A Model of U-Shaped Relationship of Corporate Performance and ESG Behavior*

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Background

- There has been a long debate about corporate social responsibility (CSR) and its impact on corporate performance on their business.
  - In these days, a wider concept, environmental, social, and governance (ESG) activity, is becoming popular, but the point remains the same.

- Questions:
  - Does it help to increase corporate financial performance (CFP)?
    - More specifically, is there positive correlation or negative one b/w them?
  - The academic literature does not seem to provide a clear answer.
    - Empirical study results show ambivalence: Some results show positive effects while others the opposite.
    - There are some theoretical analyses including the theory of slack resources.

Background (2)

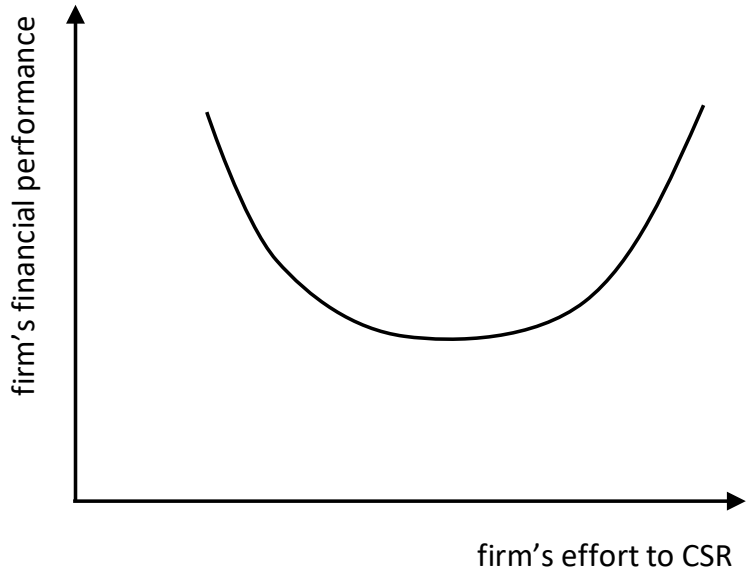
Academic studies on this line are numerous, but their results are not uniform:

- Some studies suggest a positive relationship between the implementation of ESG activities and corporate financial or business performance indicators, such as firm's profit, returns, earnings, return on asset (ROA), and return on equity (ROE).
- Other studies make a counterargument, identifying a negative relationship between ESG and corporate performance indicators.
- Several of these studies are theoretical analyses, but most are empirical, regardless of which side the study attempts to support.

Purpose

The present study attempts to provide a new perspective for understanding such mixed results in the literature.

To that end, this study proposes a hypothesis—the hypothesis of a U-shaped relationship—that can support both sides of the debate.



Studies in the literature

- CSR/ESG vs. corporate financial performance (CFP)

  Ambiguity remains in the empirical study results and theoretical suggestions on the CSR–CFP relationship.

  - Fabozzi, Ng, and Tunaru (2021) statistically investigated relationships between ESG ratings and some CFP indicators, such as Tobin's Q, ROA, and ROE.
  - The findings were a little ambiguous in that they found positive correlations between the two for Tobin's Q but negative correlations for ROA and ROE.
  - Meanwhile, Cheng, Lin and Wong (2015) investigated Chinese firms and concluded that CSR and CFP are positively correlated in China.
  - Cheung (2016) focused on corporate cash holdings that can be considered another proxy of CFP, and they concluded positive correlations.

Studies in the literature (2)

- CSR/ESG vs. corporate financial performance (CFP)

  Ambiguity remains in the empirical study results and theoretical suggestions on the CSR–CFP relationship.

  – Friede, Busch, and Bassen (2015) conducted a meta-analysis of the literature.
  – They reviewed the results of about 2,200 empirical studies investigating the ESG–CFP relationship and concluded that about 90 per cent of these studies have identified a non-negative relationship between the two.
  – This also indicates that a considerable number of studies still suggest either a negative relationship or other forms of ambiguity on the issue.

Studies in the literature (3)

- CSR/ESG vs. corporate financial performance (CFP)

  The theory of slack resources

  - Apart from empirical findings, some studies in the business and management literature propose theories that explain the firm's willingness to invest in CSR, among which the most popular is slack resource theory.
  - Slack resource theory suggests that the abundance of management resources is a significant determinant of management decision-making including investment in CSR.
  - Waddock and Graves (1997) used slack resource theory to explain the relationship between CSR and CFP. Many studies along the same lines have been published, including Xiao et al. (2018) and Surroca, Tribó, and Waddock (2010).

Motivations

- The relationship between CSR/ESG and effects on benefits for corporate businesses and/or financial activities remain controversial and ambiguous.
- Furthermore, almost all the previous academic studies have spent their efforts on making the issue simple.
  - The question set forth is always like “the relationship is positive or negative?”
  - “The relation should be black or white.”

- Is there any way to compromise this black-and-white debate?
- The present study intends to take a different perspective that allows both black and white.

Mixture of two effects

- Some firms take care of the local environment, and thus, they are appreciated by the local community, which then helps contribute to their corporate performance.
- In contrast, some startup companies would not have enough business resources to work on ESG-related issues.
  - This is consistent with the theory of slack resources, in which traditional and/or incumbent-leading companies in the market have redundant managerial and/or production resources that can be used for their divergent activities rather than strictly focusing on short-term profit-seeking.
  - However, this is not the case for startup firms. Furthermore, for some startup companies, their newly innovated products and new business domain would be free of pollutants emitted by old-style manufacturing, and thus, they would not need to take care of severe environmental impacts. An example would be IT related businesses.

Conjecture

- There is one cohort of companies where the relationship between CSR and corporate financial performance is positive: CSR is one of significant determinants of profit for them, so they are willing to engage in additional CSR activities.
- Meanwhile, some firms in another cohort are different: For them, spending their resources on CSR is a factor that reduces their profit. Thus, they will stay away from CSR engagement.

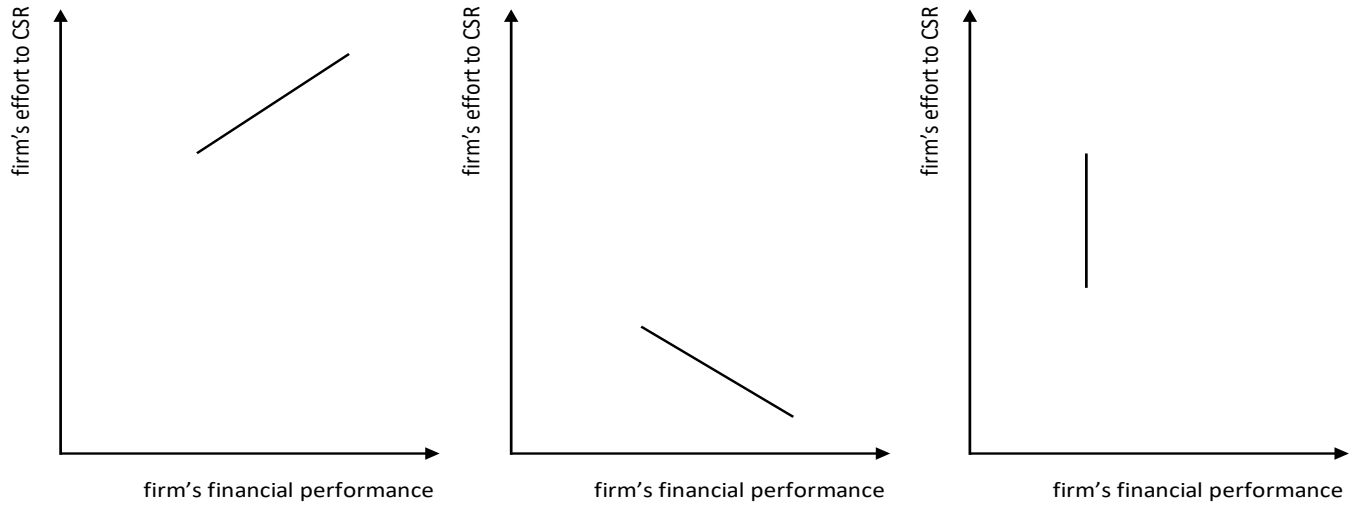
Conjecture (2)

- Let us take a vertical axis as a firm's CSR effort and a horizontal axis as their financial performance in general.

  (a) The former cohort of firms should be plotted on an upper half plane, where CSR and financial performance are positively correlated.

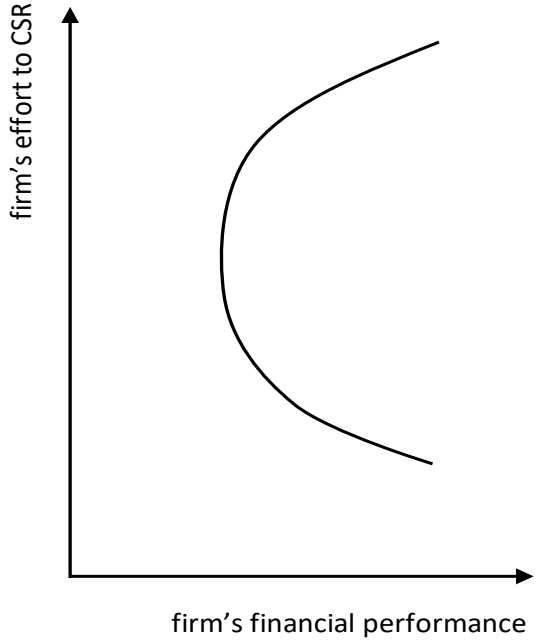
  (b) Meanwhile, the latter cohort of firms should be plotted on the other lower half of the plane, where CSR and financial performance are negatively correlated.

  (c) Furthermore, there may be an intermediate situation.

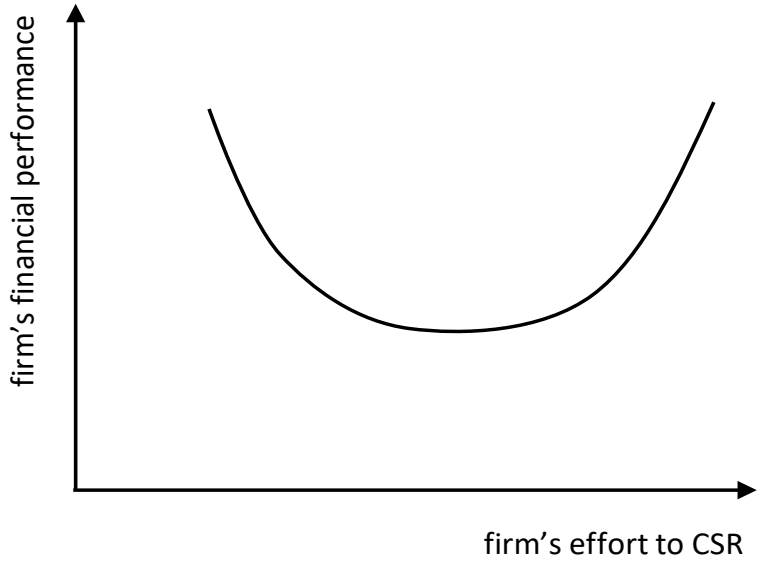


ESG U-shaped relationship hypothesis

- As a result, a smoothly connected curve will look like the panel below.



- Rotating the graph 90 degrees and flip it horizontally, we will see a U-shaped curve.



Empirical analysis

Let x and y denote the axes as follows:

x: firm's ESG/CSR effort (some ESG/CSR indicator)

y: their financial performance (some CFP indicator)

Assume that there is a certain reference point on the x axis, $\boldsymbol{x_0}$. Then assume that marginal change in y is proportional to a difference of x from that reference point, x_0. That is,

Model 1: Marginal change in y is proportional to a difference of x from a certain reference point, x_0.

$$\frac{dy}{dx} = K(x - x_0)$$

where K is a positive constant.

Starting from the norm, we can consider three other variations on the same line.

Empirical analysis (2)

x: firm's ESG/CSR effort

y: their financial performance

Model 1: Marginal change in y is proportional to a difference of x from a certain reference point, x_0.

$$\frac{dy}{dx} = K(x - x_0)$$

where K is a positive constant. This differential equation is solved for

$$y = \frac{K}{2}x^2 - Kx_0x + \left(\frac{K}{2}{x_0}^2 + C\right)$$

（Note that it is a quadratic function）

Thus, a general form is expressed as follows:

$$y = \alpha x^2 - \beta x + \gamma$$

where $\alpha > 0$ and $\beta > 0$.

Empirical analysis (3)

x: firm's ESG/CSR effort

y: their financial performance

Model 2: Elasticity of y with respect to x is proportional to a difference of x from a certain reference point, x_0.

$$\frac{dy/y}{dx/x} = K(x - x_0)$$

where K is a positive constant.

This differential equation is solved for

$$\ln y = K(x - x_0 \ln x) + C$$

Thus, a general form is expressed as follows:

$$\ln y = \alpha x - \beta \ln x + \gamma$$

where $\alpha > 0$ and $\beta > 0$.

Empirical analysis (4)

x: firm's ESG/CSR effort

y: their financial performance

Model 3: Marginal change in y is proportional to a difference of log of x from a certain reference point, x_0.

$$\frac{dy}{dx} = K\ln\left(\frac{x}{x_0}\right)$$

This differential equation is solved for

$$y = Kx\ln x - K(\ln x_0 + 1)x + KC'$$

Thus, a general form is expressed as follows:

$$y = \alpha x \ln x - \beta x + \gamma$$

where $\alpha > 0$ and $\beta > 0$.

($x_0 > 1$ is assumed.)

Empirical analysis (5)

x: firm's ESG/CSR effort

y: their financial performance

Model 4: Elasticity of y with respect to x is proportional to a difference of log of x from a certain reference point, x_0.

$$\frac{dy/y}{dx/x} = K\ln\left(\frac{x}{x_0}\right)$$

This differential equation is solved for

$$\ln y = \frac{K}{2}(\ln x)^2 - K\ln x_0 \ln x + \left(\frac{K}{2}(\ln x_0)^2 + KC'\right)$$

Thus, a general form is expressed as follows:

$$\ln y = \alpha(\ln x)^2 - \beta \ln x + \gamma$$

where $\alpha > 0$ and $\beta > 0$.

($x_0 > 1$ is assumed.)

Empirical model summary

x: firm's ESG/CSR effort

y: their financial performance

Model 1: $y = \alpha x^2 - \beta x + \gamma$

Model 2: $\ln y = \alpha x - \beta \ln x + \gamma$

Model 3: $y = \alpha x \ln x - \beta x + \gamma$

Model 4: $\ln y = \alpha (\ln x)^2 - \beta \ln x + \gamma$

The necessary as well as sufficient conditions for each model to be a U-shaped curve is $\alpha > 0$ and $\beta > 0$.

These models are ready to be tested by regression analysis.

Toyo-Keizai Data outline

- We use survey results of Toyo-Keizai CSR Industry White Paper (the English name comes from the authors; the original Japanese name is 週間東洋経済臨時増刊CSR企業白書) as a complete dataset regarding firms' CSR/ESG activities and engagement in Japan.
  - They publish this series of White Papers every year, and the latest version is Toyo-Keizai CSR Industry White Paper: Year 2022.
  - The survey datasets can also be purchased as electronic files.
  - The Toyo-Keizai CSR Industry White Paper provides their survey results in both quantitative and qualitative forms. The number of observations is over 1,500 Japanese companies that have issued securities reports publicly or an alternative form of financial reports as of November of the preceding year.

Toyo-Keizai Data outline (2)

- We used the quantitative part of the survey results outlined as follows:
  - Toyo-Keizai, for example, sent questionnaires to 3,819 Japanese companies for the 2021 volume, receiving responses from 1,561 public companies and 53 unlisted companies. Based on their responses, Toyo-Keizai estimates numerical scores for their definition, assigning digits ranging from 20.0 (the lowest) to 100.0 (the highest). The details of their score calculation method are omitted here. The scores are classified as follows:

Toyo-Keizai Data outline (3)

I. Corporate Social Responsibility (CSR) Scores (maximum 300 points)

(1) Human Resources: Gender equality ratio, Employee turnover rate

(2) Environment: Designated environment office, ISO 14001, Climate change evaluation

(3) Governance: Corporate ideology, Stakeholder engagement, Designated CSR division, Designated IR division

(4) Society: Designated regional management division, ESG indices

(5) Fundamentals:

II. Corporate Financial Performance (CFP) Scores (maximum 300 points)

(1) Growth: Growth rate of sales, Growth rate of net profit, Growth rate of free cash flow

(2) Profitability: Return on equity (ROE), Return on assets (ROA), Operating profit margin, Net profit margin

(3) Stability: Liquidity ratio, D/E ratio, Fixed asset ratio, Retained earnings over total assets

(4) Firm size: Sales revenue, EBITDA, net income, net asset, Interest bearing liabilities

(5) Financial status quo (for financial services only): Sales, Total asset, Retained earnings, ROE

Toyo-Keizai Data outline (4)

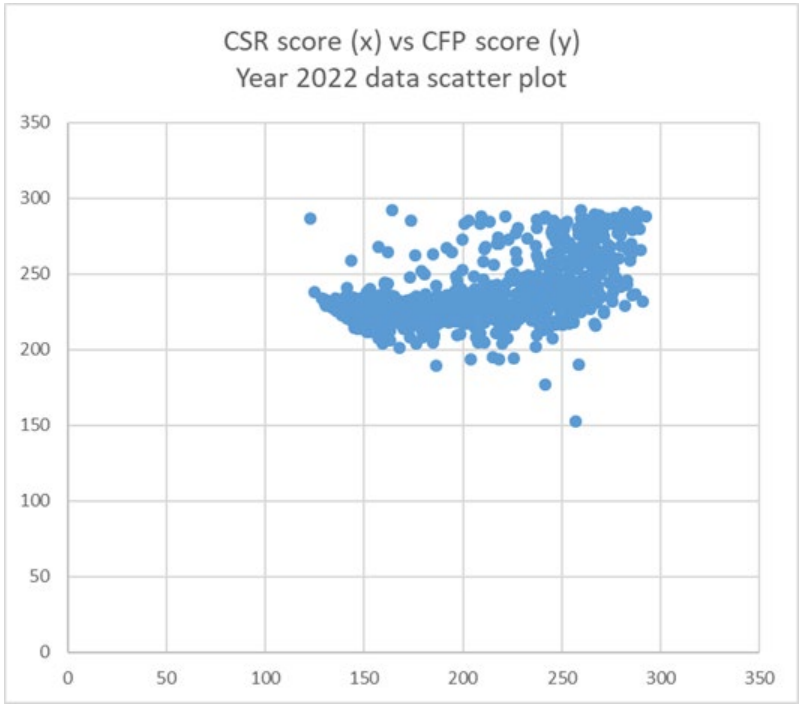
We only focus on the two top-level aggregate indexes: CSR score and CFP score.

Two top-level aggregate indexes: CSR score and CFP score.

I. Corporate Social Responsibility (CSR) Scores (maximum 300 points)

II. Corporate Financial Performance (CFP) Scores (maximum 300 points)

Scatter plots



Basic statistics

Basic statistics	CSR score	CFP score
Mean	218.01	238.98
St. err.	1.51	0.77
Median	224.40	232.20
Mode	237.20	230.70
St. dev.	42.75	21.74
Var.	1827.78	472.49
Kurtosis	-1.10	0.15
Skewness	-0.31	0.70
Range	170	140
Min	122.8	152.5
Max	292.8	292.5
Sum	174405.6	191186.8
Sample size	800	800

Regression analysis result (Models 1 and 2)

Model 1: $y = \alpha x^2 - \beta x + \gamma + \varepsilon$

Note that in the table,
the sign for β is flipped:
$(-\beta) < 0$

Model 1						
Multiple R2	0.334478					
Adjusted R2	0.332807					
Residual standard error	17.75497					
	Coeff.	St. err.	t-value	P-value (95%)	Low 95%	High 95%
intercept	336.172	16.799	20.01142	1.71E-72	303.1965	369.1475
x^2	0.003595	0.000385	9.338423	9.52E-20	0.002839	0.004351
x	-1.25965	0.1634	-7.70895	3.78E-14	-1.58039	-0.9389

Model 2: $\ln y = \alpha x - \beta \ln x + \gamma + \varepsilon$

Note that in the table,
the sign for β is flipped:
$(-\beta) < 0$

Model 2						
Multiple R2	0.323174					
Adjusted R2	0.321476					
Residual standard error	0.073336					
	Coeff.	St. err.	t-value	P-value (95%)	Low 95%	High 95%
intercept	10.24707	0.564534	18.1514	6.87E-62	9.138926	11.35522
x	0.006702	0.00064	10.47577	3.8E-24	0.005446	0.007958
ln(x)	-1.16258	0.131106	-8.86749	4.84E-18	-1.41993	-0.90522

Regression analysis result (Models 3 and 4)

Model 3: $y = \alpha x \ln x - \beta x + \gamma + \varepsilon$

Note that in the table,
the sign for β is flipped:
$(-\beta) < 0$

Model 3						
Multiple R2	0.332643					
Adjusted R2	0.330969					
Residual standard error	17.77943					
	Coeff.	St. err.	t-value	P-value (95%)	Low 95%	High 95%
intercept	480.3905	32.54133	14.76247	8.9E-44	416.5136	544.2673
xln(x)	1.460443	0.158617	9.207376	2.89E-19	1.149088	1.771799
x	-9.00013	1.005846	-8.94783	2.51E-18	-10.9746	-7.02571

Model 4: $\ln y = \alpha(\ln x)^2 - \beta \ln x + \gamma + \varepsilon$

Note that in the table,
the sign for β is flipped:
$(-\beta) < 0$

Model 4						
Multiple R2	0.320182					
Adjusted R2	0.318476					
Residual standard error	0.073498					
	Coeff.	St. err.	t-value	P-value (95%)	Low 95%	High 95%
intercept	22.89312	1.802034	12.70404	8.34E-34	19.35582	26.43041
(ln(x))^2	0.659301	0.064112	10.28352	2.24E-23	0.533452	0.785151
ln(x)	-6.78953	0.68025	-9.98093	3.47E-22	-8.12483	-5.45424

AIC

AIC is useful for model comparison:

Simplified formula, AIC = $n \ln(S/n) + 2p$

- Model 1: 4603.660
- Model 2: 4607.419
- Model 3: 4605.861
- Model 4: 4610.893

When the simplest linear regression with the equation $y = \alpha x + \gamma + \varepsilon$

- Model 0: 4684.232

We conclude that Models 1-4 are not significantly differentiated, but at least, all the models are better than the simplest linear regression model.

Summary so far

- We proposed and investigated the hypothesis: a U-shaped curve characterizes the relationship between CSR/ESG and CFP.

- A score dataset presented by Toyo-Keizai CSR Ranking survey on Japanese companies are utilized. All the results of regression analysis for four models show that our hypothesis is statistically significant.

- Similar studies could be conducted using different datasets and indicators, which should be left to other researchers.
  - The definitions of scores or indicators that specify CSR/ESG and CFP can be diverse; thus, various ways of justification shall exist, including model specification.

Theoretical model

- Let us start with considering a firm's production function with inputs of capital K and ESG goods Z. Here, the ESG goods are considered as hypothetical goods that contribute to ESG.
- As the production function, we consider a CES function with the feature of homogeneous degree of one:

$$f(Z,K) = (\phi Z^{\rho} + (1-\phi)K^{\rho})^{\frac{1}{\rho}} \qquad (1)$$

- Let r and v denote the rental price of the capital input and the price of the ESG input, respectively. The firm determines the allocation between capital and ESG according to the following equation:

$$\left(\frac{Z}{K}\right) = \left(\frac{\phi}{1-\phi}\right)^{-\sigma} \left(\frac{v}{r}\right)^{\sigma} \qquad (3)$$

$$\sigma \equiv \frac{1}{\rho - 1}$$

Theoretical model (2)

- In order to make production independent of scale, we can divide f by K to have the following:

$$y \equiv \frac{f(Z,K)}{K} = \left(\phi \left(\frac{Z}{K} \right)^{\rho} + (1-\phi) \right)^{\frac{1}{\rho}} \qquad (4)$$

Here, the interpretation of Z/K is originally the optimal ratio of ESG input to capital input, but here we simply consider it to be the ESG input per unit of capital input: The Z/K can be thus considered to be the ESG optimal input independent of size.

$x \equiv \frac{Z}{K}$: index representing firm's ESG efforts

$y \equiv \frac{f(Z,K)}{K}$: index representing financial performance

Eq. (4) leads to:

$$y = \left(\phi x^{\rho} + (1-\phi) \right)^{\frac{1}{\rho}} \qquad (6)$$

Theoretical model (3)

We introduce the following two assumptions:

Assumption 1: The larger a firm's size, the easier its financing will be.

Assumption 2: Firms with larger ESG contributions have higher elasticities of substitution between ESG goods and capital.

Theoretical model (4)

Assumption 1: The larger a firm's size, the easier its financing will be. That is, the amount of capital input K and its rental price r is inversely proportional to each other. Specifically, we assume the following:

$$\left(\frac{K}{Z}\right) = \left(\frac{r}{v}\right)^{-1}$$

By definition, $x \equiv \frac{Z}{K}$. Thus, the assumption 1 here means:

$$\left(\frac{r}{v}\right) = x \qquad (7)$$

Then, Eq. (3): $\left(\frac{Z}{K}\right) = \left(\frac{\phi}{1-\phi}\right)^{-\sigma}\left(\frac{v}{r}\right)^{\sigma}$ leads to that the following.

$$\phi = \frac{1}{1 + x^{1+\frac{1}{\sigma}}} \qquad (8)$$

Theoretical model (5)

Assumption 2: Firms with larger ESG contributions have a higher elasticity of substitution between ESG goods and capital.

In general, a higher elasticity of substitution means that the two goods are more compatible and homogeneous as goods for the firm in question: In the case of comparison of ESG goods and capital, if the elasticity of substitution is high, ESG efforts can be compatible capital inputs, but this is not the case if it is low.

This assumption can be further specified as a mathematical equation as follows. That is, σ is assumed to be a function of x as follows:

$$\sigma(x) = -\frac{x^{\alpha}}{c} \qquad (9)$$

where $\alpha > 0$ and $c > 0$ are constant coefficients. Note that $\sigma(x) < 0$.

From the definition of $\sigma \equiv \frac{1}{\rho - 1}$, we have the following:

$$\rho(x) \equiv 1 + \frac{1}{\sigma(x)} = 1 - \frac{c}{x^{\alpha}} \qquad (10)$$

Theoretical model (6)

Assumption 1: The larger a firm's size, the easier its financing will be.

$$\phi = \frac{1}{1 + x^{1+\frac{1}{\sigma}}} \qquad (8)$$

$\Rightarrow$

$$\phi(x) = \frac{1}{1 + x^{\rho(x)}} \qquad (11)$$

Assumption 2: Firms with larger ESG contributions have a higher elasticity of substitution between ESG goods and capital.

$$\rho(x) \equiv 1 + \frac{1}{\sigma(x)} = 1 - \frac{c}{x^{\alpha}} \qquad (10)$$

Usually we interpret the relationship between x and ϕ as such that the optimal composition of input goods is determined by the share parameter that defines the production function. Equation (11), on the other hand, implies a reversed order: That is, the share parameter specific to each firm can be calculated backwards from the current x.

Theoretical model (7)

Assumption 1: The larger a firm's size, the easier its financing will be.

$$\phi(x) = \frac{1}{1 + x^{\rho(x)}} \qquad (11)$$

Assumption 2: Firms with larger ESG contributions have a higher elasticity of substitution between ESG goods and capital.

$$\rho(x) \equiv 1 + \frac{1}{\sigma(x)} = 1 - \frac{c}{x^{\alpha}} \qquad (10)$$

From assumptions 1 and 2, production function (6)

$$y = \left(\phi x^{\rho} + (1 - \phi)\right)^{\frac{1}{\rho}} \qquad (6)$$

is rewritten as follows:

$$y = \left(\frac{2}{1 + x^{1 - \frac{c}{x^{\alpha}}}}\right)^{\frac{1}{1 - \frac{c}{x^{\alpha}}}} x \qquad (13)$$

where $\alpha > 0$ and $c > 0$ are constant coefficients.

Theoretical model (8)

$$y = \left(\frac{2}{1 + x^{1-\frac{c}{x^{\alpha}}}} \right)^{\frac{1}{1-\frac{c}{x^{\alpha}}}} x \qquad (13)$$

where $\alpha > 0$ and $c > 0$ are constant coefficients.

- Equation (13) has a functional form that is difficult to treat analytically, so there is no choice but to observe the shape of the function by numerical calculation.

Theoretical model (9)

$$y = \left(\frac{2}{1 + x^{1 - \frac{c}{x^{\alpha}}}} \right)^{\frac{1}{1 - \frac{c}{x^{\alpha}}}} x \qquad (13)$$

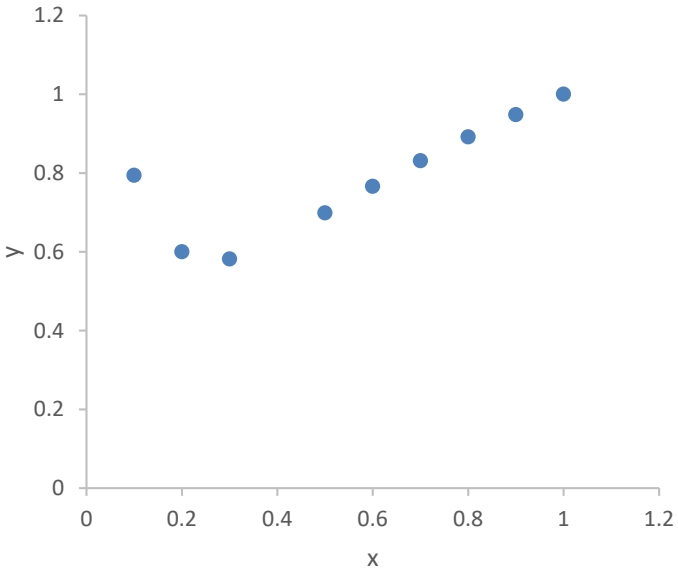


Figure 5.1(a): the shape of equation (13) ($\alpha = 1$ and $c = 0.4$)

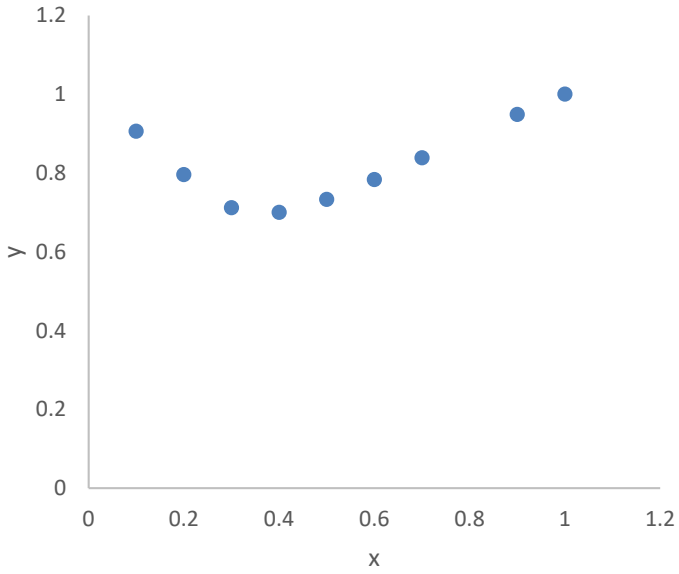


Figure 5.1(b): Shape of equation (13) ($\alpha = 1$ and $c = 0.8$)

Theoretical model (10)

$$y = \left(\frac{2}{1 + x^{1 - \frac{c}{x^{\alpha}}}} \right)^{\frac{1}{1 - \frac{c}{x^{\alpha}}}} x \qquad (13)$$

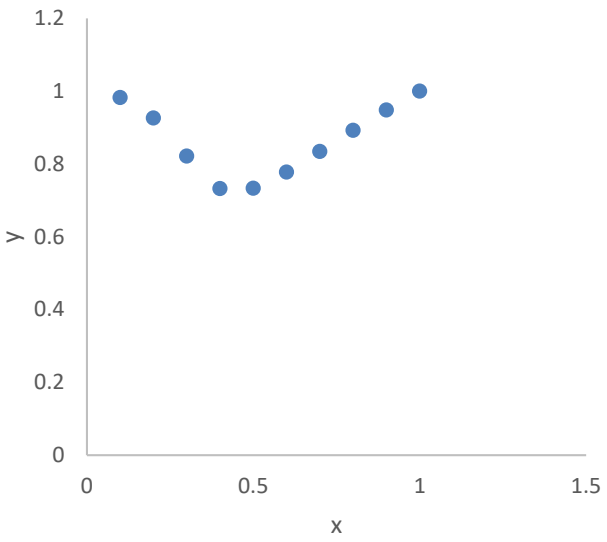


Figure 5.1(c): the shape of equation (13) ($\alpha = 2$ and $c = 0.4$)

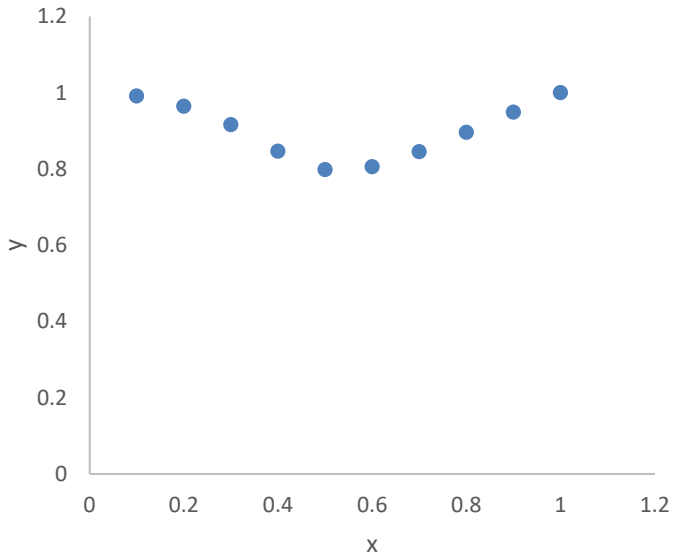


Figure 5.1(d): Shape of equation (13) ($\alpha = 2$ and $c = 0.8$)

Conclusion

- In this paper, we proposed and tested a hypothesis that the relationship between CSR/ESG and CFP is a U-shaped relationship.
- It seems to be well supported as an empirical analysis as long as the score data from the Toyo Keizai CSR Ranking Survey is used for the analysis.
- We then developed a theoretical model.
  - The CES function is very common in economic analysis, and the results obtained from the CES function are usually consistent with intuition: That is, resulting relations between variables would typically be monotonically increasing or monotonically decreasing.
  - However, the model (13) here, which is a straightforward result of CES function, showed a shape that breaks monotonicity.
  - In this respect, the model is quite unique, and beyond CSR/ESG analysis, it has great implications for other fields, such as environmental Kuznets curves.