. Additionally, green growth has emerged as a priority of our time to alleviate the impacts of climate change and foster sustainable economic progress. The rise of green finance introduces a new factor influencing both the traditional financial sector and economic development. This research aims to evaluate the impact of green finance, economic advancement, public investment in research and development, and investments in gross fixed assets on the evolution of the financial system across the 27 nations of the European Union over a

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span of 13 years, from 2010 to 2023. The objective of this study is to offer insights for future policies intended to create a robust and forward-thinking financial system.

The development of patents affects financial growth by increasing the necessary investments in research and development. Additionally, financial markets significantly influence the advancement of patents (Maskus et al., 2019). However, countries with substantial credit constraints find that financial development directly impacts both the quantity of patents and the level of innovation (Chu et al., 2019). While restricted credit markets can stifle innovation, access to external financial resources in well-developed equity markets encourages higher rates of innovation (Hsu et al., 2014). Furthermore, there exists a causal relationship between financial development and innovation (Çeştepe, 2022). The adverse effect of green finance on high-quality economic development has been corroborated by Yang (2023), and similar findings have been reported by Mohhamad (2022). The negative interplay between green finance and financial development can be attributed to the crowding out effect in heavily polluting sectors (Fan and Zang, 2024). Additionally, green growth is financed through pre-existing resources (Křístková et al., 2025). Financial development and economic growth demonstrate a positive bi-directional relationship, indicating that financial development fosters economic growth, while economic growth similarly supports financial development (Mlambo, 2024). The causal relationship between financial development and economic growth is present in the long-term, too (Leigh, 1996). The positive effect of economic development on financial development is supported by multiple authors (Ekanayake and Thaver, 2021), (Hassan et al., 2011) (Guru and Yadav, 2019). Athough gross domestic investment in fixed capital promotes economic growth, it does not necessarily contribute to financial development (Boamah et al., 2018). Furthermore, if government investments in fixed capital are poorly executed and inadequately managed, such actions can lead to financial and economic difficulties for nations. Similar consequences may occur if the investments are largely financed through debt or if there is excessive spending on unproductive projects (Ansar et al., 2016). The link between poorly executed investments and their negative impact on economic growth and financial development has been corroborated by additional research (Hakro et al., 2016) (Maune and Matanda, 2022). Nations with advanced financial systems tend to have reduced spending (Chen et al., 2019). Additionally, public spending has an adverse influence on financial development (Kapaya, 2023). In the absence of adequate institutional quality and governance, the effect of research and development may obstruct economic growth (Chagwiza et al., 2024).

2. Methodology

This study utilizes data from the 27 member countries of the European Union spanning the years 2010 to 2023. The database containing the information for all variables

besides financial development is sourced from Eurostat while the source for financial development is the World Bank. To standardize the data and reduce heteroskedasticity, all variables have been transformed into a logarithmic scale. The objective of this research is to explore the impact of green finance, patent activity, economic growth, gross fixed capital, and gross domestic expenditure on research and development in relation to financial development by employing OLS analysis and MMQR regression to assess the effects of these factors across various quantiles. Ordinary Least Squares is a fundamental regression technique that applies a least squares method to estimate statistical parameters based on certain assumptions (Allen, 2017). The primary aim of OLS is to determine whether the independent variables can effectively predict the dependent variable (Wooditch, 2021). MMQR, or multiple quantile regression, incorporates fixed effects into its analysis. This approach reveals the impact of independent variables on the dependent variable across different quantile levels (Rios-Avila, 2024). The study provides descriptive statistics for each variable, along with a correlation matrix that demonstrates the significance and nature of the relationships among them. Following this, it performs both OLS regression and MMQR regression analyses to determine how the independent variables influence the dependent variables at various levels.

3. Results

Descriptive statistics Table 1

Variable	Obs	Mean	Std. dev.	Min	Max
FD	375	4.2931	0.4860	3.1376	5.5399
GF	378	-0.6364	0.7246	-2.8134	0.9555
PAT	378	5.8414	2.1492	2.0794	10.2156
GDP	378	10.0540	0.6335	8.6464	11.5065
GFC	378	4.6751	0.2139	3.8796	5.5738
GERD	378	5.6160	1.8606	-0.4992	9.7268

Source: p*rocessed by author*

The table provides a detailed overview of the data distribution. The variable with the highest mean is GDP, which displays a moderate degree of variability, closely followed by PAT. On the other hand, FD and GF have the lowest mean values, indicating they exhibit the least variation in the dataset.

Correlation Matrix Table 2

	FD	GF	PAT	GDP	GFC	GERD
FD	1.0000					
GF	-0.2036***	1.0000				
PAT	0.4313***	-0.0975**	1.0000			
GDP	0.4903***	-0.2653***	0.7220***	1.0000		
GFC	-0.1206***	-0.1443***	-0.0232*	0.1074***	1.0000	
GERD	0.1141***	0.0293*	0.7672***	0.3013***	-0.0454*	1.0000

Note: ***, ** and * denote $p < 0.01$, $p < 0.05$, $p < 0.1$.

Source: *processed by authors*

The correlation matrix shows a weak negative relationship between green finance and financial development. A similar relationship is observed between GFC and FD, GF and GFC, as well as between GDP and GF. There is a highly significant positive correlation between the variables FD and Pat, FD and GERD, and FD and GDP. Additionally, the same type of correlation exists between PAT and GDP, GERD and PAT, GDP and GERD.

OLS Regression output Table 3

FD	**Coefficient**	**Std. err.**	**t**	**P>t**	**[95% conf.**	**interval]**
GF	-0.075639	0.0298277	-2.54	0.012	-0.1342927	-0.0169854
PAT	0.140792	0.0253292	5.56	0.000	0.0909844	0.1905996
GDP	0.1172119	0.0593621	1.97	0.049	0.0004815	0.2339422
GFC	-0.3539641	0.0983526	-3.60	0.000	-0.547366	-0.1605622
GERD	-0.1069477	0.0210035	-5.09	0.000	-0.1482492	-0.0656462
_cons	4.498114	0.6540216	6.88	0.000	3.212037	5.784191

Source: processed by author

The regression analysis reveals that the variables with the greatest positive effect on financial development are the number of patents from each country. In contrast, green finance, gross fixed capital formation, and gross domestic expenditure on research and development exert a notable negative influence on financial development. Economic growth exhibits a moderate and positive effect on financial development.

MMQR analysis Table 4

	Coeficient Quantile 0.25	**STD**	**Coeficient Quantile 0.50**	**STD**	**Coeficient Quantile 0.75**	**STD**	**Coeficient Quantile 0.90**	**STD**
GF	-0.0180*	0.0345	-0.0629**	0.0226	-0.1240***	0.0445	-0.1870***	0.0614
PAT	0.1298***	0.0268	0.0118***	0.0177	0.1499***	0.0342	0.1618***	0.0477
GDP	0.1417***	0.0603	-0.0268**	0.0397	0.0965*	0.0769	0.0697*	0.1073
GFC	-0.6421***	0.1283	0.3146***	0.0838	-0.1119*	0.1671	0.2033*	0.2281
GERD	-0.0750***	0.0264	-0.0347***	0.0173	-0.1337***	0.0338	-0.1685***	0.0469
_cons	5.2534***	0.7498	-0.8245***	0.4933	3.8637***	0.9599	3.0373***	1.3333

Note: ***, ** and * denote $p < 0.01$, $p < 0.05$, $p < 0.1$.

Source: *processed by authors*

The MMQR analysis demonstrates the impact of financial development variables. Green finance negatively affects financial development across all quantiles, with its detrimental impact increasing at higher quantiles, indicating that countries with significant green finance may experience hindered financial growth. The rising number of patent applications positively influences financial development throughout all quantiles, suggesting that a greater volume of patents and innovations fosters financial progress. Although economic growth generally aids financial development, it turns negative at the median quantile, with its effects moderating at higher quantiles. Gross capital formation exhibits a negative effect at the lowest quantiles before becoming positive at the highest quantiles, implying that investment in physical assets positively contributes to financial growth. Gross domestic expenditure on research and development consistently shows a negative effect on financial development across all quantiles, indicating that investments in research and development are not associated with financial development and may even impede it.

4. Conclusion

The study explores how green finance, innovation, and economic variables influence financial development, using data from the 27 member countries of the EU from 2010 to 2023. Through Ordinary Least Squares (OLS) and Median Quantile Regression (MMQR) estimation techniques, the research indicates that an increase in both the number of patents and economic growth substantially fosters financial development, highlighting the importance of innovation and economic advancement for strengthening financial systems. However, gross fixed capital and R&D expenditures seem to impede financial

development, especially in the short run. This unexpected outcome implies that significant investments in infrastructure and research, while crucial for long-term advancement, may lead to inefficiencies and misalignments within financial markets if not managed with care. Moreover, government support for R&D funding, particularly in the absence of proper institutional frameworks, can negatively impact financial development by channelling funds into less effective projects. The analysis also shows that public investment in fixed capital generally detracts from financial development, although this effect turns positive at higher quantiles, underscoring the significance of investment quality, especially in more developed nations. The results further indicate that traditional financial systems are under pressure from green finance, particularly in nations with extensive green financial instruments. This implies that the shift towards a green economy, while essential, needs to be handled in a manner that incorporates green finance into broader financial systems without causing destabilization. The study's policy suggestions underline the necessity for mechanisms that facilitate the shift to green economies, optimize the allocation of R&D resources, and enhance institutional frameworks. It is vital to ensure that public investments in research and infrastructure are strategically aligned with market requirements and to promote institutional quality to boost the resilience of financial systems. The research emphasizes the critical role of financial innovation and the integration of green finance to promote sustainable development, providing valuable insights for policymakers focused on reconciling economic growth, innovation, and sustainability within the financial sector.

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