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Financing the Future: The Role of Technology Budgets and Innovations in Driving Economic Growth in OECD Countries

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ABSTRACT

The study analyzes the dynamic association among technology budgets, innovations and economic growth in 24 (OECD) countries. Based on the theoretical foundations of endogenous growth theory, the research employing panel data for the period 1995 to 2024 by utilizing econometric techniques such as Panel Autoregressive Distributed Lag (PARDL), causality tests and cointegration analysis. The study used GDP as dependent variable while R&D Budget, Patents, Labor Force Participation Rate, Gross Fixed Capital Formation and Institutional Quality Index taken as independent variables. As global economies increasingly rely on knowledge-based development, the strategic allocation of public and private funds toward R&D budget and technological innovation has emerged as a crucial determinant of long-term productivity and growth. The findings conclude that strategic investments in R&D and innovation, infrastructure drive productivity and competitiveness. Policymakers aiming to optimize fiscal strategies for technological transformation and sustainable development in advanced economies.

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1. Introduction

In today's globalized and increasingly knowledge-driven economy, technology budgets, innovation, and economic growth are interlinked forces that shape the developmental trajectory of nations. The strategic allocation of financial resources toward technology and research commonly referred to as technology budgets that serves as a foundational input for driving innovation and stimulating long-term economic growth (Mohamed, Liu, & Nie, 2022). Technology budgets refer to the financial resources allocated by governments, often include funding for national science and technology agencies, universities, innovation hubs and grants to private firms for R&D technology (OECD, 2023). The size and efficiency of technology budgets are directly linked to a countries or firm's capacity to innovate. The role of technology budgets is to create the infrastructure and knowledge base necessary for innovation (Luo, Ullah, & Ali, 2021). The adequately and strategically allocation of budgets can lower the barriers to technological advancement and facilitate the creation of new products, services and processes (European Commission, 2022). Countries that consistently invest in technology tend to have stronger innovation systems and more resilient economies.

Innovation is the process through which new ideas, knowledge or technologies are transformed into useful products or processes that drive progress and solve real-world problems (Schumpeter, 1934). Innovation not only introduces efficiency gains but also fosters structural transformation and creates new market opportunities. In practice, firms that innovate tend to grow faster, export more, and pay higher wages (Romer, 1990). However, innovation requires both financial and institutional support. This underscores the importance of investing in the innovation process, which is largely supported by robust technology budgets. Economic growth is the process of long-term growth that depends not only on capital accumulation and labor inputs but also increasing on productivity and technological advancement (Solow, 1956). Technological innovation contributes to economic growth by improving production processes, enabling new industries and increasing the efficiency of resource allocation. Empirical studies confirm that countries with higher R&D intensity and innovation output tend to exhibit stronger economic growth (Aghion et al., 2009; Griliches, 1998). Furthermore, innovation-driven growth tends to be more sustainable, as it is based on knowledge accumulation and not merely on the exploitation of natural resources.

The connection between technology budgets, innovation and economic growth is supported by both theoretical and empirical research. Adequate technology budgeting enables innovation, and innovation, in turn, drives productivity and growth. The government developed the idea of "absorptive capacity," which holds that in order for businesses and economies to successfully adopt and use new technologies, they must invest in knowledge acquisition and research and development (Bye & Fæhn, 2022). According to Cohen and Levinthal (1990), technology budgets have increased dramatically over the last few decades as economies have shifted toward innovation as it is essential to the modernization of production techniques and economic advancement. Additionally, R&D and innovation expenditures encourage infrastructure development, increase productivity and advance the economy (Maradana et al., 2019). In another words, technology budgets, innovations and economic growth are all intricately linked to economic development which acts as a stimulant for long-term economic growth and productivity. With the global economy increasingly dependent on innovations, green technologies and digitalization, the relationship between these drivers will increasingly determine national development plans and international competitiveness.

2. Literature Review

Various studies have been conducted on the relationship between technology budgets, innovations and economic growth. As countries increasingly prioritize knowledge-based development, understanding how technological investments influence performance has gained attention. Scholars have explored both the direct and interactive effects of innovation inputs such as R&D budget and patent activity on growth and sustainability. In this section, the paper presents an empirical review of previous studies to conceptualize the current research.

Ali et al. (2021); Kumar Sarangi et al. (2022) and Nihal P et al. (2024) explored the impact of innovation on economic growth, revealed that research and development (R&D) technologies like innovation had a positive impact on economic growth. In the same way, Boeing, Eberle and Howell (2022) studied modern innovative technologies contributed to promoting economic growth. The study proved that technological innovation had a positive impact on GDP growth. In more recent work, Endogenous growth models offer a robust framework for examining key issues related to the role of technological change in economic growth, as well as the formulation and effectiveness of R&D and innovation policies (Broughel & Thierer, 2019; Scherer, 2011). In other words, R&D intensity is correlated positively with the patenting rate, and technological advance is correlated positively with the growth rate of output per capita (Aghion et al., 2009; Zachariadis, 2003). Most research studies emphasized that innovation is a crucial factor for economic development and necessary for ensuring competitiveness (Hadj, 2020; Neamat & Yitmen, 2017). Similarly, Ali et al. (2021) and Ren et al. (2021) examined how institutional quality affects economic growth in a knowledge-based economy. The findings showed that a strong institutional setting, highly skilled labor force, and high commercialization networks were crucial for the innovation-economic growth link to boost economic growth through innovation activities. In same pattern, Moustapha and Yu (2021) examined how R&D expenditure affects economic growth in OECD countries. The analysis suggested that governments and institutions should increase their investment in R&D to promote inclusive and sustainable development. Moreover, Wei et al. (2023) explored impact of technology budgets on innovations. Long-run estimation revealed that technology budgets and economic growth identified U-shaped linked. Based on these findings, the paper focused to enhanced technology budgets and innovation that would crucial for economic well-being.

In other words, Awad, Khalaf and Afzal (2023) analyze the relation between sustainable development and economic growth. The results indicated that these sustainable growth indicators were positively correlated with economic growth. In other way, Zheng et al. (2023) and Li et al. (2024) examined the technological innovation had a positive influence on economic expansion that highlighting the critical role of innovation in driving growth. Conversely, economic growth exerted a negative pressure on technological innovation, indicating that rapid growth could hinder further innovation. Although, Yang et al. (2025) indicated that innovations had a more significant effect on economic growth than negative effects. Overall, these results underscored the pro-cyclical nature of the relationship between R&DE, patents, and economic growth across OECD countries.

3. Theoretical Framework

This section provides the basic foundation for considerate the link between technology budgets, innovations and economic growth. Several economic theories support this linkage, including Schumpeterian Theory of Innovation highlights how technological change and creative destruction fuel economic development. The Public Finance Theory also underscores the importance of efficient budget allocation in enhancing productivity and innovation outcomes. Additionally, Endogenous Growth Theory emphasizes the role of technological innovation and R&D investment in driving long-term growth. Endogenous growth theory developed by economists such as Romer (1986) and Lucas (1988), emphasizes the role of internal factors within an economy particularly human capital, innovation and knowledge accumulation in driving long-term economic growth. The Cobb-Douglas model serves as the foundation for the neoclassical production function, which initially considers the impact of technological change on economic growth. The functional form of Cobb-Douglas production function can be written as:

$$Yt = f\,(Kt, Lt, A\,t)$$

In above equation, Y is output, t is time period, K is capital, L is labor and A is technology that captures exogenous technological change in these factors. In response to the global macroeconomic disparities of the 1970s, economists shifted their focus toward business cycle fluctuations, moving away from exogenous towards endogenous model. The Romer (1990) identified that research and development technologies play a pivotal role of economic growth. R&D activities generate knowledge that have increasing returns to scale due to their non-rival nature, meaning that once created, knowledge cannot be demining, it remains the same. This theory highlights the role of innovation and spillovers that is a critical driver of productivity and economic expansion. According Solow (1957) growth model, technological progress contributes to increase in capital and labor productivity beyond the effects of capital accumulation (Solow, 1957). In this framework, endogenous growth models emphasize that technological progress is not externally determined but arises from internal factors such as human capital accumulation. The theory also posits that advancement in innovation, knowledge and human capital drive productivity gains, thereby enhancing long-term economic performance (Lucas, 1988; Romer, 1986). For these economies, achieving consistent growth not only drives industrial development but also strengthens the capacity of global markets that fostering innovation and competitiveness. The theory also posits that innovation not only drives economic growth but can also address environmental challenges by enabling the energy-efficient practices that can reduce greenhouse gas emissions that contributed to sustainable economic progress.

4. Data and Methodology

The paper analysis the impact of technology budgets, innovations and economic growth in 24 OECD states by utilizing data for time period 1995 to 2024. Panel PARDL technique is utilized for empirical analysis in which data has been collected from different sources such as WDI and OECD iLibrary. The data of Economic Growth (EG), Labor Force Participation Rate (LFPR), Gross Fixed Capital Formation (GFCF) is taken from world development indicators while Research and Development Budget (R&D budgets) and Total Patents (TP) data is collected from OECD countries. In order to explain stochastic error term, the linear regression model is expressed as:

$$\begin{aligned} GDP\ growth = {} & \beta 0 + \beta 1(R\&D\ Budget) + \beta 2(Total\ Patents) + \beta 3(Labor\ Force\ Participation\ Rate) \\ & + \beta 4(Gross\ Fixed\ Capital\ Formation) + \beta 5(Institutional\ Quality\ Index) + \varepsilon \end{aligned}$$

In this model, GDP growth is the proxy of economic growth which is dependent variable as well as independent variables like R&D budget is the proxy of technology budget, Total Patents is the proxy of technology innovation. The model also considered LFPR, GFCF and IQI also a part of independent variables that contribute to economic growth. The Panel ARDL model (p,q,q,q…q) is specified as:

$$Y_{it} = \sum_{j=1}^{p} \lambda_{ij} Y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it}$$

Where Y_{it} represent the dependent variable (GDP growth), X_{it} represents the k x 1 vector of independent (R&D budget, Patents) and control variables like labor force participation rate (LFPR), gross fixed capital formation (GFCF) and institutional quality index (IQI). In the same way, μ_i is the fixed effects and ε_{it} is the error term. The Panel Autoregressive Distributed Lag model is an econometric technique used to analyze both the short-run and long-run relationships among variables in panel data settings, where data are observed across multiple entities (countries) over time. It is particularly useful when the variables are a mix of stationary (I(0)) and non-stationary (I(1)) series, but not I(2) and when there is potential cointegration among them. The model incorporates both dependent and independent variables that allow dynamic adjustment processes and heterogeneous responses across cross-sectional units. A common estimator for PARDL is the Pooled Mean Group (PMG), which assumes common long-run coefficients across entities but allows for short-run heterogeneity. This makes PARDL ideal for assessing how variables respond over time and across different contexts, such as the impact of technology budgets, innovations on economic growth in OECD countries.

The re-parameterized Panel ARDL (p,q,q,q….q) error correction model is defined as:

$$\Delta Y_{it} = \emptyset_i (Y_{i,t-1} + \beta_i X_{i,t}) + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta Y_{i,t-j} + \sum_{j=0}^{q-1} \delta^*_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it}$$

Where, $\emptyset_i$ is the error term and β_i shows long run relation between X_{it} and Y_{it}. λ^*_{ij} and δ^*_{ij} are the short-run coefficients. If the ECT term is negatively significant, the X_{it} and Y_{it} are cointegrated. Based on the above methodology, the study presents the econometric form of PARDL model within this framework.

$$GDPit = \beta 0it + \beta 1RDBit + \beta 2TPit + \beta 3LFPRit + \beta 4GFCFit + \beta 5IQIit + \varepsilon it$$

5. Results

In this section, the researcher presents the econometric results obtained using the Panel ARDL technique. The analysis focuses on both the short-run dynamics and long-run equilibrium relationships between technology budget innovation and economic growth performance. The results are interpreted in line with economic theory and prior empirical findings. This provides a comprehensive understanding of how innovation-related fiscal strategies influence economic outcomes over time.

Table 1: Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
GDP	720	93.42	218.3	12.66	4161.4	17.85	331.87
RDB	720	0.614	0.828	0.005	7.60	4.40	29.20
TP	720	6747.8	1316.8	7.23	68392.1	2.77	10.34
LFPR	720	0.59	0.616	-2.22	4.32	.428	6.40
GFCF	720	3.71	6.99	1.41	4.79	4.06	20.60
IQI	720	0.38	0.860	-2.79	11.39	2.19	40.21

Source: Author calculation using stata.14 software

The descriptive statistics table based on 720 observations in which GDP exhibits a high mean value of 93.42 and extreme skewness that indicating a highly right-skewed distribution with significant outliers, due to disparities in country sizes or economic outputs (Gujarati & Porter, 2009). RDB shows a mean of 0.6149 with considerable dispersion with a high skewness and kurtosis (29.205), reflecting a non-normal distribution with a concentration of lower values and a few extremely high ones. TP has a mean of 6747.8 and is also right-skewed (2.777), suggesting technological outputs are unevenly distributed across observations. LFPR has a mean of 0.5974 with moderate skewness (0.428) that indicating relatively symmetric distribution compared to other variables. GFCF with a mean of 3.710 and a high skewness (4.061) suggests right-tailed behavior while the IQI has a mean of 0.386 and exhibits significant non-normality (skewness = 2.195, kurtosis = 40.21). The wide ranges and high moments (skewness and kurtosis) across most variables indicate the presence of outliers and potential non-linear relationships, which should be carefully addressed in the empirical modeling process (Semykina & Wooldridge, 2013).

Table 2: Matrix of Correlations

Variables	GDP	RDB	TP	LFPR	GFCF	IQI
GDP	1.00					
RDB	0.52	1.00				
TP	0.41	-0.08	1.00			
LFPR	-0.12	0.16	-0.18	1.00		
GFCF	0.65	-0.09	0.72	0.00	1.00	
IQI	-0.14	0.02	0.41	0.12	-0.04	1.00

Source: Author calculation using stata.14 software.

The correlation matrix reveals that GDP exhibits a strong positive relation with GFCF and a moderate positive correlation with RDB and TP, suggesting that higher economic output is associated with increased capital investment, innovation spending and technological outputs. However, GDP shows a weak negative correlation with labor force participation rate (-0.123) and IQI (-0.145), implying that economic growth may not necessarily align with improvements in patent dynamics or institutional quality in the short run. Interestingly, TP and GFCF are strongly correlated (0.727), indicating that greater capital investment may drive technological innovation. Meanwhile, RDB shows a weak positive correlation with LFPR (0.166) and IQI (0.024) but a weak negative correlation with TP (-0.084) and GFCF (-0.097), suggesting that R&D funding alone may not directly translate into patent outputs or investment without complementary factors. Additionally, TP correlates moderately with IQI (0.415), highlighting a potential link between better institutions and innovation output. Overall, the correlations suggest interconnectedness among economic growth, innovation and institutional factors, though the relationships are uniformly strong or linear (Gujarati & Porter, 2009).

Table 3: Cross-Sectional Dependence Test

Test	CD Statistics	P_value
Pesaran	2.82	0.09
Friedman	0.42	1.02
Frees	4.66	1.00

Notes: Under the null hypothesis of cross-section independence.

The findings of CD test shows that there is no evident cross-sectional dependence in the panel data variables. Pesaran's CD test gives us the statistic value of 2.824 (0.0973) which is greater than at 5% significance level. Likewise, the Friedman test and the Frees test both lead us to the same conclusion, which points to the independence of the residuals across cross-sectional units. This means that the panel dataset is comparatively free from contemporaneous correlation between countries or entities, justifying the employment of first-generation panel estimation methods (Pesaran, Schuermann, & Weiner, 2004).

Table 4: Panel Unit Root Test

Variables	Level		1st Difference		
	Im–Pesaran–Shi	Levin–Lin–Chu	Im–Pesaran–Shi	Levin–Lin–Chu	Results
GDP	1.569 (0.108)	1.122 (0.869)	-13.683*** (0.000)	-7.526*** (0.000)	I(1)
RDB	1.145 (0.874)	3.073*** (0.201)	-5.210*** (0.000)	-2.231*** (0.012)	I(1)
TP	-1.695*** (0.004)	-0.057*** (0.002)	-10.151*** (0.000)	-6.610*** (0.000)	I(0)
LFPR	0.202 (0.580)	-0.081 (0.467)	-10.392*** (0.000)	-7.776*** (0.000)	I(1)
GFCF	-1.211*** (0.007)	-2.852*** (0.002)	-12.095*** (0.000)	-10.723*** (0.000)	I(0)
IQI	-3.212*** (0.000)	-2.897*** (0.001)	-16.571*** (0.000)	-13.844*** (0.000)	I(0)

Significance at 1% level or ***p<0.01. Significance at 5% level or ** p<0.05. * Significance at 10% level or * p<0.1.

The panel unit root test results indicate that GDP, RDB and LFPR are integrated in order I(1). Conversely, TP, GFCF and IQI are stationary at levels I(0), as indicated by statistically significant negative test statistics and confirming stationarity without differencing. Overall, the mixed integration suggests suitability of econometric techniques that can handle such cases, such as the Panel ARDL model or panel cointegration methods (Baltagi, Bratberg, & Holmås, 2005).

Table 5: Cointegration Test

Pedroni Test	Statistic		Westerlund Test	Statistic	
	Panel	Group		Value	P-value
V	3.75	.	Gt	-2.01	0.02
Rho	-0.037	-11.95	Ga	-3.79	0.00
T	-4.30	-14.56	Pt	-0.53	0.00
Adf	-0.083	-4.892	Pa	-4.42	0.00

All test statistics are distributed N(0,1), under a null of no cointegration, and diverge to negative infinity (save for panel v).

In table 5, both tests collectively confirm the presence of a long-run equilibrium relationship among the variables. Both tests result rejects the null hypothesis of no cointegration across panel members, suggesting that a long-term relationship exists among the dependent and independent variables (Pedroni, 1999) and Westerlund (2007). This implies that despite potential short-term deviations, the variables tend to move together in the long run. Overall, the evidence from both tests indicates that the model variables are cointegrated, justifying the application of long-run panel estimation techniques such as the panel ARDL model.

Table 6: Hausman (1978) Specification Test

MG vs PMG	DFE vs PMG
chi2(4) = 9.85	chi2(4) = 1.08
(0.5199)	(1.0000)

*** Significance at 1% level, **Significance at 5% level or * Significance at 10% level.

In table 6, Hausman (1978) is used to check which test is best for panel ARDL model. In both cases, the p-values are considerably higher than the 0.05 significance, indicating no significant difference in coefficients between the PMG and the alternative models (MG and DFE). Therefore, PMG is more suitable under the assumption of long-run homogeneity across panel units (Pesaran, Shin, & Smith, 1999). Therefore, the comparison of estimation techniques using the Hausman test shows that PMG model is suitable for the panel ARDL model.

Table 7: PMG_ARDL Model

Δgdp	Coef.	Std.Err.	Z	P>z	[95%Conf.	Interval]
Long run						
RDB	4.581	13.81	2.940	0.003	3.503	6.658
TP	1.167	0.055	2.850	0.004	0.027	0.052
LFPR	3.585	10.96	3.520	0.000	1.093	0.076
GFCF	1.609	3.791	4.210	0.000	8.531	2.340
IQI	2.699	8.151	2.780	0.005	6.723	3.675
Short run						
ECT	-0.074	0.039	-1.890	0.000	0.151	0.003
ΔRDB	4.691	64.10	0.650	0.015	3.944	1.326
ΔTP	0.014	0.008	0.170	0.064	0.015	0.018
ΔLFPR	2.306	2.864	1.240	0.216	1.506	3.119
ΔGFCF	3.151	1.231	2.560	0.010	7.381	5.561
ΔIQI	-6.948	4.472	-1.050	0.092	-1.310	5.414
Constant	-2.641	2.015	-0.990	0.325	-7.669	2.388

*** Significance at 1% level, **Significance at 5% level or * Significance at 10% level. Estimations are done by using Stata software.

The results from PMG estimator in the panel ARDL model reveal both long-run and short-run determinants of GDP growth. In Long-run, all the variables are positively significant, which shows a strong long-run relationship with GDP. Specifically, the RDB, TP are positively and significantly correlated with GDP, which means that R&D investment improves economic performance (Aghion et al., 2009; Romer, 1990). GFCF and LFPR also have strong positive correlations with GDP, validating the importance of physical investment and human capital. Economic growth is largely determined by IQI, reflecting the fact that better institutional arrangements and governance facilitate economic activity. The presence of a stable long-run equilibrium relationship is established by the short-run negative and statistically significant Error Correction Term (ECT). Of the differenced variables, only ΔGFCF is statistically significant (0.010), reflecting the fact that capital formation has a short-run contribution to GDP changes.

Other short-term variables such as ΔRDB, ΔTP, ΔLFPR, and ΔIQI are statistically insignificant, which means that their effects on GDP are more long-lasting and occur over the long-run. Overall, the findings support the view that innovation inputs (R&D, patents), labor participation, investment, and institutional quality are essential for sustainable economic growth, especially in the long run (Acemoglu, Johnson, & Robinson, 2005; Barro, 1996).

Table 8: Diagnostic Test

Test	Statistics	Probability	Decision
Breusch-Pagan Test	15144.29	2.382	No heteroskedasticity exits.
Jarque-Bera Test	1247.81	1.229	Residuals are normally distributed.
Autocorrelation Test	177.186	2.293	No serial correlation exits.

Source: Author calculation using stata.14 software.

The panel model is well-specified and free of serious econometric problems, according to the findings of the diagnostic tests that is used to assess its assumptions. The null hypothesis that there is no heteroskedasticity is accepted based on the test statistic of 15144.29 (2.3829) reported by the Breusch-Pagan Test for Heteroskedasticity. This suggests that the model does not require heteroskedasticity correction because the variance of the error terms remains constant across observations. A statistic of 1247.81 (1.2293) from the Jarque-Bera Normality Test indicates that the residuals are normally distributed. This is a good result because it confirms the residuals' assumed normality, which is crucial for hypothesis testing and inference. For autocorrelation, there is no serial correlation in the residuals, which yields a statistic of 177.186 (2.2930). Overall, the test results indicated that the model has no heteroskedasticity, no autocorrelation and normally distributed which supports the validity and robustness of the model's estimates.

6. Discussion of Results

This section discusses the key findings from the Panel ARDL analysis in relation to existing theoretical expectations and empirical studies. The aim is to interpret the implications of the results, particularly how technology budgets, innovations influence economic growth across 24 OECD countries. Differences in short-run and long-run effects are also examined to provide deeper policy insights. In this context, R&D budgets have a positive relationship with economic growth because R&D investments drive technological progress, productivity enhancements and innovation-led competitiveness. Increased R&D spending enables firms and economies to develop new products, improve processes and adapt to changing global markets, thereby stimulating growth. Romer (1990) endogenous growth theory highlights how R&D contributes to knowledge accumulation. Empirical evidence by Ghosh and Parab (2021) also confirm that higher R&D intensity is correlated with stronger GDP growth, especially in OECD countries.

In the same way, Total patents are positively related to economic growth because they serve as a proxy for innovation. As technological change drives productivity, more patents often correlate with higher output and improved economic performance. Various studies showing that countries with higher patent counts tend to experience stronger GDP growth due to sustained innovation activity Furman et al. (2021) and Spyropoulos and Varsakelis (2023). Additionally, the LFPR positively influences economic growth because it reflects the active portion of the population contributing to production. A higher LFPR means more people are working or actively seeking work which boosts output, increases income levels and enhances aggregate demand. Additionally, an engaged workforce promotes human capital development and innovation. Empirical evidence from studies like Barro (1999) and Bloom, Canning and Sevilla (2004) confirms this positive relationship, showing that increased labor participation leads to higher GDP growth through expanded productive capacity and improved labor market efficiency. Moreover, GFCF positively influences economic growth because it represents investment in physical assets such as infrastructure, machinery and equipment, which enhance productive capacity. According to De Long and Summers (1991), countries with higher rates of capital formation tend to experience faster growth due to stronger capital accumulation. Similarly, Ndikumana and Verick (2008) created a significant relation among GFCF and GDP growth in African countries, underlining capital investment's critical role in long-term economic development.

Furthermore, IQI has a positive relationship with economic growth because strong institutions promote policy stability, reduce corruption, enforce property rights and ensure efficient resource allocation factors. Effective institutions also boost investor confidence, fostering innovation and productivity. As Acemoglu, Johnson and Robinson (2005) argue, institutions are the fundamental cause of long-term economic growth. The study of Kaufmann, Pajoro and Angenent (2010), confirms that improved governance and institutional frameworks are strongly correlated with sustained economic performance. Lastly, the paper explained some limitations of the study. First of all, the study applied Panel ARDL which explore the overall impact of R&D budgets, innovations on economic growth but in future studies quantile estimations should be applied. Moreover, current study focused on OECD countries but in future studies comparison between developed and developing countries should be conductive.

6.1. Policy Recommendations

This section offers policy recommendations based on the study's empirical findings and theoretical insights. Drawing from Endogenous Growth Theory, the recommendations emphasize the importance of sustained investment in R&D and innovation-driven budgeting to enhance long-term economic performance. Based on these supportive theories and results, the study explored some recommendations that can stimulate productivity, competitiveness and sustainable growth. Firstly, OECD Governments should allocate more of national budgets for R&D technology. Investment in human capital required to sustain innovation that labor force could revise in response to technological innovation. Furthermore, Governments of OECD need to establish an enabling environment to allow companies to invest in innovation. This may serve to counter market failures and increase research commercialization. In the same way, Governments need to focus on developing infrastructure, particularly in deprived or rural regions, to make innovation benefit inclusive. Additionally, innovation policies are meant to combat inequality through technology diffusion benefits reaching every region and social class. Lastly, innovation policies can direct R&D towards green technologies and circular economy models so that growth is economically and ecologically sustainable.

7. Conclusion

In this study, the paper has explored technology budgets, innovation and economic growth that are all intricately linked with economic development, which is a stimulant for long-term economic growth and productivity in 24 OECD countries for the time period between 1995 and 2024. PARDL techniques employs for empirical analysis in which different variables like gross fixed capital formation, labor force participation and gross domestic growth on R&D for technology budget as well as total patents as proxies for innovation-related activities are used. The study has underscored the importances of strategic R&D investment in innovations process that is the essential pillars for long term sustainable economic growth. According to endogenous growth theory, the results confirm that economic performance is not only due to exogenous causes but is also largely influenced by internal policy decisions, especially those concerning how countries invest in technological progress and human capital accumulation.

The findings indicated that R&D budget is statistically significant factor in promoting economic growth. However, the factors such as institutional frameworks, widespread corruption, inadequate collaboration between academic institutions, industry and poor policy coordination mechanisms all constrain the effective utilization of innovation investments. In addition, the findings indicate that increasing government expenditure on R&D and innovation will be able to spur more economic development at large both indirectly and directly. Higher investment in R&D can potentially increase labor productivity and better utilize capital, hence aiding continuous growth. Empirical knowledge suggests that countries that consistently prioritize funding for R&D and innovation-led strategies tend to experience higher productivity, better competitiveness, and more robust economic systems. This link highlights the need for long-term national policies going beyond short-term budgetary planning to encompass broader goals of scientific advancement and technology spread. Also, innovation-led growth tends to have favorable spill-over effects across various industries, enhancing efficiency and creating fresh opportunities for employment, exports, and industrial diversification. Overall, investment in technology budgets and innovation is critical for nations that seek to achieve sustainable success. For OECD countries, fiscal measures with innovation aims can significantly enhance their growth and competitiveness within an increasingly technologically driven world.

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