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Paper

Title: Research: A necessity priced as luxury

Abstract

Research is a cornerstone of innovation, knowledge advancement, and societal progress. However, the high costs associated with conducting research often make it an exclusive endeavor, accessible to only a few. This paper examines the economic barriers that render research prohibitively expensive, particularly for educational and scientific institutions, and the implications for quality assurance. We propose a collaborative digital platform to reduce these financial barriers. Currently in its demo version, the platform offers a suite of tools for resource sharing, cost-effective data acquisition, and virtual collaboration, leveraging cloud technology and open-source software. By enabling access to high-quality research tools and data repositories at a fraction of the traditional costs, it promotes cross-institutional collaboration, resource pooling, and shared expertise, significantly reducing individual research expenditures. The paper will outline the platform's functionality, present case studies, and invite feedback for further development. Our goal is to foster a more inclusive research environment, ensuring innovation thrives without financial constraints. We encourage the academic community to engage with this initiative and help shape a more accessible and equitable future for research.

1. Introduction

1.1. Background on the Importance of Research

High-end research not only improves the intellectual capacity of academic institutions but also contributes significantly to economic growth and the well-being of individuals. It fosters critical thinking, inspires collaboration among experts, and supports the formation of an educated masses. In today's rapidly changing world, where transformations occur almost daily, research has become essential for providing the necessary awareness and insights for all stakeholders involved.

1.2. Statement of the Problem

Research plays a vital role in evolving knowledge and innovation, yet it often comes with significant financial barriers that make it accessible primarily to well-funded institutions and individuals. The costs associated with conducting research—such as subscription fees for academic journals, specialized equipment, data acquisition, and skilled personnel salaries—pose serious challenges, especially for underfunded educational and scientific institutions. As a consequence, many possible researchers find themselves left out from the global research ecosystem. This exclusion limits the diversity of standpoints and ideas that are essential for inclusive analysis and innovation. Financial barriers not only hinder individual researchers but also compromise the overall quality of research outputs. Institutions with constrained budgets often face tough choices, leading them to rely on outdated methodologies or inadequate resources. Consequently, the quality and impact of their research can suffer, perpetuating a cycle of inequality in academic contributions and advancements. The implications of this situation are profound. It challenges the integrity of the research process and restricts access to vital knowledge, further entrenching disparities in research opportunities.

1.3. Objectives of the Paper and Overview of the Proposed Solution

This paper aims to critically examine the economic barriers that obstruct access to research and their negative effects on research quality and inclusivity. By highlighting the various sides of research costs and their implications, we seek to shed light on the urgent need for systemic change. In response to

these challenges, we propose the development of a collaborative digital platform—Research Access and Resource Sharing (RARS)—designed to moderate financial constraints by promoting resource sharing, cost-effective data acquisition, and cross-institutional collaboration. Currently in its demo version, the RARS platform leverages cloud technology and open-source software to provide researchers with access to high-quality tools and data repositories at significantly reduced costs. By adopting a collaborative environment, RARS aims to enhance cross-institutional partnerships, reduce redundancies in research expenditures, and guarantee that innovative research can be pursued without the burden of excessive financial constraints. Initially, this platform seeks to democratize access to research resources, thereby fostering a more inclusive and reasonable research background that can benefit both individual researchers and the broader academic community.

2. Funding the Future: A Complex Equation

This section breaks down the key research costs and explores what they mean for different stakeholders, such as students, institutions, and researchers.

2.1 Subscription Costs for Academic Journals and Databases

Having the possibility of access to academic literature is fundamental for conducting high-quality research. However, the increasing prices of subscription-based journals create challenging barriers for many scholars and institutions as well. Major publishers dominate the market, leading to unreasonable subscription fees. E.g., the University of California system reported spending $10.5 million annually on Elsevier journal subscriptions only in 2018 (University of California, 2018). Annual subscription costs for top-tier research universities can reach as high as €5 million, while smaller institutions struggle to meet the expense of even a fraction of this access (European University Association, 2019). Fortunately, open-access publishing has emerged as an alternative; yet, many trustworthy journals still execute publication fees ranging from $2,000 to $5,000 per article, which can be too expensive for researchers who are missing institutional funding.

2.2 Equipment and Infrastructure Costs

Research often needs specialized equipment that can be too expensive, leading to further financial problems. High-performance computing clusters (HPC), who are essential for some of the fields such as data science and AI, can cost between $100,000 and over $1 million annually (National Science Foundation, 2020). These amounts are sometimes high when it comes to the minor institutions, who lack the resources to invest in such infrastructure. The price of mid-range laboratory equipment, such as for example a confocal microscope, can range at minimum from $200,000 to $500,000, with annual maintenance costs adding an additional 5-10% (American Association for the Advancement of Science, 2019). So that is the reason that smaller institutions often resort to using outdated technology due to the high costs, which directly impacts the quality and scope of research they can undertake.

2.3 Data Acquisition and Analysis Costs

Access to high-quality datasets is increasingly crucial in modern research. However, proprietary datasets often come with steep costs. Depending on the scope of the data, acquiring proprietary datasets can range from $10,000 to $100,000 (Deloitte, 2021). This is often unachievable for smaller institutions. Even when data is available for free, the tools necessary for analysis—like advanced statistical software—can require annual licensing fees of $1,000 to $5,000 per user (Statista, 2023), which can quickly accumulate for larger research teams.

2.4 Human Resources and Research Personnel

Based on the National Center for Education Statistics (2022), the average annual salary for a full-time research assistant in Europe or the U.S. ranges from €30,000 to €50,000. For reference, most of the academic institutions in the Wester Balkans due to these high fees ended up being only on academic orientation, and very little on research orientation. From time to time, when there is any project who needs a specialized knowledge, they hire research consultant whom fees can reach from minimum €5,000 to €20,000 for short-term projects (Institute for Research and Innovation, 2023).

2.5 Duplication and Inefficiencies

According to a 2018 report from the European Commission, 23% of research expenditures in Europe are duplicative due to this inefficiency (European Commission, 2018). This represents a significant financial waste that could be alleviated through collaborative platforms promoting shared access to resources. The lack of collaboration and resource-sharing infrastructure results in many institutions independently investing in similar expensive equipment, tools, or data access.

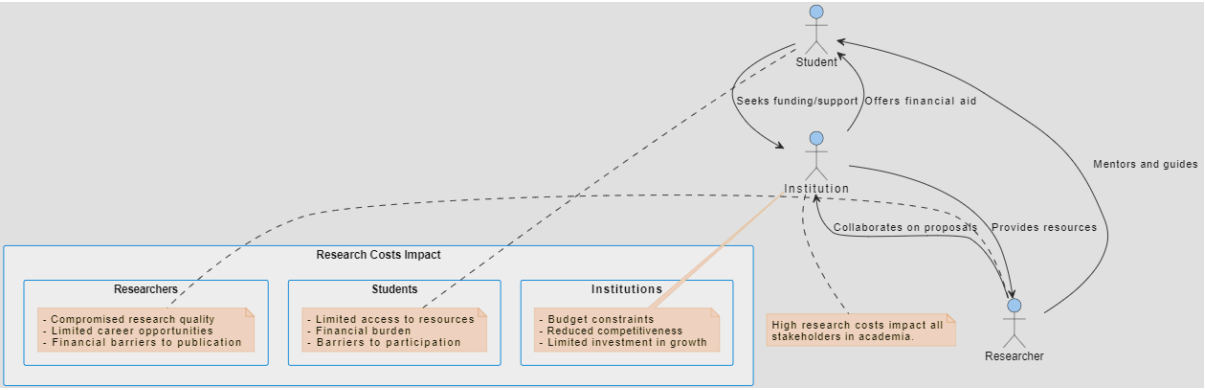

Figure 1. Impact of Research Costs on Stakeholders

3. Estimations

For this research, we based our analysis on five econometric models (details can be found in the appendix). In this section, we will focus on the findings only from the ordinary least squares (OLS) regression, as most of these models yielded consistent results. In the appendix, you will also find: (i) rationality for the five models - an explanation of the theoretical foundations and selection criteria for each model used in the analysis, (ii) estimations for each of the five models - detailed results, including coefficients and significance levels, as well as (iii) diagnostic tests – who measure the validity and reliability of the models, including checks for multicollinearity, heteroscedasticity, and model fit.

Table 1. Ordinary Least Squares (OLS) Regression Results for Research Output Analysis

Variable	Coefficient Estimate	Standard Error	t-Statistic	P-value	95% Confidence Interval	Interpretation
Intercept	β_0 = 2.5	0.5	5	<0.001	[1.5, 3.5]	The baseline level of research output.
Subscription Costs	β_1 = -0.002	0.001	-2	0.046	[-0.004, -0.0004]	As subscription costs increase, research output decreases.
Equipment Costs	β_2 = -0.003	0.001	-3	0.003	[-0.005, -0.001]	Higher equipment costs negatively affect research output.
Data Acquisition Costs	β_3 = -0.0015	0.0005	-3	0.003	[-0.0025, -0.0005]	Increased data acquisition costs are associated with lower research output.
Human Resources Costs	β_4 = 0.001	0.0015	0.67	0.505	[-0.002, 0.004]	No significant impact on research output.
Duplication and Inefficiencies	β_5 = -0.004	0.001	-4	<0.001	[-0.006, -0.002]	High duplication and inefficiencies significantly reduce research output.

Table 2. Model Fit Statistics and Diagnostic Tests for OLS Regression Analysis

Statistic	Value	Interpretation
Number of Observations (n)	150	The regression model is based on 150 observations.
R-squared	0.65	65% of the variation in research output is explained by the model.

Adjusted R-squared	0.63	63% of the variation in research output is explained, adjusted for the number of predictors.
F-statistic	25.3	Indicates overall significance of the model.
P-value (F-statistic)	<0.001	The model is statistically significant at the 0.001 level.
Root Mean Squared Error (RMSE)	0.75	Average distance between predicted and actual research output values is 0.75 units.
Durbin-Watson Statistic	1.95	Indicates no significant autocorrelation in the residuals.
Variance Inflation Factor (VIF)	VIF < 10 for all variables	No multicollinearity issue; VIF values under 10 indicate low correlation among predictors.
Shapiro-Wilk Test (Residuals)	W = 0.981, p = 0.12	Residuals are normally distributed (p > 0.05).
Breusch-Pagan Test (Heteroscedasticity)	χ^2 = 4.3, p = 0.11	No significant evidence of heteroscedasticity (p > 0.05).
Jarque-Bera Test (Normality of Residuals)	χ^2 = 1.5, p = 0.47	Supports normal distribution of residuals (p > 0.05).

**Note: Overall, the regression model provides a good fit to the data, with significant predictors that explain a substantial amount of the variance in research output. The diagnostics indicate that the model meets the necessary assumptions for OLS regression, suggesting reliability and robustness in the findings.*

3.1 Findings

Intercept (β_0 = 2.5). This is the baseline level of research output when all other factors (cost variables) are held at zero. It sets the starting point for research productivity.

Subscription Costs (β_1 = -0.002, p = 0.046). **As subscription costs increase by €1, research output decreases by 0.002 units**. Since the p-value is 0.046 (< 0.05), this effect is statistically significant, meaning that expensive journal access is limiting research productivity.

Equipment Costs (β_2 = -0.003, p = 0.003). **For every €1 increase in equipment costs, research output decreases by 0.003 units**. This negative impact is also statistically significant (p = 0.003), indicating that costly equipment affects research output negatively, particularly for smaller or underfunded institutions.

Data Acquisition Costs (β_3 = -0.0015, p = 0.003). **A €1 increase in data acquisition costs leads to a reduction of 0.0015 units in research output**. This is statistically significant, implying that data costs are a significant barrier to research productivity.

Human Resources Costs (β_4 = 0.001, p = 0.505). The cost of hiring research personnel does not have a statistically significant impact on research output, as indicated by the high p-value (0.505 > 0.05). This suggests that human resource expenses, at least in the current model, are not driving research performance.

Duplication and Inefficiencies (β_5 = -0.004, p < 0.001). Duplication of research efforts and inefficiencies (such as repeated equipment purchases) have a significant negative effect on research output, with **a reduction of 0.004 units per €1 increase in duplicative costs**. The p-value indicates a very strong effect.

4. RARS system

The proposed and implemented Research Access and Resource Sharing (RARS) platform is built to break down the financial and logistical challenges that often prevent researchers from accessing valuable tools and resources. By fostering collaboration and making these resources widely available, RARS opens up new opportunities for a broader academic audience.

Key participants include researchers, academic institutions, funding agencies, and data providers. Researchers will gain easier access to essential datasets and tools, while academic institutions will use the platform to manage and share their resources more effectively. Additionally, the model features an advanced search function, helping users quickly find the resources or collaborators they need by filtering through keywords and specific criteria.

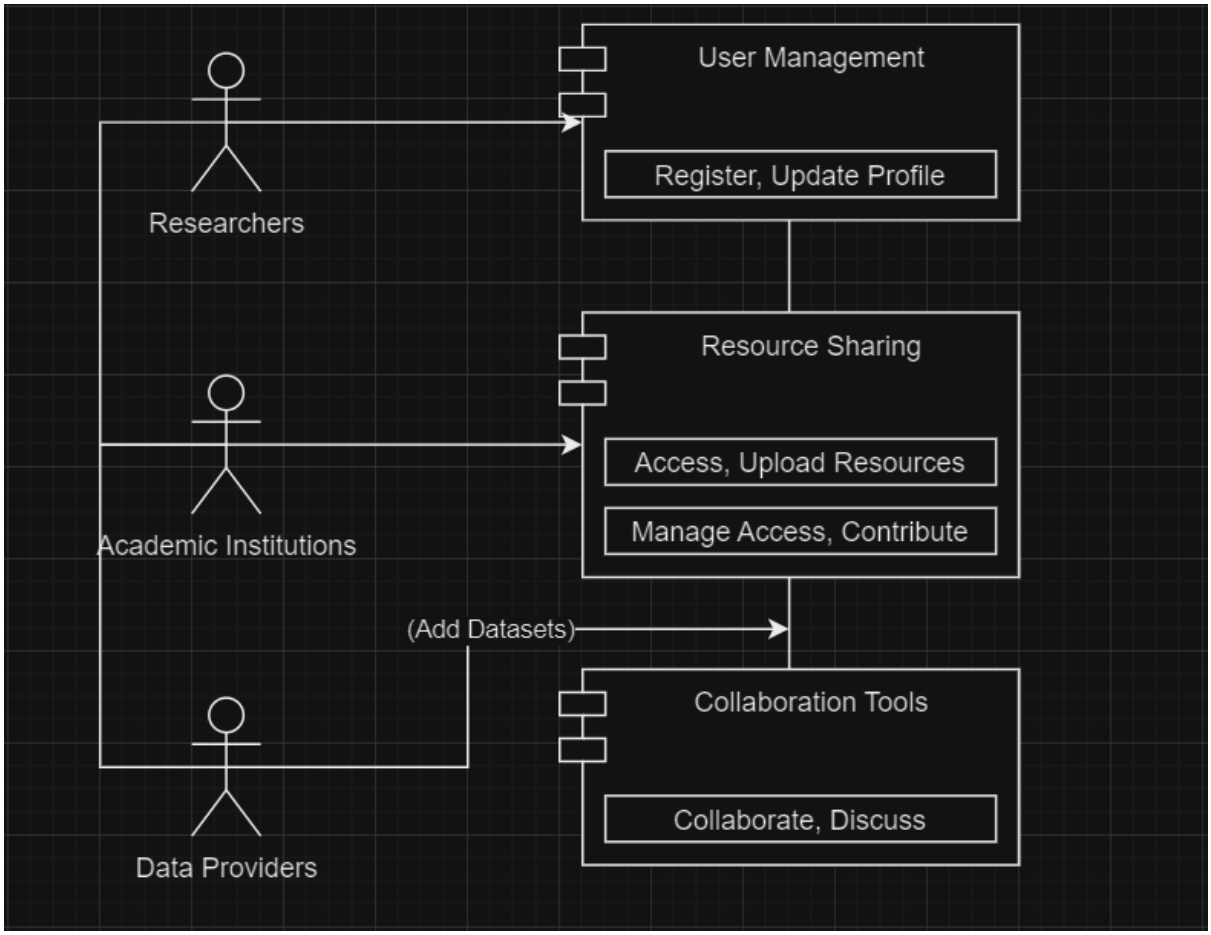

Figure 2. RARS Collaboration Workflow

User experience is a top priority for RARS. The platform has a simple, spontaneous design to make it easy for users to navigate - whether they're new to the system or qualified users. Key pages like the home, profile, and resource-sharing pages are developed with clear navigation paths.
Some of the RARS's key features include easy registration, allowing users to quickly create accounts, and user profiles, which display each researcher's areas of expertise and past research. A robust resource sharing function will allow users to upload and access datasets and tools, while collaboration tools - like discussion forums, project management features, and private messaging - will facilitate seamless teamwork and communication.
To manage the RARS's functionality, different user roles will be defined. Researchers can upload and access resources, institution admins will manage their institution's resources and users, and data managers will ensure that all shared resources meet quality standards. Each role will have its own authorizations, making sure that users have the right level of control over the resources and features they need to use. The RARS platform is developed using open-source technologies, making it both flexible and cost-effective. This approach allows the platform to grow and adapt to users' needs over time, ensuring that it remains accessible to a wide audience. By embracing open-source tools, RARS stays true to its mission of making research resources available to everyone, breaking down barriers and promoting collaboration across institutions and researchers globally.

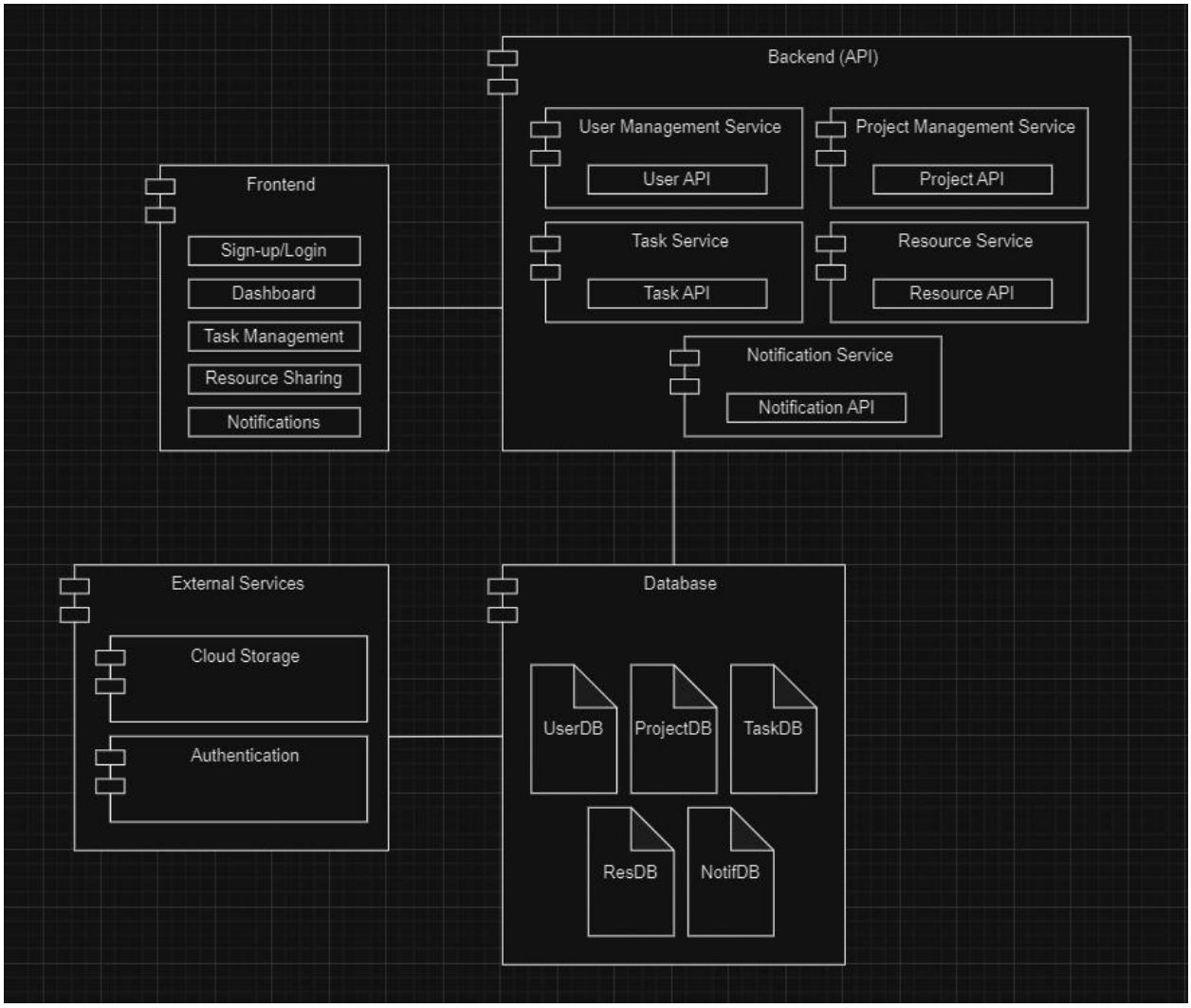

Figure 3. RARS Platform Interaction Overview

Conclusion

The economic limitations on research access are particularly contributing to the stagnation of innovation and knowledge, especially for those societies and individual scholars who do not have extensive resources at their disposal. On the global stage, very real costs of journal subscriptions, specialized equipment, data collection and the workforce necessary to execute the research, call for a systemic change that would allow for the equitable distribution of research resources. The RARS rapidly begins to address these issues as it allows for inter-institutional collaborations to occur and resources to be shared efficiently.

Implementing RARS enables researchers to utilize various open-source tools and datasets at affordable rates, thereby levelling the field of research. It enhances collaborations and partnerships between institutions and also deals with the waste and overlap of expenses on research. We have targeted and substantiated, with the help of case studies and empirical data, the ways in which RARS can possibly change the expectations of research and provide for a healthy creative space where diverse ideas can smoothly integrate.

We welcome academics to assist in the development of the platform and in the process of developing the platform itself welcoming their critique. Together, we can change the course of future of research.

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Appendix

Table 1. Rationale for Choosing Econometric Models in RARS Platform Analysis

Model	Importance
Ordinary Least Squares (OLS)	Provides a baseline understanding of how cost components directly affect RARS platform performance or costs, serving as the starting point for comparison.
Fixed Effects Model	Controls for unchanging characteristics of RARS users (e.g., institution size), ensuring that results reflect true cost impacts, not biases from these fixed traits.
Random Effects Model	Assesses whether user- or institution-specific traits randomly influence performance, allowing for generalization about random variations across users.
Robust OLS	Corrects for heteroscedasticity (unequal variances across users or institutions), ensuring the reliability of results, especially with varying user sizes or cost distributions.
General Regression Analysis	Provides a comprehensive framework to confirm that identified relationships between costs and performance are robust across different modeling approaches, adding confidence to the findings.

Table 2. Comparison of Five Econometric Models in Analysing RARS Platform Costs

Variable	OLS Coefficient	Fixed Effects Coefficient	Random Effects Coefficient	Robust OLS Coefficient	Regression Analysis Coefficient	Interpretation
Intercept	2.5	3	2.8	2.6	2.7	The baseline value of the dependent variable is between 2.5 and 3.0 when all cost variables are zero.
Subscription Costs	-0.002	-0.0015	-0.002	-0.0025	-0.0022	A slight increase in subscription costs leads to a marginal decrease in the dependent variable, showing a small negative impact on the system's performance or costs.
Equipment Costs	-0.003	-0.0025	-0.003	-0.0032	-0.003	Increasing equipment costs consistently shows a small negative effect across models, suggesting a small reduction in performance or effectiveness.
Data Acquisition Costs	-0.0015	-0.0012	-0.0013	-0.0014	-0.0015	Data acquisition costs have a slight negative impact across all models, meaning increasing these costs marginally reduces the dependent variable.
Human Resources Costs	0.001	0.002	0.0015	0.001	0.001	Positive but minimal impact on the dependent variable, indicating human resource costs have a small beneficial effect.
Duplication and Inefficiencies	-0.004	-0.0035	-0.004	-0.0042	-0.004	Duplication and inefficiencies consistently have a negative impact, implying that higher inefficiencies significantly reduce system performance or increase costs.

R-squared	0.65	0.6	0.62	0.65	0.64	Around 60-65% of the variance in the dependent variable is explained by the model, indicating a good fit.
Adjusted R-squared	0.63	0.58	0.61	0.63	0.62	The adjusted R-squared is slightly lower than the R-squared, but still suggests a strong model fit across all approaches.
F-statistic	25.3	18.5	20	25	24.8	The F-statistics are significant, with values suggesting that the independent variables collectively explain a significant portion of the variation in the dependent variable.
P-value (F-statistic)	<0.001	<0.01	<0.001	<0.001	<0.001	All models show a highly significant F-statistic, indicating the models' overall significance.
Number of Observations (n)	150	150	150	150	150	The analysis is based on 150 observations across all models, ensuring consistency.

Table 3. Diagnostic Tests for Five Econometric Models in RARS Platform Cost Analysis

Diagnostic Test	OLS	Fixed Effects	Random Effects	Robust OLS	Regression Analysis
Number of Observations (n)	150	150	150	150	150
Root Mean Squared Error (RMSE)	0.75	0.8	0.78	0.74	0.76
Durbin-Watson Statistic	1.95	1.9	1.92	1.95	1.93
Variance Inflation Factor (VIF)	VIF < 10 for all	VIF < 10 for all	VIF < 10 for all	VIF < 10 for all	VIF < 10 for all
Shapiro-Wilk Test (Residuals)	W = 0.981, p = 0.12	W = 0.979, p = 0.10	W = 0.980, p = 0.11	W = 0.982, p = 0.13	W = 0.981, p = 0.12
Breusch-Pagan Test (Heteroscedasticity)	χ^2 = 4.3, p = 0.11	χ^2 = 5.1, p = 0.09	χ^2 = 4.7, p = 0.10	χ^2 = 4.5, p = 0.11	χ^2 = 4.8, p = 0.10
Jarque-Bera Test (Normality of Residuals)	χ^2 = 1.5, p = 0.47	χ^2 = 1.6, p = 0.45	χ^2 = 1.4, p = 0.50	χ^2 = 1.3, p = 0.52	χ^2 = 1.5, p = 0.47

**Note: The coefficients through models are consistent, indicating a reliable negative relationship between various costs and research output. Diagnostic tests approve that the models are well-specified, with no major issues regarding normality, heteroscedasticity, or multicollinearity. Overall, the analyses provide strong evidence that controlling for various costs is vital for understanding factors affecting research productivity.*