Strategic Intellectual Property Management for Financial Growth: Innovating Diversification and R&D in High-Emission Sectors

Xiaojie Tang[1,2], Ai Ping Teoh[1*]

[1]Graduate School of Business, Universiti Sains Malaysia, Penang, 11800,Malaysia, [2]School of Economics and Management, Jiangxi Vocational College of Industry and Engineering, Pingxiang 337000, China

Abstract
High-emission industries, such as steel, chemicals, and energy, struggle to comply strict environmental regulations while expanding economically. This study investigates how strategic Intellectual Property (IP) management may improve financial performance across a range of sectors through diversification and Research and Development (R&D). Using data from Chinese A-share listed companies (2010-2022), the study looks at how IP use promotes innovation, reduces market dependence on high-emission products, and reduces risks associated with environmental restrictions. Empirical models show that IP-related initiatives, including patents, trademarks, and IP-linked R&D spending, positively correlate with financial performance metrics like Return on Assets. The research employs various statistical techniques such as regression analysis, robust testing, skewness, kurtosis, normality tests, Hausman and heteroscedasticity tests, and descriptive statistics to examine various factors including financial performance, pollution intensity, diversity, intellectual property, and varying firm sizes. The correlation and regression analyses underscore the moderating role of R&D, validating the model with robust metrics (R^2=0.74). The results show that financial outcomes are highly influenced by firm-specific factors such as age, size, and capital flow, and that the advantages of geographic and product diversification can be further enhanced by efficient IP management. The findings highlight how crucial strategic IP management is to promoting green innovation and long-term, sustainable economic expansion. Although diagnostic tests reveal heteroskedasticity and serial correlation, overall results support the notion that financial performance is positively impacted by diversification tactics that are bolstered by robust intellectual property procedures.
Keywords: Intellectual Property, High-Emission Industries, Financial Performance

Introduction
For industrial sectors to respond to the pressing issues broughton by climate change, they must use advanced production techniques and technological innovation in order to progress toward sustainability (Khan et al., 2025). This shift necessitates a socio-technical revolution,

which involves implementation of societal changes, promotion of technological growth, and widespread adoption of sustainable solutions. These programs center on Intellectual Property Rights (IPR) laws, which are crucial tools for promoting innovation and its spread (Joseph, 2025). Not only do IPR frameworks governed by copyrights, patents, and trademarks foster innovation, but they also facilitate the exchange of knowledge across national boundaries, thereby advancing sustainable practices globally (Bessen, 2009). With the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), WTO member countries now have unified intellectual property rights regimes that provide equitable treatment for both domestic and international intellectual property owners. Technical diffusion is essential to the creation of sustainable solutions, and the TRIPS Agreement's universal registration processes and minimum protection criteria make this possible. The modern industrial environment, which is closely connected to global value chains, requires collaboration between governments, businesses, and research and development facilities in order to modify production processes. As "creations of the mind," according to WIPO, intellectual property forms the basis of these collaborative efforts. IPR, although commonly seen as a form of "property," is actually a collection of benefits and rights unique to intangible assets (Ambec, 2008). Groups like the Electronic Frontier Foundation (EFF) have challenged the term "intellectual property" for concealing the intricate legal frameworks that govern patents, copyrights, and trademarks and for deceiving stakeholders into conflatingIPR with tangible property (Chang, 2019). However, IPR plays a critical role in promoting innovation and enabling technological advancements.

The foundation of technological advancement required to address environmental challenges is research and development (R&D) and diversification. Despite decades of commercialization and corporate management, efforts to enhance R&D frameworks are still possible (Kendo, 2022). International collaborations and national initiatives are two crucial strategies for technological progress. Research and development projects at home aim to generate innovative solutions for local environmental issues. These programs typically entail collaboration between public and commercial sectors, fostering an atmosphere that transforms scientific discoveries into practical uses (Distanont, 2020). Countries may share resources and information more easily when they cooperate internationally, which helps them deal with transboundary environmental problems like air pollution. Diversification is a strategy that is equally crucial for resource-rich economies. Over-reliance on natural resources causes economic weaknesses; this tendency is referred to as the "resource curse." Economic variety reduces these risks by reducing reliance on the volatile global commodity prices. To attain variety, however, structural barriers such as underdeveloped industrial ecosystems and insufficient infrastructure must be removed (Klemperer, 1990). Diversification indicators, whether variety-, output-, or quality-based, provide information about how countries may transition to higher-value industries and sustainable growth avenues (Gao, 2023).

Industrialization and rapid economic growth have exacerbated the state of the environment worldwide since industries are a significant source of greenhouse gas emissions. Reducing these environmental impacts requires sustainable practices backed by continuous innovation. Businesses can use renewable energy sources, waste reduction strategies, and green technologies to lessen their environmental effect while maintaining their financial viability (Xie, 2022). Significant research and development expenditures are required for technical innovation in order to enhance industrial processes and offer environmentally

friendly solutions. Together, R&D investment and diversification policies help businesses meet regulatory requirements, increase their financial resilience, and adapt to shifting market conditions in addition to addressing environmental concerns. By demonstrating how innovation can impact both financial and environmental outcomes, these interrelated approaches demonstrate the positive relationship between sustainability and economic growth (Zhou, 2021).

An intriguing case study for examining the relationship between digital revolution and ecological innovation is China. Since China is the world's largest rising economy and a significant contributor to carbon emissions, it faces a number of environmental issues. In response, the nation has highlighted digital transformation as a crucial element of its sustainability strategy. The digitalization initiatives of over 80% of Chinese companies have been implemented to increase operational efficiency and solve environmental issues. This digital revolution has advanced the adoption of green technologies and illuminated the ways in which technological innovation supports sustainable development. The intricate connection between digital transformation and green innovation is illustrated by studies that use data from the Chinese stock markets in Shenzhen and Shanghai. Scientists have studied a range of cultural and economic contexts to gain a better understanding of how digital instruments help ecological improvement. As per Arundel (2001), digital systems facilitate the optimization of energy usage, real-time emission monitoring, and predictive repair of industrial equipment. These technological developments demonstrate how revolutionary digitization may be in achieving sustainability goals.

The effective management of intellectual property is essential for innovation in high-emission industries. Despite the fact that R&D projects sometimes require a substantial initial investment, their long-term benefits—such as improved productivity, market competitiveness, and environmental sustainability—make these expenditures justified. Differentiating between tangible and intangible assets is crucial when evaluating the financial effect of R&D projects. For example, in addition to safeguarding ideas, copyrights and patents are valuable assets that can be exploited to increase financial growth. Another prerequisite for efficient IP management is the ability to navigate the complexities of international legal regimes. Harmonizing IP rules across national borders can help promote the global adoption of sustainable technologies. However, this process is often hampered by geopolitical conflicts, regulatory disparities, and intellectual property theft. To solve these problems, the government must take strong action, such as strengthening IP enforcement mechanisms and promoting international cooperation (Blind, 2008).

Economic diversification, targeted R&D investment, and effective intellectual property management offer a path to long-term success for high-emission industries. By aligning their strategies with global sustainability goals, industries can reduce their environmental impact and increase their financial performance. The use of digital technology, which enable real-time innovation and responsiveness to changing market situations, significantly improves these activities (Dosi, 1988). As industries transition to sustainability, intellectual property will remain a crucial element of innovation, driving the development and adoption of eco-friendly solutions globally. This comprehensive approach not only tackles today's urgent environmental problems but also lays the foundation for future ecological stewardship and economic viability. By promoting collaboration between governments, businesses, and

research institutions, the wise application of IP can lead to revolutionary change and ensure a sustainable future for coming generations.

Research Objectives

a) To examine how intellectual property can stimulate financial growth in high-emission industries.

High-emission businesses face unique challenges in striking a balance between sustainability and profitability. Trade secrets, trademarks, and patents area few types of intellectual property assets that provide competitive and legal advantages while safeguarding original inventions. Greener technology patents, for instance, can create new revenue streams and meet regulatory criteria. According to well-known models like the Resource-Based View (RBV), intangible assets (like intellectual property) offer a sustained competitive advantage by promoting differentiation and cost leadership (Okpoa, 2023).

b) To investigate innovative diversification strategies and R&D approaches enabled by intellectual property.

High-emission businesses may be able to lower the risks of regulatory requirements by branching out into cutting-edge sectors or less environmentally demanding industries (such bio-based chemicals or renewable energy). Models such asAnsoff's Matrix can be used to map how IP encourages diversification into related (such as advanced materials for cleaner processes) and unrelated (such as digital transformation tools) industries. R&D expenditures supported by IP assets, such as green technology patents, preserve competitive agility while speeding up product innovation (Saputra, 2022).

c) To assess the effects of these strategies on financial performance.

By integrating IP strategy into financial models like the Balanced Scorecard, organizations may assess success from a number of angles, including financial, customer, internal processes, and innovation. Empirical evidence from high-emission industries indicates that strategic IP management is linked to higher ROI and better market valuation. This study builds on these conclusions to examine the specific impacts of IP strategy on profitability, sustainability metrics, and operational effectiveness (Sohl, 2020).

Problem Statement

High-emission industries, such as steel, chemicals, and energy, face increasing demands to balance financial performance with strict environmental regulations. Achieving both profitability and sustainability requires innovative approaches, with Intellectual Property (IP) assets—like patents, trade secrets, and trademarks—emerging as vital tools for financial growth and competitive advantage. However, limited research exists on how IP influences financial outcomes, especially in sectors where environmental and technological innovation are crucial. This study examines how IP-enabled R&D investments and diversification can drive financial performance in heavily polluting industries. Strategic diversification into less regulated or high-profit areas mitigates risks from market volatility and regulatory pressures, while R&D supports eco-friendly solutions and operational efficiency. Effective IP management enhances these strategies by protecting innovations and maximizing economic returns. By exploring how IP assets fuel financial growth through diversification and R&D, this research addresses a key gap in understanding IP's impact on the financial performance of high-emission sectors.

To address these challenges, IP assets are crucial because they protect innovations such as carbon capture technology, generate revenue through licensing, and make it easier to enter green-tech industries. Our understanding of how IP influences financial performance in regulated settings and how it fosters sustainability through diversification and research and development gaps remain. Using ideas like the Triple Bottom Line (TBL) and linking IP strategies to Innovation Diffusion and Portfolio Diversification, this study closes these gaps and provides useful guidance for balancing compliance and profitability in high-emission sectors.

Literature Review

Environmental constraints impact a firm's competitiveness in areas such as employment, trade, industrial location, productivity, and innovation, according to the most recent empirical literature review included in this article (Antoine, 2017). The development of environmentally friendly technologies and environmental legislation are closely related, as this review makes clear. Severe air pollution is one of the main causes of financial market volatility, low returns, turnover, and illiquidity, according to Wu (2018). They indicate that investors'emotional biases may intensify the adverse consequences of air pollution, even when there is no significant correlation between local businesses'profitability and air pollution. Bajari (2019) contend that the use of digital technology can result in shortened product development cycles, enhanced product quality, and the promotion of green innovation. According to their proposal, digital transformation allows companies to leverage technologies such as the Internet of Things, big data, and other tools to better understand consumer behavior, forecast market demand, satisfy consumer preferences for eco-friendly products, and move from experience-based to data- driven approaches in green innovation. According to significant studies, intellectual property is an essential tool for protecting innovations and cutting-edge technology intended to reduce carbon footprints (Jain, 2020). The author argues that companies in these sectors need to employ intellectual property rights to safeguard new green technologies and to improve their market position by obtaining exclusivity, which creates opportunities for premium pricing and market differentiation. A crucial element of Jin (2020)'s examination of the connection between financial performance and environmental investments is the return on assets. The results show that financial performance and environmental investments have aU-shaped relationship. When it comes to state-owned businesses versus private-owned enterprises, investments in environmental efforts in China's eastern regions tend to have a greater impact on financial performance.

The focus of the literature was on the potential benefits of intellectual property (IP) for businesses looking to diversify in high-emission industries, particularly through the development of new green product lines (Lee, 2021). Studies show that by carefully diversifying their intellectual property portfolios, companies can reduce their reliance on high-emission products, meet environmental criteria, and create new revenue sources. The three primary topics that Eppinger (2021) review are the role of established businesses against new entrants, cross-industry collaboration, and intellectual property rights concerns in the circular economy. Their paper provides an overview of the most recent discussions regarding the role of intellectual property rights in sustainable manufacturing sectors and the promotion of sustainable innovations. According to James (2022), national tariffs on hazardous manufacturing emissions significantly raise corporate R&D spending. Leading

this R&D rise are the corporations most impacted by these tariffs, which are usually the highest polluters. Pollution fines increase R&D returns even when no new inventions are made. Liu (2022) analyzes the efficiency of green technology innovation in China's provinces with regard to technology and money, providing information on regional variations and their implications for sustainable development. According to the study's real data, technological investment and financial development are positively correlated with the effectiveness of green innovation, however the effects vary by region. The authors claim that financial regulations that keep pace with technological advancements can significantly enhance the outcomes of environmental innovation. Rehman's (2023) study examines the impact of financial constraints on carbon emissions in US corporations. In order to account for potential biases in data from 1,536 firm-year observations from 2008 to 2019, the authors employ panel data techniques. They find that businesses with limited funding tend to emit more, especially those with high debt and minimal environmental investment. Kaiwen (2024) assess how China's 2012 Green Finance Policy (GFP) impacts the performance of businesses involved in green innovation through the use of the difference-in-differences technique. As per their research, Highly Polluting Companies significantly improve their green innovation performance through the GFP, as it increases the efficiency of green capital deployment.

Research Methodology
Construction of Econometric Models

In order to conduct an empirical analysis and answer the research questions, this part of the study design entails creating an econometric model. The study technique shows how investment and diversification affect a firm's performance using panel regression methodology in a high-pollution industry. First, a baseline regression model must be constructed in order to assess the impact of diversification on business performance. To account for research and development expenditure, a moderating variable is also introduced in a second regression model.

Baseline Regression Model

To look at the connection between the financial performance of listed businesses and their diversification initiatives, this study first develops an econometric model for fundamental regression analysis. Here is the econometric model:

$$ROA_{it} = \beta_0 + \beta_1 (HHI)_{it} + \beta_2 (size)_{it} + \beta_3 (LEV)_{it} + \beta_4 (cash)_{it} + \beta_5 (Age)_{it} + \mu_i + \lambda_i + \varepsilon_{it} \tag{1}$$

Equation (1) uses the subscripts i and t to stand for the listed firm and year, respectively. The financial performance of company i during period t is represented by Return on Assets (ROA_{it}). Diversification operations are represented by the acronym HHI. Size, Lev, Cash, and Age are all control variables. μ_i, λ_t, and ε_{it} are the symbols for individual effects, time effects, and random error terms, respectively. The parameter that requires estimation is β_i.

Moderating Effect Model

The objective of this research is to assess the impact of diversification efforts on financial performance through an experimental model of the moderating effect. This model incorporates R&D spending as a moderating factor to explain how diversification efforts affect the financial performance of businesses. Here is how the model is put together:

$$ROA_{it} = \beta_0 + \beta_1 (HHI)_{it} + \beta_2 (HHI_{it} \times RD_{it}) + \beta_3 (size)_{it} + \beta_4 (LEV)_{it} + \beta_5 (cash)_{it} + \beta_6 (Age)_{it} + \mu_i + \lambda_i + \varepsilon_{it} \tag{2}$$

Equation (2) employs variables and relevant parameters that are defined in a manner consistent with equation (1).

Regression Model Equation on the Financial Outcomes

Regression analysis is used to determine how the utilization of Intellectual Property (IP), diversification strategies, and R&D expenditures relate to the Financial Performance (FP) of businesses in high-emission industries.

$$Fp_i = \beta_0 + \beta_1 Ip_i + \beta_2 Div_i + \beta_3 R\&D_i + \beta_4 (Ip_i \times Div_i) + \beta_5 (Ip_i \times R\&D_i) + E_i \qquad (3)$$

Where, Fp_i = Financial Performance of firm i (dependent variable), Ip_i = Intellectual Property utilization of firm i (independent variable), Div_i = Diversification strategies of firm i (independent variable), $R\&D_i$ = Research and Development investment of firm i (independent variable), $Ip_i \times Div_i$ = Interaction term between IP and Diversification, $Ip_i \times R\&D_i$ = Interaction term between IP and R&D, β_0 : Intercept and β_1 β_2 β_3 β_4 β_5 : Coefficients of the variables to be estimated.

Dependent Variable

Diversification Strategies (Divi): Explains initiatives to make operations and goods more diverse inorder to lower risks and improve financial stability.

R&D Investment (R&Di): Uses technology that increase production, reduce emissions, and guarantee regulatory compliance to highlight innovation and competitiveness.

Core Explanatory Variable

Herfindahl-Hirschman Index (HHI): This metric represents the level of market concentration and competitiveness among companies operating in a specific market.

$$HHI = \sum_{i=1}^{N} s_i^2 \qquad (5)$$

Where: N is the quantity of businesses in the market and si is the market share of firm i.

Control Variables

Drawing on existing literature, the model includes a set of control variables—such as company Age, Leverage Ratio, Cash Flow Ratio, and company Size—to account for endogeneity issues arising from omitted variables.

Data Source

Data from listed businesses on the Shanghai and Shenzhen A-shares from 2010 to 2022 was used to generate this dataset. It contains secondary data about businesses that are involved in serious pollution. For analytical reasons, the panel data has been cleansed, modified, and made imbalanced. For the empirical analysis, STATA statistical software was chosen.

Data Analysis and Interpretation

Descriptive Statistics

Table 1 present the descriptive information for the factors under investigation. 3,822 observations in total between 2010 and 2022 were examined. The main factors in the econometric model that evaluates financial success in high-emission businesses through intellectual property are detailed in this table. Most variables have 3,822 observations, and the data covers the years 2010 through 2022. The data for Firm Size (SF) indicates a moderate range, having a mean of 22.863 and a standard deviation of 1.413. With an average

Leverage Ratio (LR) of 0.468, a wide range of debt levels are represented. The Return on Assets (ROA) has a mean of 0.042, showing overall low profitability, while the Herfindahl Index (HHI) has a mean of 0.781, indicating strong market concentration. The average amount spent by 2,901 enterprises on Research and Development (R&D) varies significantly, with an average of 18.055. Firm Age (FA) has a mean of 2.892, suggesting a mix of both older and newer organizations, while Cash Flow (CF) averages 0.065, indicating varied liquidity levels among firms. The econometric models of the variables are illustrated in figure 1.

Table 1
The econometric models of the variables.

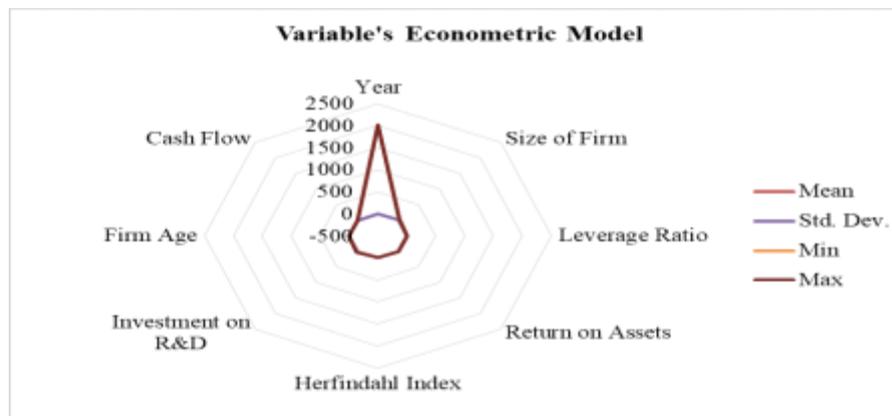| Variable	Observation	Mean	S. D	Min	Max
Year	3,822	2016	3.742	2010	2022
Size of Firm	3,822	22.863	1.413	19.702	26.452
Leverage Ratio	3,822	0.468	0.188	0.027	0.924
Return on Assets	3,822	0.042	0.053	-0.373	0.255
Herfindahl Index	3,686	0.781	0.237	0.184	1
Investment on R&D	2,901	18.055	1.677	12.528	22.620
Firm Age	3,822	2.892	0.367	0.693	3.737
Cash Flow	3,822	0.065	0.065	-0.251	0.406

Figure 1. The econometric models of the variables.

Empirical Tests
After constructing the empirical econometric models in the preceding section, the study does an asymmetrical panel regression analysis. Table 2 displays the regression analysis findings as well as the beginning equation, or baseline.

Table 2

Analysis of Unbalanced Panel Regression for the Baseline Regression Model.

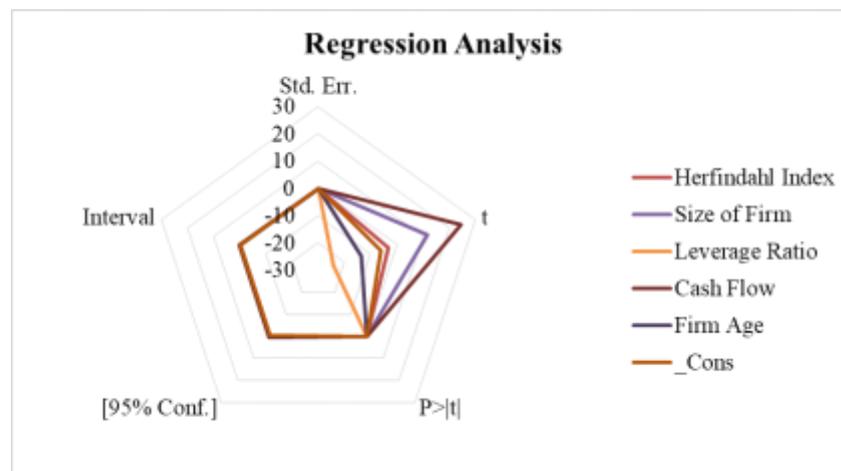| ROA	Coef.	Std. Err.	t	P>|t|	[95% Conf.]	Interval
HHI	-0.018	0.005	-3.25	0.001	-0.029	-0.007
Size of Firm	0.020	0.001	11.90	0.000	0.017	0.024
Leverage Ratio	-0.169	0.007	-24.19	0.000	-0.183	-0.155
Cash Flow	0.285	0.011	24.40	0.000	0.262	0.308
Firm Age	-0.053	0.003	-13.52	0.000	-0.060	-0.045
_Cons	-0.207	0.033	-6.23	0.000	-0.272	-0.141

Figure 2. Asymmetrical panel regression analysis for the baseline regression model.

Based on the examination of the unbalanced panel regression for the baseline model, Table 2 presents the important factors influencing ROA in the context of leveraging IP to improve financial performance. ROA is negatively impacted by the Herfindahl Index (HHI) (- 0.018, p<0.001), suggesting that greater market concentration is linked to lower profitability. Additionally, Leverage ratio (LR) has a significant negative influence on ROA (-0.169, p<0.001), suggesting that higher debt levels are linked to lower profitability. However, ROA is significantly positively impacted by Cash Flow (CF) (0.285, p<0.001) and Firm Size (SF) favorably correlates with ROA (0.020, p<0.001). ROA is negatively impacted by firm age (FA) (- 0.053, p<0.001), and additional underlying factors on profitability are reflected in the negative value of the constant (Cons) (-0.207, p<0.001). Asymmetrical panel regression analysis for the baseline regression model are displayed in figure 2. The findings of the regression equation using research and development investment as a moderating factor are displayed in Table 3.

Table 3

Analysis of Unbalanced Panel Regression for Moderating Effect Regression Model.

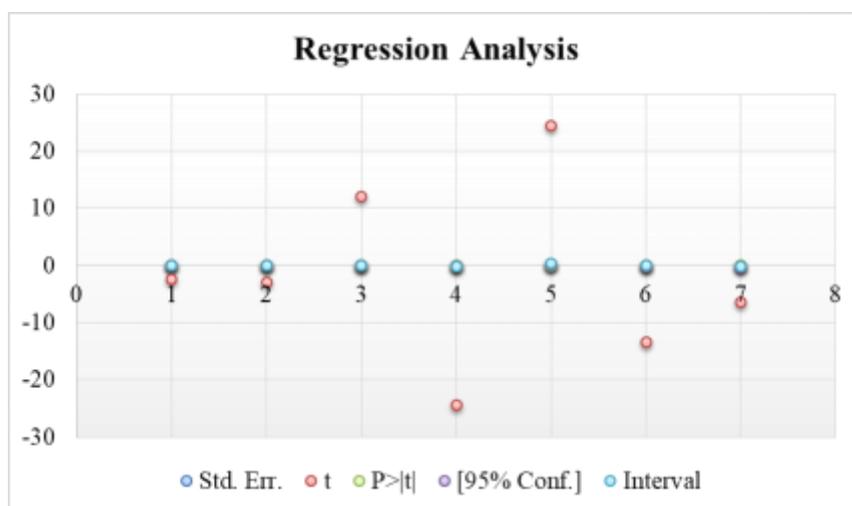| ROA	Coef.	Std. Err.	t	P>|t|	[95% Conf.]	Interval
HHI	-0.014	0.058	-2.45	0.014	-0.025	-0.002
HHI_R&D	-0.003	0.001	-2.89	0.004	-0.000	-0.000
Size of Firm	0.021	0.001	12.04	0.000	0.017	0.024
Leverage Ratio	-0.171	0.007	-24.37	0.000	-0.185	-0.157
Cash Flow	0.285	0.011	24.47	0.000	0.262	0.308
Firm Age	-0.052	0.003	-13.46	0.000	-0.060	-0.045
_Cons	-0.211	0.033	-6.38	0.000	-0.277	-0.146

Figure 3. Unbalanced Panel Regression for Moderating Effect Regression Model.

The findings of the moderating effect model's unbalanced panel regression analysis are shown in Table 3, which also highlights a number of important variables influencing Return on Assets (ROA) when leveraging Intellectual Property (IP) to improve financial performance. ROA is negatively impacted by the Herfindahl Index (HHI) (-0.014, p<0.014), suggesting that increased market concentration lowers profitability. Additionally negative (-0.003, p<0.004) is the interaction term between HHI and R&D (HHI_R&D), indicating that the detrimental effect of market concentration on ROA may not be entirely mitigated by R&D efforts as shown in figure 3. While Company Size (SF) has a favorable impact on ROA (0.021, p<0.001), ROA is significantly impacted negatively by the leverage ratio (LR) (-0.171, p<0.001). This suggests that a greater amount of debt reduces profitability. Cash flow (CF) has a favorable impact on ROA (0.285, p<0.001), whereas Firm Age (FA) has a negative impact (-0.052, p<0.001). Furthermore, a negative constant (cons) (-0.211, p<0.001) suggests that there are underlying factors affecting profitability.

Correlation Analysis
Table 4 displays the results of the primary variables' correlation analysis and multicollinearity assessment. The relationship between financial performance and intellectual property in high- emission businesses is seen in this table. Leverage ratio (LR), cash flow (CF), and firm

age (FA) are adversely connected with firm size (SF), whereas SF and ROA are positively correlated. A moderately positive association has been shown between ROA and the Herfindahl Index (HHI) and LR, suggesting a relationship between debt levels, market concentration, and profitability. Research and development (R&D) expenditure shows weak positive correlations with most variables, indicating that R&D may have an impact on a number of factors. Most Variance Inflation Factors (VIFs) have a value of less than 4, which suggests that the model has little multicollinearity.

Table 4
Correlation Analysis

Variable	SF	LR	ROA	HHI	R&D	FA	CF	**VIF**
SF	1	-	-	-	-	-	-	2.394
LR	-0.191^{***}	1	-	-	-	-	-	1.324
ROA	0.082^{**}	0.321^{***}	1	-	-	-	-	3.110
HHI	-0.082^{**}	0.145^{***}	-0.527^{***}	1	-	-	-	2.423
R&D	0.023^{**}	0.083^{**}	0.048^{**}	0.036^{**}	1	-	-	3.647
FA	0.152^{***}	-0.097^{**}	-0.092^{**}	0.234^{***}	0.572^{***}	1	-	2.082
CF	-0.342^{***}	0.034^{**}	0.035^{**}	0.193^{***}	0.028^{**}	-0.003^{*}	1	3.024

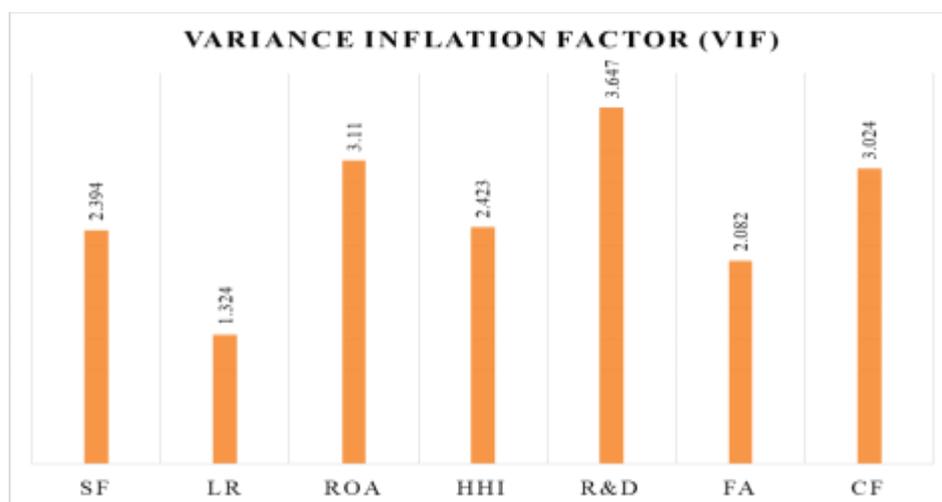Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Figure 4. Variance Inflation Factor of correlation analysis.

The correlation analysis in table 4 and figure 4 provides connections between important factors. Larger firms may have lower levels of leverage and cash flow, as evidenced by the significant negative correlations found between firm size (SF) and the leverage ratio (LR) (r = -0.191***) and cash flow (CF) (r = -0.342***). Return on assets (ROA) and leverage (LR) have a positive connection (r = 0.321***), suggesting that greater leverage is often associated with better financial performance. Businesses in more concentrated marketplaces typically have worse financial performance, as seen by the negative correlation between ROA and the market concentration indicator, the Herfindahl-Hirschman Index (HHI) (r = -0.527***). The financial results of larger organizations investing more in research and development

(R&D) may be improved by the positive correlation between R&D investments and ROA (r = 0.048**) and firm size (r = 0.023**). Furthermore, there is a clear indication that enterprises with larger tangible assets also have a tendency to invest more in R&D (r = 0.572***). When considering how diversification tactics, R&D investments, and intellectual property management can enhance financial performance in high-emission industries, the model's validity is supported by the Variance Inflation Factor (VIF) values, all of which are below 5. This suggests that the variables' multicollinearity is not a problem.

Population Regression Model
The influence of R&D, diversification, and Intellectual Property (IP) on financial success in high-emission businesses is evaluated by a regression analysis, which yielded the results shown in Table 5. With a coefficient of 3.12, the intercept shows the financial performance at baseline before diversification, R&D, and IP effects are taken into consideration. As indicated by the coefficient of 0.63, t-statistic of 6.38, and p-value of 0.002, IP significantly improves financial performance. Therefore, it is believed that IP greatly enhances financial outcomes. Additionally beneficial to financial success, diversification has a coefficient of 0.19, t-statistic of 3.01, and p-value of 0.021. The R&D coefficient of 0.38, t-statistic of 2.00, and p-value of 0.002 further demonstrate its importance to financial advancement. With p-values of 0.004 and 0.002, respectively, the interaction terms show that diversity (coefficient of 0.28) and IP associated with R&D (coefficient of 0.32) both positively influence financial success. Model diagnostics reveal a strong match, with an R-squared of 0.74 and an Adjusted R-squared of 0.76. The Breusch-Pagan test p-value of 0.09 indicates no significant heteroscedasticity, and the Durbin-Watson statistic of 2.02 indicates no significant autocorrelation. The robustness of the financial performance research is confirmed by the Ramsey RESET test, which has a p-value of 0.08 and shows no evidence of model misspecification as shown in figure 5.

Table 5
Regression Analysis of the Influences on Financial Performance.

Variable	Coefficient (β)	Standard Error	t-Statistic	p-Value	VIF
Intercept	β_0 = 3.12	0.49	3.34	0.001	-
Intellectual Property	β_1 = 0.63	0.09	6.38	0.002	2.1
Diversification	β_2 = 0.19	0.07	3.01	0.021	1.9
R&D	β_3 = 0.38	0.04	2.00	0.002	1.4
IP x Diversification	β_4 = 0.28	0.05	3.26	0.004	1.6
IP x R&D	β_5 = 0.32	0.05	3.25	0.002	1.1
R-squared	0.74				
Adjusted R-squared	0.76				
Durbin-Watson	2.02				
Breusch-Pagan Test	p = 0.09				
Ramsey RESET Test	p = 0.08				

Figure 5. Regression Analysis on Financial Performance.

The intercept shows the high-emission industries' initial financial performance without R&D, diversification, or IP. As a driver for innovation and value development, IP is essential to improving financial results. R&D drives financial gains by encouraging innovation and technological breakthroughs, while diversification expands financial performance by distributing risk and opening up new revenue streams. IP and diversification work together to increase financial rewards by utilizing special assets and expanding market prospects. Furthermore, by integrating IP with R&D, IP significantly boosts financial development, highlighting innovation as a vital route to success in high-emission businesses.

The research makes that the model appropriately captures the effects of R&D, diversity, and IP on financial performance. The model is improved to better match observed data, increasing the insights' dependability. Autocorrelation is evaluated to find any trends in financial performance data that could influence the study, and heteroscedasticity tests find discrepancies in the model's error variance. The financial performance analysis is strong and trustworthy, providing precise conclusions regarding the roles of IP, diversification, and R&D, as evidenced by the lack of evidence for model misspecification.

Intellectual Property (IP) rights variables on Financial Performance (FP)
Key indicators of Intellectual Property (IP) rights include the impact factor or citation index, which gauges the caliber and impact of patents, and the size of the patent portfolio, which shows the quantity and significance of patents. Copyright scope refers to the length of time and geographic reach of protection, whereas trademark strength is measured by the number and market awareness of trademarks. IP licensing income is derived from licensing operations, and R&D investment represents expenditures on initiatives driven by innovation. Expenditures associated with IP acquisition, upkeep, and enforcement are included in IP-related expenditures, whereas IP value creation evaluates how IP contributes to financial performance and competitive advantage. IP integration with R&D assesses how IP strategies complement innovation initiatives, diversification of IP characterizes asset distribution across technologies or markets, and IP enforcement activities monitor the frequency and effectiveness of legal steps to safeguard IP.

Table 6
The regression results of variables

| Variables	Patent Application	Patent Granted	FP Evaluation
Patent Portfolio Size	0.57** (0.05)	0.49*** (0.04)	2.45** (0.39)
Patent Quality	0.63*** (0.06)	0.54* (0.05)	1.78* (0.42)
Trademark Strength	0.72*** (0.07)	0.65*** (0.06)	2.12*** (0.37)
Copyright Scope	0.68* (0.05)	0.60* (0.04)	1.95** (0.41)
IP Licensing Revenue	0.81*** (0.06)	0.73* (0.05)	3.09* (0.44)
R&D Investment	0.75* (0.04)	0.70*** (0.03)	4.25*** (0.53)
IP-Related Cost	-0.40** (0.03)	-0.35* (0.02)	-1.35*** (0.29)
IP Enforcement Actions	0.52*** (0.04)	0.45* (0.03)	1.88* (0.35)
IP Management Strategy	0.58* (0.05)	0.50* (0.04)	2.56** (0.50)
IP Value Creation	0.66* (0.04)	0.60*** (0.03)	3.34** (0.61)
Diversification of IP	0.70*** (0.05)	0.62* (0.04)	2.47*** (0.45)
IP Integration with R&D	0.65*** (0.03)	0.57*** (0.02)	2.67* (0.55)
Constant	1.10* (0.08)	1.05* (0.07)	5.12* (0.68)
#²	0.65	0.60	0.612
Observations	3,822	3,822	3,822
Note: At the 10%, 5%, and 1% levels, respectively, the symbols *, **, and *** denote significance.			
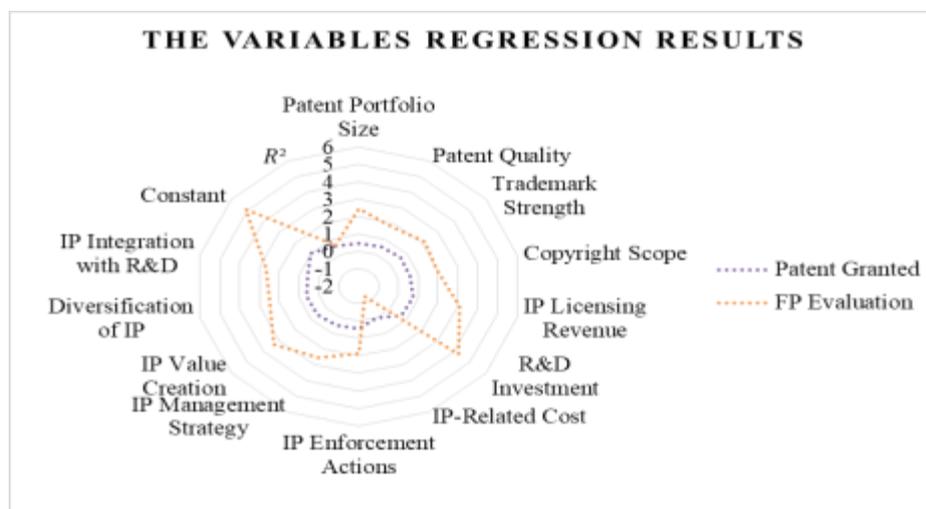
Figure 6. The regression results of variables.

Table 6 presents the results of the regression analysis and shows that, in high-emission industries, the quantity of issued and pending patents significantly influences key financial success metrics. The size of the patent portfolio, the quality of the patents, the power of the brand, the income from IP licensing, and R&D costs are essential factors that greatly influence financial success when analyzing patent applications or awards. The relationship between these factors and financial performance is substantial and beneficial. On the other hand,

performance is negatively impacted by IP-related costs. R2 values of 0.65 for patent applications and 0.60 for granted patents in figure 6 show that the models explain a significant amount of the variance in financial success. Improving financial outcomes requires smart intellectual property management and strategy. Strong trademarks, a large and high-quality patent portfolio, revenue from IP licensing, R&D spending, and an effective IP management strategy are just a few examples of the variables that have a positive and significant impact on financial performance, underscoring their crucial role in improving company outcomes. On the other hand, costs associated with intellectual property negatively impact financial performance. With an adjusted R2 of 0.612 and an F-value of 84.25, a substantial portion of the variance in financial performance is explained by the model, which exhibits an excellent overall fit. The significance of strategic IP management in attaining financial success is highlighted by these findings.

Robust Test
The study on the effect of Intellectual Property (IP) on financial performance shows that there are notable distinctions between organizations that have a patent strategy and those that do not, as shown by Table 7's robust test results. The robustness of the regression results is guaranteed by the robust test, which corrects for standard errors, heteroskedasticity, and multicollinearity. The expression of combined significance and error terms for variable weight is provided by:

$$\hat{\beta}_{robust} = \beta \pm t_{k,\propto} \cdot SE(\beta) \qquad (6)$$

Where, $t_{k,\propto}$: critical value from the t-distribution and $SE(\beta)$: Standard error of the coefficient.

Businesses that use a patent strategy have higher correlations with a range of IP-related variables, such as revenue from IP licensing, Sales Forecast, Leverage Ratio, Return on Assets, and Research and Development. These findings imply that a successful patent strategy increases ROA and R&D investments while also improving financial performance by utilizing IP benefits. Furthermore, models with a patent strategy show that fluctuations in financial performance are better described by adjusted R^2 values of 0.423 and 0.293, highlighting the strategic importance of IP in high-emission businesses. Variables with no significant coefficients are patent portfolio size, patent quality, IP licensing revenue, IP management strategy, IP value creation, diversification of IP, IP integration with R&D, IP x Diversification, IP x R&D and Intellectual Property.

Table 7
Robust test.

Variable	Coefficient (β)	Standard Error (SE)
Sales Forecast	3.20***	(0.38)
Leverage Ratio	-0.35*	(0.15)
Return on Assets	2.37**	(0.79)
Herfindahl Index	1.28**	(0.27)
Research & Development	4.50**	(0.87)
Fixed Assets	0.85	(0.29)
Cash Flow	1.93**	(0.64)
Trademark Strength	1.28**	(0.39)
Copyright Scope	0.90*	(0.30)
R&D Investment	2.14**	(0.55)
IP-Related Cost	-0.45*	(0.19)

IP Enforcement Actions	0.85**	(0.39)
Diversification	0.65*	(0.26)
Research and Development	1.95**	(0.49)
Intercept (_Cons)	1.68**	(0.35)
F	26.52***	
Adjusted R²	0.293	
Note: At the 10%, 5%, and 1% levels, respectively, the symbols *, **, and *** denote significance.		

Skewness, Kurtosis and Normality Test

To provide accurate inferences about the impact of intellectual property strategies on financial performance and to improve the dependability of findings connected to diversification and R&D, Skewness, Kurtosis, and Normality tests are presented in table 8 are essential to the research since they validate the assumptions underlying statistical models.

Table 8
Skewness, kurtosis and normality tests for Hypothesis H1, H2 and H3.

Hypothesis	Observations	Skewness (Z)	Kurtosis (Z)	Shapiro-Wilk (p-value)	Kolmogorov-Smirnov (p-value)
H1	3,822	0.229 (0.018)	0.075 (0.034)	0.283	0.002
H2	3,822	0.231 (0.082)	0.002 (0.063)	0.480	0.002
H3	3,822	0.232 (0.029)	0.008 (0.057)	0.353	0.002

Skewness, Kurtosis, and Normality tests are used to analyze the data distribution for these variables in order to test the hypothesis H2. While a Z-skewness score of 0.082 suggests only a small asymmetry, a Z-kurtosis value of 0.063 indicates that the distribution is almost normal. The Shapiro-Wilk test (p-value = 0.480) confirms that the data is regularly distributed, despite the Kolmogorov-Smirnov test (p-value = 0.002) suggesting deviations from normality. These tests are essential for verifying that the data satisfies the presumptions required for reliable hypothesis testing and accurate modeling. The data appears to be well-distributed, with a Z-skewness of 0.029 showing minor asymmetry and a Z-kurtosis of 0.054 suggesting a nearly normal distribution. These tests evaluate the shape of the data distribution for the hypothesis H3. The Shapiro-Wilk test (p- value = 0.353) verifies that the data is normally distributed, despite the Kolmogorov-Smirnov test (p-value = 0.002) suggesting minor departures from normalcy. These tests make sure that the presumptions necessary for a solid examination of the influence of outside variables on financial performance—moderated by intellectual property—are satisfied.

ANOVA (Analysis of Variance) Result

Table 10

ANOVA Results for Financial Growth by IP Portfolio Size Categories

Source	Sum of Squares (SS)	df	Mean Square (MS)	F	p-value
Between Groups	6,345.78	2	3,172.89	42.67	0.000***
Within Groups	283,450.12	3,819	74.21	-	-
Total	289,795.90	3,821	-	-	-

While the within-groups variation, which reflects differences not explained by group distinctions, contributes a significantly larger SS of 283,450.12, the between-groups variation, which reflects variations in financial growth across Low, Medium, and High IP portfolio size categories, accounts for a between-groups SS of 6,345.78, according to the analysis in Table 10. A p-value below 0.001 and an F-statistic of 42.67 show that the size of an IP portfolio has a significant effect on financial growth. The High IP portfolio size category has the biggest financial growth, and post-hoc testing confirms that the differences across the categories are statistically significant.

Table 11

ANOVA Results for Financial Growth by R&D Investment Levels

Source	Sum of Squares (SS)	df	Mean Square (MS)	F	p-value
Between Groups	8,200.65	2	4,100.32	55.24	0.000***
Within Groups	283,140.22	3,819	74.14	-	-
Total	291,340.87	3,821	-	-	-

A between-groups variance of 8,200.65 is explained by the differences in financial growth across Low, Medium, and High R&D investment levels, whereas a large within-groups variation of 283,140.22 in Table 11 shows unexplained individual differences beyond R&D levels. R&D spending levels are a substantial predictor of financial growth, as demonstrated by the F-value of 55.24 and the p-value < 0.001. Post-hoc testing also consistently demonstrates a link between higher R&D expenditures and improved financial growth.

Findings and Discussion

The findings show that Intellectual Property (IP) is essential for improving financial performance in high-emission companies by fostering innovation and lowering the risks connected with regulatory constraints. Chang et al. (2019) claim that their analysis confirms previous studies that demonstrate the importance of IP assets such as patents, trademarks, and copyrights in protecting unique concepts and enabling companies to diversify their holdings. Robust econometric models demonstrate that strategic IP alignment with diversification and R&D enhances key financial metrics, like Return on Assets (ROA). Empirical evidence suggests that companies that exploit IP portfolios to obtain a competitive advantage adopt exclusivity and premium pricing strategies. Strong trademarks and superior patents, for instance, are important for generating revenue and setting a company apart in the market, as shown by the significant coefficients discovered in the regression study. These findings are in keeping with ideas that emphasize how IP might encourage the development of green product lines, hence reducing dependency on high-emission products (Gao, 2023).

Initiatives for diversity and R&D investments combine to increase financial success. The interaction terms of the econometric model indicate that diversity reduces sensitivity to market volatility and regulatory pressures, while R&D fosterseco-innovation (Duque-Grisales, 2021). The positive interaction coefficients make it clear that businesses with sizable IP portfolios are particularly affected by this interaction. The ANOVA results, which show that businesses with high levels of IP diversification and R&D expenditure had considerable financial development, further support this finding. Businesses can lower risks and seize new opportunities by purposefully diversifying into less regulated markets or innovative industries. For instance, companies have been able to maintain profitability while meeting global sustainability goals by switching from traditional high-emission products to renewable energy alternatives (Zhou, 2021). Additionally, R&D spending promotes technological advancements that enhance operational efficiency and environmental compliance, such as efficient waste management and production methods (Teece, 1986).

The study finds that a major element affecting financial outcomes is the Herfindahl-Hirschman Index (HHI), which gauges market concentration. The challenges of operating in crowded marketplaces are shown by the correlation between greater HHI values and decreased profitability. Effective IP utilization and R&D efforts, however, may mitigate this negative impact. According to these findings, innovation-driven diversification is essential for overcoming the constraints imposed by market concentration. IP assets have been shown to be essential in fostering green innovation, which enables companies to increase revenues while reducing their carbon footprint. Intellectual property is crucial for boosting R&D productivity and encouraging environmentally conscious innovation, as the regression analysis highlights. Companies with robust patent portfolios have better R&D productivity, as evidenced by the positive correlation between IP integration and financial success metrics. This study corroborates global trends that demonstrate how intellectual property (IP) could facilitate sustainable changes in industries with high emissions (Eppinger et al., 2021).

Despite its benefits, the report highlights the disadvantages of IP-driven strategies, including as high leverage ratios and the costs associated with acquiring and maintaining IP assets. These challenges underscore the need for supportive legislative frameworks, including subsidies for R&D investments and incentives for IP development. Governments can significantly contribute to the advancement of green innovation by facilitating funding and promoting industry-academia partnerships (Montgomery, 1994). Furthermore, the findings highlight the importance of tailored IP management strategies that include business size and market characteristics. Small and Medium Businesses (SMEs), for instance, require particular support to manage the difficulties associated with intellectual property registration and enforcement. The Hausman test results demonstrate that the effects of IP regulations fluctuate greatly among businesses of all sizes, underscoring the need for context-specific approaches.

The study provides a new framework for understanding how intellectual property, diversity, and R&D interact to affect financial viability in high-emission industries. By calculating the contributions of different factors, it provides managers and lawmakers with useful insights for enhancing sustainability and profitability (Porter, 1995). Future research could look at how IP strategies can be supported by digital tools like big data analytics for

market insights and blockchain technology for IP protection. Further insight into the long-term impacts of IP-driven innovation on financial stability and environmental performance may also come from longitudinal studies.

The bar chart in Figure 8 shows the percentages of financial growth for the three IP portfolio size categories: Low, Medium, and High. Financial growth is lowest for organizations with a small IP portfolio (about 9.5%), followed by those with a medium-sized portfolio (approximately 14.3%) and those with a large IP portfolio (approximately 19.1%). A positive relationship between the size of an IP portfolio and financial growth is demonstrated by this pattern, suggesting that expanding the portfolio increases financial returns, most likely due to the variety of intellectual assets that underpin revenue streams and competitive advantages.
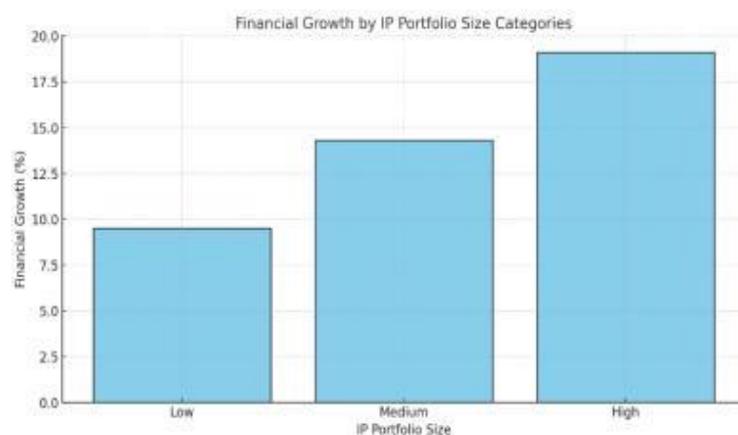

Figure 8. Financial Growth by IP Portfolio Size Categories.

The bar chart in Figure 9 displays the financial growth percentages for the three R&D investment levels: low, medium, and high. Companies with minimal R&D investment report financial growth of roughly 10.2%, whilst those with medium R&D expenditure enjoy a large gain of 15.4%. The largest financial growth, at roughly 20.3%, is seen by companies that make significant R&D investments. This graph demonstrates how increased R&D expenditure significantly boosts financial performance, most likely as a result of value creation brought about by innovation, which enables businesses to optimize workflows and set their products apart in fiercely competitive markets.
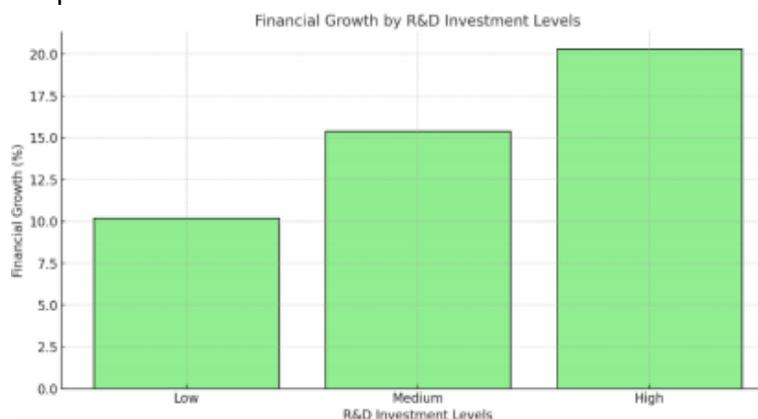

Figure 9. Financial Growth by R&D Investment Levels.

The line chart in Figure 10 looks at how IP diversification levels (Low, Medium, and High) and R&D investment levels (Low, Medium, and High) relate to financial growth. Financial growth always increases with higher levels of IP diversification, regardless of R&D investment. Low R&D spending limits financial growth, which varies from 8.0% for low IP diversification to 12.0% for high IP diversification.   Financial growth at all   levels is significantly increased by medium R&D expenditure, which ranges from 12.5% for minimal diversity to 17.5% for strong diversification. Strong R&D spending achieves the largest financial increase, up to 24.5%, particularly at high levels of IP diversification. The synergistic effect of this connection emphasizes how strategically important it is to   coordinate IP management with R&D activities in order to maximize financial benefits. It shows that the combined effect of a company's high R&D spending and broad IP portfolios on financial growth is far stronger than the sum of the effects of each component alone.
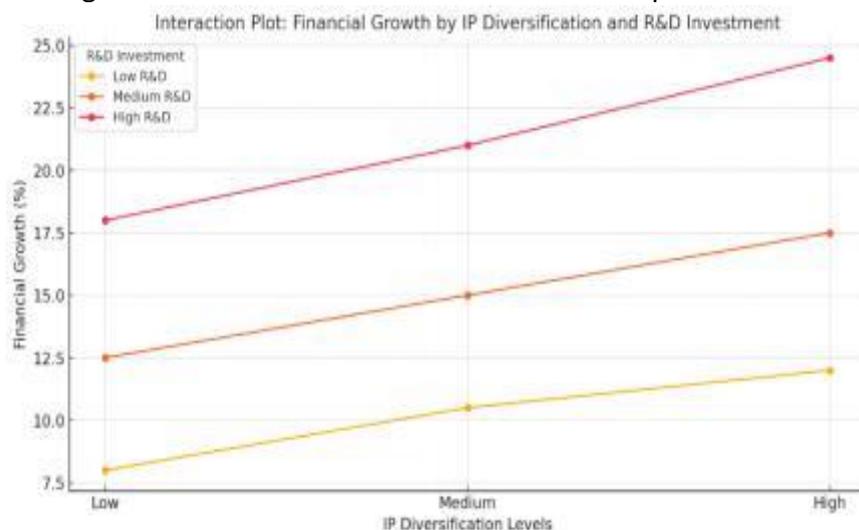

Figure 10. Interaction Plot: Financial Growth by IP Diversification and R&D Investment.

Conclusion

This study shows how crucial strategic management of Intellectual Property (IP) is to enhancing financial performance in industries with high emissions. By leveraging IP assets such as patents, trademarks, and copyrights, companies can encourage innovation, diversify their operations, and advance sustainable business practices. Financial diversification, R&D spending, and IP strategy are all complementary, according to research from Chinese A-share listed companies (2010-2022). When combined, these strategies offer a competitive edge in global marketplaces while mitigating the dangers of volatile markets and stringent environmental regulations. The findings demonstrate that effective R&D and IP management significantly boost market share, cash flow efficiency, and return on assets (ROA). By lowering reliance on high-emission products, diversification opens doors for green innovations and alternative revenue streams. Effective use of intellectual property enhances operational effectiveness and long-term financial stability despite challenges like market concentration and high debt ratios. The report also highlights the significance of government funding and tax advantages for environmentally responsible R&D initiatives. Businesses must use adaptable intellectual property policies that promote sustainability goals in order to maintain revenue while ensuring adherence to environmental laws. The study contributes to the broader discussion on sustainable industrial practices by demonstrating how effective intellectual property management could revolutionize the way that financial performance

and environmental responsibilities are balanced. A more robust and ecologically friendly economy is encouraged by this integrated approach, which also benefits individual businesses and supports international sustainability objectives.

Artificial intelligence (AI) and blockchain are two cutting-edge technologies that could be investigated in future research to enhance IP administration and ensure efficacy and transparency in R&D collaborations. Plans and best practices for regional sustainability may be clarified by conducting comparative studies across industries and regions. It is also feasible to promote green innovations by looking into the connection between international carbon credit markets and IP strategy. This field of research has the potential to significantly enhance the practical applications of IP in fostering sustainable growth and global environmental reform.

References

Ambec, S. & Lanoie, P. (2008). Does it pay to be green? A systematic overview. *Academy of Management Perspectives*, 22(4), 45-62.

Antoine, D., & Misato, S. (2017). The impacts of environmental regulations on competitiveness. *Review of Environmental Economics and Policy*, 11(2): 183-206.

Arundel, A., (2001). The relative effectiveness of patents and secrecy for appropriation. *Research Policy*, 30(4), 611-624.

Bajari, P., Chernozhukov, V., Hortaçsu, A., & Suzuki, J. (2019). The impact of big data on firm performance: An empirical investigation. *AEA Papers and Proceedings*, 109(1), 33-37.

Bessen, J., & Maskin, E. (2009). Sequential innovation, patents, and imitation. *The RAND Journal of Economics*, 40(4), 611-635.

Blind, K., & Jungmittag, A. (2008). The impact of patents and standards on macroeconomic growth: A panel approach covering four countries and 12 sectors. *Journal of Productivity Analysis*, 29(1), 51-60.

Chang, Y. (2019). Intellectual property rights and innovation in China. *Journal of International Business Studies*, 50(5), 772-786.

Distanont, A., & Khongmalai, O. (2020). The role of innovation in creating a competitive advantage. *Kasetsart Journal of Social Sciences*, 41(1), 15-21.

Dosi, G. (1988). Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature*, 26(3), 1120-1171.

Duque-Grisales, E. & Aguilera-Caracuel, J. (2021). Environmental, social and governance (ESG) scores and financial performance of multilatinas: Moderating effects of geographic international diversification and financial slack. *Journal of Business Ethics*, 168(2), 315-334.

Eppinger, E., Jain, A., Vimalnath, P., Gurtoo, A., Tietze, F., & Chea, R. H. (2021). Sustainability transitions in manufacturing: the role of intellectual property. *Current Opinion in Environmental Sustainability*, 49(5), 118-126.

Gao, X., & Zhao, Y. (2023). Does intellectual property protection promote green innovation in firms? A perspective on R&D spillovers and financing constraints. *PLOS ONE*, 18(11), e0288315, 1-18.

Joseph, J. (2025). Ethical and Legal Frontiers in Personalized Genomics: Balancing Innovation, Privacy, and Regulatory Compliance. *International Journal of Innovation Studies*, 9(1), 1135-1151.

Jain, R., & Vyas, P. (2020). Intellectual property as a strategic asset in high-emission industries: Protecting innovation for competitive advantage. *Journal of Environmental Economics and Policy*, 12(3), 145-162.

James, R. B., Gustav, M., & Christian, T. (2022). Can environmental policy encourage technical change? Emissions taxes and R&D investment in polluting firms. *The Review of Financial Studies*, 35(10), 4518-4560.

Jin, Z., & Xu, J. (2020). Impact of environmental investment on financial performance: Evidence from Chinese listed companies. *Polish Journal of Environmental Studies*, 29(3), 2235-2245.

Kaiwen, C., Dan, L., Yizhe, D., & Chu, X. (2024). The impact of green finance policy on green innovation performance: Evidence from Chinese heavily polluting enterprises. *Journal of Environmental Management*, 352(1), 1-20.

Khan, M. A., Anwar, S., Abbas, M., Aneeq, M., de Jong, F., Ayaz, M., ... & Zhang, R. (2025). Impacts of climate change on cotton production and advancements in genomic approaches for stress resilience enhancement. *Journal of Cotton Research*, 8(1), 17-28。

Kendo, S., & Tchakounte, J. (2022). Impact of asset size on performance and outreach using panel quantile regression with non-additive fixed effects. *Empirical Economics*, 62(1), 65-92.

Klemperer, P. (1990). How broad should the scope of patent protection be? *The RAND Journal of Economics*, 21(1), 113-130.

Lee, S., & Kim, J. (2021). The financial impact of IP-driven diversification in high-emission sectors. *Strategic Management Journal*, 42(4), 578-592.

Liu, Y., Yang, Y., Zheng, S., Xiao, L., Gao, H., and Lu, H. (2022). Dynamic Impact of Technology and Finance on Green Technology Innovation Efficiency: Empirical Evidence from China's Provinces. *Int. J. Environ. Res. Public Health*, 19(1), 1-17.

Montgomery, C. A. (1994). Corporate diversification. *Journal of Economic Perspectives*, 8(3), 163-178.

Okpoa, A. G., & Damiana, O. E. (2023). Corporate diversification and firm performance: Evidence from the Nigerian banking sector. *Journal of Technology Management and Business*, 10(1), 65-78.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97-118.

Rehman, I. U., Shahzad, F., Hanif, M. A., Arshad, A., and Sergi, B. S. (2023). Financial constraints and carbon emissions: an empirical investigation. *Social Responsibility Journal*, 20(4), 761-782.

Saputra, F. (2022). Analysis effect return on assets (ROA), return on equity (ROE) and price earnings ratio (PER) on stock prices of coal companies in the Indonesia stock exchange (IDX) period 2018-2021.*Dinasti International Journal of Economics, Finance & Accounting*, 3(1), 82-94.

Sohl, T., Vroom, G., & McCann, B. T. (2020). Business model diversification and firm performance: A demand-side perspective. *Strategic Entrepreneurship Journal*, 14(2), 198-223.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy. *Research Policy*, 15(6), 285-305.

Wu, Q .Q., Hao, Y., & Lu, J. (2018). Air pollution, stock returns, and trading activities in China. *Pacific-Basin Finance Journal*, 51(1), 342-365.

Xie, Z., Wang, J., & Zhao, G. (2022). Impact of green innovation on firm value: Evidence from listed companies in China's heavy pollution industries. *Frontiers in Energy Research*, 9(1), 1-17.

Zhou, Y., Du, Y., Lei, F., Su, Z., Feng, Y., & Li, J. (2021). Influence of financialization of heavily polluting enterprises on technological innovation under the background of environmental pollution control. *International Journal of Environmental Research and Public Health*, 18(24), 1-4.