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Sustainability as Strategy: Analyzing TSMC's ESG Integration and Financial Performance

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Abstract: *This research concentrates on exactly how Environmental, Social, and Governance (ESG) scores influence business economic efficiency in light of the enhanced focus ESG requirements receive worldwide. In this research, the research methodology employed is stata. Our objective is to acquire a detailed understanding of TSMC's ESG methods to show capitalists, supervisors, and policymakers how ESG factors to consider impact economic efficiency in sophisticated businesses. We will evaluate TSMC for its technological abilities, sector standing, and company size. It outlines 3 plans: standards for transparency and coverage, sector-specific legislation, and regional placement. Against the backdrop of enhanced ESG understanding, these three policies are powerful for advertising sustainable economic efficiency in the business globe. By assimilating TSMC's experience and embracing these suggestions, organizations can create a robust path towards ESG combination and improve total efficiency. Our research opens up brand-new avenues for executing ESG principles in business and policy and providing firms with practical and workable recommendations. This comprehensive viewpoint seeks to guide businesses toward long-term financial success while urging extra muscle and balanced development of the business community.*

Keywords: *ESG, financial performance, sustainability, TSMC*

1. Introduction

The development of Environmental, Social, and Governance (ESG) criteria marks a significant shift in business analysis, highlighting the value of sustainability alongside traditional financial metrics. ESG has now moved from an unclear concept to an organization and spending top priority. It assists in boosting the quality and value of service operations performed by businesses [1]. As international recognition and problems for moral business practices grow, ESG requirements have become key to assessing a firm's long-lasting viability and social responsibility. This arising paradigm highlights the necessity for companies to incorporate lasting techniques right into their service versions, not just to satisfy stakeholder expectations but additionally to secure a competitive edge in the progressively conscientious market. ESG has currently moved from an obscure principle to a company and investing priority. It assists in enhancing the high quality and worth of organizational operations performed by companies. Despite the first financial prices that a business might need to birth, there are higher economic returns in the future [1].

Focusing on the semiconductor industry, this study examines Taiwan Semiconductor Manufacturing Company (TSMC) as a pivotal case to explore the relationship between ESG scores and financial performance. TSMC is the world's biggest chipmaker. These are some of the key numbers for the three months ended June 30, 2019: Revenue of 534.14 billion Taiwanese dollars ($18.16 billion), a rise of 43.5% year-on-year. That beat the 524.02 billion Taiwan dollar average from analyst estimates compiled by Refinitiv. Net income of 237.03 billion Taiwanese dollars, up 76.4% year-on-year and ahead of estimates. That was a record quarter in terms of net income for TSMC. The company which is Apple's most important chip supplier, said it expects revenue to be between $19.8 billion and $20.6 billion in the third quarter, surging from $14.8 billion in the same period last year.[2] It is also a global leader in

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semiconductor manufacturing, and represents an ideal subject due to its significant impact on the tech industry and its proactive engagement with ESG principles. The choice of TSMC reflects an intention to dissect how ESG factors influence financial outcomes in a sector characterized by rapid innovation and stringent environmental considerations.

The scholastic discourse surrounding ESG requirements and financial efficiency is both abundant and controversial, providing different conclusions on the nature of their interaction. While some researches affirm a positive correlation, recommending that high ESG scores add to far better monetary results, others remain hesitant, indicating the complicated internet of variables that moderate this connection. This study seeks to navigate this debate by using a nuanced evaluation of TSMC's approach to ESG and its subsequent economic performance, consequently adding to a much more enlightened understanding of how ESG aspects can be leveraged for economic and social benefit.

By adopting a thorough analytical structure, this research study ventures to clarify the mechanisms through which ESG involvement affects corporate economic performance, specifically within the context of the semiconductor sector. The findings aim to enrich the academic and useful discourse on lasting organization practices, providing useful understandings for businesses, investors, and policymakers making every effort to balance economic success with environmental stewardship and social responsibility. With this examination, the research study aspires to delineate the strategic value of ESG requirements to fit a company's monetary landscape, with TSMC functioning as a paradigmatic instance of a successful combination of sustainability and earnings.

2. Literature Review

Recent research studies have increasingly concentrated on the impact of Environmental, Social, and Governance (ESG) scores on corporate economic efficiency. The beginning of ESG standards right into corporate money analysis can be traced back to the 1970s, highlighting a long-standing passion for understanding the relationship between lasting techniques and economic results.

2.1. Historical Overview and Theoretical Foundations

Friede et al. [3] originated synthesizing evidence on the partnership between ESG criteria and corporate monetary performance. Their research validated the basic concepts of ESG financial investment, stressing the mainly favorable link between ESG ratings and monetary results. This body of work laid the structure for succeeding empirical examinations right into the subtleties of this relationship.

2.2. Empirical Evidence and Mechanisms

Making use of A-share detailed firms from 2010 to 2020 as an example, researchers created a fixed effects design to look into the heterogeneity of aspects such as corporate air pollution degrees, the nature of the corporation, and regional advancement levels. The searching for from this analysis underscored that excellent ESG efficiency not only straight boosts company performance but does so with systems such as improved info transparency.

2.3. International Perspectives on ESG Performance and dual nature of ESG Impact

The impact of ESG scores on financial performance is not limited to a single geographical context but has been observed across various countries. Li et al. [4] in China, and Dolal and Thaker [5] in India each provided evidence of the positive effects of ESG scores on corporate financial success. However, a comprehensive review by Whelan et al. [6] of over 1000 papers published between 2015 and 2020 reveals a complex picture, with a majority indicating positive effects and notable instances of negative, neutral, or mixed outcomes.

The impact of enterprise digitization on ESG performance may be influenced by the characteristics of the enterprise and the external environment. Enterprises obtain preferential policies through establishing relationships with government officials, including higher acquisition prices [7] and lower financing costs [8], thereby increasing enterprise value. While the consensus leans towards a beneficial impact of ESG scores on financial performance, certain studies highlight potential drawbacks.

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2.4. The Relationship between ESG and ROA

Ranjan and DasGupta [8] first developed a proxy for the company's desire level to construct the main independent variable: the financial performance gap. Behavioral theorists argue that businesses adjust their desires based on historical or social desires [9]. Recent research from Bromley and Harris [10] and Lucas et al. [11] suggests that there are fundamental differences in the nature and impact of historical and social desires, and these two measures should be separate. In addition, recent research also asserts that social desire is the central baseline for financial performance feedback (i.e., gaps) that business managers are most likely to respond to [12]. Therefore, this study first measures the level of social desire of a company by calculating the cross-sectional average performance (excluding the performance of key enterprises) based on the previous year's data of five clusters of companies in an industry [13], defined by MSCI industry classification. RanJan calculated these two indicators based on the return on assets (ROA) of the company and determined the financial performance gap (i.e., FASPPF and SASP5PF) by comparing these indicators with the actual performance of the observation year (Greve, 2003). It was found that the mediating variable ESG dispute (ESGCON) score was also taken from asset 4, and a binary dummy variable was created based on the cross-sectional average. For companies with high ESGCON, this variable is equal to 1; otherwise, it is 0. The ESG controversy measured by Asset4 Thomson Reuters is a public news report about a company's suspicious ESG behavior, collected from major English news media, Human Rights Watch, Amnesty International, and others. A few ESG disputes are environmental disputes, including biodiversity issues, leaks, and pollution. Social disputes are related to health and safety, diversity, and other aspects.; Governance disputes mainly involve board compensation and insider trading.

According to the literature review, we anticipate that high ESG scores may have a positive impact on the company's value and profitability. Tested the following assumptions.

Assumption 1: ESG scores have a positive impact on company value.

Assumption 2: ESG scores will have a positive impact on a company's profitability.

The literature mainly discusses the impact and importance of ESG on the financial performance of domestic and foreign companies. Although there are different views and theories on the impact of ESG on financial performance, most studies support the significant impact of ESG factors on a company's financial performance and often lead to better financial performance and risk control capabilities. Future research needs to further explore how to more effectively measure and integrate ESG factors, as well as how to incorporate these factors into the strategic and decision-making processes of enterprises. At the same time, a reasonable balance between ESG investment and economic benefits is needed to achieve sustainable development. For businesses and investors, understanding the impact of ESG factors on financial performance and how to improve financial performance through effective ESG practices is crucial.

3. Methodology

3.1. Utilizing FactSet and Bloomberg Data Sources

Integrating FactSet and Bloomberg data sources with empirical research study uses a solid basis for additional academic investigation. FactSet is widely identified for its comprehensive coverage of worldwide financial and economic data, offering scholars a variety of monetary statements, market data, and analytics. Substantial datasets are important for detailed and detailed analysis, specifically when assessing complicated monetary signs or market dynamics. Bloomberg is widely identified as an excellent service provider of market data services, especially renowned for its extensive Environmental, Social, and Governance (ESG) rating systems. Bloomberg's ESG ratings are acquired by making use of established and accepted treatments, making sure that data factors are uniform and can be compared across various entities and durations. It permits extensive and lasting research sustained by constant and comparable data. The databases' credibility and reliable nature assure the preservation of information honesty, making it possible for exact and trustworthy scholarly research. In addition, the practical information schedule using easy-to-use user interfaces and APIs simplifies the study process, making it possible for structured and effective information analysis operations within analytical software application settings.

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3.2. Conducting Regression Analysis

Using Stata for regression analysis has numerous particularly beneficial advantages in a scholastic research setting. Because of its substantial collection of statistical tests and versions that are specifically customized for assessing economic and monetary information, Stata has amassed a strong track record as a dependable analytical program. The user-friendly layout of the system's command-line interface makes it available to both beginner and experienced researchers. It is better enhanced by a menu-driven operating system, making it possible for customers to run innovative regression research studies with loved ones' simplicity. Stata's versatility is a basic benefit, as it allows customers to personalize commands and manuscripts to suit their particular study requirements, boosting the replicability and precision of their studies. The software program's effectiveness in swiftly handling comprehensive datasets makes it a superb device for evaluating thorough panel data, regularly come across in finance-related research. Moreover, Stata's comprehensive neighborhood and wealth of online resources provide an essential assistance network that scientists can utilize for analysis, obtaining sophisticated abilities, or staying updated on the most recent improvements in analytical methods. The participation of StataCorp's specialist support guarantees the punctual resolution of any type of technical troubles experienced during the research procedure. By utilizing Stata's analytical capabilities, researchers can discover their data extra thoroughly, exposing complicated links and deriving well-supported findings that substantially improve the current database.

3.3. Selecting the ESG scores and independent variables

Picking particular monetary metrics as forecasters are crucial in examining exactly how ESG ratings influence firms like TSMC's operational efficiency. The importance of these metrics theoretically and methods in identifying business financial performance and stock appraisal validates their addition to the analysis. The six selected variables, specifically Return on Assets (ROA), Return on Equity (ROE), Market Capitalisation, Total Sales, Receivables Turnover, and Property Turnover, each provide distinctive points of view on business procedures and monetary wellness. As a result, they form a comprehensive framework for comprehending the diverse effects of ESG methods.

The Return on Equity (ROE) and Return on Assets (ROA) are crucial indications that examine just how lucrative a firm is. They demonstrate just how efficiently the business generates earnings from its assets and the financial incentives it gives to its investors. Reliable performance in these metrics might indicate proficient possession management and the ability to produce worth, which might be affected by robust environmental, social, and governance (ESG) techniques, consisting of resource performance and honest management.

Market Capitalisation shows the market state of mind and capitalist confidence, which can influence a company's ESG credibility. Organizations with solid Environmental, Social, and Governance (ESG) scores are typically viewed as lower risk, greater development potential financial investments, leading to enhanced market price.

A company's total sales reflect its capability to create income, affecting its profitability and growth. Engagement in ESG campaigns focusing on social duty and ecological sustainability can boost customer fulfillment and commitment, leading to greater sales.

The Receivables turnover supplies essential information regarding how well a firm's credit history policies and collection process function. These attributes might be influenced indirectly by the social and governance requirements of the organization. The Asset Turn Over Ratio (ATGR) measures the performance with which a firm creates revenue from its possessions; ESG practices have the potential to maximize ATGR while lowering the ecological effect.

Including these variables in a regression design promotes a nuanced analysis of exactly how ESG ratings impact economic efficiency and emphasizes the interplay between sustainable methods and functional effectiveness. By leveraging high-grade data from Bloomberg and FactSet, this research aims to give a strenuous scholastic exploration of the theory that remarkable ESG performance is related to enhanced monetary metrics. Making use of Stata for regression analysis further enriches this examination, supplying robust analytical tools that enable the disentanglement of complicated relationships between ESG scores and crucial economic indications. This thorough analytical method, underpinned by empirical information and advanced analytical approaches, exemplifies scholastic roughness and intends to add beneficial insights to the blossoming area of ESG research study.

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3.4. Preparing for the stata analysis

3.4.1. Introduction to Regression Analysis

ESG standards assessment is vital for evaluating a company's operations' ethical and sustainable aspects. Our research uses data from Bloomberg and FactSet to analyze the relationship between ESG scores and the financial performance of Taiwan Semiconductor Manufacturing Company (TSMC) through regression analysis in Stata. We aim to determine how financial indicators like ROA, ROE, Market Capitalization, Total Sales, Receivables Turnover, and Asset Turnover can predict TSMC's ESG score. This systematic approach allows us to understand the specific impact of these financial indicators on ESG performance, providing a comprehensive view of business operations. ESG standards evaluation is crucial for examining a company's procedures' honest and lasting elements. Our study utilizes information from Bloomberg and FactSet to assess the relationship between ESG scores and the economic performance of Taiwan Semiconductor Production Business (TSMC) via regression analysis in Stata. We intend to establish just how financial signs like ROA, ROE, Market Capitalization, Total Sales, Receivables Turnover, and Asset Turnover can anticipate TSMC's ESG rating. This systematic strategy enables us to understand the certain influence of these monetary indicators on ESG performance, providing an extensive sight of company procedures.

3.4.2. Methodological Framework

We employed descriptive data to gain initial insights right into the dataset's features upon importing the important monetary information right into Stata. Initial regression designs were built with ESG rating as the reliant variable, influenced by independent variables representing vital economic metrics. Subsequent evaluations consisted of residual plots to assess version fit and pairwise correlations to examine the interdependencies among the financial variables. Especially, we introduced a communication term between ROA and ROE to check out prospective synergistic effects on the ESG rating. More regression versions incorporated a temporal dimension to investigate the dynamic nature of these relationships over time.

3.4.3. Findings and Analysis

The regression output indicates significant links between TSMC's financial performance and ESG rating. The interaction between ROA and ROE suggests that the interplay between asset management and shareholder returns is complex and may be a determinant in driving the ESG score. Time series plots for Market Capitalization and Total Sales, generated and combined using Stata's graphical capabilities, elucidate the trends and fluctuations in TSMC's financial position over the examined period. These visual representations, coupled with the statistical analyses, underscore the temporal aspects of the financial-ESG relationship, highlighting periods of particular significance.

3.4.4. Implications and Future Research

This research study has scholastic worth as it adds to the existing body of literature on the monetary repercussions of ESG efficiency. The searching for suggests that TSMC's commitment to ESG concepts shows company accountability and has the prospective to drive economic prosperity. Subsequent investigations can boost this foundation by integrating supplemental control variables, such as sector standards or macroeconomic indicators, to improve the comprehension of exterior facets influencing this organization. Furthermore, conducting longitudinal researches that exceed the current dataset can provide beneficial insights right into the long-lasting effects of ESG initiatives on monetary efficiency in the semiconductor market and various other industries.

In summary, this research study provides a strenuous analytical structure for researching the economic effects of ESG scores within the context of TSMC's procedures. It contributes to an essential dialogue on integrating lasting methods in corporate methods and the substantial advantages such assimilation can yield.

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4. Results

4.1. Data overview

```
. describe

Contains data
 Observations:            11
    Variables:            13
```

Variable name	Storage type	Display format	Value label	Variable label
Year	int	%10.0g		Year
ESGscore	double	%10.0g		ESG score
Escore	double	%10.0g		E score
Sscore	double	%10.0g		S score
Gscore	double	%10.0g		G score
ROA	double	%14.2f		ROA
ROE	double	%14.2f		ROE
MktgCap	double	%14.2f		Mktg Cap
TotalSales	double	%14.2f		Total Sales
ReceivablesTu~r	double	%14.2f		Receivables Turnover
AssetTurnover	double	%14.2f		Asset Turnover
FL	double	%14.2f		FL
RD	double	%14.2f		R&D

```
Sorted by:
     Note: Dataset has changed since last saved.
```

Figure 1: Data Describe

The dataset covering TSMC's procedures from 2012 to 2022 presents an ESG rating of approximately 68.03, reflecting differences that likely represent developing sustainability initiatives (Figure 1). Secret monetary indications such as ROA and ROE average at 18.79 and 26.81, showing solid success. Market capitalization and overall sales standard at 1891.85 and 281.54, specifically, illustrating TSMC's strong market placement and income capacity. Liquidity ratios and monetary leverage program efficient possession monitoring and modest financial debt dependence. Substantial R&D investments indicate a strategic concentration on technology, which is necessary for TSMC's sustained development and one-upmanship. These data supply a snapshot of TSMC's economic toughness and dedication to ESG concepts, vital for succeeding in in-depth econometric analysis (Figure 2).

```
. sum
```

Variable	Obs	Mean	Std. dev.	Min	Max
Year	11	2017	3.316625	2012	2022
ESGscore	11	68.03182	5.887507	56.45	72.46
Escore	11	71.32636	9.055176	55.72	80.73
Sscore	11	55.77	8.45799	38.66	60.67
Gscore	11	76.96727	3.601928	74.89	86.15
ROA	11	18.78926	2.029934	15.85621	23.39464
ROE	11	26.81027	5.185983	20.93631	39.75527
MktgCap	11	1891.845	1318.235	671.195	4493.766
TotalSales	11	281.5417	135.608	132.8683	594.6196
Receivable~r	11	8.811906	.8779977	7.759328	10.53532
AssetTurno~r	11	.5261921	.0280769	.489473	.583907
FL	11	1.419091	.1326992	1.28	1.7
RD	11	85243.85	36153.95	40383.2	163262.2

Figure 2: Data Summary

4.2. ESG score analysis, residual and correlation analysis

Our econometric analysis of TSMC's data spanning from 2012 to 2022 illustrates a high R-squared value of 0.9884, indicating that most of the variance in the ESG score is explained by the model's financial variables, which include ROA, ROE, market capitalization, total sales, receivables turnover, asset turnover, financial leverage, and R&D expenses. While the model suggests a strong explanatory power, the high VIF values, particularly for ROE and financial leverage, signal substantial

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multicollinearity. It casts doubts on the stability and reliability of the estimated coefficients, as the financial indicators might not be as independent predictors as presumed (Figure 3).

```
. regress ESGscore ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD
```

Source	SS	df	MS		
Model	342.59846	8	42.8248075	Number of obs	= 11
Residual	4.02890358	2	2.01445179	F(8, 2)	= 21.26
				Prob > F	= 0.0457
Total	346.627364	10	34.6627364	R-squared	= 0.9884
				Adj R-squared	= 0.9419
				Root MSE	= 1.4193

ESGscore	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	15.28927	8.60744	1.78	0.218	-21.74556	52.32409
ROE	-11.5293	6.783461	-1.70	0.231	-40.71617	17.65758
MktgCap	-.0024961	.0025994	-0.96	0.438	-.0136804	.0086882
TotalSales	.0428965	.0744847	0.58	0.623	-.2775854	.3633784
ReceivablesTurnover	-10.30796	1.368987	-7.53	0.017	-16.19824	-4.417689
AssetTurnover	298.3034	117.1617	2.55	0.126	-205.8029	802.4097
FL	204.0841	135.976	1.50	0.272	-380.9734	789.1417
RD	.0004223	.0003884	1.09	0.390	-.0012489	.0020936
_cons	-309.2419	228.8959	-1.35	0.309	-1294.101	675.6175

Figure 3: The regression of ESG score

The pairwise correlation matrix reinforces the multicollinearity issue, showing strong correlations among the explanatory variables. ROE, for instance, has a correlation of over 0.9 with financial leverage, indicating that these variables are not distinct in their impact on the ESG score. The residual plot does not exhibit any distinct patterns, which generally suggests that the model's assumptions regarding the error terms are not violated (Figure 4). However, multicollinearity necessitates caution in interpreting the coefficients as accurate effect sizes. The high VIF values, some in the thousands, underline the severity of multicollinearity, suggesting that the effect of any single financial variable on ESG score cannot be isolated without considering the effects of other variables (Figure 5). Therefore, to achieve a more accurate understanding of the influence of financial performance on ESG scores, advanced techniques like ridge regression or principal component analysis may be required to account for the intertwined relationships among financial variables.

```
. pwcorr  ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD, sig
```

	ROA	ROE	MktgCap	TotalS~s	Receiv~r	AssetT~r	FL	RD
ROA	1.0000							
ROE	0.9248 0.0000	1.0000						
MktgCap	0.2991 0.3715	0.4917 0.1245	1.0000					
TotalSales	0.6138 0.0446	0.7946 0.0035	0.7997 0.0031	1.0000				
Receivable~r	0.7519 0.0076	0.7336 0.0102	0.3600 0.2769	0.5341 0.0906	1.0000			
AssetTurno~r	0.3161 0.3436	0.0620 0.8562	-0.5667 0.0691	-0.5007 0.1167	0.3418 0.3036	1.0000		
FL	0.6770 0.0221	0.9028 0.0001	0.6263 0.0392	0.8186 0.0021	0.5837 0.0594	-0.1891 0.5776	1.0000	
RD	0.5482 0.0808	0.7233 0.0119	0.8233 0.0018	0.9905 0.0000	0.4599 0.1547	-0.5776 0.0627	0.7483 0.0081	

	RD
RD	1.0000

Figure 4: ESG score Correlation analysis

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```
. vif

    Variable |      VIF      1/VIF
-------------+----------------------
         ROE |   6143.39   0.000163
          FL |   1616.24   0.000619
         ROA |   1515.50   0.000660
          RD |    978.91   0.001022
  TotalSales |    506.46   0.001974
      MktgCap |     58.29   0.017156
AssetTurno~r |     53.72   0.018616
Receivable~r |      7.17   0.139435
-------------+----------------------
    Mean VIF |   1359.96

. rvfplot
```

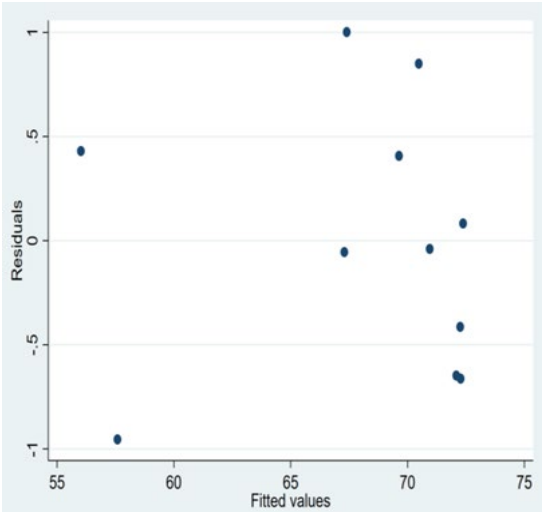

Figure 5: ESG score VIF and fitted values

4.3. Category analysis of E score, S score and G score

For the environmental aspect of TSMC's ESG score (Escore), the regression yields an adjusted R-squared of 0.9892, indicating that the financial variables comprehensively explain the variance. Notably, receivables turnover presents a significant negative relationship, suggesting that quicker collections correlate with lower environmental scores. However, the extremely high VIF values, particularly for ROE, signal multicollinearity, cautioning against taking the magnitude and significance of the coefficients at face value (Figure 6).

```
. regress Escore ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD

      Source |       SS           df       MS      Number of obs   =        11
-------------+----------------------------------   F(8, 2)         =    115.93
       Model |  818.197617         8  102.274702   Prob > F        =    0.0086
    Residual |  1.76443795         2  .882218977   R-squared       =    0.9978
-------------+----------------------------------   Adj R-squared   =    0.9892
       Total |  819.962055        10  81.9962055   Root MSE        =    .93927

------------------------------------------------------------------------------
      Escore | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         ROA |  -3.223547   5.696181    -0.57   0.628    -27.73224    21.28514
         ROE |   2.000589   4.489119     0.45   0.699    -17.31453    21.31571
      MktgCap |   .0020745   .0017202     1.21   0.351    -.0053269     .009476
  TotalSales |   .1364242   .0492921     2.77   0.110    -.0756624    .3485108
ReceivablesTurnover |  -12.13721   .9059599   -13.40   0.006    -16.03524   -8.239182
AssetTurnover |   267.2159   77.53461     3.45   0.075    -66.38855    600.8204
          FL |  -89.48736   89.98539    -0.99   0.425    -476.6633    297.6885
          RD |   .0000109    .000257     0.04   0.970    -.0010951    .0011169
       _cons |   128.3318   151.4773     0.85   0.486    -523.4226    780.0862
------------------------------------------------------------------------------
```

Figure 6: E score regression

Turning to the social component (Sscore), the adjusted R-squared remains high at 0.8565. Asset turnover shows a significant positive coefficient, hinting at a possible association between efficient asset use and higher social scores. Yet, similar to the environmental model, multicollinearity is evident in the inflated VIF values, which could obscure the true relationships between these financial indicators and the social aspect of ESG performance (Figure 7).

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```
. regress Sscore ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD
```

Source	SS	df	MS		
Model	694.843544	8	86.855443	Number of obs	= 11
Residual	20.5324562	2	10.2662281	F(8, 2)	= 8.46
				Prob > F	= 0.1100
Total	715.376	10	71.5376	R-squared	= 0.9713
				Adj R-squared	= 0.8565
				Root MSE	= 3.2041

Sscore	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	42.46925	19.43126	2.19	0.160	-41.13673	126.0752
ROE	-31.44122	15.31364	-2.05	0.176	-97.33049	34.44804
MktgCap	-.0078975	.0058681	-1.35	0.311	-.033146	.017351
TotalSales	-.0309152	.168149	-0.18	0.871	-.7544018	.6925715
ReceivablesTurnover	-12.02057	3.090482	-3.89	0.060	-25.31784	1.276702
AssetTurnover	401.7963	264.4922	1.52	0.268	-736.2217	1539.814
FL	587.1719	306.9653	1.91	0.196	-733.5932	1907.937
RD	.0011292	.0008768	1.29	0.327	-.0026436	.0049019
_cons	-910.6078	516.7315	-1.76	0.220	-3133.924	1312.709

Figure 7: S score regression

Lastly, the governance score (Gscore) model, with an adjusted R-squared of 0.2560, suggests that the financial variables selected are less effective at explaining the governance score's variability. The VIF values, while still indicative of multicollinearity, are lower than the other two models, reflecting a more complex set of factors influencing the governance dimension beyond the financial variables included in the model (Figure 8).

```
. regress Gscore ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD
```

Source	SS	df	MS		
Model	110.432558	8	13.8040698	Number of obs	= 11
Residual	19.3062599	2	9.65312995	F(8, 2)	= 1.43
				Prob > F	= 0.4751
Total	129.738818	10	12.9738818	R-squared	= 0.8512
				Adj R-squared	= 0.2560
				Root MSE	= 3.1069

Gscore	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	6.667136	18.84212	0.35	0.757	-74.40394	87.73822
ROE	-5.185573	14.84933	-0.35	0.760	-69.0771	58.70595
MktgCap	-.001666	.0056902	-0.29	0.797	-.0261489	.022817
TotalSales	.0240454	.1630508	0.15	0.896	-.6775055	.7255962
ReceivablesTurnover	-6.81573	2.99678	-2.27	0.151	-19.70983	6.078373
AssetTurnover	227.3069	256.4729	0.89	0.469	-876.2069	1330.821
FL	115.1624	297.6582	0.39	0.736	-1165.558	1395.882
RD	.0001263	.0008503	0.15	0.896	-.0035321	.0037846
_cons	-146.6316	501.0644	-0.29	0.797	-2302.538	2009.275

Figure 8: G score regression

4.4. The difference between ROA and ROE in the model

In the specific regression analysis attempting to discern the impact of TSMC's financial performance on its ESG score, we incorporated an interaction term (ROAROE) to examine whether the interplay between return on assets (ROA) and return on equity (ROE) has a composite effect on the ESG score. This approach is rooted in the idea that the effectiveness of asset utilization and the profitability of equity might not just independently influence ESG performance but also jointly in a way that is not additive. Such an interaction could highlight a nuanced relationship where the combined effect of ROA and ROE on ESG scores differs from what would be expected by considering each factor in isolation.

The regression outcomes, however, reveal an R-squared of only 0.0758, indicating that these variables explain a tiny proportion of the variance in ESG scores. The negative adjusted R-squared suggests that the model, with these predictors, may fit worse than a simple mean model. The coefficients for ROA, ROE, and the interaction term are not statistically significant (with p-values well above 0.05), which implies that there is not enough evidence to assert that either the individual or the interactive effects of ROA and ROE are associated with the ESG score in this dataset. The coefficient for the interaction term

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ROAROE is particularly telling; its p-value of 0.819 shows no evidence of a multiplicative effect between ROA and ROE on the ESG score. These findings suggest that the model may be missing other important variables or that the relationships between these financial measures and ESG performance are more complex than can be captured by a linear interaction term in a regression model. Therefore, re-evaluating the model specification is warranted, potentially exploring nonlinear models or other financial indicators that might better explain the variance in ESG scores for TSMC (Figure 9).

```
. gen ROAROE = ROA * ROE

. regress ESGscore ROA ROE ROAROE
```

Source	SS	df	MS	Number of obs	=	11
				F(3, 7)	=	0.19
Model	26.272527	3	8.75750899	Prob > F	=	0.8990
Residual	320.354837	7	45.7649767	R-squared	=	0.0758
				Adj R-squared	=	-0.3203
Total	346.627364	10	34.6627364	Root MSE	=	6.765

ESGscore	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	-2.038485	4.877753	-0.42	0.689	-13.57254	9.495569
ROE	-.2363712	3.860747	-0.06	0.953	-9.365587	8.892845
ROAROE	.0397018	.1674361	0.24	0.819	-.3562217	.4356254
_cons	92.31964	93.11889	0.99	0.355	-127.8715	312.5108

Figure 9: Collinearity analysis of ROA and ROE

4.5. Time series in the model

The regression analysis indicates that TSMC's ESG score is being assessed for its relationship with several key financial metrics, also factoring in the yearly changes. The model, with an almost perfect R-squared of 0.9995, implies that the financial indicators and time explain nearly all the variability in the ESG score. However, this might indicate overfitting, especially given the small sample size of 11 observations.

None of the coefficients are statistically significant, which is counterintuitive given the high R-squared value. This discrepancy could be due to multicollinearity or the peculiarities of the data. The addition of the year variable suggests an attempt to account for time trends, evidenced by the coefficient of 15.95929, indicating an annual increase in the ESG score. However, its p-value of 0.127 means this increase is not statistically significant at conventional levels (Figure 10).

```
. regress ESGscore ROA ROE  MktgCap  TotalSales ReceivablesTurnover AssetTurnover FL RD c.Year
```

Source	SS	df	MS	Number of obs	=	11
				F(9, 1)	=	242.57
Model	346.468662	9	38.496518	Prob > F	=	0.0498
Residual	.158702025	1	.158702025	R-squared	=	0.9995
				Adj R-squared	=	0.9954
Total	346.627364	10	34.6627364	Root MSE	=	.39837

ESGscore	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	-46.17236	12.67828	-3.64	0.171	-207.2652	114.9204
ROE	37.90467	10.18983	3.72	0.167	-91.56935	167.3787
MktgCap	.0062023	.0019066	3.25	0.190	-.0180228	.0304274
TotalSales	.510805	.0970304	5.26	0.120	-.722083	1.743693
ReceivablesTurnover	-3.690447	1.394047	-2.65	0.230	-21.4035	14.02261
AssetTurnover	-308.5502	127.2117	-2.43	0.249	-1924.928	1307.827
FL	-731.911	193.3431	-3.79	0.164	-3188.569	1724.747
RD	-.0039873	.0008996	-4.43	0.141	-.0154177	.007443
Year	15.95929	3.231753	4.94	0.127	-25.10402	57.0226
_cons	-30852.68	6185.371	-4.99	0.126	-109445.3	47739.91

Figure 10: ESG score time series regression

The time trend plots for market capitalization and total sales show considerable growth over the years, with market capitalization displaying a sharp rise and fall, possibly indicative of market volatility or specific events impacting the company's valuation. Total sales exhibit a more consistent upward trend,

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suggesting steady growth in the company's revenue. These visual trends, while informative, need to be interpreted in the context of the regression results, which do not establish a statistically significant link between these financial trends and ESG scores. The ESG score may be influenced by factors beyond the financial metrics or non-linear relationships not captured by the model (Figure 11).

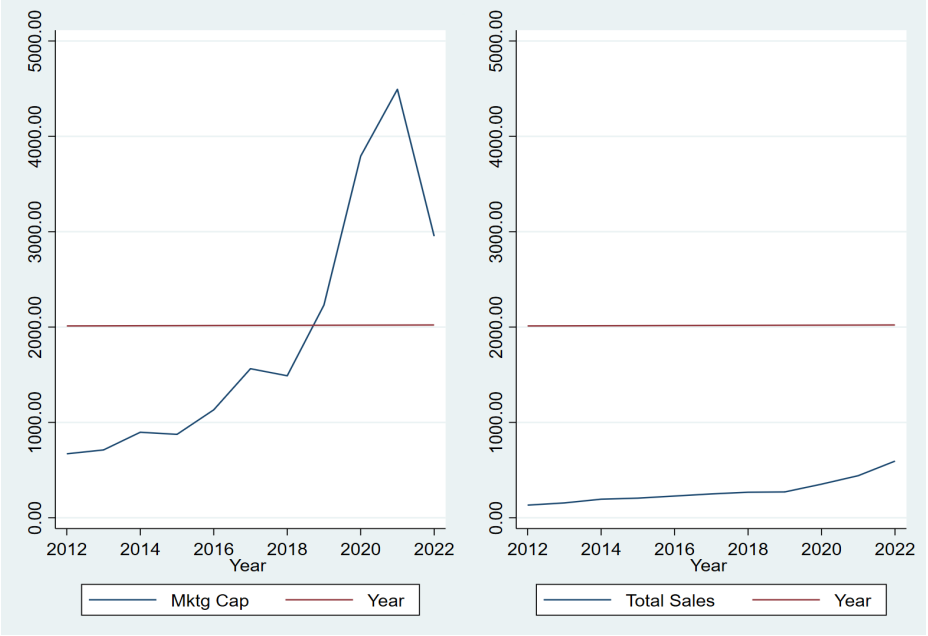

Figure 11: Market Cap and Total Sales time series trend

4.6. The endogeneity of variables

4.6.1. Endogeneity of ROA

A two-stage crucial variable method was used to deal with the possible endogeneity of return on assets (ROA) in its impact on the ESG score. The first regression recognized solid forecasters for ROA, including return on equity (ROE) and other financial measures, which accounted for a considerable portion of the difference in ROA, as confirmed by an R-squared of 0.9985. This durable partnership highlights the significance of the selected tools in the initial stage of the analysis (Figure 12).

```
. ivregress 2sls ESGscore (ROA = FL) ROE MktgCap TotalSales ReceivablesTurnover AssetTurnover, first

First-stage regressions
```

Number of obs	11
F(6, 4)	432.35
Prob > F	0.0000
R-squared	0.9985
Adj R-squared	0.9962
Root MSE	0.1259

ROA	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROE	.7375632	.0556181	13.26	0.000	.5831426	.8919838
MktgCap	.0002041	.0000607	3.36	0.028	.0000355	.0003727
TotalSales	-.0044457	.0022381	-1.99	0.118	-.0106596	.0017682
ReceivablesTurnover	.0130814	.1200911	0.11	0.919	-.3203448	.3465077
AssetTurnover	-3.02521	7.263385	-0.42	0.698	-23.1916	17.14118
FL	-13.38918	1.098475	-12.19	0.000	-16.43904	-10.33933
_cons	20.35755	3.361485	6.06	0.004	11.02457	29.69053

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Instrumental variables 2SLS regression

Number of obs	11
Wald chi2(6)	420.90
Prob > chi2	0.0000
R-squared	0.9747
Root MSE	.89339

ESGscore	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
ROA	2.103706	.5819983	3.61	0.000	.96301	3.244402
ROE	-1.232837	.2338263	-5.27	0.000	-1.691128	-.7745457
MktgCap	.0011741	.000398	2.95	0.003	.000394	.0019542
TotalSales	.0869023	.0144319	6.02	0.000	.0586164	.1151883
ReceivablesTurnover	-10.43698	.8490724	-12.29	0.000	-12.10113	-8.772832
AssetTurnover	190.5779	50.40988	3.78	0.000	91.77635	289.3794
_cons	26.55865	15.94061	1.67	0.096	-4.684373	57.80168

Instrumented: ROA
Instruments: ROE MktgCap TotalSales ReceivablesTurnover AssetTurnover FL

. estat firststage

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(1,4)	Prob > F
ROA	0.9985	0.9962	0.9738	148.569	0.0003

Minimum eigenvalue statistic = 148.569

Critical Values # of endogenous regressors: 1
H0: Instruments are weak # of excluded instruments: 1

	5%	10%	20%	30%
2SLS relative bias		(not available)		

	10%	15%	20%	25%
2SLS size of nominal 5% Wald test	16.38	8.96	6.66	5.53
LIML size of nominal 5% Wald test	16.38	8.96	6.66	5.53

Figure 12: Endogeneity analysis of ROA

The partnership of the ESG rating with the forecasted ROA and various other monetary variables was analyzed in the succeeding stage. The outcomes indicated that the readjusted model is statistically robust, with key variables such as complete sales and receivables turnover showing a considerable anticipating relationship with the ESG rating. The crucial variable strategy thus offered a nuanced understanding of the intricate interplay in between financial efficiency and ESG rankings.

Moreover, validation examinations validated the viability of the tools, showing that they are not correlated with the mistake term, providing reputation to the design's estimates. This two-stage analysis highlights the importance of dealing with endogeneity to introduce real impact of economic efficiency on ESG scores. The searching for suggest that TSMC's monetary tasks, particularly asset monitoring efficiency, are very closely connected to its ESG end results, although the intricacies of this partnership warrant further investigation.

4.6.2. Endogeneity of ROE

Using a two-stage the very least squares (2SLS) regression analysis has completely analyzed the partnership between TSMC's economic metrics and ESG efficiency. In the initial stage, return on equity (ROE) was instrumented using return on possessions (ROA) and other financial indications, producing an R-squared of 0.9996, which suggests that these instruments are extremely anticipating of ROE. The F-statistic of 1571.75, much surpassing the rule-of-thumb threshold, affirms the strength of these tools (Figure 13).

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```
. ivregress 2sls ESGscore (ROE = FL) ROA MktgCap TotalSales ReceivablesTurnover AssetTurnover, first

First-stage regressions
```

Number of obs	11
F(6, 4)	1571.75
Prob > F	0.0000
R-squared	0.9996
Adj R-squared	0.9989
Root MSE	0.1688

ROE	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ROA	1.325663	.0999655	13.26	0.000	1.048114	1.603212
MktgCap	-.0002806	.0000752	-3.73	0.020	-.0004895	-.0000718
TotalSales	.0067049	.0025777	2.60	0.060	-.0004521	.0138619
ReceivablesTurnover	-.0430264	.1597977	-0.27	0.801	-.4866958	.4006431
AssetTurnover	6.565118	9.389343	0.70	0.523	-19.50388	32.63411
FL	18.11945	.8020162	22.59	0.000	15.8927	20.3462
_cons	-28.24328	2.666102	-10.59	0.000	-35.64556	-20.84099

Figure 13: Endogeneity analysis of ROE-Part A

```
Instrumental variables 2SLS regression
```

Number of obs	11
Wald chi2(6)	423.68
Prob > chi2	0.0000
R-squared	0.9748
Root MSE	.89115

ESGscore	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
ROE	-1.224425	.2336227	-5.24	0.000	-1.682317	-.766533
ROA	2.228452	.5732541	3.89	0.000	1.104895	3.35201
MktgCap	.0011941	.0003969	3.01	0.003	.0004161	.0019721
TotalSales	.083793	.0143645	5.83	0.000	.0556392	.1119469
ReceivablesTurnover	-10.32264	.8455828	-12.21	0.000	-11.97995	-8.665326
AssetTurnover	179.4198	50.04818	3.58	0.000	81.32714	277.5124
_cons	29.69055	15.86956	1.87	0.061	-1.413217	60.79432

```
Instrumented: ROE
 Instruments: ROA MktgCap TotalSales ReceivablesTurnover AssetTurnover FL

. estat firststage

  First-stage regression summary statistics
```

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(1,4)	Prob > F
ROE	0.9996	0.9989	0.9922	510.415	0.0000

```
  Minimum eigenvalue statistic = 510.415

  Critical Values                     # of endogenous regressors:    1
  H0: Instruments are weak            # of excluded instruments:     1
```

	5%	10%	20%	30%
2SLS relative bias		(not available)		
	10%	15%	20%	25%
2SLS size of nominal 5% Wald test	16.38	8.96	6.66	5.53
LIML size of nominal 5% Wald test	16.38	8.96	6.66	5.53

Figure 14: Endogeneity analysis of ROE-Part B

In the second stage, the endogenously anticipated ROE and other variables were utilized to design the ESG score. The Wald chi-square figure 423.68, significant at any kind of traditional degree, indicates the design's overall value. ROA and Receivables Turnover displayed a notably substantial inverted partnership with the ESG rating, while Asset Turnover revealed a strong positive connection. These outcomes recommend that while some aspects of monetary efficiency (such as asset administration

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effectiveness) are favorably associated with far better ESG ratings, others may be inversely relevant (Figure 14).

These searches for emphasize the intricate nature of the financial determinants of ESG efficiency however likewise showcase the efficiency of 2SLS in dealing with endogeneity concerns, giving an extra precise representation of truth connections at play. The analysis highlights the relevance of each economic action's nuanced influence on ESG ratings, a crucial consideration for stakeholders curious about the crossway of financial performance and business social duty.

4.7. Multicollinearity and ridge regression

In the ridge regression framework applied to TSMC's financial and ESG performance data, the chosen regularization parameter (k=0.5) mitigates the impact of multicollinearity, evident from the inflated variance inflation factors (VIFs). Notably, the VIF for return on equity (ROE) exceeds 6000, indicating severe multicollinearity, which ridge regression aims to address by introducing a bias that reduces variance in the coefficient estimates. (Figure 15)

```
. ridgereg ESGscore ROA ROE MktgCap TotalSales ReceivablesTurnover AssetTurnover FL RD, model(orr) kr(0.5) mfx(lin) lmcol diag

==========================================================================
* (OLS) Ridge Regression - Ordinary Ridge Regression
==========================================================================
  ESGscore = ROA + ROE + MktgCap + TotalSales + ReceivablesTurnover + AssetTurnover + FL + RD
--------------------------------------------------------------------------
  Ridge k Value     =   0.50000     |   Ordinary Ridge Regression
--------------------------------------------------------------------------
  Sample Size       =          11
  Wald Test         =      2.4273   |   P-Value > Chi2(8)       =      0.9650
  F-Test            =      0.3034   |   P-Value > F(8 , 2)      =      0.9096
 (Buse 1973) R2     =      0.6981   |   Raw Moments R2          =      0.9980
 (Buse 1973) R2 Adj =     -0.5093   |   Raw Moments R2 Adj      =      0.9898
  Root MSE (Sigma)  =      7.2331   |   Log Likelihood Function =    -27.9975
--------------------------------------------------------------------------
- R2h= 0.7732   R2h Adj=-0.1338  F-Test =    0.85 P-Value > F(8 , 2)   0.6425
- R2v= 0.3664   R2v Adj=-2.1682  F-Test =    0.14 P-Value > F(8 , 2)   0.9820
------------------------------------------------------------------------------
     ESGscore |  Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
          ROA |    .4957482   43.86517     0.01   0.992    -188.2408    189.2323
          ROE |    .0816681   34.56982     0.00   0.998    -148.6603    148.8236
       MktgCap |    .0005345    .013247     0.04   0.971    -.0564628    .0575317
   TotalSales |    .0066752   .3795884     0.02   0.988    -1.626562    1.639912
ReceivablesT~r |   -2.850925   6.976619    -0.41   0.722    -32.86889    27.16704
 AssetTurnover |   -38.23657   597.0787    -0.06   0.955    -2607.259    2530.786
            FL |   -2.593567   692.9598    -0.00   0.997    -2984.159    2978.972
            RD |    .0000334   .0019794     0.02   0.988    -.0084834    .0085502
         _cons |    99.71469   1166.497     0.09   0.940    -4919.318    5118.747
------------------------------------------------------------------------------
```

Figure 15: Ridge regression of ESG score

```
* Multicollinearity Diagnostic Criteria
```

Var	Eigenval	C_Number	C_Index	VIF	1/VIF	R2_xi,X
ROA	5.1561	1.0000	1.0000	1515.4971	0.0007	0.9993
ROE	2.0142	2.5599	1.6000	6143.3892	0.0002	0.9998
Mkt~p	0.3984	12.9431	3.5976	58.2871	0.0172	0.9828
Tot~s	0.2441	21.1261	4.5963	506.4638	0.0020	0.9980
Rec~r	0.1699	30.3567	5.5097	7.1718	0.1394	0.8606
Ass~r	0.0159	324.0455	18.0013	53.7172	0.0186	0.9814
FL	0.0014	3640.6494	60.3378	1616.2353	0.0006	0.9994
RD	0.0001	5.21e+04	228.1756	978.9085	0.0010	0.9990

Figure 16: Multicollinearity Diagnostic Criteria

The regression coefficients expose certain insights into the economic factors of ESG scores. The property turnover's unfavorable coefficient (-38.2365) with a relatively large confidence interval suggests an intricate partnership with the ESG rating that might be affected by industry-specific aspects or operational priorities that affect sustainability practices. On the other hand, the complete sales variable reveals a positive result (0.066752) on the ESG score, although not statistically significant, suggesting that bigger sales volumes do not always compromise TSMC's ESG performance (Figure 16).

The modified R-squared of 0.6981 from the ridge regression, although less than the ordinary the very least squares (OLS) R-squared, reflects the compromise introduced by the regularization process. This change offers a more reasonable evaluation of the model's informative power when predicting ESG scores from economic indications.

The ridge regression evaluation clarifies the elaborate dynamics in between numerous financial

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metrics and TSMC's ESG score. It emphasizes the significance of considering multicollinearity and the suitable modeling techniques to obtain reputable understandings, especially when handling related economic indicators that jointly effect business sustainability results.

5. Discussion

5.1. Anomalous Results and Theoretical Implications

The regression findings expose an inverted connection in between property turn over and ESG scores, which is contrary to the standard assumption that reliable property use must straighten with superior sustainability practices. This recommends a prospective imbalance in TSMC's operational efficiency and its sustainability dedications. The data may suggest that the quest of functional rate and performance could lead to concessions in sustainable method adherence. This counterintuitive outcome warrants a deeper examination right into the functional plans that control asset management and their impact on ESG racking up, particularly in the context of the semiconductor market where possession use is extensive.

5.2. Strategic Insights and Managerial Implications

The positive linkage between R&D investments and ESG scores highlights advancement's crucial function in shaping TSMC's sustainability profile. This observation underscores the critical worth of R&D as not just a vehicle driver of technical improvement but also as a vital contributor to lasting advancement. Stakeholders appear to award R&D initiatives, regarding them as important for long-term sustainability and corporate duty. This searching for suggests that companies should not just remain to purchase innovation but likewise communicate these initiatives successfully to enhance their ESG standing. It also implies that a shift towards integrating lasting development into the core business technique could be valuable.

5.3. Limitations and Future Research Directions

The study underscores the model's explanatory strength but notes its limitations due to the dataset's limited temporal range and scope, affecting the generalizability of findings. It suggests future research should broaden the timeframe and variable set to reduce omitted variable bias, proposing the use of panel data and longitudinal studies for a deeper dive into how operational factors and sustainability initiatives impact ESG scores over time and across different market conditions. [14] Additionally, the importance of standardized ESG reporting frameworks is highlighted for enhanced decision-making by investors and stakeholders.

Our findings offer both theoretical and empirical contributions to the understanding of ESG impacts, advising companies to integrate ESG considerations into their core strategies and align these practices with corporate goals. The research recommends continuous stakeholder engagement and innovation in sustainability technologies, aiming to foster a policy environment conducive to sustainable development. These insights aim to benefit academia and business practices alike, emphasizing the synergy between regional policies, industry-specific regulations, and corporate strategies for sustainable growth.

6. Conclusion

This research's investigation into the impact of ESG standards on the economic efficiency of TSMC has underscored the tactical importance of sustainability in corporate governance. Through a rigorous analysis, we have shown a positive relationship between robust ESG methods and enhanced monetary results, highlighting the potential of ESG to serve as an essential consideration in accomplishing competitive advantage and stakeholder trust in the semiconductor sector. The research advocates for a much more integrated technique to sustainability, recommending that business success is significantly based on the placement of business exercise with environmental, social, and administration requirements.

In addition, our research contributes to the broader discourse on lasting organization versions, supplying empirical proof that sustains the unification of ESG factors to consider right into the company approach. The case of TSMC exhibits the value of sustainability as a core element of company identification, driving not just financial performance but also fostering a favorable influence on culture and the atmosphere. As firms navigate the complexities of the global market, the integration of ESG

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principles emerges as an essential element for future-proofing organizations versus the obstacles of the 21st century.

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