Equivalence of Various Environmental Policies and Green Central Bank

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Current ESG lending: distort asset allocation

1, **Banks' Loan Allocation :**

two-parameter approach

(i) Rate of Return (R), (ii) Risks (σ^2)

2, **ESG component is added for the asset allocation**

(iii) ESG (Greenness score): multi-factor model

3, **ESG criteria is different from one rating agency to another**

4, **Each Investor changes its' asset allocation based on specific score of ESG given by the rating agency**

Green Banking and Green Investments

Banks used to examine

“Rate of Return” and “Risks”

No attention was paid to “Green factors”

(1) ESG scoring (ESG rating)

(2) Green Bonds

(3) Carbon Pricing and Carbon Trading

(4) Carbon Tax

Model

(1)Rate of return (R)　(2) Risk (σ^2)　(3) ESG

$$U(R_t, \sigma_t^2, ESG_t) = R_t - \beta\sigma_t^2 + \underline{\gamma(ESG_t)} \tag{7}$$

$$\text{s.t. } R_t = \alpha_t R_t^A + (1 - \alpha_t) R_t^B \tag{8}$$

$$\sigma_t^2 = \alpha_t^2 (\sigma_t^A)^2 + (1 - \alpha_t)^2 (\sigma_t^B)^2 \tag{9}$$

$$ESG_t = \alpha_t (ESG_t^A) + (1 - \alpha_t)(ESG_t^B)$$

$$\frac{\partial U}{\partial \alpha_t} = (R_t^A - R_t^B) - \beta\{2\alpha_t(\sigma_t^A)^2 + 2(1-\alpha_t)(\sigma_t^B)^2\}$$

$$+ (2 - 4\alpha_t)\sigma_t^{AB} + \gamma(ESG_t^A - ESG_t^B) = 0 \qquad (6)$$

Writing equation (6) for the results in equation (7):

$$\alpha_t = \frac{\frac{1}{2\beta}(R_t^A - R_t^B) - (\sigma_t^B)^2 - \sigma_t^{AB} + \frac{\gamma}{2\beta}(ESG_t^A - ESG_t^B)}{(\sigma_t^A)^2 - (\sigma_t^B)^2 - 2\sigma_t^{AB}} \qquad (7)$$

α = asset allocation between two companies

(1)Rate of Return (2)Risks (3) ESG

Different Evaluation scores of ESG by various Rating Agencies

E-scores Environmental Scores

Table 1: Rating methods provided by major ESG rating agencies

ESG Score	Evaluation criteria overview
Bloomberg ESG Disclosure Scores	Evaluated based on the degree of disclosure. Environmental aspects are evaluated based on the degree of disclosure.
FTSE Russell's ESG Ratings	ESG risks are evaluated based on disclosure, commitment to policy formulation and improvement, etc. In terms of the environment, in addition to disclosure, we evaluate the existence of policies and commitments to improvement.
MSCI ESG Ratings	Evaluated based on 37 key ESG issues (ESG key issues). The environment side is also evaluated by setting a key issue.
Sustainalytics' ESG Risk Ratings	Based on ESG measures, information disclosure, and the level of problems. The same is true in terms of the environment.
Thomson Reuters ESG Scores	10 items: for the Environment factor, resource use, emissions, and innovation; for Society factor, employees, human rights, local communities, and product responsibility; and on Governance, management, shareholders, and CSR strategy. Regarding the environment, evaluated based on actual carbon emissions and whether or not there is a policy.

(Source) Created by the authors after processing part of the data of Yoshino and Yuyama (2021), Yuyama (2020), and each rating agency.

	Bloomberg	Sustainalytics	Robecco Sam
Company A	2.9	9.6	8.6
Company B	3.9	1.3	1.8
% Share of A (Investment)	54%	74%	71%
% Share of B (Investment)	46%	26%	29%

Empirical analysis of the relationship between ESG scores and risk/return

- Japan's Nikkei 225 as of December 30, 2021

Correlation between ESG and Return

	Dependent variable : Stock return 2021						
	ESG score						
	bld2021	ble2021	bls2021	blg2021	blep2021	blsp2021	blgp2021
ESG score	0.004*	0.003**	0.002	0.003	-0.000	-0.001	0.001
	(0.051)	(0.046)	(0.330)	(0.161)	(0.939)	(0.577)	(0.264)
Control variabls							
Total asset	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.796)	(0.932)	(0.831)	(0.758)	(0.700)	(0.718)	(0.795)
ROA	0.008	0.008	0.008	0.007	0.008	0.008	0.008
	(0.211)	(0.186)	(0.223)	(0.244)	(0.213)	(0.220)	(0.244)
Equity ratio	-0.003**	-0.003**	-0.003*	-0.002*	-0.003*	-0.003*	-0.003*
	(0.047)	(0.031)	(0.058)	(0.100)	(0.056)	(0.068)	(0.059)
Constant	0.028	0.138*	0.188**	-0.033	0.280***	0.298***	0.223***
	(0.821)	(0.079)	(0.020)	(0.871)	(0.007)	(0.000)	(0.007)
Observations	223	223	223	223	195	195	195

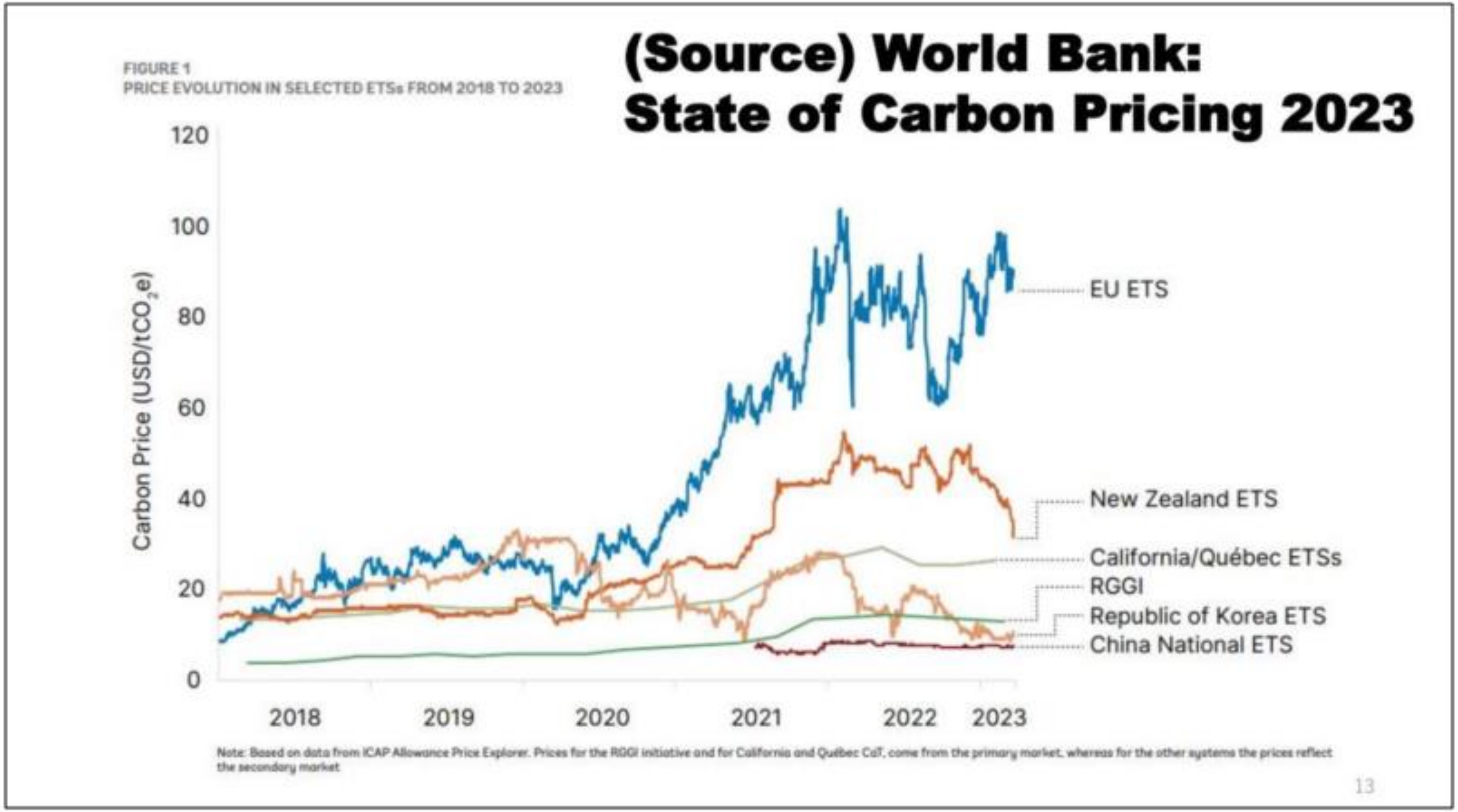
Correlation Between ESG and Risks

	Dependent variable : Stock volatility 2021						
	ESG score						
	bld2021	ble2021	bls2021	blg2021	blep2021	blsp2021	blgp2021
ESG score	-6.984*	-3.473	-4.302	-6.426	-3.192	-1.689	-2.223
	(0.074)	(0.115)	(0.269)	(0.124)	(0.102)	(0.361)	(0.252)
Control variabls							
Total asset	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.540)	(0.648)	(0.553)	(0.489)	(0.721)	(0.647)	(0.767)
ROA	32.320***	31.726***	32.584***	33.244***	31.574***	31.209***	32.519***
	(0.003)	(0.004)	(0.003)	(0.002)	(0.008)	(0.009)	(0.006)
Equity ratio	6.510**	6.861***	6.334**	5.668**	6.276**	7.118**	6.667**
	(0.011)	(0.008)	(0.013)	(0.028)	(0.032)	(0.016)	(0.023)
Constant	327.761	128.131	91.275	511.782	209.148	54.832	78.085
	(0.131)	(0.352)	(0.517)	(0.151)	(0.256)	(0.706)	(0.597)
Observations	223	223	223	223	195	195	195

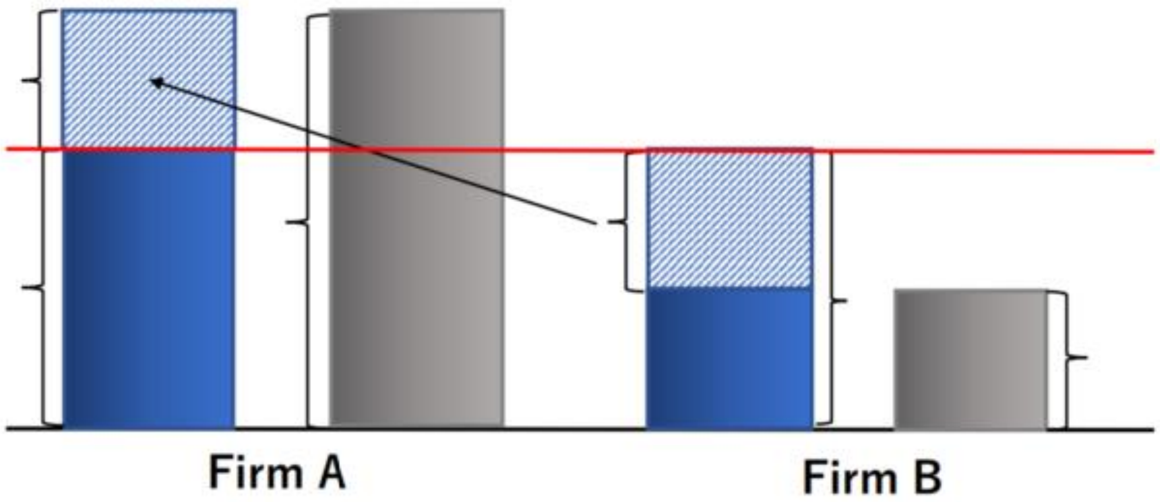
Various Policy Tools
to Achieve Green Economy

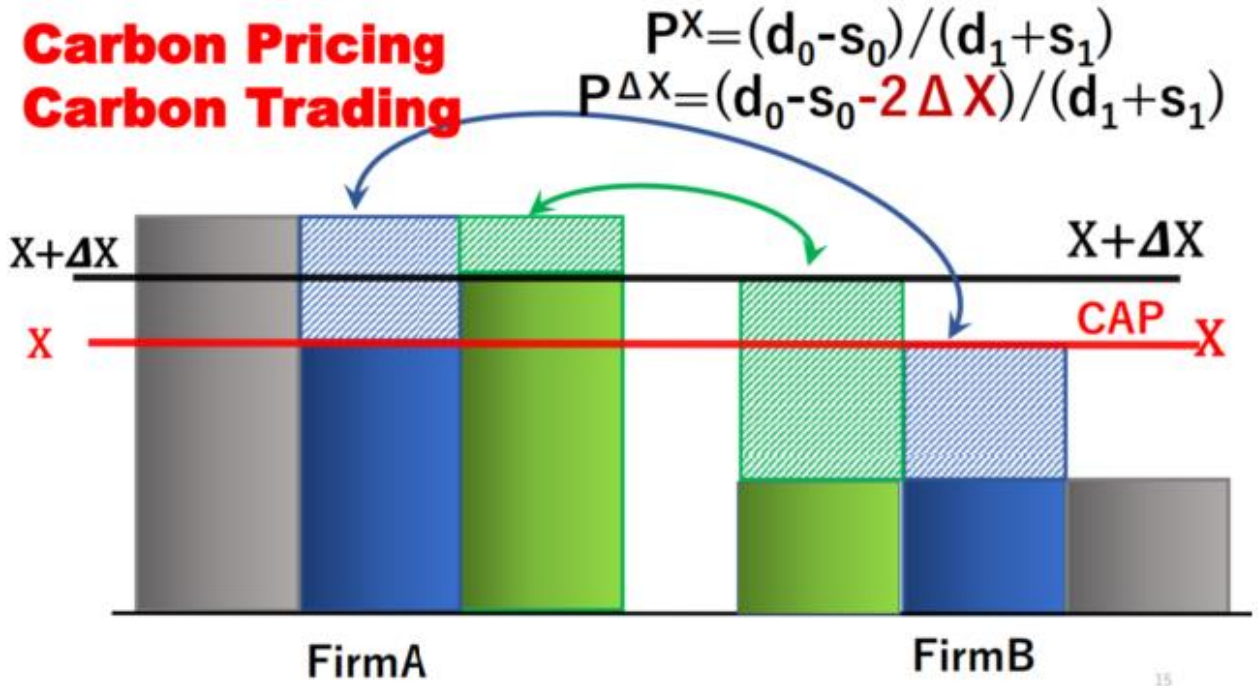
1, Green Credit Rating (ESG Rating)
2, Green Bonds
3, Carbon Pricing and Carbon Trading
4, Carbon Tax

Figure 2: Price evolution in selected ETSs from 2018 to 2023



Carbon Trading and Carbon Pricing





Carbon Supply & Demand

$S=s_0+s_1P+\Delta X$ (Supply)

$D=d_0+d_1P-\Delta X$ (Demand)

$\Delta X=$ (Cap-Actual emission)

Equilibrium Carbon Price

$(d_0-s_0)-2\Delta X$

Voluntary Process Guidelines for Issuing Green Bonds

International Capital Market Associations

- **Renewable energy** (including production, transmission, appliances and products);
- **Energy efficiency** (such as in new and refurbished buildings, energy storage, district heating, smart grids, appliances and products);
- **Pollution prevention and control** (including reduction of air emissions, greenhouse gas control, soil remediation, waste prevention, waste reduction, waste recycling and energy/ emission-efficient waste to energy);
- **Environmentally sustainable management of living natural resources and land use** (including environmentally sustainable agriculture; environmentally sustainable animal husbandry; climate smart farm inputs such as biological crop protection or drip-irrigation; environmentally sustainable fishery and aquaculture; environmentally sustainable forest including afforestation or reforestation, and preservation or restoration of natural landscapes);

and Staff. It ma

- **Terrestrial and aquatic biodiversity** conservation (including the protection of coastal, marine and watershed environments);
- **Clean transportation** (such as electric, hybrid, public, rail non-motorised, multi-modal transportation, infrastructure f clean energy vehicles and reduction of harmful emissions);
- **Sustainable water and wastewater management** (including sustainable infrastructure for clean and/or drinki water, wastewater treatment, sustainable urban drainage systems and river training and other forms of flooding mitigation);
- **Climate change adaptation** (including efforts to make infrastructure more resilient to impacts of climate change, as well as information support systems, such as climate observation and early warning systems);
- **Circular economy adapted products, production technologies and processes** (such as the design and introduction of reusable, recyclable and refurbished materials, components and products; circular tools and services); **and/or certified eco-efficient products**;
- **Green buildings** that meet regional, national or internationally recognised standards or certifications for environmental performance.

Example of Green Building in Japan

Several Building were constructed by issuing

Green Bonds

(1) How much CO2 be cut?

20% cut, 30% cut etc.

(2) Energy efficient elevators

(3) Better ventiration of air quality

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GREEN BONDS AND GLOBAL OPTIMAL PORTFOLIO ALLOCATION

Naoyuki Yoshino[a] and Muhammad Zubair Mumtaz[b]

Optimal Portfolio Allocation based on Green Score

$$\mathrm{GB}_{1t} = \frac{-a_1(\mathrm{CO_2}) - a_2(\mathrm{N_2O}) - a_3(\mathrm{CH_4})}{Y_1} \tag{5}$$

$$\mathrm{GB}_{2t} = \frac{-b_1(\mathrm{CO_2}) - b_2(\mathrm{N_2O}) - b_3(\mathrm{CH_4})}{Y_2} \tag{6}$$

$$\alpha' = \frac{\frac{1}{\beta}(R_1 - R_2) - (2\sigma_{12} - 2\sigma_2^2) + \frac{\gamma}{\beta}(\mathrm{GB}_1 - \mathrm{GB}_2)}{(2\sigma_1^2 + 2\sigma_2^2 - 4\sigma_{12})} \tag{9}$$

Eqs. (8) and (9) estimate the percentage of investment in green bonds without and with the greenness measures, respectively. We assume that investors participate in a higher proportion of investments if the firm accounts for greenness activities.

Table 1. Comparison of Greenness Measures.

	R_1	R_2	σ_1^2	σ_2^2	α	$\acute{\alpha}$	α^*	$\alpha^* - \acute{\alpha}$
Panel A: Developed Country								
Japan	3.12%	1.88%	2.87%	2.20%	0.49	0.74	0.80	0.06
Panel B: Developing Countries								
Indonesia	6.82%	9.07%	3.33%	4.72%	0.50	0.64	0.76	0.12
Malaysia	7.51%	6.22%	5.09%	4.14%	0.48	0.67	0.78	0.11
Pakistan	11.88%	8.53%	8.71%	6.60%	0.42	0.62	0.81	0.19
Thailand	4.30%	3.345	2.90%	1.18%	0.51	0.66	0.79	0.13

Notes: This table presents the rate of return and variance of green bonds "1" and "2" in the oil and gas and manufacturing sectors. α refers to the proportion of investment in green bonds without taking green measures by a firm, $\acute{\alpha}$ denotes the proportion of investment considering green measures, and α^* is the optimal level of proportion based on the global measures of greenness. $\alpha^* - \acute{\alpha}$ identified the gap between global measures of greenness and firms' actions account for the greenness.

Policies based on CO2 Emissions

1, Green Credit Rating: Based on CO2 emission

AAA, AA, A, BBB, BB, B, CCC, CC, C $= \theta \times (CO_2)$

2, Green Bond Rating: Based on CO2 Emissions

AAA, AA, A, BBB, BB, B, CCC, CC, C $= \theta \times (CO_2)$

3, Set up the ceiling of the amount of CO2 emissions

Carbon Trading and Carbon Pricing

Carbon pricing will become identical to the Tax rate

$P \times (CO_2)$

4, Carbon Tax

Tax rate x CO2 $= t \times (CO_2)$

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Green Credit Rating	Carbon Tax	Green Bond	Carbon Pricing
$\vartheta \times (CO_2)$	$t \times (CO_2)$	$\vartheta \times (CO_2)$	$P = \dfrac{(d_0 - S_0) - 2\Delta X}{(d_1 + S_1)}$ $P \times (CO_2)$

Measure of the Amount of CO_2 Emissions

$\alpha \quad X \quad (CO_2)$

Table 6: Examples of Credit Scoring, GHG tax, and Green Bonds Based on GHG Emissions

	Country	Company Name	Scope 1 GHG Emissions	Emissions per Million USD Revenue/ Sales/ Income	Green Bond Rating	Credit Rating	Carbon Tax
O&G	Japan	Cosmo Oil	7,287	420	C	C	t*7287
		Idemitsu Kosan	13,858	236	B	B	t*13858
		Inpex	6,839	476	C	C	t*6839
	India	Indian Oil Corporation	20,210	179	BB	BB	t*20210
		Bharat Petroleum	10,242	160	BBB	BBB	t*10242
		Hindustan Petroleum	3,342	60	AA	AA	t*3342

	US	ExxonMobil	92,000	267	C	C	t*92000
		Phillips 66	24,800	168	BBB	BBB	t*24800
		Valero Energy	24,800	171	BB	BB	t*24800
Pharmaceuticals	Japan	Daiichi Sankyo Co Ltd	86	11	AAA	AAA	t*86
		Takeda Pharmaceutical Co Ltd	316	12	AAA	AAA	t*316
		Chugai Pharmaceutical Co Ltd	48	7	AAA	AAA	t*48
	India	Sun Pharma	67	13	AAA	AAA	t*67
		Dr Reddy's Lab	302	101	A	A	t*302
		Cipla	38	14	AAA	AAA	t*38
	US	Johnson & Johnson	320	4	AAA	AAA	t*320
		Eli Lily & Co	182	5	AAA	AAA	t*182
		Merck & Co	1,236	21	AAA	AAA	t*1236
Automotives	Japan	Toyota	2,370	10	AAA	AAA	t*2370
		Honda	1,090	10	AAA	AAA	t*1090
		Nissan Motors	661	10	AAA	AAA	t*661
	India	Mahindra and Mahindra	59	6	AAA	AAA	t*59
		Suzuki	420	31	AAA	AAA	t*420
		Tata Motors	60	8	AAA	AAA	t*60
	US	General Motors	2,700	16	AAA	AAA	t*2700
		Ford	1,108	6	AAA	AAA	t*1108
		Stellantis	1,400	7	AAA	AAA	t*1400

ource: Author's calculations based on companies' financial and sustainability reports

Comparison of Various Policy Tools

Carbon credit ratings impose an indirect financial burden on the private sector through potential impacts on cost of capital and reputation. However, they do not generate direct financial flows.

Carbon taxes place a direct financial burden on the private sector, with funds collected by the government. This represents a transfer from private entities to the government.

In carbon pricing systems (e.g., cap-and-trade), the financial burden is initially borne by the private sector. However, unlike carbon taxes, the funds generally circulate within the private sector as companies trade emissions allowances.

Private green bonds involve a flow of funds from private investors to private issuers. While they create a financial obligation for the issuer, they also provide access to capital for green projects. A lower rating could imply a higher interest burden on the issuer.

Public green bonds, like private ones, involve private investors. However, the funds are directed to the government, like traditional government bonds. This allows the public sector to finance green initiatives through market mechanisms

Gains and Costs

Carbon Credit Rating	Carbon Tax	Carbon Pricing	Private Green Bonds	Public Green Bonds
Within private	Collected by government	Within private	Within private	Collected by government
Fund supply → recipients	Private → government	Excess supply → Lower supply	Private investor → private issuer	Private investor → government

Tools to Measure CO2 Emissions in Japan

35 US $

45 US $

20 US $

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5,980円 送料無料

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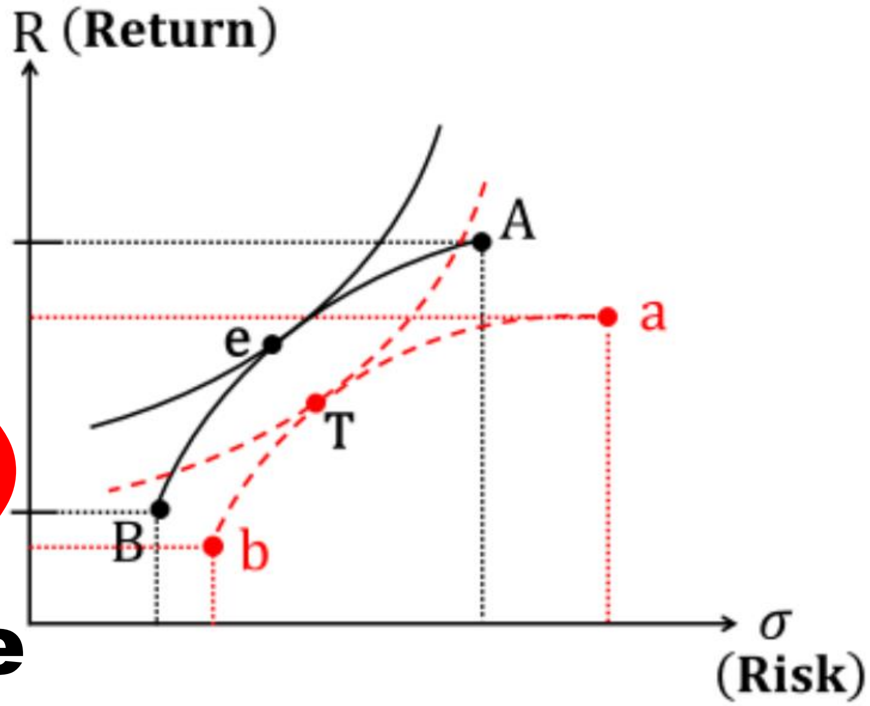
Carbon Pricing = Px(CO2)



After pricing: Return and Risks (After CO2 Pricing:R and Risks)

Optimal portfolio allocation can be achieved by taxing on carbon emission

Company A's return after carbon tax: $\underline{R_A} = R_A$ – (Carbon Tax TA)

Risks After Carbon Tax: $\underline{\sigma}\ \underline{A}$

Company B's return after carbon tax: $\underline{R_B} = R_B$ – (Carbon Tax TB)

Risk After Carbon Tax: $\underline{\sigma}\ \underline{B}$

Carbon Tax= t x (CO2)
Carbon Pricing = P x (CO2)

$$\tilde{R}_t^A = R_t^A - \underline{T_t^A} \tag{11}$$

$$\tilde{R}_t^B = R_t^B - \underline{T_t^B} \tag{12}$$

Equations (11) and (12) show the "after-tax rate of return" of company A and company B. The optimal allocation of assets between company A and B is computed as equations (13) and (14) that show the optimal rate of return and risk, respectively:

$$\tilde{R}_t = \tilde{\alpha}_t \tilde{R}_t^A + (1 - \tilde{\alpha}_t)\tilde{R}_t^B \tag{13}$$

$$\tilde{\sigma}_t^2 = \tilde{\alpha}_t^2 (\tilde{\sigma}_t^A)^2 + (1 - \tilde{\alpha}_t)^2 (\tilde{\sigma}_t^B)^2 + 2\tilde{\alpha}_t (1 - \tilde{\alpha}_t)\tilde{\sigma}_t^{AB} \tag{14}$$

Next, to find the optimal portfolio allocation ratio between asset A and asset B, we obtain the first-order condition of the utility function for $\tilde{\alpha}$:

$$\frac{\partial U}{\partial \tilde{\alpha}_t} = (\tilde{R}_t^A - \tilde{R}_t^B) - \beta\{2\tilde{\alpha}_t (\tilde{\sigma}_t^A)^2 + 2(1 - \tilde{\alpha}_t)(\tilde{\sigma}_t^B)^2\} + (2 - 4\tilde{\alpha}_t)\tilde{\sigma}_t^{AB} = 0 \tag{15}$$

$$\tilde{\alpha}_t = \frac{\frac{1}{2\beta}\left(\tilde{R}_t^A - \tilde{R}_t^B\right) - (\tilde{\sigma}_t^B)^2 - \tilde{\sigma}_t^{AB}}{(\tilde{\sigma}_t^A)^2 - (\tilde{\sigma}_t^B)^2 - 2\tilde{\sigma}_t^{AB}} \tag{16}$$

Evidently, as in equation (16), investors do not need to consider ESG as an additional item, as shown in equation (7). Instead, investors maximize their utility based only on the rate of return and the risk after tax. The optimal portfolio allocation is as shown in equation (16). $\tilde{\alpha}_t$ indicates the optimal portfolio as shown in Figure 3.5 by point *f*. *f* is the optimal point after the adoption of the international GHG taxation scheme.

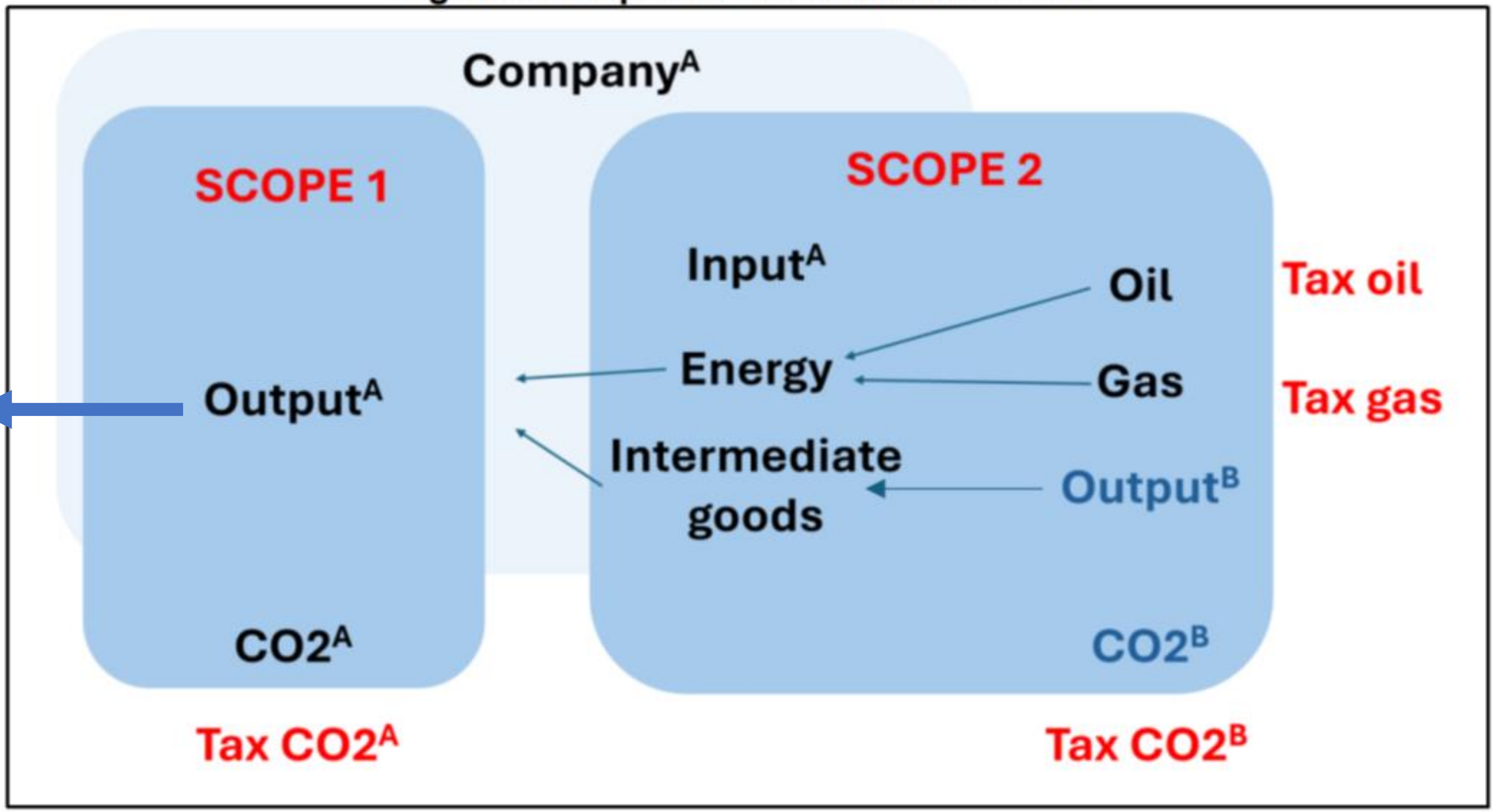
Scope1, Scope2 and Scope3: Value Chain

Scope 3

Y ← Inputs

CO2
Tax

Figure 3: Proposed Taxation Mechanism



Global Value Chain--- Scope 1, 2 and 3

$g_1(CO2, Y_1) = F_1(K, L, X_2)$ Scope 1

g_2

$(X_2, CO2) = F_2(K, L)$

Scope

2

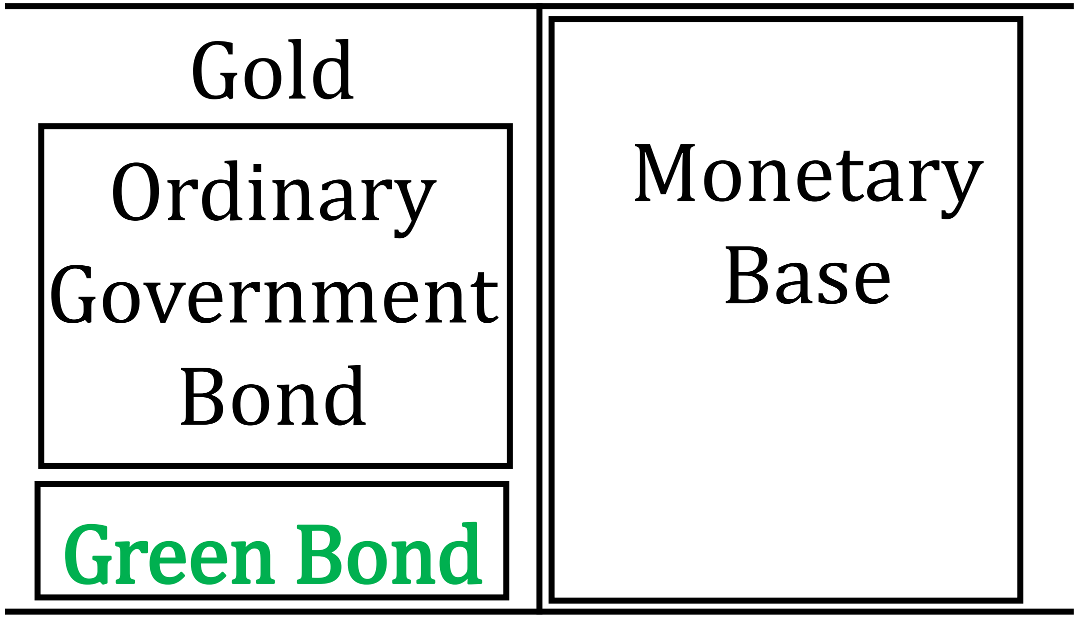
$g_3(CO2, Y_3) = F_3(Y_1, K, L)$

			Scope 1[8]	Scope 2[9]	Scope 3[10]
Oil & Gas	Japan	Cosmo Oil	7,287	243	71,748
		Idemitsu Kosan	13,858	553	122,324
		Inpex	6,839	69	84,926
	India	Indian Oil Corporation	20,210	630	301,500
		Bharat Petroleum	10,242	715	141,175
		Hindustan Petroleum	3,342	637	116,301
	United States	ExxonMobil	92,000	6,000	540,000
		Phillips 66	24,800	6,400	354,000
		Valero Energy	24,800	4,900	NA
Pharmaceuticals	Japan	Daiichi Sankyo	86	24	2,122
		Takeda Pharmaceutical	316	0	4,462
		Chugai Pharmaceutical	48	3	1,137
	India	Sun Pharma	67	353	357
		Dr Reddy's Lab	302	166	470
		Cipla	38	187	NA
	United States	Johnson & Johnson	320	123	6,866
		Eli Lily & Co	182	345	NA
		Merck & Co	1,236	227	4,594
Automobiles	Japan	Toyota	2,370	2,870	570,490
		Honda	1,090	2,730	284,410
		Nissan Motors	661	1,435	118,828
	India	Mahindra and Mahindra	59	202	80,214
		Suzuki	420	720	19,860
		Tata Motors	60	266	3,141
	United States	General Motors		2,700	241,000
		Ford	1,108	1,355	384,120
		Stellantis	1,400	1,700	457,600

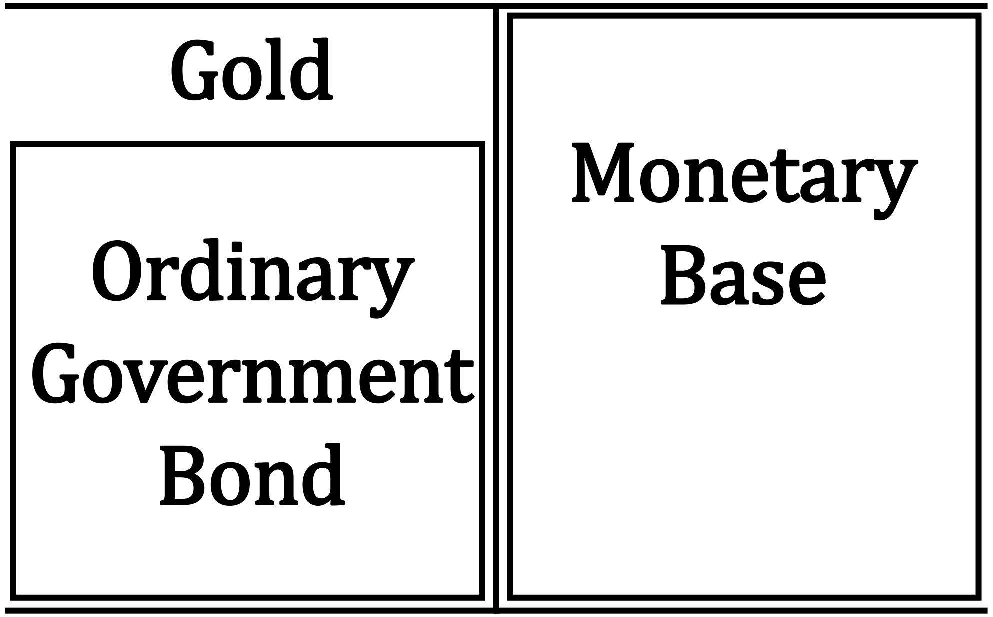
Source: Companies' ESG disclosures

Green Central Banking (Independence?)

① Central Bank



② Central Bank



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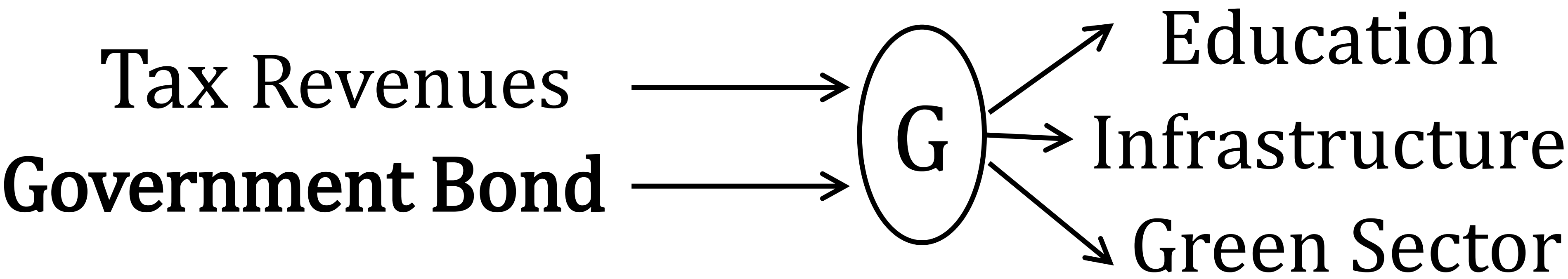

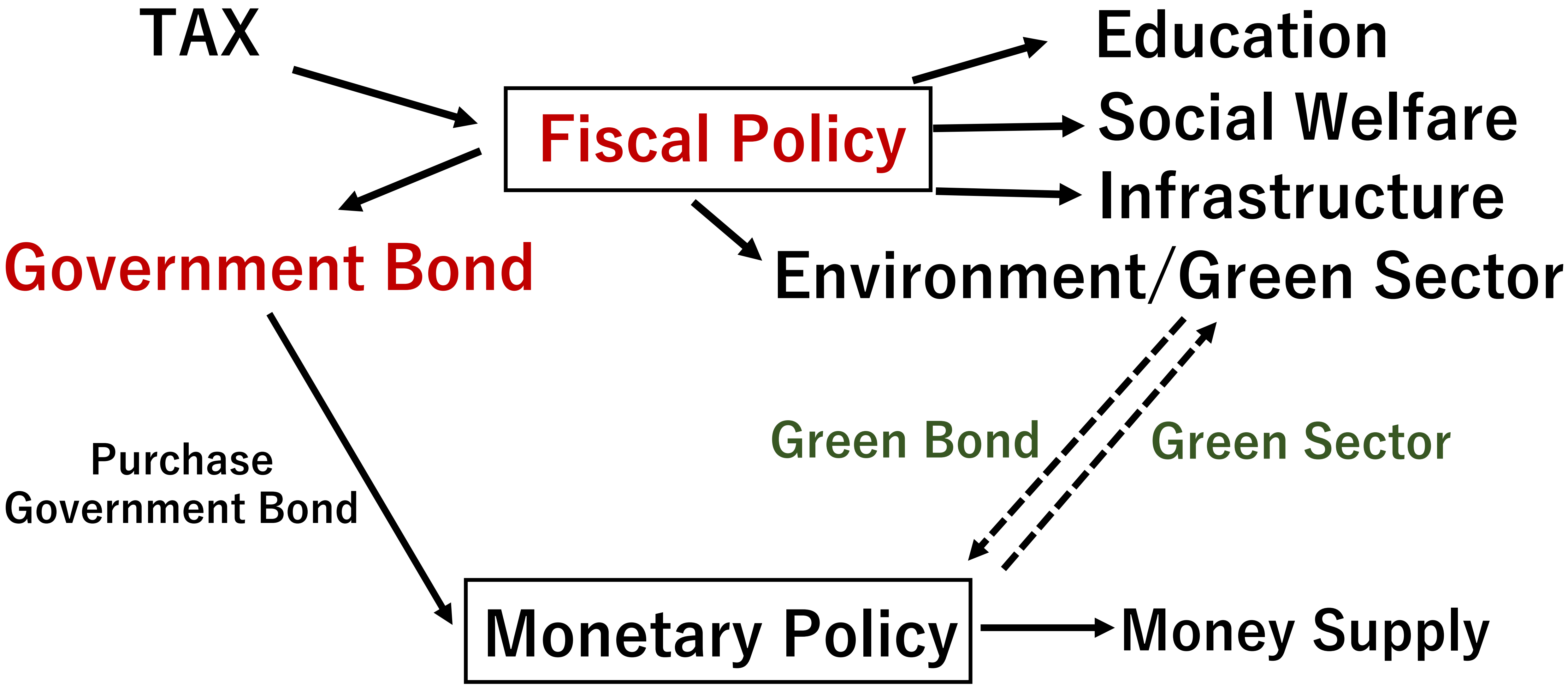
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Green Bond
Green Sector
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Naoyuki Yoshino, Aashi Agarwal,
and KE Seetha Ram

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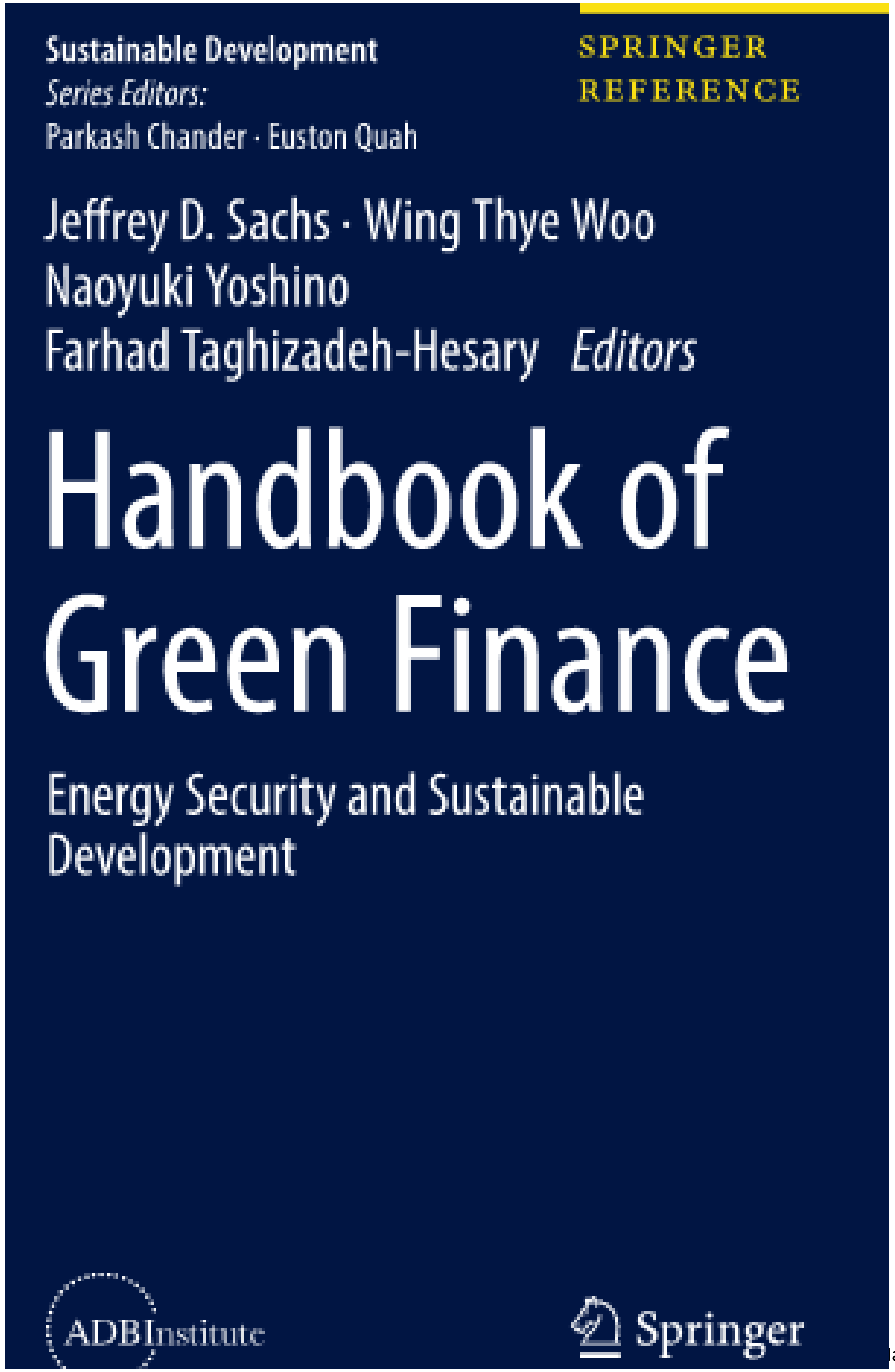
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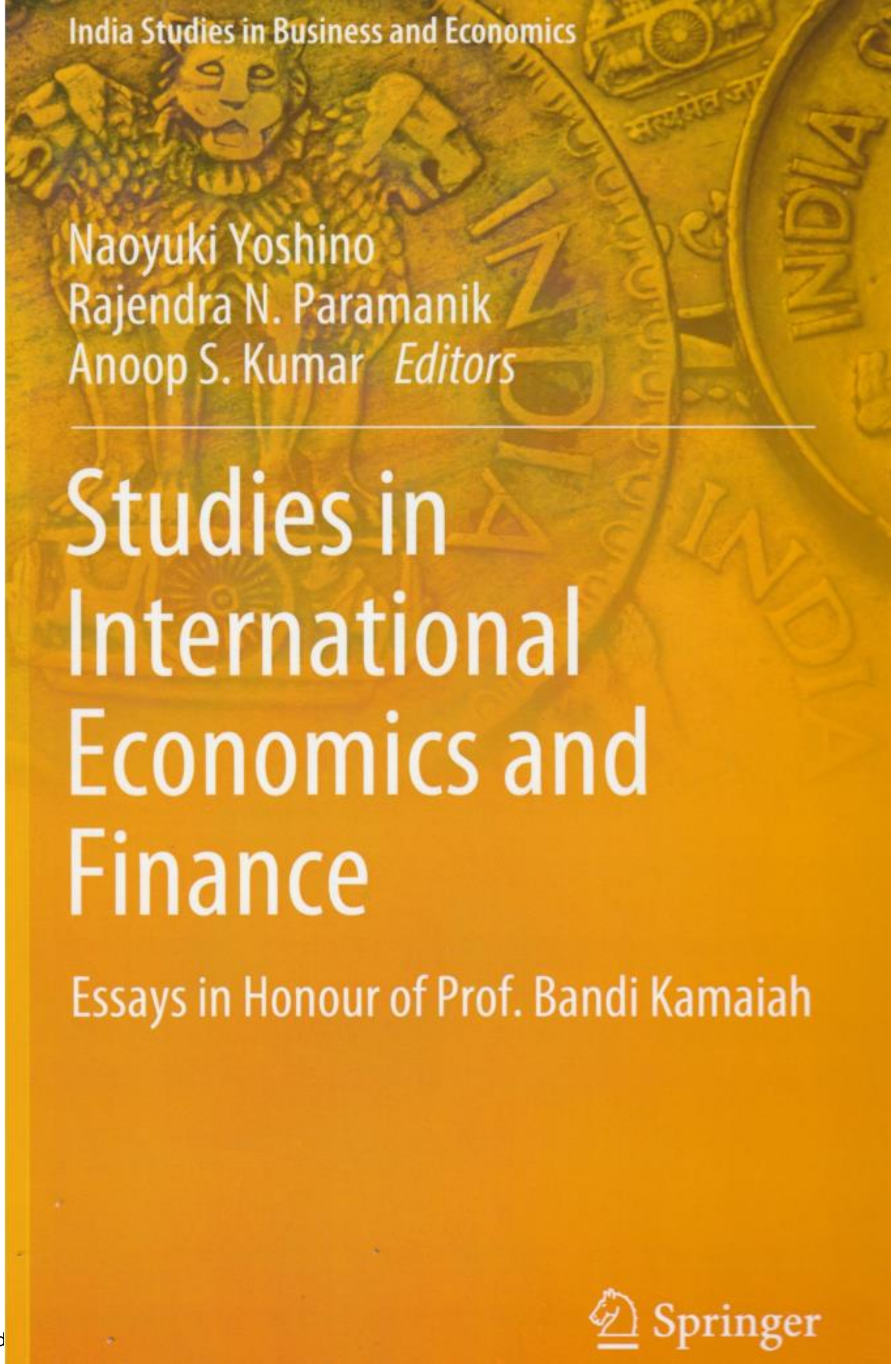
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