Does Carbon Premium differ among Estimated, Mandatorily- and Voluntarily-Disclosed Emissions? - Evidence in Australia

[updated analysis]

Ivan Diaz-Rainey

Work with: Ling Liao, Duminda Kuruppuarachchi

6th JRC Summer School on Sustainable Finance (27-28 June 2024)

GriffithUNIVERSITY
Griffith Business School
Queensland, Australia

Outline

- Introduction

    - Research Questions

    - Key Findings

- Literature Review and Hypotheses Development

- Data

- Methodology

- Result Highlights

- Conclusion

Introduction

Why

- Rising demand for better climate disclosures (Diaz-Rainey et al., 2023; Flammer et al., 2021; Ilhan et al., 2023a; Pástor et al., 2021).

- To inform policymaking: insights into impact of estimated and voluntary emissions disclosures?

How

- Disclosure-Choice Logit Model: Heckman (1979) and inverse Mills ratio

- Ordinary Least Squares (OLS) Models

- Fama-MacBeth Cross-Sectional Regressions

Contribution

- Identified an overlooked and significant information uncertainty risk priced in cross-section

- Enriched the literature on carbon premium and mandatory disclosures

- Provided climate policy implications and investment strategies

Motivation and Research Questions

- Existing literature:
    - Existence of carbon premium (Aswani et al., 2023a; Bolton & Kacperczyk, 2021b, 2023b; Pástor et al., 2021, 2022)
    - Inconsistent third-party emissions estimation (Busch et al., 2022) & self-selection bias of the voluntarily disclosed emissions (Choi et al., 2021; Choi & Luo, 2021; Matsumura et al., 2014)
- Literature gap: does the market distinguish the information uncertainty risk between estimation, and mandatory or voluntary disclosure?
- RQ: Can the carbon emissions and information (un)certainty of voluntarily-, mandatorily-disclosed, and estimated emissions explain the cross-sectional returns?

Total Emissions and Disclosure Frequency Over Time

- Panel B Disclosure Frequency Over Time
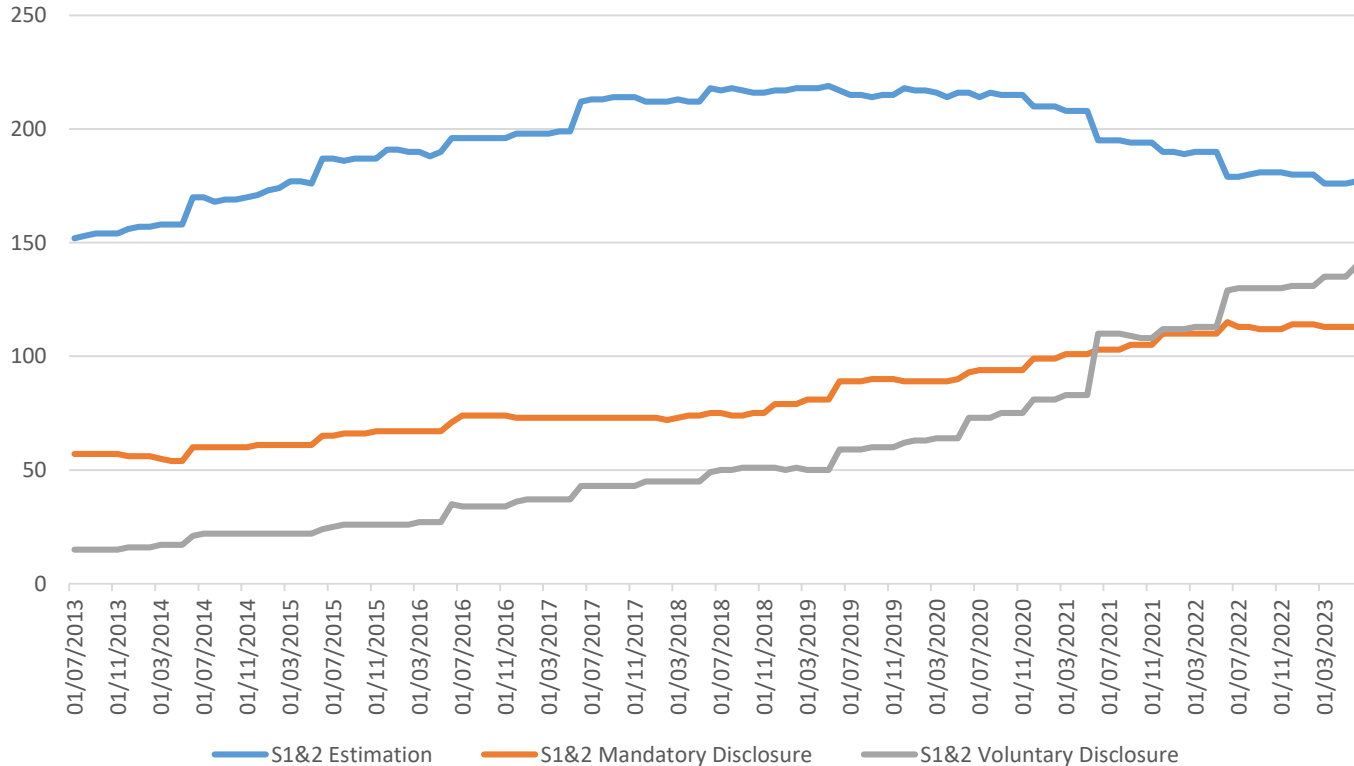
Key Findings

1. 1) Voluntarily-disclosed S1&2 emissions positively relate to the stock returns in the current and 3-7 months ago
2. 2) Voluntarily (mandatorily) disclosed emissions intensity in the previous 11 and 12 months (in the current and previous 1-2 months) negatively relate to the present returns
3. 3) Voluntary and mandated disclosures positively relate to stock returns at firm level, showing that disclosure reduces information asymmetry
4. 4) Significant excess premium between the estimated and the mandatorily-disclosed S1&2 emissions

Griffith UNIVERSITY
Griffith Business School
Queensland, Australia

Literature and Hypotheses Development

- Traditional asset pricing literature: CAPM and risk factor models, e.g. Fama-French risk factors

- Contemporary carbon premium literature:

  - Bolton & Kacperczyk (2021,2023): in most countries, $r_{green} < r_{brown}$

  - Pástor, Stambaugh, & Taylor (2021, 2022): in equilibrium, $E(r_{green}) < E(r_{brown})$

- Australian businesses are likely experiencing material climate related risks channelled from:

  - Policy risks: mandatory climate disclosure for listed firms (Regulatory Guide 247.66) and carbon emissions reporting for firms and facilities above thresholds (National Greenhouse and Energy Reporting (**NGER**) Act, 2007)

  - Litigation risks: Australia is facing the second largest climate litigation cases (Climate Change Laws of the World Database)

  - Physical risks (from extreme and severe weather events, eg. bushfires, droughts and flooding) affecting firms' financial performance and stock returns (Griffin, Jiang, & Sun, 2023; Griffin, Lont, & Lubberink, 2022).

- Thus, the market is likely pricing such risks and requiring a higher return rate for the increased carbon emissions risk:

H1: There is a positive relationship between carbon emissions risk and ASX stock returns.

Literature and Hypotheses Development

- Australia's *threshold-based* NGER disclosure mandate: different types (or sources) of emissions data, namely the mandatorily- and voluntarily- disclosed emissions and estimated emissions

- Thus, Disclosure -> more transparency -> lower information uncertainty risk -> lower required rate of return:

H2: Disclosure mandate and voluntary disclosure decision positively relate to stock returns.

Literature and Hypotheses Development

- Avramov, Cheng, Lioui, & Tarelli (2022): higher ESG rating uncertainty -> lower demand for green assets -> higher premium in equilibrium.

- In Australia, information certainty differs among the types of emissions data
  - Inconsistent third-party emissions *estimation* (Busch et al., 2022)
  - Self-selection bias of the *voluntarily* disclosed emissions (Choi et al., 2021; Choi & Luo, 2021; Matsumura et al., 2014)

- Thus, information uncertainty risk: estimated > voluntary > mandatory

H3: Relative to the estimated emissions, voluntarily- or mandatorily-disclosed emissions are associated with a lower carbon premium.

Data

Data sourced from Refinitiv Eikon (RE):1922 ASX firms (including delisted firms) between July 1st 2013 and June 30th 2023.

- Month-end close prices
  - compute continuous compounded returns and remove outliers which are greater than 100% (Bolton & Kacperczyk, 2021)
- Yearly emissions data
  - Categorize into 3 types based on the RE's labelling and the NGER threshold.
  - Compute the emissions intensity as the ratio of tons of CO_2-e over revenues in million Australian dollars (in % and winsorized at 2.5% level).
- Other financial data to generate financial controls following Bolton & Kacperczyk (2021)
- Global Industry Classification Standard (GICS)

Data sourced from Kenneth R. French - Data Library:

- Monthly Fama/French risk factors for the Asia Pacific (excluding Japan)
  - market excess return, size, value, momentum, operation profitability and investment premia

Methodology: Pre-estimation Analysis

- Step 1: disclosure-choice logit model and compute inverse Mills ratio

$$Logit(Disclose_{i,t}) = \alpha_0 + \alpha_1 RTN_{i,t} + \sum \alpha_{2,j}\, FINANCIALS_{j,i,t} + \epsilon_{i,t} \qquad \text{(1)}$$

$Disclose_{i,t}$: dummy variable indicating whether the emissions information exists (= 1) or not (= 0) for firm i at month t;
$RTN_{i,t}$: monthly stock returns of firm i at month t
$FINANCIALS_{j,i,t}$:

- the natural logarithm of the monthly market capitalization ($LOGSIZE_{i,t}$),
- the book value of equity divided by market value of equity ($B/M_{i,t}$) (winsorized at 2.5% level);
- the total debt to total asset ratio ($LEVERAGE_{i,t}$) (winsorized at 2.5% level);
- the total capital expenditure divided by book value of assets ($INVEST/A_{i,t}$) (winsorized at 5% level);
- the monthly return on equity ($ROE_{i,t}$) (winsorized at 2.5% level);
- the Herfindahl index of the business sector of a company with weights proportional to revenues ($HHI_{i,t}$);
- the natural logarithm of the net total property plant and equipment value ($LOGPPE_{i,t}$);
- the dollar change in monthly firm revenues normalized by last month's market capitalization ($SALESGR_{i,t}$) (winsorized at 5% level);
- the dollar change in monthly earnings per share, normalized by the firm's month-end close price ($EPSGR_{i,t}$) (winsorized at 5% level);
- the average of the most recent 12 months' returns on stock i ($MOM_{i,t}$) (winsorized at 5% level)
- the standard deviation of the past 12 months' returns on stock i ($VOLAT_{i,t}$) (winsorized at 5% level)

Methodology: Hypotheses Testing

- Step 2: Ordinary Least Squares (OLS) Models

$$RTN_{i,t} = \alpha_0 + \alpha_1 LOGEMISSIONS_{i,t-n} + \alpha_2 IMR_{i,t} + \alpha_3 FINANCIALS_{i,t-1} + IE_i + FE + YE + \epsilon_{i,t} \tag{2}$$

$$RTN_{i,t} = \alpha_0 + \alpha_1 LOGEMISSIONS_{i,t-n} + \alpha_2 Voluntary_{i,t} + \alpha_3 Mandatory_{i,t} + \tag{3}$$
$$\alpha_4 IMR_{i,t} + \alpha_5 FINANCIALS_{i,t-1} + IE_i + FE + YE + \epsilon_{i,t}$$

$$RTN_{i,t} = \alpha_0 + \alpha_1 LOGEMISSIONS_{i,t-n} + \alpha_2 Voluntary_{i,t} + \alpha_3 Mandatory_{i,t} + \alpha_4 Voluntary * LOGEMISSIONS_{i,t-n} + \tag{4}$$
$$\alpha_5 Mandatory_{i,t} * LOGEMISSIONS_{i,t-n} + \alpha_6 IMR_{i,t} + \alpha_7 FINANCIALS_{i,t-1} + IE_i + FE + YE + \epsilon_{i,t}$$

$LOGEMISSIONS_{i,t-n}$:
- de-meaned natural logarithm of estimated, mandatorily- and voluntarily- disclosed emissions (in tons of CO2-e) for S1&2 of stock i at month t.
- carbon emissions intensity: scaled emissions amounts by the sales at month t.

$voluntary_{i,t} = 1$: voluntarily disclosed emissions;
$mandatory_{i,t} = 1$: mandatorily disclosed emissions;
$voluntary_{i,t} = 0$ and $mandatory_{i,t} = 0$: estimated emissions.
$IMR_{i,t}$: the inverse Mills ratio computed from the pre-estimation disclosure-choice logit model
IE, FE, and YE are controls for industry (according to the GICS), firm, and year-fixed effects, respectively.

- to accept H1, α_1 should be positively significant.
- to accept H2, α_2 and α_3 should be positively significant.
- to accept H3, α_4 and α_5 should be negatively significant.

GriffithUNIVERSITY
Griffith Business School
Queensland, Australia

Methodology: Investment Strategy Application

- Step 3: Fama-MacBeth Cross-Sectional Regressions

$$RTN_{i,t} = \beta_{0,t} + \beta_{1,t}LOGEMISSIONS_{i,t} + \beta_{2,t}FINANCIALS_{i,t-1} + \beta_{3,t}IMR_{i,t} + \epsilon_{i,t} \qquad \text{(5)}$$

- Step 4: compute the differences in $\beta_{1,t}$ between each pair and derive the excess premium:
    - between the estimated and the mandatorily- disclosed emissions (intensity) (i.e. $ep_{est-man}$),
    - between the estimated and the voluntarily-disclosed emissions (intensity) (i.e. $ep_{est-vol}$),
    - between the voluntarily- and mandatorily-disclosed emissions (intensity) (i.e. $ep_{vol-man}$).
- Step 5: test the statistical significance of each excess premium

$$ep_{j,t} = \gamma_{j,0} + \gamma_{j,1}Factors_t + \epsilon_{j,t} \qquad \text{(6)}$$

ep_j is the excess premium that could either be $ep_{est-man}$, $ep_{est-vol}$ or $ep_{vol-man}$
$Factors$ includes the market excess return (MktRF), size (SMB), value (HML), momentum (WML), operation profitability (RMW) and investment premia (CMA).

Griffith UNIVERSITY
Griffith Business School
Queensland, Australia

Result Highlights

Summary Statistics

Panel A Emission variables

VARIABLES	Estimated S1&2 Sample				Voluntary S1&2 Sample				Mandatory S1&2 Sample			
	N	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd
S1&2 Emissions	23,330	0.316	0.004	4.678	7,027	0.014	0.008	0.014	9,813	2.666	0.262	6.903
S1&2 Intensity	22,866	2.596	0.277	6.660	6,487	0.821	0.105	3.395	9,320	4.275	1.981	6.365

Panel B Cross-sectional return variables

VARIABLES	Estimated S1&2 Sample				Voluntary S1&2 Sample				Mandatory S1&2 Sample			
	N	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd
RTN	23,330	-0.005	0.000	0.164	7,027	-0.001	0.003	0.113	9,813	0.001	0.006	0.106
MOM	22,955	-0.004	0.000	0.049	6,999	-0.000	0.002	0.034	9,699	0.002	0.003	0.030
VOLAT	22,955	0.138	0.115	0.089	6,999	0.099	0.082	0.060	9,699	0.093	0.080	0.052
SIZE	23,288	1.615	0.467	4.609	7,027	4.626	2.134	7.136	9,813	17.377	5.142	33.243
B/M	23,278	0.777	0.504	0.880	6,952	0.693	0.553	0.586	9,813	0.721	0.618	0.521
LEVERAGE	23,320	0.190	0.144	0.196	6,942	0.225	0.211	0.172	9,813	0.236	0.230	0.142
INVEST/A	22,390	-0.066	-0.031	0.091	6,288	-0.041	-0.017	0.062	9,648	-0.057	-0.044	0.057
HHI	23,330	0.007	0.006	0.005	7,027	0.007	0.006	0.005	9,813	0.007	0.006	0.005
PPE	22,610	0.281	0.051	1.131	6,556	0.713	0.117	1.602	9,752	6.322	1.541	15.655
ROE	22,145	-5.329	6.988	47.644	6,050	8.254	10.488	25.544	9,225	7.531	9.307	22.726
EPSGR	23,315	0.003	0.000	0.113	6,942	0.001	0.000	0.076	9,813	-0.000	0.000	0.059
SALESGR	23,075	0.002	0.000	0.040	6,615	0.002	0.000	0.034	9,325	0.002	0.000	0.040

CP among Estimated, Mandatorily- and Voluntarily-Disclosed Emissions

Panel A Log S1&2 Emissions

VARIABLES	Lag=0	Lag=1	Lag=2	Lag=3	Lag=4	Lag=5	Lag=6	Lag=7	Lag=8	Lag=9	Lag=10	Lag=11	Lag=12
LOGS1&2	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	-0.002	-0.001	-0.000	-0.001	-0.001	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
voluntary	0.014**	0.013**	0.011**	0.010*	0.012**	0.012**	0.011*	0.011*	0.011**	0.013**	0.012**	0.012**	0.013**
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
mandatory	0.019*	0.017	0.020*	0.018	0.021*	0.021*	0.020*	0.022*	0.025**	0.023**	0.027**	0.026**	0.019
	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)
voluntary * LOGS1&2	0.005*	0.004	0.004	0.005*	0.004*	0.005*	0.005*	0.005*	0.004	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
mandatory * LOGS1&2	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.005	0.005	0.007	0.006	0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
IMR	-0.117***	-0.117***	-0.119***	-0.119***	-0.119***	-0.119***	-0.121***	-0.122***	-0.121***	-0.122***	-0.122***	-0.124***	-0.124***
	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Constant	0.898***	0.898***	0.913***	0.911***	0.918***	0.919***	0.931***	0.945***	0.939***	0.945***	0.955***	0.958***	0.960***
	(0.096)	(0.097)	(0.098)	(0.099)	(0.099)	(0.099)	(0.100)	(0.102)	(0.102)	(0.103)	(0.104)	(0.104)	(0.105)
FINANCIALS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
obs	34,632	34,504	34,161	33,823	33,476	33,128	32,775	32,427	32,076	31,722	31,362	31,002	30,634
R^2	0.075	0.075	0.076	0.076	0.076	0.076	0.078	0.078	0.078	0.078	0.080	0.079	0.079

CP among Estimated, Mandatorily- and Voluntarily-Disclosed Emissions

Panel B S1&2 Intensity

VARIABLES	Lag=0	Lag=1	Lag=2	Lag=3	Lag=4	Lag=5	Lag=6	Lag=7	Lag=8	Lag=9	Lag=10	Lag=11	Lag=12
S1&2 Intensity	-0.000	-0.000	-0.000	-0.000	-0.001	-0.000	-0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
voluntary	0.015***	0.015***	0.013**	0.011**	0.013**	0.013**	0.013**	0.013**	0.013**	0.015***	0.014**	0.015***	0.016***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
mandatory	0.023***	0.022***	0.022***	0.020**	0.021***	0.022***	0.023***	0.023***	0.024***	0.025***	0.026***	0.025***	0.023***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
voluntary * S1&2 Intensity	-0.000	-0.001	-0.001	-0.000	-0.000	0.000	-0.000	-0.000	-0.001	-0.000	-0.000	-0.001**	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
mandatory * S1&2 Intensity	-0.001**	-0.001*	-0.001*	-0.001	-0.000	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
IMR	-0.115***	-0.115***	-0.117***	-0.116***	-0.116***	-0.117***	-0.119***	-0.120***	-0.119***	-0.120***	-0.120***	-0.121***	-0.121***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Constant	0.895***	0.895***	0.905***	0.903***	0.911***	0.914***	0.923***	0.936***	0.933***	0.938***	0.943***	0.943***	0.950***
	(0.096)	(0.097)	(0.097)	(0.098)	(0.099)	(0.099)	(0.100)	(0.102)	(0.103)	(0.104)	(0.105)	(0.105)	(0.106)
FINANCIALS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
obs	34,610	34,611	34,266	33,931	33,589	33,244	32,894	32,549	32,201	31,850	31,494	31,137	30,772
R^2	0.074	0.074	0.075	0.074	0.075	0.075	0.076	0.076	0.076	0.076	0.077	0.077	0.077

Factor Models for Excess Premiums

Panel A Log S1&2 Emissions

VARIABLES	$ep_{est-man}$					$ep_{est-vol}$					$ep_{vol-man}$				
	Baseline	CAPM	FF3	FF5	FF6	Baseline	CAPM	FF3	FF5	FF6	Baseline	CAPM	FF3	FF5	FF6
MktRF		-0.000	-0.000	-0.000	-0.000		0.001	0.001	0.001	0.001		-0.001	-0.001	-0.001	-0.001
		(0.000)	(0.000)	(0.000)	(0.000)		(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
SMB			0.000	0.000	0.001			-0.001	0.001	0.001			0.001	-0.000	0.000
			(0.000)	(0.001)	(0.001)			(0.002)	(0.002)	(0.001)			(0.002)	(0.002)	(0.002)
HML			0.000	0.001*	0.001			-0.001	0.004	0.004			0.001	-0.003	-0.003
			(0.000)	(0.001)	(0.001)			(0.001)	(0.004)	(0.005)			(0.001)	(0.004)	(0.005)
RMW				0.000	0.000				0.007	0.007				-0.007	-0.007
				(0.001)	(0.001)				(0.007)	(0.007)				(0.007)	(0.007)
CMA				-0.002*	-0.002**				-0.004	-0.004				0.002	0.002
				(0.001)	(0.001)				(0.004)	(0.004)				(0.004)	(0.003)
WML					-0.001***					0.000					-0.001
					(0.000)					(0.001)					(0.001)
Constant	0.002**	0.003**	0.002**	0.002**	0.003**	-0.002	-0.002	-0.002	-0.005	-0.005	0.004	0.005	0.005	0.007	0.008
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)	(0.006)	(0.007)	(0.004)	(0.004)	(0.004)	(0.006)	(0.007)
obs	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

Factor Models for Excess Premiums

Panel B S1&2 Intensity

VARIABLES	$ep_{est-man}$					$ep_{est-vol}$					$ep_{vol-man}$				
	Baseline	CAPM	FF3	FF5	FF6	Baseline	CAPM	FF3	FF5	FF6	Baseline	CAPM	FF3	FF5	FF6
MktRF		-0.000	-0.000	-0.000	-0.000		-0.000	-0.001	-0.002*	-0.002**		0.000	0.001	0.002*	0.002*
		(0.000)	(0.000)	(0.000)	(0.000)		(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
SMB			0.000*	0.000	0.000			-0.005***	-0.004***	-0.003**			0.005***	0.004***	0.004**
			(0.000)	(0.000)	(0.000)			(0.002)	(0.001)	(0.001)			(0.002)	(0.001)	(0.001)
HML			0.000	0.000	0.000			-0.001	0.006	0.006			0.001	-0.006	-0.005
			(0.000)	(0.000)	(0.000)			(0.001)	(0.006)	(0.005)			(0.001)	(0.006)	(0.005)
RMW				-0.000	-0.000				0.006	0.006				-0.006	-0.006
				(0.000)	(0.000)				(0.006)	(0.005)				(0.006)	(0.005)
CMA				-0.000***	-0.000***				-0.011	-0.011				0.010	0.011
				(0.000)	(0.000)				(0.007)	(0.007)				(0.007)	(0.007)
WML					-0.000					-0.002					0.002
					(0.000)					(0.002)					(0.002)
Constant	-0.000	-0.000	-0.000	-0.000	0.000	-0.004	-0.004	-0.005	-0.007	-0.005	0.004	0.004	0.005	0.007	0.005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.006)	(0.007)	(0.008)	(0.006)	(0.006)	(0.006)	(0.007)	(0.008)	(0.006)
obs	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

Conclusion

Conclusion

- H1: Voluntarily-disclosed S1&2 emissions positively relate to the stock returns in the current and 3-7 months ago; Voluntarily (mandatorily) disclosed emissions intensity in the previous 11 and 12 months (in the current and previous 1-2 months) negatively relate to the present returns

- H2: Voluntary and mandated disclosures positively relate to stock returns, supporting a legislation that mandates emissions disclosure for all companies, to reduce the information uncertainty

- H3: Significant excess premium between the estimated and the mandatorily-disclosed S1&2 emissions, suggesting that investors can profit from an investment strategy based on emissions information from different sources especially if the spread of the aggregate carbon premium is sufficiently large
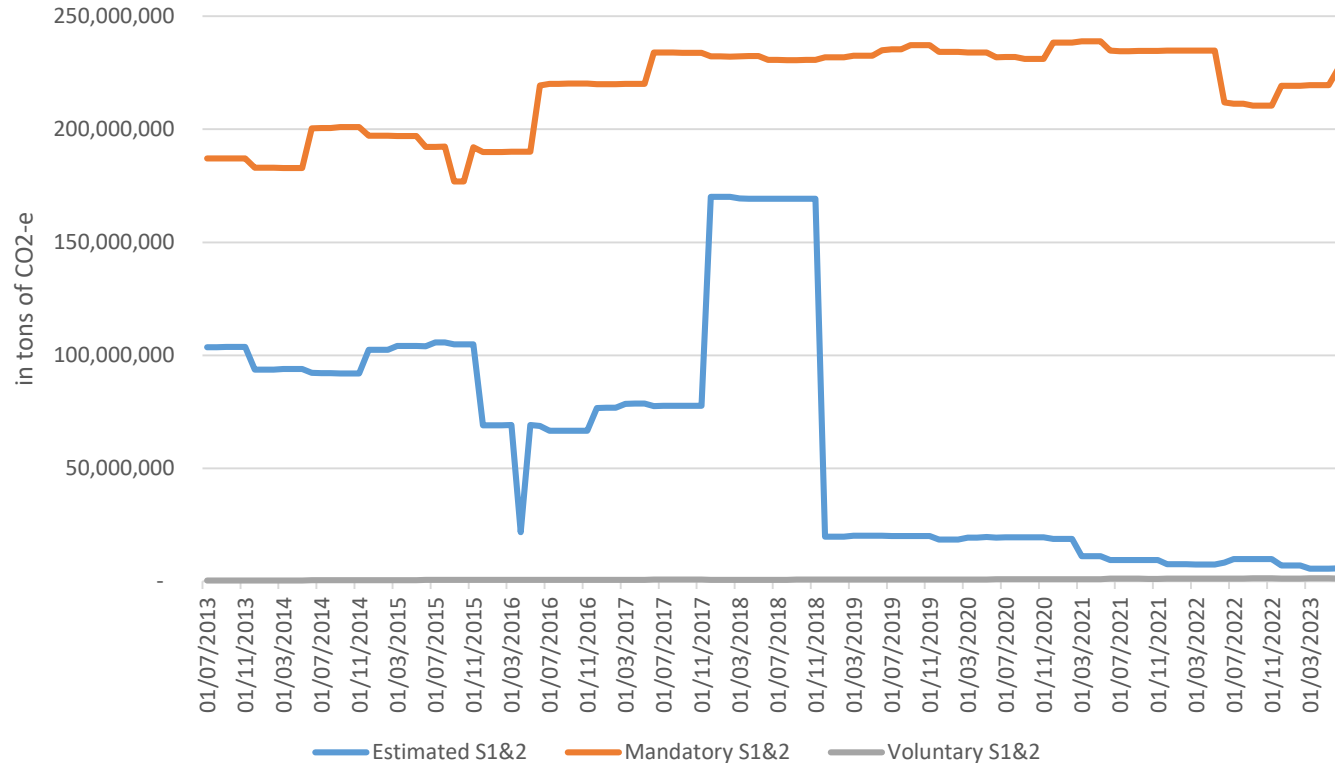
Thank you

Contact:
i.diaz-rainey@griffith.edu.au

Appendix

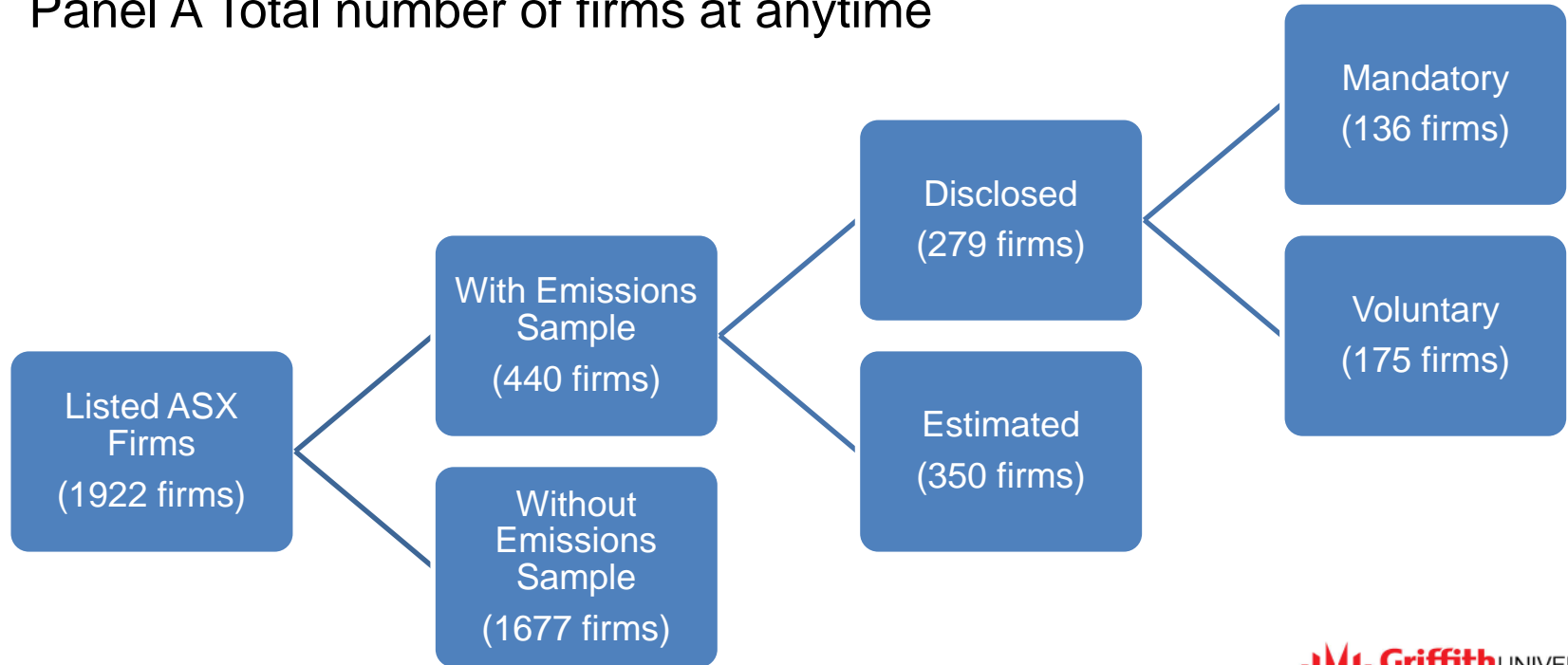# Total Emissions and Disclosure Frequency Over Time

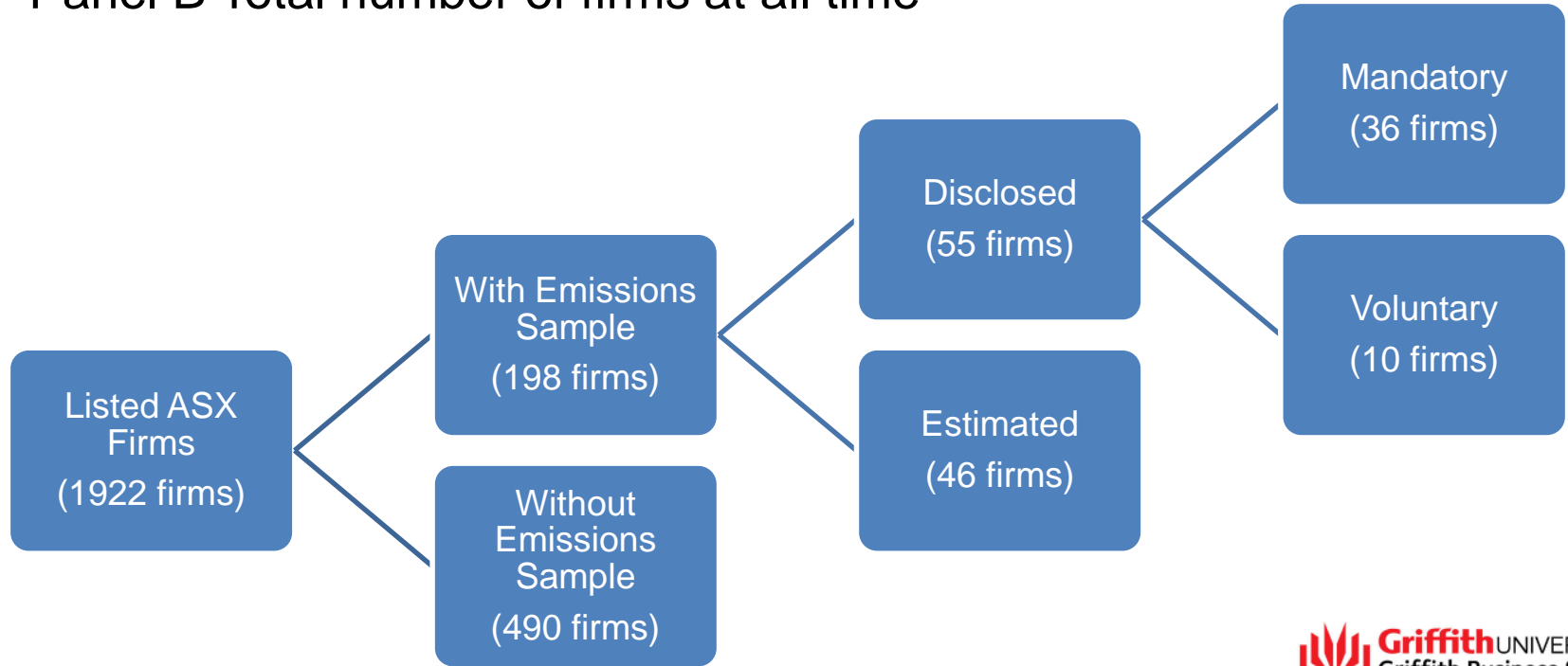- Panel A Total Emissions Over Time

Number of Firms Disclosing by Emissions Type

- Panel A Total number of firms at anytime

Number of Firms Disclosing by Emissions Type

- Panel B Total number of firms at all time

Number of Firms with Changes in Emissions Information

- This table summarizes the number of firms whose emissions information has numerous changes in source over the sample period from July 2013-June 2023.

N times of Changes in Emissions Information / Number of Firms	Without to/from With Emissions	Estimated to/from Disclosed S1&2	Mandatory to/from non-Mandatory S1&2	Voluntary to/from non-Voluntary S1&2
4	0	1	0	2
3	1	5	6	5
2	5	29	20	33
1	202	154	70	125

Disclosure-Choice Logit Model

VARIABLES	(1)	(2)	(3)
ROE	-0.002***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
LOGSIZE	1.363***	1.487***	1.492***
	(0.010)	(0.011)	(0.011)
BM	0.884***	0.733***	0.718***
	(0.014)	(0.015)	(0.015)
LEVERAGE	0.463***	0.565***	0.558***
	(0.055)	(0.058)	(0.058)
INVESTA	-0.329***	0.198*	0.226**
	(0.107)	(0.111)	(0.111)
LOGPPE	0.110***	0.098***	0.098***
	(0.005)	(0.005)	(0.005)
EPSGR	0.400***	0.493***	0.507***
	(0.099)	(0.097)	(0.097)
SALESGR	-1.573***	-1.299***	-1.298***
	(0.239)	(0.248)	(0.248)
HHI	2.237	4.135**	4.209**
	(1.995)	(2.086)	(2.088)
MOM		-7.911***	-8.001***
		(0.210)	(0.211)
VOLAT		1.819***	1.882***
		(0.117)	(0.117)
RTN			-0.611***
			(0.060)
Constant	-9.024***	-9.704***	-9.728***
	(0.059)	(0.069)	(0.069)
Observations	147,619	141,787	141,787

Griffith UNIVERSITY
Griffith Business School
Queensland, Australia