

Impacts of Financial and Sustainability Measures on Shareholder Value Added based on Resource-based View and Modern Organisational Performance Theories: An Econometric Analysis

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Abstract

This empirical study investigates the most important financial and sustainability performance measures that contribute to shareholder value added (SVA). We employ econometric modelling, with a particular emphasis on simultaneous equation system analysis. We carefully selected resources from the resource-based view (RBV) to identify the capabilities to define the main variables for S&P 500 companies. To obtain consistent and efficient estimates, we employ a seemingly unrelated regression (SURE) method. For each equation in the system, we use a causality framework that includes tests for stationarity, cointegration, and causality. Additionally, we estimate an error-correction model and a cointegration regression to identify long-run relationships. Our sample covers 503 companies in the Standard & Poor's index over 20 years (2005-2024). We used Stata 19.5 and EViews 12 to conduct the econometric analysis.

First, our analysis provides evidence that the three main resources of the resource-based view theory are key to shareholder value added, and that the chosen variables (capabilities) are significant. Second, the variables are cointegrated, and we successfully estimated cointegration regressions for each equation in the system. Third, the error-correction terms are significant in the error-correction models, confirming their role in the process of adjusting to deviations from the long-run equilibrium.

Our empirical study focuses on financial and sustainability performance measures. The analysis is performed at the company level and encompasses all sectors of the economy, as in the S&P 500. This approach differs from previous studies that compared industrial and financial companies separately and generally focused on only certain sustainability measures. We analyse the environmental, social, and governance (ESG) scores separately.

Keywords: Shareholder value added, Financial and sustainability performance measures, ESG, Environmental governance and social pillar scores, Resource-based View, Simultaneous equations models.

JEL Codes: G30, L25, M41, Q50, C30 and O30.

1. Introduction

1.1 Problem Statement

Many performance frameworks cover all aspects of organisations. However, such frameworks focus mainly on financial measures, and in today's business, shareholder value creation is driven not only by financial outcomes but also by organisational capabilities, knowledge assets, innovation, intellectual capital, strategic alignment, stakeholder relationships, and the effective execution of business models in strategic business units for mature companies.

Existing research has extensively examined the relationship between sustainability indicators and financial outcomes such as profitability and firm value. However, the literature remains fragmented, with most studies focusing on isolated relationships between sustainability and financial performance rather than on developing integrated quantitative models that simultaneously explain shareholder value added across both financial and sustainability dimensions. Consequently, robust quantitative frameworks are needed to operationalise shareholder value added as a multidimensional construct and empirically assess the joint contribution of financial and sustainability measures. This

study contributes to the literature by addressing this methodological and empirical gap.

Many existing performance measurement systems are complex and may be viewed as bureaucratic in terms of their implementation. Concerns have been raised that these performance frameworks risk becoming ends in themselves rather than tools for enhancing performance, as they are largely rooted in manufacturing practices. The main aim of our research was to identify the most appropriate financial and sustainability metrics for key processes in mature companies in this context to ensure success and to simplify these processes.

Previous studies have recognised a gap in the literature regarding the aspects we wanted to address in our research. Many studies have covered only partial aspects, which is why we seek a theoretical framework, such as the resource-based view and modern organisational performance theories, that provides a complete and integrated approach to the main subject of our research.

1.1 Research Hypothesis

Our main objective, to be tested by the research, is to determine which key financial and sustainability variables are significantly associated with shareholder value added (SVA). The main discipline is econometrics, and related subdisciplines include panel data, endogeneity, simultaneous equation modelling, stationarity, cointegration tests, causality tests, error-correction models, and cointegration regression.

The related subobjectives of our research are:

- To identify the key financial and sustainability variables to study.
- To identify the data source and collection.
- To develop a general model, select the preferred specification for the baseline panel data, address endogeneity, and respecify the model.
- To define statistical hypothesis testing.
- To estimate the final system of simultaneous equations.
- To understand stationarity, cointegration, and causality tests.
- To estimate the error-correction model and cointegration regression, and
- To perform robustness tests.

2. Literature review

An extensive body of literature on business performance measurement has evolved around a common objective: identifying the organisational factors that drive sustainable shareholder value creation. Although different frameworks adopt distinct perspectives, they generally seek to link strategic objectives, organisational capabilities, and performance outcomes through a combination of financial and nonfinancial indicators.

A first stream of research focuses on performance measurement systems (PMSs). Frameworks such as the balanced scorecard (Kaplan & Norton, 1992, 2001; Schneiderman, 1987), performance prism (Neely et al., 2002) and other multidimensional performance models (Carton & Hofer, 2006; Brignall et al., 1991) emphasise the importance of integrating financial measures with customer, process, learning, capability and stakeholder dimensions. These approaches recognise that financial outcomes often result from underlying organisational drivers and, therefore, advocate a balanced set of performance indicators.

A second stream is represented by value-based management (VBM) approaches (Martin & Petty, 2001; Rappaport, 1998). This literature focuses explicitly on shareholder value creation and identifies value drivers such as sales growth rate, operating profit margin, income tax rate, working capital investment, fixed capital investment, cost of capital, and forecast duration. While these frameworks provide direct links between managerial actions and shareholder returns, they have often been criticised for their limited attention to intangible assets and nonfinancial value drivers.

A third stream originates from competitive advantage theories, particularly the resource-based view (Wernerfelt, 1984; Barney, 1991). This perspective argues that sustainable superior performance results from possessing and deploying valuable organisational resources and capabilities. More recent developments, including the knowledge-based view (Grant, 1991; Kogut & Zander, 1992), intellectual capital theory (Bontis, 1998; Edvinsson & Malone, 1997; Stewart, 1997) and dynamic capabilities theory (Teece et al., 1997; Teece, 2007; Eisenhardt & Martin, 2000; Winter, 2003), emphasise that knowledge, innovation, organisational learning, employee competencies, and stakeholder relationships have become critical sources of competitive advantage and long-term value creation.

A fourth stream encompasses modern performance frameworks, including models such as Kotter (1980), The McKinsey 7S (Waterman et al. 1980), Burke-Litwin (1992) and Klofsten (1994). These frameworks focus on the

organisational conditions necessary for growth, change management, adaptation, and sustained performance. Their central premise is that organisational effectiveness depends on aligning of strategy, leadership, culture, structures, processes, and human resources, particularly in dynamic and uncertain environments.

A fifth stream examines the relationship between sustainability practices and financial performance and firm value but lacks a unified analytical framework. Walean & Mandagi (2026) performed a comprehensive review of the current literature and concluded that the field remains fragmented, with the primary interest in identifying the causal relationship between sustainability and financial performance, as well as a growing interest in structural equation modelling (SEM) exploring shareholder perceptions, sustainability, and value creation mechanisms. Among the 266 studies, econometric analysis is reported in 102 articles (Matsali et al., 2025; Naz et al., 2025; Laskar, 2025), and structural equation modelling in 53 articles (Lara-Perez et al., 2023; Nguyen, 2024). Silvia (2026) developed a meta-analysis of ESG, financial performance, and non-financial outcomes across different industries and regions with 79 studies based on panel data regressions (#67), differences-in-differences (#4), generalised method of moments (GMM) (#3), data envelopment analysis (DEA) (#2), partial least squares structural equation modelling (PLS-SEM) (#2), and dynamic panel data (#1). She found that potential endogeneity issues limit causal interpretation.

Finally, business excellence and business model frameworks, such as the EFQM-European Foundation for Quality Management Model (2025), the Baldrige Excellence Framework (1987), the APQC Process Classification Framework (1992), and the Business Model Canvas developed by Osterwalder & Pigneur (2010), provide integrated approaches for managing organisational performance, continuous improvement, innovation, and strategic execution. These frameworks offer to organisations practical mechanisms for aligning resources, capabilities, and processes with strategic objectives while adapting to changing competitive environments.

Despite their differences, these theoretical streams converge on a common conclusion: sustainable shareholder value creation depends on the effective integration of financial performance, organisational capabilities, knowledge assets, innovation, stakeholder relationships, and strategic execution. Consequently, contemporary performance management systems increasingly combine traditional financial indicators with measures of intellectual capital, organisational learning, capability development, and business model effectiveness to capture the multidimensional drivers of long-term organisational success.

3. Methodology

3.1 Identification of the Dependent Variable

Sustained competitive advantage ultimately manifests through long-term shareholder value creation. While competitive advantage may generate intermediate outcomes, such as profitability, revenue growth, innovation, or investment attraction, these outcomes contribute to shareholder value added by increasing the firm's expected future cash flows and growth opportunities. Consequently, shareholder value added provides an integrative measure that captures the long-term economic benefits derived from both financial and sustainability-related competitive advantages.

In our investigation, we employed the shareholder value added (SVA) as the dependent variable (Fernández, 2002, p. 5), calculated as follows:

$$SVA = \text{Increase in equity market value} + \text{Dividends paid during the year} + \text{Other payments to shareholders (discounts on par value, share buy-backs, etc.)} - \text{Outlays for capital increases, exercise of options and warrants} - \text{Conversion of convertible debentures.} \quad (1)$$

We used the following as a proxy:

$$SVA \text{ (proxy)} = \text{Increase in equity market value} + \text{Dividends paid during the year} + \text{Other payments (share buy-backs).} \quad (2)$$

From a theoretical perspective, Fernández's (2002) theory of SVA and created shareholder value (CSV) provides a comprehensive and critical approach to value-based management that emphasises aligning corporate strategy with shareholder interests. His work introduced concepts and refinements that differ from those of other value-based measures (such as EVA, MVA, CFROI, and CVA).

3.2 Identification of the Independent Variables

From a resource-based perspective, Wernerfelt (1984) viewed firms as bundles of resources, and Barney (1991) further classified these resources into physical, human, and organisational capital resources, arguing that valuable, rare, inimitable, and non-substitutable resources can generate sustained competitive advantage. Competitive advantage enables value creation; long-term organisational sustainability requires value capture. Mature firms typically capture value through profitability, organisational reputation, and investor confidence, whereas start-ups may temporarily rely on external financing while demonstrating a credible path toward future profitability.

We extend Barney's taxonomy and, drawing on Grant (1991), consider physical, human, and financial capital resources because funding liquidity, leverage, and capital structure are key to value creation.

Consistent with the resource-based view of the firm, different categories of strategic resources may contribute to competitive advantage through distinct value-creation mechanisms. Physical and intangible capital resources provide the productive and operational foundation required to achieve superior performance. In mature firms, these advantages are expected to be reflected primarily in profitability. In contrast, in start-ups, they may enhance the firm's ability to attract external investment and secure the resources necessary for survival and growth. Human capital resources, particularly intellectual capital, sustainability, and organisational knowledge, constitute a strategic resource that facilitates innovation, reputation, and differentiation, thereby contributing to firm value beyond its tangible asset base. Financial capital resources, whether obtained through equity or debt financing, enable the acquisition and development of strategic resources and capabilities, thereby supporting firm growth and overall value creation (Whittington et al., 2023).

In the next two tables, we summarise how different resources may manifest their economic benefits through different performance dimensions:

Table 1. Resource-based view theory: resources and capabilities

Resources (what we have)	Competitive advantage mechanism	Main Outcome (mediator)	Capabilities (what we do)
Physical capital	Operational and market advantages, and differentiation	Profitability (mature firms) and Investment attractiveness and survival (start-ups)	Innovation, Knowledge capital: Product and Market and Operational organisation
Human capital	Innovation, learning, positive reputation and differentiation	Market value in excess of recorded assets	Intellectual capital, ESG environmental, ESG governance, ESG social performance, Employee sizing and productivity
Financial capital	Resource for funding, liquidity, acquisitions and growth opportunities	Increase in shareholders' equity.	Attract Shareholders and Debt funding

We identified the most relevant variables based on Barney (1991), Grant (1991), Williamson (1991), Becker (1964), Kotter (1980), and Klofsten (1994), and measured them according to the specifications in Table 2.

Table 2. Independent variables for the first analysis in the variable selection process

Capabilities (what we do)	Ref.	Measurement	Variables Description
1. Operational Performance of Physical Capital (Mediator)	1.1	Net Income	Net income to total assets ratio
	1.2	EBIT	EBIT to total assets ratio
	1.3	Net Income Growth	One- and three-year growth based on Venkatraman & Ramanujan (1985).
2. Knowledge capital: Product	2.1	R&D Investment	Stock of R&D capital to total assets ratio. Initial stock is estimated at a 20% depreciation rate, with growth specific to each company.
	2.2	Advertising Expenditures	Stock of ADV capital to total assets ratio. Initial stock is estimated at a 30% depreciation rate, with growth specific to each company.
	2.3	M&A Investments	Stock of M&A capital to total assets ratio. Initial stock is estimated with a coefficient equal to 4 and a 15%

				depreciation rate.
3. Knowledge capital: Market	3.1	Salesforce Deployment		Selling, general, and administration expenditures (SG&A) to total assets ratio.
	3.2	M&A Investments		Stock of M&A capital to total assets ratio. Initial stock is estimated with a coefficient equal to 4 and a 15% depreciation rate.
	3.3	Market Index		S&P500 Market Index in log form.
4. Operational Organisation	4.1	Working Investment	Capital	Working capital to total assets ratio.
	4.2	PP&E Investment		Stock of PP&E capital to total assets ratio. Initial stock is estimated with a coefficient equal to 4 and an 11% depreciation rate. PP&E = property, plant and equipment.
	4.3	IA Investment		Total intangible assets to total assets ratio.
5. Intellectual capital - Human capital (Mediator)	5.1	Intellectual Capital		Market value to total assets ratio (Tobin's Q) based on Wernerfelt & Montgomery (1988). Market value to shareholders equity ratio based on Stewart (1997) and Joia (2000).
6. ESG Knowledge	5.2	Environmental Knowledge		ESG environmental pillar score in log form.
	5.3	Governance Knowledge		ESG governance pillar score in log form.
7. Employee sizing and productivity	6.1	Number of Employees		Number of employees in log form.
	6.2	Resources		Selling, general, and administration expenditures (SG&A) to total assets ratio.
	6.3	Productivity		Revenue per employee ratio.
8. Human Networks and Social Knowledge	7.1	Workforce Satisfaction		Workforce Score in log form. It measures effectiveness in the context of achieving job satisfaction and a healthy, safe workforce.
	7.2	Customer Satisfaction		The ACSI American Customer Satisfaction Index in log form.
	7.3	Social Knowledge		ESG social pillar score in log form.
9. Financial Capital (Mediator)	8.1	Equity Investment		Shareholder equity to total assets ratio.
10. Shareholders and Debt Funding	9.2	Net Income		Net Income to total assets ratio
	9.3	Intellectual capital		Market value to total assets ratio (Tobin's Q)
	9.4	Financial leverage		Total debt to total assets ratio
	9.5	Total Capital		Total capital to total assets ratio.
11. Control Variables	9.1	Company Size		Revenue to total assets ratio
	9.2	Revenue Growth		Change in the revenue to total assets ratio

We calculated the R&D, ADV, M&A, and PP&E capital stocks from the original variables, adjusted them to 2024 constant US dollars, and then applied the perpetual method (Hall et al., 2009, p. 16). We winsorised all variables were at 0.5% in each tail to avoid giving excessive weight to extreme observations in the regressions.

3.3 Data Collection

The sample data included 503 S&P 500 companies from 2005 to 2024. We have 20 years of cross-sectional data with 10,960 observations, and we obtained the financial data from LSEG Eikon Workspace (Note 1). We used Stata 19.5 and EViews 12 to conduct the econometric analysis.

3.4 Development of a General Model

We specified the variables in levels and first differences to capture their significance in the long- and short-term contributions (Easton & Harris 1991, 23). Although this approach lacks theoretical support, it is empirically very efficient. We scaled (divided) each regression term by total assets at the beginning of the year to ensure that variables across units were measured on comparable scales and to mitigate potential heteroskedasticity. In summary, all the variables were divided by total assets (1st lag), except for the S&P 500 Market index, ESG scores, and the number of employees, which were expressed in log form.

Based on the first attempt at a fixed-effects panel data regression and the correlation matrix, we reduced the variables from a general unrestricted model by sequentially removing the variable with the least significant coefficient (Hendry, 1985).

The final significant variables are detailed below, and all the capabilities related to the resource-based view theory are described, including the main objectives, measurements, and final significant variables.

The general specification of the model was as follows:

$$\frac{Y_{it}}{A_{it-1}} = \beta_0 + \sum_{i=1}^N \sum_{t=1}^T \left(\beta_i \frac{X_{it}}{A_{it-1}} + \beta_{i+1} \frac{\Delta X_{it}}{A_{it-1}} + \beta_{i+2} \ln X_{it} + \beta_{i+3} \Delta \ln X_{it} \right) + \varepsilon_{it} \quad (3)$$

where: β_0 = Intercept

$\beta_1 \dots \beta_6$ = Coefficients

ε_{it} = Residuals

The dependent variable was as follows:

WSVA_{it} = Shareholder value added to total assets at the beginning of the year

The independent variables included the following:

WASNP500_{it} = The change in the S&P 500 market index in log form

WANI_{it} = The change in net income to total assets at the beginning of the year

WRND_{it} = The stock of R&D capital to total assets at the beginning of the year

WAMNA_{it} = The change in the stock of M&A capital to total assets at the beginning of the year

WASGNA_{it} = The change in selling, general, and administrative expenditures to total assets at the beginning of the year

WAWC_{it} = The change in working capital to total assets at the beginning of the year

WASHE_{it} = The change in shareholders' equity to total assets at the beginning of the year

WTQ_{it} = Market value to total assets ratio – Tobin's Q

WESGE_{it} = ESG environmental pillar score in log form

WESGG_{it} = ESG governance pillar score in log form

WEMP_{it} = Number of employees in log form

WESGS_{it} = ESG social pillar score in log form

WLEV_{it} = Total debt to total assets at the beginning of the year

The control variables included the following:

WSIZE_{it} = Revenue to total assets at the beginning of the year

WGR_{it} = The change in revenue to total assets at the beginning of the year

3.5 Baseline Panel Data Estimation

The empirical analysis began by estimating conventional panel-data models under both fixed-effects (FE) and random-effects (RE) specifications to control for unobserved firm-specific heterogeneity. We used the Hausman test to determine whether the random-effects (RE) estimator is consistent or whether the fixed-effects (FE) estimator should be selected instead.

We identified a significant heteroskedasticity issue in the fixed-effects estimator. This issue constitutes a critical violation of the model's assumptions, thereby rendering the traditional Hausman test inapplicable. We ran several alternative tests, including the Baltagi and Khanti-Akom test, the cluster-robust Hausman test, the Mundlak test, and the test of overidentifying restrictions, to identify the best estimator.

3.6 Detection of Endogeneity and Model Respecification

According to the Resource-based View theory, resources are categorised into three pillars: physical, human, and financial capital. The Durbin–Wu–Hausman chi-square test confirmed the inconsistency of the OLS estimator (Davidson & MacKinnon, 1993, pp. 237-242). Additionally, we determined through testing that the mediators, the change in net income (ΔNI), Tobin's Q (WTQ), and the change in shareholders' equity (ΔSHE), are endogenous variables alongside the shareholder value added ($WSVA$). The proposed theoretical framework comprises three endogenous mediators that are jointly determined but governed by distinct structural relationships. Each structural equation includes its own theoretically motivated explanatory variables.

Based on the previous findings, a single-equation estimation was deemed inappropriate because OLS and FE estimators would yield inconsistent and biased coefficients. We may consider using IV-instrumental variables for panel data models; although consistent, it is inefficient in the presence of heteroskedasticity. We could also consider the System GMM-2 estimator (Arellano & Bond, 1991), which produces consistent and unbiased results. Alternatively, we selected a simultaneous equation system framework (Zellner & Theil, 1962) that allows us to estimate all equations, yielding estimates that are more consistent and precise than those obtained by estimating them individually. We analyse the results of several estimators (see Table 18 in the Appendix). Compared with separate Fixed-effects IV and System GMM-2 estimates, the SURE simultaneous equation system yields more precise parameter estimates, as reflected in lower standard errors, while preserving consistency.

3.7 Specification of the Simultaneous Equation System

We express the general form of the structural system as follows:

Equation 1. Shareholder value added

$$WSVA = \beta_0 + \beta_1 \Delta SNP500 + \beta_2 \Delta NI + \beta_3 WTQ + \beta_4 \Delta SHE + \beta_5 WSIZE + \beta_6 WGR + \varepsilon_1$$

Equation 2. Operational performance of physical capital

$$\Delta NI = \beta_7 + \beta_8 \Delta SNP500 + \beta_9 WRND + \beta_{10} \Delta MNA + \beta_{11} \Delta SGNA + \beta_{12} \Delta WC + \beta_{13} WSIZE + \beta_{14} WGR + \varepsilon_2$$

Equation 3. Intellectual capital – Human capital

$$WTQ = \beta_{15} + \beta_{16} \Delta SNP500 + \beta_{17} WESGE + \beta_{18} WESGG + \beta_{19} WEMP + \beta_{20} \Delta SGNA + \beta_{21} WESGS + \beta_{22} WSIZE + \beta_{23} WGR + \varepsilon_3$$

Equation 4. Financial capital

$$\Delta SHE = \beta_{24} + \beta_{25} \Delta SNP500 + \beta_{26} \Delta NI + \beta_{27} WTQ + \beta_{28} WLEV + \beta_{29} WSIZE + \beta_{30} WGR + \varepsilon_4$$

We confirmed model identification using the order and rank conditions, which ensured consistent estimation of each structural equation. As indicated in Table 3, all the equations were overidentified and satisfied the order condition. Furthermore, the 'checkreg3' command in Stata confirmed that the rank conditions were satisfied for each equation in the system (Baum, 2007). These findings lead us to conclude that the system has been fully identified.

Table 3. Order condition for identification of the structural equations

Equation	Included endogenous variables m_i	Included exogenous variables k_i	Excluded exogenous variables $K - k_i$	Identification $m_i < (K - k_i)$
1	4	3	11	Overidentified
2	1	7	7	Overidentified
3	1	8	6	Overidentified
4	3	4	10	Overidentified

3.8 Statistical Hypothesis Testing

The following null hypotheses are defined based on shareholder value theory, the literature review, and the selected variables:

H₀₁: The change in the S&P 500 market index (WΔSNP500) is not statistically significant in explaining the shareholder value added to total assets (WSVA).

H₀₂: The change in net income to total assets (WΔNI) is not statistically significant in explaining shareholder value added to total assets (WSVA).

H₀₃: The market value to total assets–Tobin’s Q (WTQ)—is not statistically significant in explaining shareholder value added to total assets (WSVA).

H₀₄: The change in shareholders' equity to total assets (WΔSHE) is not statistically significant in explaining shareholder value added to total assets (WSVA).

H₀₅: Revenue to total assets (WSIZE) is not statistically significant in explaining shareholder value added to total assets (WSVA).

H₀₆: The change in revenue to total assets (WGR) is not statistically significant in explaining shareholder value added to total assets (WSVA).

H₀₇: The stock of R&D capital to total assets (WRND) is not statistically significant in explaining the change in net income to total assets (WΔNI).

H₀₈: The change in the stock of M&A capital to total assets (WΔMNA) is not statistically significant in explaining the change in net income to total assets (WΔNI).

H₀₉: The change in selling, general, and administration expenditures to total assets (WΔSGNA) is not statistically significant in explaining the change in net income to total assets (WΔNI).

H₀₁₀: The change in working capital to total assets (WΔWC) is not statistically significant in explaining the change in net income to total assets (WΔNI).

H₀₁₁: The ESG environmental pillar score in log form (WESGE) is not statistically significant in explaining market value to total assets–Tobin’s Q (WTQ).

H₀₁₂: The ESG governance pillar score in log form (WESGG) is not statistically significant in explaining market value to total assets–Tobin’s Q (WTQ).

H₀₁₃: The number of employees in log form (WEMP) is not statistically significant in explaining market value to total assets–Tobin’s Q (WTQ).

H₀₁₄: The ESG social pillar score in log form (WESGS) is not statistically significant in explaining market value to total assets–Tobin’s Q (WTQ).

H₀₁₅: Total debt to total assets–leverage (WLEV) is not statistically significant in explaining the change in shareholder equity to total assets (WΔSHE).

3.9 Simultaneous Equation System Estimation

We can use five different estimators to determine the system: two-stage least squares (2SLS), three-stage least squares (3SLS), full-information maximum likelihood (FIML), iterated three-stage least squares (I3SLS), and seemingly unrelated regression (SURE) (Zellner, 1962). The latter approach improves the efficiency of the three-stage estimator

and can be applied when the dependent variables in some equations appear as regressors in others. In our case, the change in the net income to total assets ($W\Delta NI$), the market value to total assets (WTQ), and the change in the shareholder equity ($W\Delta SHE$) are dependent variables in their respective equations but independent variables in the shareholder value added to total assets ($WSVA$) equation. We compared the results and select the most efficient estimator (see Table 18 in the Appendix).

3.10 Stationarity, Cointegration and Causality

To mitigate spurious regression in our equation analysis, we employed a causality framework that involved testing for stationarity (using Lütkepohl's lag-order selection and Fisher-type unit-root tests), cointegration (using methods such as Kao and augmented Engle–Granger tests), and causality (specifically using the pairwise Granger causality test) for each equation in the simultaneous equation system.

3.11 Error-Correction Model and Cointegration Regression

We estimated an error-correction model using the Engle–Granger two-step method to determine the coefficient and significance of the error-correction term. Moreover, a cointegration regression was performed using the FMOLS estimator to ensure robust long-run relationships across the equations of the simultaneous equation system.

3.12 Robustness Testing

We performed a series of robustness tests to determine the strength of our findings. First, we analysed alternative measures to shareholder value added, such as total shareholder return (TSR) and market value added (MVA), and compared the results within a simultaneous-equations system framework. Second, we estimated alternative estimators to seemingly unrelated regression (SURE), such as two-stage least squares (2SLS), three-stage least squares (3SLS), and full-information maximum likelihood (FIML), as well as the SURE estimator with robust and clustered ID errors. Third, we performed the Chow test to assess structural changes and ran CUSUM and CUSUMQ stability tests.

4. Results and Discussion

4.1 Descriptive statistics

This section presents the results of the statistical analysis, the multicollinearity analysis based on the correlation matrix, and the variance inflation factor (VIF) test of the independent variables. The variance inflation factor (VIF) has been widely acknowledged and endorsed in the contemporary literature (Kutner et al. 2005).

The statistical analysis indicates very low means, standard deviations, and variances, indicating that the variable transformation is consistent. The variables show a consistent positive sign, in line with our theoretical expectations, whereas the change in S&P 500 ($W\Delta SNP500$) shows a slightly negative mean over the entire period. All variables have been winsorised at 0.5% in each tail (see Table 4 in the Appendix).

The correlation matrix presents the pairwise correlations among all the independent variables. Among these correlations, three values exceed an absolute value of 0.5—specifically, they fall between 0.52 and 0.65—whereas the remaining values are less than 0.40 (see Table 5 in the Appendix). These findings indicate a moderate level of correlation, which is acceptable. To assess the impact of these correlations on our regressions, we used a more comprehensive test of multicollinearity: the variance inflation factor (VIF). These results are summarised in Table 6.

Table 6. Variance Inflation Factor (VIF)

Equation	Dep. Variable	Largest VIF	Mean VIF
1	WSVA	1.69	1.27
2	$W\Delta NI$	2.02	1.36
3	WTQ	1.83	1.44
4	$W\Delta SHE$	1.54	1.19

Analysts rely on informal rules of thumb to interpret multicollinearity when the largest VIF exceeds 10 (some analysts use a more conservative threshold of 30) and the mean VIF exceeds the critical value of 5. In our scenario, the largest VIF recorded was 2.02, and the greatest mean VIF was 1.44. The test indicated low multicollinearity, and we concluded that our regressions had no significant multicollinearity or reliability problems.

4.2 Baseline Panel Data Estimation

We conducted regressions using both fixed- and random-effects estimators and recorded the residuals for each

regression. We then performed the Hausman test to determine whether systematic differences were evident between the two estimates under the null hypothesis. Our initial results indicated that the Hausman test rejected the null hypothesis (p -value = 0.000), thus indicating that the fixed-effects estimator was the better choice.

However, we identified significant heteroskedasticity in the fixed-effects estimator. The Wald test for groupwise heteroscedasticity strongly rejected the null hypothesis of homoscedasticity (p -value = 0.000), thus indicating unequal variances across groups. This finding rendered the traditional Hausman test inapplicable. To address this, we ran the alternative tests summarised in Table 7.

Table 7. Alternative tests to the traditional Hausman test

Test	Null hypothesis	Statistic	Conclusion	Final estimator
1. Baltagi and Khanti-Akom test	Coefficients are jointly zero.	$F(15,499)=8.69$ p -value=0.000	The null hypothesis was rejected at 1% level	Fixed-effects are satisfied
2. Cluster-Robust Hausman test	Diff. in coefficients not systematic	$\text{Chi}2(15)=79.81$ p -value=0.000	The null hypothesis was rejected at 1% level	Fixed-effects are satisfied
3. Mundlak test	Coefficients are jointly zero.	$\text{Chi}2(15)=150.90$ p -value=0.000	The null hypothesis was rejected at 1% level	Fixed-effects are satisfied
4. Test of overidentifying restrictions (xtoverid)	Overidentifying restrictions implied by RE are valid	Sargan-Hansen statistic $\text{Chi}2(15)=135.33$ p -value=0.000	The null hypothesis was rejected at 1% level	Random-effects assumptions failed

Baltagi and Khanti-Akom test (1990) is very robust to certain violations, such as heteroskedasticity and serial correlation. Mundlak test (1978) is very robust in testing the correlation between time-invariant unobserved individual effects and the regressors, as well as heteroskedasticity. The cluster-robust Hausman test uses a cluster-robust bootstrap procedure and accounts for heteroskedasticity, serial correlation, and clustering (Cameron et al. 2005). The overidentifying restrictions test for the random-effects estimator relies on the additional orthogonality condition, which requires the regressors to be uncorrelated with the group-specific error u_i (Baum et al. 2003).

Based on the results of the previous tests, we concluded that the fixed-effects model is the better choice.

4.3 Detection of Endogeneity

Given the potential endogenous variables in our OLS model, we must test whether the least squares estimates are consistent. In this section, we use the Durbin–Wu–Hausman (DWH) test, as outlined by Davidson and MacKinnon (1993, 237-242). In the Hausman test, the null hypothesis is that the OLS estimator is consistent and efficient. We performed this test by fitting the model using both instrumental variables (IV) and OLS and comparing the resulting coefficient vectors. After estimating and storing these results, the endogeneity test yielded a $\text{chi}2(1) = 8.95$ with a p -value = 0.002; consequently, we rejected the null hypothesis that OLS is an appropriate estimation technique, and the Hausman test indicated that OLS is an inconsistent estimator for this equation.

We conducted the endogeneity test for the suspected endogenous variables after estimating an instrumental-variables regression using instruments for those variables (Baum et al. 2003). The outcomes of the endogeneity tests—the *ivendog* command—are summarised in Table 8.

Table 8. Endogeneity tests

Variable	Ho: Null hypothesis	Durban-Wu-Hausman chi-squared test	Conclusion
W Δ NI	Regressor is exogenous	Chi2(1)=119.48 and p-value=0.000	The null hypothesis is rejected
WTQ	Regressor is exogenous	Chi2(1)=12.35 and p-value=0.000	The null hypothesis is rejected
W Δ SHE	Regressor is exogenous	Chi2(1)=34.61 and p-value=0.000	The null hypothesis is rejected

The three endogeneity tests reject the null hypotheses, and we can confirm that the change in net income to total assets (W Δ NI), the market value to total assets–Tobin’s Q (WTQ), and the change in shareholders’ equity to total assets (W Δ SHE) are endogenous. The three variables are also jointly determined, as both dependent and independent variables, justifying the use of a simultaneous equation system.

4.4 Simultaneous Equation Model Estimation

We implemented two-stage least squares (2SLS), three-stage least squares (3SLS), full information maximum likelihood (FIML), iterated three-stage least squares (I3SLS), and seemingly unrelated regression (SURE) estimators. However, the expected coefficient signs and lower standard errors came from seemingly unrelated regression (SURE), which was more efficient than the other estimators (see Table 18 in the Appendix). The seemingly unrelated regression is most efficient when the independent variables are uncorrelated and when the disturbances in the separate OLS regressions are correlated (Zellner 1962). In our case, the independent variables are uncorrelated, and the disturbances are correlated, as indicated by correlations ranging from 0.27 to 0.76. The average correlation was 0.47, indicating a moderate correlation.

Table 9. Summary of statistics and estimates of the seemingly unrelated regression (SURE)

Equation	Obs.	Params	RMSE	R-squared	Chi2	p-values
WSVA	6,520	6	0.9876	0.4311	5092.93	0.000
W Δ NI	6,520	7	0.0592	0.1733	1342.58	0.000
WTQ	6,520	8	2.0831	0.1401	1105.32	0.000
W Δ SHE	6,520	6	0.1576	0.1965	1653.48	0.000

Endog. Variables	Exog. Variables	Coeff.	Std. err.	z	p-values
WSVA	W Δ SNP500	0.80702	0.04874	16.56	0.000
	W Δ NI	0.48933	0.20528	2.38	0.017
	WTQ	0.30788	0.00561	54.79	0.000
	W Δ SHE	1.97030	0.07708	25.56	0.000
	WSIZE	-0.07268	0.01934	-3.76	0.000
	WGR	0.53909	0.08471	6.36	0.000
	_cons	-0.32107	0.02023	-15.87	0.000
W Δ NI	W Δ SNP500	0.01588	0.00291	5.45	0.000
	WRND	0.01387	0.00321	4.32	0.000
	W Δ MNA	-0.02782	0.00595	-4.67	0.000
	W Δ SGNA	-0.26093	0.02023	-12.89	0.000
	W Δ WC	0.06339	0.00856	7.40	0.000

	WSIZE	-0.00357	0.00114	-3.11	0.002
	WGR	0.16430	0.00516	31.83	0.000
	_cons	0.00242	0.00117	2.07	0.039
WTQ	WΔSNP500	0.53069	0.10305	5.15	0.000
	WESGE	-0.43738	0.04534	-9.65	0.000
	WESGG	-0.40935	0.06463	-6.33	0.000
	WEMP	-0.24628	0.01926	-12.79	0.000
	WΔSGNA	10.94997	0.68795	15.92	0.000
	WESGS	1.07392	0.08726	12.31	0.000
	WSIZE	0.60901	0.04248	14.33	0.000
	WGR	-0.24296	0.18084	-1.34	0.179
	_cons	2.59710	0.34381	7.55	0.000
WΔSHE	WΔSNP500	-0.02964	0.00776	-3.82	0.000
	WΔNI	0.40706	0.03223	12.63	0.000
	WTQ	0.00754	0.00089	8.44	0.000
	WLEV	0.08110	0.00823	9.85	0.000
	WSIZE	-0.01571	0.00308	-5.10	0.000
	WGR	0.33220	0.01287	25.81	0.000
	_cons	-0.00404	0.00410	-0.99	0.324

4.5 Stationarity

For each equation in the system, we examined lag-order selection and assessed panel-data unit roots for each variable to determine their stationarity.

4.5.1 Lag-Order Selection

We employed preestimated Lütkepohl's lag-order selection, which reports the final prediction error (FPE), Akaike's information criteria (AIC), Schwarz's Bayesian information criteria (SBIC), and Quinn information criteria (HQIC) lag-order selection statistics for vector autoregressions VARs and vector error-correction models VECMs.

Following Lütkepohl (2005), the tests selected a four-lag model for Equations (1), (3), and (4). However, the test also selected a three-lag model for Equation 2. Ultimately, our research relied on a four-lag model. Nielsen (2001) reported that the lag-order selection discussed here can be used in the presence of I(1) variables (see Tables 10.1 to 4 in the Appendix).

4.5.2 Panel Data Unit-Root Tests

To ensure the accuracy of our regression results (non-spurious), we analysed the seasonality of the variables by performing the Fisher unit-root test (Whitehead 2002, 9.8) based on the augmented Dickey–Fuller test with four lags, and we demeaned the series to mitigate the potential impact of cross-sectional dependence (Levin et al. 2002).

The results of the Fisher tests revealed that three variables, i.e., Tobin's Q (WTQ), the revenue to total assets (WSIZE), and the stock of R&D to total assets (WRND), exhibit probabilities (p-values) exceeding 0.05, thus indicating a lack of stationarity. However, when the first differences of the variables are examined, all tests have p-values below 0.01, rejecting the null hypothesis that all panels contain unit roots and providing evidence that the variables' first differences are stationary at the 1% confidence level. These findings indicate that the variables are integrated of order one I(1) (see Table 11 in the Appendix).

4.6 Cointegration

To test whether the current variables are cointegrated and whether long-run relationships exist in each equation, we applied the Kao and Engle–Granger cointegration tests.

4.6.1 Kao Cointegration Test

The Kao (1999) cointegration test yielded p-values less than 0.01, thus rejecting the null hypothesis at the 1%

confidence level for all the equations. These findings support the conclusion that all equations show evidence of cointegration and that a long-run cointegration relationship exists for each equation (see Table 12 in the Appendix).

4.6.2 Engle–Granger cointegration test

The test proposed by Engle and Granger (1987) reports the test statistic plus the critical values calculated by MacKinnon (2010).

The augmented Engle–Granger cointegration test indicated that the statistic does not exceed the critical value at the 1% level for Equations 1, 2, and 4, or at the 5% level for Equation 3. Consequently, we reject the null hypothesis in all cases, concluding that all equations show evidence of cointegration (see Table 13 in the Appendix).

Based on the Kao and Engle–Granger cointegration test results, we concluded that the variables are cointegrated across all equations and that the regressions are valid (i.e., non-spurious).

4.7 Causality

By performing pairwise Granger causality tests, we checked for causality within each equation of a vector autoregressive (VAR) model, thus providing a convenient alternative to the tests proposed by Granger (1969).

We concluded that the independent variables drive shareholder value added (SVA). The Granger test results rejected the null hypothesis at the 5% level, as indicated by p-values less than 0.05. The only exception was the change in mergers and acquisitions (WΔMNA), which featured a p-value of 0.2531; this variable does not cause the change in net income to total assets (WΔNI) in Equation 2. Furthermore, the ESG environmental score (WESGE) with a p-value of 0.3538 does not cause Tobin's Q (WTQ) in Equation 3; and leverage (WLEV) with a p-value of 0.3435 does not cause the change in shareholder equity to total assets (WΔSHE) in Equation 4 (see Tables 14.1 to 4 in the Appendix).

In conclusion, we identified strong evidence of causality between the independent variables and shareholder value added (WSVA). The only exceptions pertain to Equations 2, 3, and 4.

4.8 Error-correction model

We used the Engle–Granger two-step method to estimate the error-correction model and determine the error-correction term (ECT). This approach is critical to understanding how deviations in long-run shareholder value added adjust in response to changes in the independent variables. The first step involves regressing the shareholder value added on the independent variables, including the intercept, and predicting the residuals. The second step involves estimating the first differences of shareholder value added based on the first differences of the independent variables and the first lag of the residuals (Note 2) (Engle & Granger 1987). The results of the error-correction terms of the different equations are as follows:

Table 15. Error-correction terms by equation

Equation	Coefficient	Std. errors	t	P>/t/
1	-0.81741	0.01626	-50.26	0.000
2	-1.37872	0.02047	-67.35	0.000
3	-0.07004	0.00743	-9.43	0.000
4	-0.81731	0.01763	-46.34	0.000

Lags: 2

The coefficient on the lagged residuals measures the speed at which the cointegrated model converges to its long-run equilibrium. According to Pakes and Schankerman (1984), there is typically a 1.2 to 2.5-year lag between R&D spending and the first revenue generated from it. Based on these findings, we determined that a 2-year lag is the most realistic approach, and it yielded large, highly significant coefficients of -0.81741 and -0.81731 for the error-correction terms (ECT) in Equations 1 and 4, respectively, indicating a swift movement toward balance. The stabilisation process is notably rapid, resulting in quick adjustments in Equations 1 and 4. For Equation 2, the error-correction term is -1.37872, which is acceptable; the variable adjusts too strongly and may oscillate around equilibrium before stabilising. Accordingly, the adjustment to equilibrium is very fast but may exhibit oscillatory behaviour. Some processes, such as R&D, may not adjust within a single period but rather do so gradually over multiple periods. Equation 3 indicates an error-correction term of -0.07004, which is acceptable, but the adjustment is very slow.

The relatively small error-correction coefficient in Equation 3 indicates that deviations from the long-run equilibrium are corrected only gradually, at 7% per annum. This slow adjustment is consistent with the cumulative nature of

intellectual capital and ESG-related environmental, governance, and social factors, which require sustained investments in physical assets, employee development, organisational learning, governance practices, and cultural transformation before their effects are fully reflected in firm value performance. Consequently, firms tend to restore long-run equilibrium progressively rather than through rapid short-term adjustments.

4.9 Cointegration regression

We estimated the cointegrating regression using fully modified ordinary least squares (FMOLS), in which we estimated the long-run covariance using a Bartlett kernel and the Andrews automatic bandwidth method for each equation. This estimator eliminates problems arising from cross-correlation between the cointegrating equation errors and the regressors' innovations (Phillips & Hansen 1988, 1990).

Table 16. Cointegration regressions

Eq. 1	WSVA	Eq. 2	WΔNI	Eq. 3	WTQ	Eq. 4	WΔSHE
Variables	Coeff. std. err.	Variables	Coeff. std. err.	Variables	Coeff. std. err.	Variables	Coeff. std. err.
WΔNI	2.2817*** (0.1473)	WΔSNP	0.0110*** (0.0013)	WESGE	-0.6145*** (0.1220)	WΔSNP	-0.0134*** (0.0052)
WTQ	0.2433*** (0.0042)	500		WESGG	-0.6324*** (0.1739)	500	
WΔSHE	1.7471*** (0.5194)	WRND	0.0050** (0.0021)	WEMP	-0.2449*** (0.0516)	WRND	0.5902*** (0.0278)
WSIZE	-0.1136*** (0.0154)	WΔMNA	-0.0179*** (0.0039)	WΔSGNA	18.837*** (1.6315)	WΔMNA	0.0045*** (0.0008)
WGR	0.8958*** (0.0541)	WΔSGNA	-0.2135*** (0.0108)	WESGS	1.4829*** (0.2338)	WLEV	0.0214*** (0.0073)
_cons	-0.1619*** (0.0163)	WΔWC	0.0956*** (0.0053)	WSIZE	0.6852*** (0.1045)	WSIZE	-0.0302*** (0.0029)
		WSIZE	-0.0034*** (0.0008)	_cons	2.361*** (0.9244)	WGR	0.3991*** (0.0100)
		WGR	0.1331*** (0.0030)			_cons	0.0280*** (0.0039)
		-cons	0.0045*** (0.0008)				
R-sq	0.4619		0.1260		-0.2286		0.1851
Adj. R-sq	0.4616		0.1253		-0.2298		0.1846
Band-width	2.7416		14.1670		6.1574		3.8564

Note. Fully modified least squares (FMOLS) method. Long-run covariance estimates (Bartlett kernel, Andrews automatic bandwidth, VAR lag = 1). Standard errors are presented in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1%, **5%, and *10% levels of significance according to a two-sided test.

Hence, the results provide evidence of significant long-run relationships of our independent variables in each equation at the 1% level of significance. The only exceptions were the stock of R&D capital to total assets (WRND), which was significant at the 5% level in Equation 2, and the change in the S&P 500 and the growth rate (WGR), which were not significant in Equation 3.

4.10 Robustness tests

4.10.1 Alternative Dependent Variables

To verify the reliability of the results, we re-estimated the seemingly unrelated regression estimator based on alternative measures of shareholder value added, such as total shareholder return (WTSR) and market value added to total assets (WMVA). The total shareholder return (WTSR) measures the change in market value plus dividends on the previous year's market value, expressed as a percentage, and the market value added (WMVA) measures the difference between market value and the book value of capital—i.e., shareholder equity plus long-term debt—on total assets. We also winsorised both measures at 0.5% in each tail.

We found similar signs, coefficients, significance levels, and standard errors across estimates of shareholder value added (WSVA), total shareholder return (WTSR), and market value added (WMVA) measures of shareholder value. However, the market value added (WMVA) exhibited a negative sign for the change in net income ($W\Delta NI$), which is not in accordance with the theory and empirical studies. This finding indicates that shareholder value added (WSVA) is a better indicator of value creation than market value added (WMVA) (see Table 17 in the Appendix).

4.10.2 Alternative estimators for the simultaneous equation model

We estimated the model using two-stage least squares (2SLS), three-stage least squares (3SLS), full-information maximum likelihood (FIML), and seemingly unrelated regression (SURE) estimators. However, we obtained the expected coefficient signs, significance, and lower standard errors using the seemingly unrelated regression (SURE), which was more efficient than the other estimators (see Table 18 in the Appendix).

We did not use the iterated three-stage (I3SLS) estimates because the model failed to converge after 300 iterations. The signs, coefficients, significance levels, and standard errors did not align with the results of the estimators discussed above.

In the seemingly unrelated regression, we specified robust standard errors to account for certain kinds of misspecification and clustered ID errors to allow for intragroup correlation. The robust and clustered ID error regressions exhibited the same signs and coefficients, alongside similar levels of significance. However, both regressions showed about twice as many errors as the unadjusted regressions, and the change in net income to total assets ($W\Delta NI$) was not significant in the final estimates (p -value = 0.29). This last outcome is not consistent with theory or relevant empirical studies. In summary, the estimates obtained from the SURE with robust and clustered ID errors were similar, and both were less efficient than those obtained from the SURE estimator with unadjusted errors. Therefore, we concluded that the latter is the better choice in this context.

4.10.3 Chow Test for Structural Change

Our dataset extends from 2005 to 2025 and highlights two major breaks in 2009 and 2020. At the beginning of 2009, the world economy underwent the most severe recession in modern history (Clark 2010), followed by the COVID-19 pandemic in 2020.

Chow's breakpoint test for structural change was performed after the dataset was divided into two periods—2005-2015 and 2016-2025—and the SURE was run with the *pre and *post variables in each equation. The test was a Wald-type test, with the null hypothesis that the coefficient vectors are equal across the two periods for each equation.

Table 19. Results of the Chow tests

Equation	Endog. Variable	chi-squared	p-value
1	WSVA	chi2(12)=5386.36	0.000
2	$W\Delta NI$	chi2(14)=1552.60	0.000
3	WTQ	chi2(16)=1604.52	0.000
4	$W\Delta SHE$	chi2(12)=1838.53	0.000

As Table 19 shows, all the tests rejected the null hypothesis of equal coefficients across the two periods. The signs indicate equality across the two periods, except for a sign change in the control variable (WSIZE) in the first period and Equation 3. The confidence levels are consistent with p-values of 0.000, thereby not exceeding the 1% confidence level, except for $W\Delta NI$ in the first and second periods and Equation 1, WRND and WSIZE in period 1 and Equation 2, and WGR in the first period and Equation 3.

4.10.4 Tests of Model Stability

Based on the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive squared residuals (CUSUMQ) tests proposed by Brown, Durbin and Evans (1975), we tested each equation and analyse the different graphs. The results for Equations 1, 2, and 4 indicated coefficient stability (CUSUM) and stable residual variance (CUSUMQ). However, the W_t statistic graph for Equation 3 shows movements outside the 5% critical lines, indicating coefficient instability during the sample period, as shown in Figure 1.

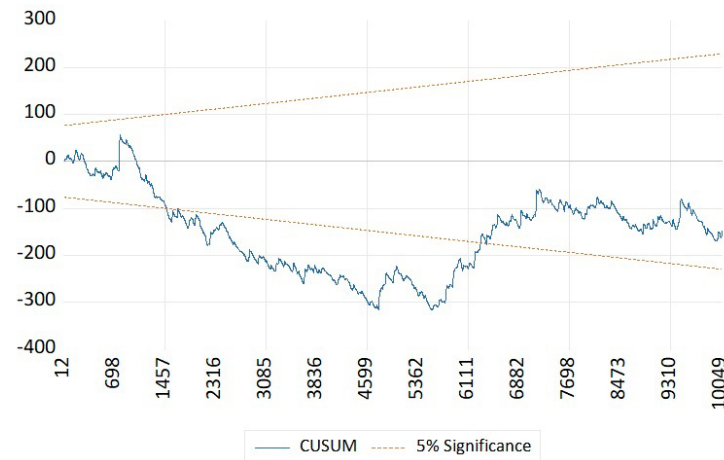


Figure 1. CUSUM Test for Equation 3

Y-Axis: W_t statistic; X-Axis: Sample period (No observations)

Figure 2 shows that the S_t statistic also moves outside the 5% critical line, thus indicating instability in the residual variance for Equation 3.

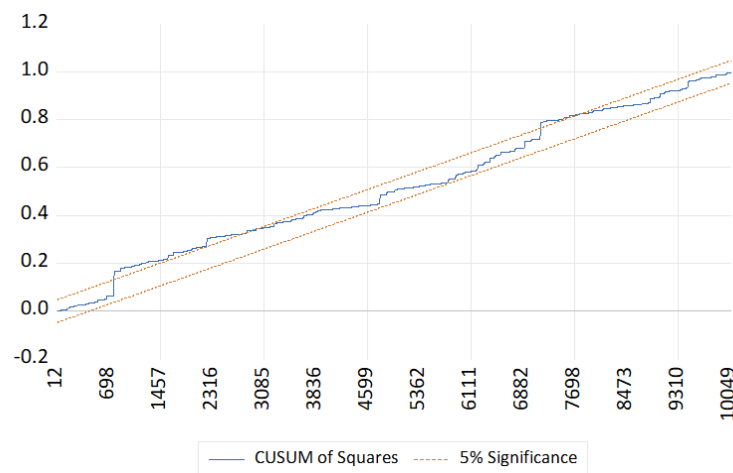


Figure 2. CUSUM of the Squares Test for Equation 3

Y-Axis: S_t Statistic; X-Axis: Sample period (No observations)

In summary, the CUSUM and CUSUMQ tests indicated stability for Equations 1, 2, and 4, but instability for Equation 3.

4.11 Discussion

We assessed the null hypotheses presented in Section 3.8 using the simultaneous-equations system estimates detailed in Table 9, alongside the related theory and literature review. Our findings can be interpreted as follows.

H₀₁. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the change in the S&P 500 market index (WASNP500) is positively and significantly associated with shareholder value added to total assets (WSVA) at the 1% level. The change in the market index reflects the performance of the 500 leading listed companies on U.S. stock exchanges, capturing the influence of overall market performance (Gourieroux & Jasiak 2001, 415–417).

H₀₂. The significance test rejected the null hypothesis ($p\text{-value}=0.017<0.05$), indicating that the change in net income to total assets (WANI) is positively and significantly associated with shareholder value added to total assets (WSVA) at the 5% level. Grant (1991, pp. 117–118) studied resources as the basis for profitability and differentiated between resources that provide competitive advantage and those that provide industry attractiveness. In both cases, he mentioned the capabilities to be developed and the investments required to achieve a profit rate above the competitive level. Previous studies have examined the significance of net income: Wiranti et al. (2021) reported that net income significantly affects stock returns on the Indonesian Stock Exchange. Other studies have reported that earnings per share (EPS) serve as a significant factor with respect to stock returns: Ismail (2006), Gupta and Sikarwar (2016), Mathangi and Vijaykarthigeyan (2020), Nugroho et al. (2019), Rakshit et al. (2017), and Sura, Panchal and Lather (2023). In turn, studies that found earnings per share (EPS) statistically significant in explaining created shareholder value (CSV) included Panigrahi et al. (2015) and Panigrahi (2017).

H₀₃. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that market value-to-total assets–Tobin's Q (WTQ)– is positively and significantly associated with shareholder value added to total assets (WSVA) at the 1% level. We used the market value-to-total assets as a proxy for intellectual capital (IC) (Daryaei et al. 2011). Joia (2000, 3) revealed a strong correlation between market-to-book value and intellectual capital. Chen et al. (2004) investigated the strong correlation between intellectual capital and business performance, as measured by return on net assets. Lev and Radhakrishnan (2005) identified organisational capital as the primary production factor generating market value and sales growth. Additionally, these authors reported a positive and significant contribution of organisational capital to the excess market-to-book value at the 1% level. Fama and French (1992) reported that companies with high market-to-book value are strong performers and increase in value; whereas companies with low ratios are weak performers and decrease in value.

H₀₄. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the change in shareholders' equity-to-total assets (WASHE) is positively and significantly associated with shareholder value added to total assets (WSVA) at the 1% level. Similar research findings have been reported by Atiyet (2012), who investigated capital structure with the goal of maximising shareholder value based on a dataset consisting of 88 French listed companies during the period from 1999 to 2005 and revealed a positive and significant contribution of self-financing to market value added (MVA), as a measure of value creation. For debt and equity issuances, the study identified a negative and significant contribution to value creation. Dushnitsky and Lenox (2006) reported that corporate venture capital investments make a positive and significant contribution to value creation, as measured by Tobin's Q, only when such investments are pursued for strategic reasons, mainly in the devices and information technology sectors, as well as in the context of strategic, novel technologies that require specialised knowledge. For purely financial objectives, value creation is less likely because of misaligned incentives, internal conflicts, and incompatible objectives. The dataset included a large panel of U.S. public firms (#1173) for the period from 1990 to 1999.

H₀₅. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that revenue-to-total-assets (WSIZE) is negatively and significantly associated with shareholder value added-to-total-assets (WSVA) at the 1% level. We included revenue-to-total-assets (WSIZE) and the change in revenue-to-total-assets (WGR) as control variables. Our results are consistent with those reported by Humphery-Jenner and Powell (2014), Moeller et al. (2004), and Jensen (1986), who identified large firm size as a source of value destruction in the context of analysing takeover returns, resulting from agency conflicts and managerial entrenchment, in well-governed, open economies such as the United States. Large acquirers can achieve higher stock returns when acquisitions occur in countries with weak governance.

H₀₆. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the change in revenue to total assets (WGR) is positively and significantly associated with shareholder value added to total assets (WSVA) at the 1% level. Ramezani et al. (2001) reported that moderate growth in sales and earnings is positively and significantly associated with profitability and shareholder value. However, there is an optimal point beyond which further growth reduces shareholder value and profitability. Our results are consistent with the first part of these authors' study.

H₀₇. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the stock of R&D capital

to total assets (WRND) is positively and significantly associated with the change in net income to total assets (WANI) at the 1% level. Radenovic et al. (2023) reported a positive and significant association between R&D investment and profitability (ROA) across 24 R&D-intensive companies globally for the period from 2013 to 2021. R&D capital is the most commonly used variable to identify product and process innovation. This process produces scientific and technological knowledge that can support research and development for new products launched at a commercial scale (Rosenberg & Nelson 1994). Boer (1994) reported a significant increase in shareholder value resulting from modest increases in real growth. This finding contributed to continued investment in research and development. Barnard and Herbst (2017) investigated the demand- and supply-side conditions necessary to support innovation and entrepreneurship aimed at creating value. These authors identified four primary factors pertaining to value: price, benefits, satisfaction, and experience. These factors enable the quantification, measurement, and comparison of innovation, ultimately leading to value creation. Klassen et al. (2022) highlighted strategies that executives can use to promote a culture of innovation to achieve long-term value creation. These authors described the conditions that characterise high innovators, such as explicit processes, leadership, resources deployed to innovation and long-term projects, and knowledge management systems. Fernández et al. (2019) investigated the effects of 562 mergers and acquisitions (M&As) on R&D intensity and profitability for the 1000 largest European companies for the period from 2004 to 2012 identifying a positive and significant association between mergers and R&D intensity in both the short and long term; whereas mergers affect profitability only in the long term.

H₀₈. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the change in the M&A capital stock to total assets (WAMNA) is negatively and significantly associated with the change in net income to total assets (WANI) at the 1% level. For the period from 2005 to 2025, the change in the stock of M&A capital to total assets gradually decreases, while the change in net income to total assets slightly increases. This shift is the primary factor behind the negative association between the two variables in this context. We analysed mergers and acquisitions (M&As) in terms of net cash acquisitions, defined as acquisitions of businesses minus disposals of businesses sold, adjusted by the implicit GDP deflator. Finally, we calculated the M&A capital stock.

The literature has reported both negative and positive associations between M&A and profitability. Ravenscraft and Scherer (1987), Agrawal et al. (1992), Dickerson et al. (1997), Rau and Vermaelen (1998), and Moeller et al. (2005) are among those authors who have reported a negative association; while positive associations have been identified by Gan (2024), Fernández et al. (2019), Kotnal (2016), Bausch and Fritz (2009), Kumar and Bansal (2008), Healy et al. (1992), and Seth (1990). These opposite results have been obtained across different subjects: (1) the method used to estimate profitability post-announcement or in the long-term since –a post-announcement estimation does not include the post-merger restructuring of the merged companies–; (2) the method used to calculate acquisitions, including either the net cash of acquisitions and disposal of businesses or only acquisitions announcements; (3) the method of payment, i.e., cash or shares; (4) the differentiation between glamour bidders and value bidders; (5) related and unrelated acquisitions; and (6) the relative size between the bidder and target. These aspects may lead to different results when analysing the impact of mergers on profitability.

During the research period, we identified four M&A waves (e.g., 2005-2007, 2013-2015, 2021, and 2024-2025), with peaks in 2007, 2015, 2021, and 2025. The compound annual growth rate for total M&As in the U.S., measured in trillions of current U.S. dollars, is a low 3.19% for the research period from 2005 to 2025, based on deal announcements and excluding business disposals. M&A waves support a consolidated company's profitability, and profitability increases after acquisitions as synergies (post-merger restructurings, cost rationalisation, etc.) are realised; moreover, new acquisitions decline after the M&A wave (downturn). In all industries, larger companies have already acquired the larger or more closely related opportunities, and the remaining opportunities are smaller and harder to implement in terms of the changes and energy required to achieve profitability. Management is key to implementing integration. These factors explain the negative associations between mergers and profitability, as well as the importance of selecting the dataset period.

H₀₉. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the change in selling, general, and administration expenditures to total assets (WASGNA) is negatively and significantly associated with the change in net income to total assets (WANI) at the 1% level. The negative sign indicates that reductions in selling, general, and administration expenditures contribute to improved net income. Zilka (2009) reported similar findings, noting that restructuring benefits include organisational efficiency, business process improvement, and outsourcing to reduce costs and improve net income. Khurana and Lippincott (2000) investigated restructuring processes involving personnel reductions and divestitures of unprofitable product lines to increase profitability. These authors outlined investors' perceptions that these activities positively affect market value and, consequently, shareholder value added.

Additionally, the extant research on incentives to executives and the salesforce has indicated a positive contribution to value creation (Banker et al. 2009, 5). However, Stickney et al. (2007) clarified that short-term incentives create

benefits that also expire quickly.

H₀10. The significance test rejected the null hypothesis ($p\text{-value} = 0.00 < 0.01$), indicating that the change in working capital to total assets ($W\Delta WC$) is positively and significantly associated with the change in net income to total assets ($W\Delta NI$) at the 1% level. In our dataset, S&P 500 companies increased working capital, and the change in working capital relative to total assets decreased slightly over the period under analysis. This finding is consistent with Aktas et al. (2014, 3), who found that companies with a negative excess of working capital were positively associated with firm and stock performance. In this case, Aktas et al. identified companies with low working capital (i.e., underinvestment in WC). The negative excess of working capital reduces unnecessary working capital and improves company profitability and stock performance. This finding supports the significant and positive coefficient of change in working capital observed in this context, thus indicating the potential to fund additional acquisitions with available cash (Aktas et al., 19). Boisjoly et al. (2020) examined the valuation proxy, Tobin's Q, relative to working capital components. Improvements in the cash conversion cycle (CCC), days payables outstanding (DPO) (lower values), inventory turns, and accounts-receivables turns (higher values) are associated with significant increases in valuation in terms of Tobin's Q, and Magni (2015) highlighted the investments on net fixed assets and working capital, and the conditions required to create value by equity and debt. In terms of rates of return, economic value is created when return on assets (ROA) exceeds the weighted average cost of capital (WACC).

H₀11. The significance test rejected the null hypothesis ($p\text{-value} = 0.00 < 0.01$), indicating that the ESG environmental pillar score in log form (WESGE) has a negative and significant association with market value to total assets–Tobin's Q (WTQ) at the 1% level. Our findings align with those reported by Abdi et al. (2022), who found a significant negative contribution of ESG environmental factors to firm value across 38 global airlines from 2009 to 2019. Chong and Loh (2023) identified a significant negative association between the ESG environmental score and the price-to-earnings ratio, a measure of firm valuation, for 36 palm-oil-dominant companies in Southeast Asia in 2021. Erol et al. (2021) investigated real estate investment trusts and highlighted a negative effect on environmental investments due to capital drain. The dataset includes 234 ESG-rated companies from 2003 to 2019. Using a sample of 738 firm-years of data from 2019 to 2021, Palupi (2023) identified a significant negative impact of the ESG environment on firm value across ASEAN countries. A common understanding is that higher ESG scores tend to decrease a company's value, and studies have highlighted a negative impact on value. Van Huijgevoort (2017) and Prabawati and Rahmawati (2022) reported significant negative effects on Tobin's Q for European and ASEAN member countries, respectively. Additionally, Lima and Juca (2024) found a nonsignificant negative effect between the ESG environmental score and Tobin's Q in a database of 2509 companies across 5 developed countries and 4 key OECD partners from 2010 to 2022. They highlighted that the costs of environmental practices do not yield immediate compensation benefits.

Further analysis of the ESG environment pillar score in our database revealed that 39.9% of the companies exhibited an increase in the score for the whole period from 2005 to 2024, and the majority of companies (58.6%) experienced both an increase in scores from their baseline and a decrease from a maximum in 2016; this trend continued until 2024, resulting in an average overall decrease of -15.8% from the maximum at the firm level. Accordingly, the companies implemented ESG environmental actions to decrease costs – mainly by reducing energy use and waste from operations (Bonini 2012, 98) – in the first period from 2005 to 2016, receiving financial and reputational benefits; subsequently, the companies' ESG environmental scores decreased from 2016 to 2024 as they scaled back their environmental efforts, no longer experiencing meaningful financial gains. This decrease can be attributed to diminishing financial returns. Additionally, 1.5% of companies did not report ESG environmental score data. Buallay et al. (2022) found an inverted U-shaped relationship between sustainability performance and market valuation in a database of 37 countries from 2008 to 2017. These results closely mirror the evolution of ESG environmental scores over the years: initially rising, peaking, and then declining as returns in financial benefits diminished.

H₀12. The significance test rejected the null hypothesis ($p\text{-value} = 0.00 < 0.01$), indicating that the ESG governance pillar score in log form (WESGG) has a negative and significant association with market value-to-total assets ratio–Tobin's Q (WTQ) at the 1% level. S&P 500 companies have highly professional management, making it difficult to improve governance scores. Accordingly, any reduction in the ESG governance score is associated with an increase in firm value, as reflected in the evolution of S&P 500 companies. Palupi (2023) reports similar findings, identifying a significant negative association between ESG (environmental, social, and governance) and firm value using ASEAN panel data from 2019 to 2021, covering 738 firm-years. Any reduction in scores increases firm value, and the main reason reported is the high cost of ESG activities, which are detrimental to the firm's interests. Ben Dahmash et al. (2026) investigated ESG scores, reporting a significant negative relationship between the ESG governance score and Tobin's Q for 84 listed companies from Gulf Cooperation Council (GCC) countries for the period from 2019 to 2023. These authors argued that ESG governance requirements may create agency costs or compliance burdens compared with efforts in more developed economies. Benvissuto (2025) investigated a panel of European countries and identified

a significant negative relationship between ESG governance and Tobin's Q. They highlighted that governance costs, managerial flexibility, internal problems, agency conflicts between shareholders and managers, and certain governance mechanisms that are perceived as barriers to value creation contribute to a lower ESG governance pillar score. Additionally, Lima and Juca (2024) found a nonsignificant negative effect between the ESG governance score and Tobin's Q in a database of 2509 companies across 5 developed countries and 4 key OECD partners from 2010 to 2022. They highlighted that the negative association between global governance indicators and Tobin's Q implies that companies may thrive in countries with less strict regulations, allowing for more operational flexibility.

H₀13. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the number of employees in log form (WEMP) has a negative and significant association with market value to total assets–Tobin's Q (WTQ) at the 1% level. Li and Kong (2013) reported similar findings, investigating the effects of takeovers on value creation and finding that acquirers can generate value by improving productivity through better allocation of capital and labour resources. They achieved this goal through significant reductions in capital expenditure, wages, and employment at the acquired plants without compromising output levels. These authors identified employee layoffs among nonproduction workers. Falato et al. (2022) provided evidence that the rise of powerful institutional shareholders in U.S. companies led to labour reductions, higher shareholder returns, and no improvements in labour productivity. Their dataset, which was drawn from the U.S. Census Bureau, covers U.S. companies from 1982 to 2015. Finally, OECD estimates based on 2012 data put estimated job losses from automation at about 9% in the U.S. (Arntz et al. 2016). Our findings align with these results.

H₀14. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that the ESG social pillar score in log form (WESGS) has a positive and significant association with market value to total assets–Tobin's Q (WTQ) at the 1% level. Our findings align with those reported by Qureshi et al. (2020), who showed that social disclosure and female board representation positively and significantly affect firm value, based on a large dataset of 812 listed European companies. Xie et al. (2017) reported a positive association between social activities (such as equal opportunities, training policies, and a human rights policy) and market value. Additionally, social policies may promote an ideal corporate culture and a stronger reputation, thus indirectly leading to a better workplace. Finally, Margolis et al. (2009), who conducted a meta-analysis of 251 studies, reported a small, positive, and significant relationship between corporate social and financial performance that ultimately generates firm value, even if the effect is small. Alareeni and Hamdan (2020) examined corporate social responsibility (CSR) among S&P 500 companies and reported a significant positive association between CSR and Tobin's Q from 2009 to 2018. Additionally, Lima and Juca (2024) identified a significant positive effect between the ESG social score and Tobin's Q in a database of 2509 companies across 5 developed countries and 4 key OECD partners from 2010 to 2022.

H₀15. The significance test rejected the null hypothesis ($p\text{-value}=0.00<0.01$), indicating that total debt-to-total assets (WLEV) is positively and significantly associated with the change in shareholder equity-to-total assets (WΔSHE) at the 1% level. In our dataset, the average total debt-to-equity ratio is 61.05%, thus indicating a capital structure of 62.1% equity and 37.9% debt, and the average total debt-to-capital ratio is 43.9% across the 503 companies in the S&P500. These debt levels matter, and these findings are consistent with McConnell and Servaes (1995): firms with few positive net present value projects are associated with a positive effect of debt on the firm's value. The positive sign indicates that equity issuance is positively related to debt levels. A certain level of approved debt instils trust in the business model's stability in potential investors. High-growth companies tend to use less debt than stable-growth firms (Damodaran 2002, 310). When companies do not want to miss out on opportunities with a high amount of net present value (NPV), they invest and issue shares/debt depending on the trade-off between the cost of issuing shares and/or debt and the amount of the growth opportunity to be financed (Myers & Majluf, 1984). Grubisic and Orsag (2015, 108) reported that companies that have prior experience in debt issuance are more likely to issue shares, although this process is slower than issuing debt.

5. Conclusion

The main aim of this research was to investigate the most important financial and sustainability performance measures that contribute to shareholder value added (SVA) running an integrated quantitative proposal to explain SVA across both financial and sustainability dimensions simultaneously, encompassing all sectors of the economy.

Based on the Resourced-based view theory of the firm, we summarised the three main resource areas (what we have) and the main capabilities (what to do). Defining all variables allowed us to identify four equations in the simultaneous equation system with four endogenous variables, the main related variables, and two control variables. The estimates of the simultaneous equation system showed strong significance for the independent variables and their related endogenous variables, and the signs were as expected and consistent with those reported in many relevant studies.

In our analysis, we used a framework consisting of stationarity, cointegration, and causality. Based on this approach,

we determined that the independent variables were integrated of order one $I(1)$. For each equation, we also tested for cointegration to confirm the presence of a cointegrating relationship and revealed that the variables are indeed cointegrated, thus indicating a non-spurious relationship.

To gain further insight, we estimated an error-correction model for each equation to analyse the short-term adjustment dynamics toward equilibrium. Additionally, we estimated a cointegration regression for each equation to examine the long-run relationships between the independent and endogenous variables. Finally, after performing relevant tests, we determined that the appropriate panel-data estimator for each equation was the fixed-effects estimator. The resulting estimates were comparable to those of the cointegration regressions.

The robustness checks revealed results similar to those obtained for shareholder value added (WSVA) with alternative dependent variables, such as total shareholder return (WTSR) and market value added to total assets (WMVA). As alternative estimators to seemingly unrelated regressions (SURE), we used two-stage least squares (2SLS), three-stage least squares (3SLS), and full-information maximum likelihood (FIML) for the simultaneous equation system, which yielded similar estimates. However, the seemingly unrelated regression was the most efficient among the various benchmarks. The Chow tests for structural change rejected coefficient equality across the two subsamples and across all equations because of major breaks in the dataset. The CUSUM and CUSUMQ tests of model stability indicated stability for Equations 1, 2, and 4, and instability for Equation 3. In summary, the model stability test results were consistent with those indicated by the previous Chow test.

In conclusion, our paper identified the variables that create shareholder value added and outlined the significant variables across different resources, such as physical, human, and financial capital, including knowledge capital, operational organisation, ESG knowledge, employee sizing and productivity, social knowledge, and shareholders and debt funding. It analysed these variables as a multidimensional construct and assessed them empirically across all economic sectors.

6. Recommendations

Our research covered all sectors of the S&P 500, thus providing a broad perspective. However, we did not obtain insights into several advertising-intensive sectors, and variables such as the Workforce Score and the ACSI (American Customer Satisfaction Index) were statistically non-significant. Future research may involve conducting sector-specific analyses, adjusting the sample size, examining broader ESG sustainability measures, assessing entrepreneurial and managerial abilities, analysing relevant traits and behaviours, and evaluating innovation capabilities. Certain variables could be collected through direct surveys and primary research methods.

Author Contributions

Francisco Rosique: Conceptualisation, data curation, formal analysis, investigation, methodology, software, validation, visualisation, writing-original draft.

Maria-Antonia Tarrazon-Rodon: Conceptualisation, formal analysis, investigation, project administration, resources, supervision, writing-review and editing.

Use of AI Tools Declaration

The authors declare that they did not use any artificial intelligence (AI) tools in creating this article.

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Conflicts of interest

All authors declare no conflicts of interest related to this paper.

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Notes

Note 1. Data Availability Statement: The data used in this study were obtained from LSEG-Eikon Workspace. Due to licensing restrictions, the authors cannot share the data. Researchers with access to LSEG-Eikon Workspace can replicate the dataset using the variable descriptions in this paper.

Note 2. Due to space constraints, we do not report the full estimates of the error-correction models. The short-run dynamic and error-correction terms are consistent with the long-run results discussed in the text and are available from the authors upon request.

Appendices

Table 4. Descriptive statistics

Variables	Obs.	Mean	Std. dev.	Variance	Skewness	Kurtosis
WSVA	9,539	0.3338	1.5660	2.4526	3.6568	31.986
WΔSNP500	10,059	-0.0001	0.3933	0.1547	-3.0479	12.070
WΔNI	9,540	0.0072	0.0759	0.0057	1.2536	15.967
WTQ	9,541	1.8560	2.4411	5.9590	3.9897	25.107
WSIZE	9,540	0.7967	0.7622	0.5809	2.1708	9.139
WGR	9,540	0.0513	0.2524	0.0637	1.0528	19.031
WRND	9,540	0.1192	0.2676	0.0716	3.6552	19.919
WΔMNA	9,540	0.0122	0.1439	0.0207	5.0782	40.023
WΔSGNA	9,539	0.0134	0.0662	0.0043	2.4575	26.400
WΔWC	9,540	0.0117	0.1076	0.0115	1.7332	15.417
WΔSHE	9,540	0.0415	0.2260	0.0510	4.0239	31.831
WESGE	7,382	3.7737	0.7830	0.6131	-1.9990	7.636
WESGG	8,206	3.9554	0.5052	0.2553	-1.6879	6.552
WEMP	8,155	9.6946	1.5692	2.4624	-0.4874	3.534
WESGS	8,206	3.9558	0.4738	0.2245	-1.2532	4.619
WLEV	9,540	0.3028	0.2701	0.0729	2.3800	13.385

Table 5. Correlation Matrix

	WSVA	WΔSNP500	WΔNI	WTQ	WSIZE	WGR	WRND	WΔMNA
WSVA	1.000							
WΔSNP500	0.174	1.000						
WΔNI	0.209	0.050	1.000					
WTQ	0.565	0.058	0.141	1.000				
WSIZE	0.132	-0.033	0.132	0.195	1.000			
WGR	0.258	-0.042	0.360	0.179	0.462	1.000		
WRND	0.217	-0.010	0.085	0.293	0.015	0.093	1.000	
WΔMNA	0.118	0.016	-0.033	0.021	0.070	0.149	0.043	1.000
WΔSGNA	0.333	-0.034	0.071	0.261	0.251	0.522	0.230	0.208
WΔWC	0.290	0.032	0.163	0.170	0.096	0.181	0.197	-0.129
WΔSHE	0.349	-0.041	0.287	0.116	0.136	0.397	0.160	0.252
WESGE	-0.098	0.072	-0.027	-0.137	-0.083	-0.096	0.003	-0.023
WESGG	-0.091	0.035	-0.003	-0.106	0.003	-0.041	-0.050	-0.031
WEMP	-0.080	-0.022	-0.028	-0.112	0.262	0.041	-0.062	-0.001
WESGS	-0.025	0.112	-0.012	0.003	-0.066	-0.067	0.082	-0.010
WLEV	0.056	0.005	0.009	-0.002	0.007	0.075	-0.068	0.255

	WΔSGNA	WΔWC	WΔSHE	WESGE	WESGG	WEMP	WESGS	WLEV
WSVA								
WΔSNP500								
WΔNI								
WTQ								
WSIZE								
WGR								
WRND								
WΔMNA								
WΔSGNA	1.000							
WΔWC	0.203	1.000						
WΔSHE	0.363	0.319	1.000					
WESGE	-0.129	-0.077	-0.076	1.000				
WESGG	-0.127	-0.073	-0.093	0.319	1.000			
WEMP	-0.014	-0.074	-0.085	0.302	0.112	1.000		
WESGS	-0.065	-0.081	-0.061	0.644	0.302	0.306	1.000	
WLEV	0.036	-0.038	0.137	0.053	0.011	-0.060	0.071	1.000

Note. Number of observations = 6,520

Table 10.1. Lutkepohl's lag-order selection criteria. Equation 1

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-20145.4				0.00105	-6.8607	-6.8607	-6.8607
1	-11354.5	17582.0	16	0.000	0.00014	-8.8168	-8.8125	-8.8041
2	-11206.0	297.09	16	0.000	0.00014	-8.8463	-8.8377	-8.8210
3	-11124.7	162.63	16	0.000	0.00014	-8.8609	-8.8480	-8.8229*
4	-11084.7	79.9*	16	0.000	0.00014*	-8.8662*	-8.8490*	-8.8156

Note. (*). Optimal lag. Number of observations = 8,972

Endogenous: WSVA WΔNI WTQ WΔSHE

Exogenous: WΔSNP500 WSIZE WGR _cons

Table 10.2. Lutkepohl's lag-order selection criteria. Equation 2

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	11920.3				0.00424	-5.4634	-5.4634	-5.4634
1	12179.2	517.9	1	0.000	0.00401	-5.5203	-5.5200	-5.5195
2	12236.8	115.28	1	0.000	0.00396	-5.5327	-5.5322	-5.5312
3	12244.0	14.324*	1	0.000	0.00395*	-5.5341*	-5.5333*	-5.5317*
4	12244.7	1.438	1	0.230	0.00395	-5.5340	-5.5330	-5.5309

Note. (*). Optimal lag. Number of observations = 9,080

Endogenous: WΔNI

Exogenous: WΔSNP500 WRND WΔMNA WΔSGNA WΔWC WSIZE WGR _cons

Table 10.3. Lutkepohl's lag-order selection criteria. Equation 3

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-13808.5				4.3667	1.4712	1.4712	1.4712
1	-9134.4	9348.1	1	0.000	1.0158	0.0129	0.0133	0.0139
2	-9110.0	48.882	1	0.000	1.0084	0.0056	0.0063	0.0077
3	-9073.3	73.309	1	0.000	0.9973	-0.0055	-0.0044	-0.0023
4	-9067.5	11.516*	1	0.001	0.9958*	-0.0069*	-0.0055*	-0.0027*

Note. (*). Optimal lag. Number of observations = 6,409

Endogenous: WTQ

Exogenous: WΔSNP500 WESGE WESGG WEMP WΔSGNA WESGS WSIZE WGR_cons

Table 10.4. Lutkepohl's lag-order selection criteria. Equation 4

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-6278.5				0.00081	-7.1140	-7.1140	-7.1140
1	71.83	12701.0	9	0.000	0.00019	-8.5276	-8.5252	-8.5205
2	205.99	268.32	9	0.000	0.00019	-8.5555	-8.5506	-8.5412
3	264.35	116.73	9	0.000	0.00019	-8.5665	-8.5592*	-8.5451*
4	273.51	18.309*	9	0.032	0.00019*	-8.5665*	-8.5568	-8.5380

Note. (*). Optimal lag. Number of observations = 8,972

Endogenous: WΔSHE WΔNI WTQ

Exogenous: WΔSNP500 WLEV WSIZE WGR_cons

Table 11. Panel data unit-root tests

Variable	Statistic (P)	p-value	Variable	Statistic (P)	p-value
WSVA	1429.331	0.000	ΔWSVA	2015.355	0.000
WΔSNP500	2925.452	0.000	ΔWΔSNP500	3606.433	0.000
WΔNI	1792.121	0.000	ΔWΔNI	2755.185	0.000
WTQ	997.774	0.442	ΔWTQ	1688.582	0.000
WΔSHE	1621.912	0.000	ΔWΔSHE	2275.176	0.000
WSIZE	1031.275	0.133	ΔWSIZE	1739.068	0.000
WGR	1585.521	0.000	ΔWGR	2561.945	0.000
WRND	646.739	1.000	ΔWRND	3684.474	0.000
WΔMNA	1421.444	0.000	ΔWΔMNA	2916.866	0.000
WΔSGNA	1185.914	0.000	ΔWΔSGNA	3548.489	0.000
WΔWC	1668.986	0.000	ΔWΔWC	2612.295	0.000
WESGE	1053.063	0.000	ΔWESGE	1380.899	0.000
WESGG	1546.007	0.000	ΔWESGG	1497.980	0.000
WEMP	1263.529	0.000	ΔWEMP	1350.264	0.000
WESGS	1140.993	0.000	ΔWESGS	1602.220	0.000
WLEV	1553.191	0.000	ΔWLEV	1881.686	0.000

Note. Fisher-type based on augmented Dickey–Fuller tests. ADF regressions: 4 lags

H_0 : All panels contain unit roots.

H_a : At least one panel is stationary.

Table 12. Kao cointegration tests

Equation	Nr of Panels	Avg. number of Periods	Statistic	p-value
1	503	16.638	-46.190	0.000
2	503	16.678	-59.790	0.000
3	500	10.316	8.049	0.000
4	503	16.638	-41.639	0.000

Note. Test Type: Augmented Dickey–Fuller t, Bartlett kernel, and lag=4

H_0 : No cointegration

H_a : All panels are cointegrated.

Table 13. Augmented Engle–Granger test for cointegration

Equation	Test Statistic- Z(t)	1% Critical Value	5% Critical Value	10% Critical Value
1	-41.168	-5.515	-4.979	-4.698
2	-47.235	-5.766	-5.232	-4.952
3	-5.481	-6.003	-5.471	-5.192
4	-41.035	-5.515	-4.979	-4.698

Note. Number of lags = 4. N(test) = 3614

H_0 = The variables are not cointegrated.

Table 14.1. Pairwise Granger causality tests, Equation 1

Null Hypothesis	Obs	F-Statistic	p-value
$W\Delta SNP500$ does not Granger-cause WSVA	9080	35.1669	3.E-29
$W\Delta NI$ does not Granger-cause WSVA	9080	5.61380	0.0002
WTQ does not Granger-cause WSVA	8972	65.2777	2.E-54
$W\Delta SHE$ does not Granger-cause WSVA	9080	5.61662	0.0002
WSIZE does not Granger-cause WSVA	9080	2.49096	0.0411
WGR does not Granger-cause WSVA	9080	2.34972	0.0519

Note. Lags: 4

Table 14.2. Pairwise Granger causality tests, Equation 2

Null Hypothesis	Obs	F-Statistic	p-value
$W\Delta SNP500$ does not Granger-cause $W\Delta NI$	9081	7.30200	7.E-06
WRND does not Granger-cause $W\Delta NI$	9081	18.7526	2.E-15
$W\Delta MNA$ does not Granger-cause $W\Delta NI$	9081	1.33802	0.2531
$W\Delta SGNA$ does not Granger-cause $W\Delta NI$	9080	13.9193	3.E-11
$W\Delta WC$ does not Granger-cause $W\Delta NI$	9081	28.0811	3.E-23

WSIZE does not Granger-cause WΔNI	9081	11.5073	3.E-09
WGR does not Granger-cause WΔNI	9081	22.1156	3.E-18

Note. Lags: 4

Table 14.3. Pairwise Granger causality tests, Equation 3

Null Hypothesis	Obs	F-Statistic	p-value
WΔSNP500 does not Granger-cause WTQ	9081	28.8329	8.E-24
WESGE does not Granger-cause WTQ	5315	1.10187	0.3538
WESGG does not Granger-cause WTQ	6155	3.03339	0.0165
WEMP does not Granger-cause WTQ	5998	8.52352	7.E-07
WΔSGNA does not Granger-cause WTQ	8972	16.8618	9.E-14
WESGS does not Granger-cause WTQ	6155	2.63185	0.0325
WSIZE does not Granger-cause WTQ	8972	8.05484	2.E-06
WGR does not Granger-cause WTQ	8972	12.4036	5.E-10

Note. Lags: 4

Table 14.4. Pairwise Granger causality tests, Equation 4

Null Hypothesis	Obs	F-Statistic	p-value
WΔSNP500 does not Granger-cause WΔSHE	9081	21.2462	2.E-17
WΔNI does not Granger-cause WΔSHE	9081	2.91944	0.0200
WTQ does not Granger-cause WΔSHE	8972	59.0057	3.E-49
WLEV does not Granger-cause WΔSHE	9081	1.12311	0.3435
WSIZE does not Granger-cause WΔSHE	9081	4.34551	0.0016
WGR does not Granger-cause WΔSHE	9081	7.40300	6.E-06

Note. Lags: 4

Table 17. Alternative Dependent Variables

End. Variables	End. Variables	WSVA	WTSR	WMVA
		Coeff.	Coeff.	Coeff.
	Exog. Variables	Std. err.	Std. err.	Std. err.
	WΔSNP500	0.8070*** (0.0487)	41.0086*** (1.6738)	0.0567 (0.0360)
	WΔNI	0.4893** (0.2052)	98.4838*** (7.3342)	-0.7100*** (0.1517)
	WTQ	0.3078*** (0.0056)	2.3582*** (0.1940)	1.1834*** (0.0041)
	WΔSHE	1.9703*** (0.0770)	71.5538*** (2.7586)	1.8124*** (0.0569)
	WSIZE	-0.0726*** (0.0193)	-1.3010** (0.6637)	-0.0311** (0.0143)
	WGR	0.5390***	19.2418***	0.5484***

		(0.0847)	(2.9227)	(0.0626)
	_cons	-0.3210***	5.7656***	-0.8329***
		(0.0202)	(0.6964)	(0.0149)
WΔNI	WΔSNP500	0.0158***	0.0157***	0.0159***
		(0.0029)	(0.0028)	(0.0029)
	WRND	0.0138***	0.0153***	0.0137***
		(0.0032)	(0.0031)	(0.0032)
	WΔMNA	-0.0278***	-0.0219***	-0.0292***
		(0.0059)	(0.0058)	(0.0059)
	WΔSGNA	-0.2609***	-0.1955***	-0.2681***
		(0.0202)	(0.0206)	(0.0202)
	WΔWC	0.0633***	0.0780***	0.0610***
		(0.0085)	(0.0085)	(0.0085)
	WSIZE	-0.0035***	-0.0038***	-0.0035***
		(0.0011)	(0.0011)	(0.0011)
	WGR	0.1643***	0.1551***	0.1655***
		(0.0051)	(0.0050)	(0.0051)
	_cons	0.0024**	0.0020*	0.0024**
		(0.0011)	(0.0011)	(0.0011)
WTQ	WΔSNP500	0.5306***	0.5251***	0.5318***
		(0.1030)	(0.1034)	(0.1030)
	WESGE	-0.4373***	-0.4454***	-0.4357***
		(0.0453)	(0.0457)	(0.0453)
	WESGG	-0.4093***	-0.4083***	-0.4065***
		(0.0646)	(0.0651)	(0.0645)
	WEMP	-0.2462***	-0.2430***	-0.2424***
		(0.0192)	(0.0193)	(0.0192)
	WΔSGNA	10.9499***	10.4729***	11.3346***
		(0.6879)	(0.7309)	(0.6876)
	WESGS	1.0739***	1.0723***	1.0709***
		(0.0872)	(0.0876)	(0.0872)
	WSIZE	0.6090***	0.6012***	0.6062***
		(0.0424)	(0.0426)	(0.0424)
	WGR	-0.2429	-0.1606	-0.2873
		(0.1808)	(0.1832)	(0.1808)
	_cons	2.5971***	2.6129***	2.5528***
		(0.3438)	(0.3467)	(0.3436)
WΔSHE	WΔSNP500	-0.0296***	-0.0313***	-0.0296***
		(0.0077)	(0.0074)	(0.0077)
	WΔNI	0.4070***	0.5294***	0.4072***
		(0.0322)	(0.0321)	(0.0322)

WTQ	0.0075*** (0.0008)	0.0050*** (0.0008)	0.0075*** (0.0008)
WLEV	0.0811*** (0.0082)	0.0869*** (0.0079)	0.0813*** (0.0082)
WSIZE	-0.0157*** (0.0030)	-0.0123*** (0.0029)	-0.0157*** (0.0030)
WGR	0.3322*** (0.0128)	0.3021*** (0.0125)	0.3321*** (0.0128)
_cons	-0.0040 (0.0041)	-0.0038 (0.0039)	-0.0041 (0.0041)

Note. Standard errors are presented in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1% level, **5% level and *10% level of significance according to a two-sided test.

Table 18. Alternative estimators for the simultaneous equation model

End. Variables	End. Variables	SURE Coeff. Std. err.	2SLS Coeff. Std. err.	3SLS Coeff. Std. err.	FIML Coeff. Std. err.
WSVA	WΔSNP500	0.8070*** (0.0487)	0.9034*** (0.0560)	0.9874*** (0.0559)	1.8815*** (0.3328)
	WΔNI	0.4893** (0.2052)	-1.4575 (1.0315)	-1.1015 (1.0296)	-61.2344*** (19.1034)
	WTQ	0.3078*** (0.0056)	0.2722*** (0.0185)	0.1777*** (0.0182)	0.2681*** (0.0169)
	WΔSHE	1.9703*** (0.0770)	4.3620*** (0.2339)	6.2525*** (0.2224)	2.2760*** (0.6630)
	WSIZE	-0.0726*** (0.0193)	-0.0286 (0.0237)	0.0432* (0.0236)	-0.2858** (0.1215)
	WGR	0.5390*** (0.0847)	-0.1212 (0.1889)	-0.8075*** (0.1863)	8.8772*** (2.8356)
	_cons	-0.3210*** (0.0202)	-0.3447*** (0.0297)	-0.2776*** (0.0296)	-0.1155 (0.1080)
WΔNI	WΔSNP500	0.0158*** (0.0029)	0.0157*** (0.0029)	0.0169*** (0.0029)	0.0172*** (0.0021)
	WRND	0.0138*** (0.0032)	0.0187*** (0.0032)	0.0160*** (0.0030)	-0.0008*** (0.0002)
	WΔMNA	-0.0278*** (0.0059)	-0.0270*** (0.0059)	-0.0565*** (0.0056)	-0.0107*** (0.0015)
	WΔSGNA	-0.2609*** (0.0202)	-0.2651*** (0.0202)	-0.2612*** (0.0199)	-0.0263*** (0.0039)
	WΔWC	0.0633*** (0.0085)	0.0707*** (0.0086)	0.0106 (0.0082)	-0.0194*** (0.0027)

	WSIZE	-0.0035*** (0.0011)	-0.0035*** (0.0011)	-0.0034*** (0.0011)	-0.0037*** (0.0013)
	WGR	0.1643*** (0.0051)	0.1634*** (0.0051)	0.1715*** (0.0051)	0.1424*** (0.0028)
	_cons	0.0024** (0.0011)	0.0018 (0.0011)	0.0024** (0.0011)	0.0029** (0.0012)
WTQ	WΔSNP500	0.5306*** (0.1030)	0.5261*** (0.1031)	0.5737*** (0.1028)	0.5294*** (0.1033)
	WESGE	-0.4373*** (0.0453)	-0.4457*** (0.0456)	-0.2650*** (0.0393)	-0.4284*** (0.0365)
	WESGG	-0.4093*** (0.0646)	-0.3964*** (0.0650)	-0.3610*** (0.0555)	-0.4189*** (0.0592)
	WEMP	-0.2462*** (0.0192)	-0.2465*** (0.0193)	-0.1844*** (0.0169)	-0.2485*** (0.0181)
	WΔSGNA	10.9499*** (0.6879)	10.1873*** (0.6896)	12.3936*** (0.6655)	10.6896*** (0.5118)
	WESGS	1.0739*** (0.0872)	1.096*** (0.0877)	0.6496*** (0.0765)	1.0691*** (0.0898)
	WSIZE	0.6090*** (0.0424)	0.6096*** (0.0425)	0.5662*** (0.0420)	0.6111*** (0.0446)
	WGR	-0.2429 (0.1808)	-0.1465 (0.1810)	-0.3543** (0.1798)	-0.2111 (0.1651)
	_cons	2.5971*** (0.3438)	2.4910*** (0.3458)	2.8722*** (0.2954)	2.6426*** (0.3436)
WΔSHE	WΔSNP500	-0.0296*** (0.0077)	-0.0374*** (0.0096)	-0.0629*** (0.0095)	0.3939*** (0.0778)
	WΔNI	0.4070*** (0.0322)	-0.4127** (0.1795)	0.5857*** (0.1698)	-24.5861*** (3.5796)
	WTQ	0.0075*** (0.0008)	0.0435*** (0.0027)	0.0580*** (0.0025)	0.0072** (0.0034)
	WLEV	0.0811*** (0.0082)	0.0821*** (0.0097)	0.0628*** (0.0077)	0.0558*** (0.0040)
	WSIZE	-0.0157*** (0.0030)	-0.0350*** (0.0038)	-0.0379*** (0.0038)	-0.1112*** (0.0377)
	WGR	0.3322*** (0.0128)	0.3928*** (0.0283)	0.2386*** (0.0269)	3.7396*** (0.4892)
	_cons	-0.0040 (0.0041)	-0.0515*** (0.0059)	-0.0680*** (0.0055)	0.0693** (0.0337)

Note. Standard errors are presented in parentheses under the coefficients. The individual coefficient is statistically significant at the ***1%, **5%, and *10% levels of significance according to a two-sided test.

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