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**Centre for Energy and
Environmental Markets**

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Value Relevance of Greenhouse Gas (GHG) Emissions Disclosures on Stock Market Performance: An International Study

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Research question & Contribution

- Investigates the value relevance of voluntary disclosure of GHG emissions to investors in capital markets
 - Worldwide: 48 countries
 - Over six years from financial years 2007 to 2012

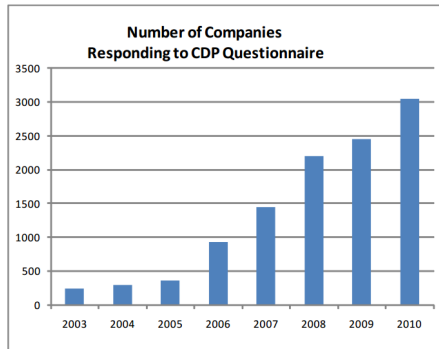
- Large sample of voluntary disclosures with increases in companies responding to the CDP questionnaire over the period 2006 to 2011
 - Extend the existing evidence, which is limited to three countries, to 48 countries which report to the CDP
 - Considers the change over time in the informational value of GHG disclosures as businesses and investors learn to adapt to the new information.

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Background: Carbon disclosure project (CDP)

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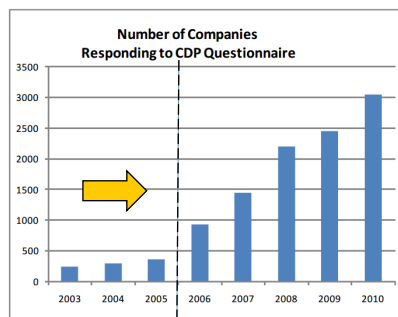
- Founded in year 2000
- Main purpose: to collect GHG emission disclosures from companies about total GHG emissions (scope 1 and 2), emission reduction targets, climate change risk and management strategies
- Holds the largest database
- Increasing voluntary disclosure by companies
- Why companies respond to CDP?
 - Institutional investors AUM U\$78 trillion

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Global initiatives before 2006

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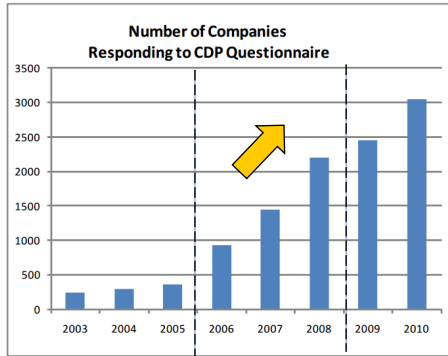
- First World Climate Conference (WCC) in 1979
- Second WCC 1990
- Carbon taxes were implemented in certain countries in early 1990s
- United Nations Framework Convention on Climate Change (UNFCCC) in 1992
- Kyoto Protocol 1997
 - Marrakesh Accord in October/ November 2001 set-up
 - ETS, CDM and JI

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Global initiatives 2006-2008

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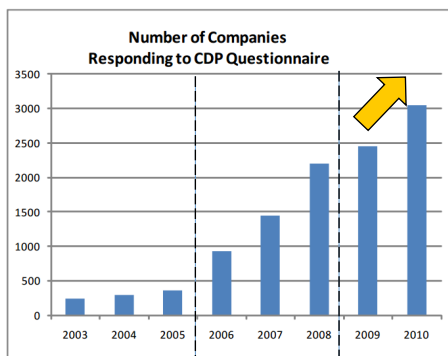
- First Phase of European Union Emissions Trading Scheme (EU ETS) in place
- Australia signs the Kyoto Protocol in 2007
- United States established state-wide regulations since 2007

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Global initiatives 2009 and after

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- Copenhagen Accord in 2009
- Investors' concern to climate change increase slightly, (Nielsen Report, 2011)

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Literature review: North American studies

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- Hughes (2000): 1986-1993, 44 utilities targeted (46 non-targeted) as high polluting
 - Non-financial pollution proxy value relevant
- Johnston Sefcik & Soderstrom (2008): 1995-2000, 58 firm-years, 58 US electric utilities
 - Emission allowances have asset or real option value priced into firm value
- Griffin Lont & Sun (2011): 2006–2009: 825 S&P, 259 Toronto SE firm-years
 - GHG emission negatively associated with firm value for both disclosers and non-disclosers (used model to predicted GHG)
- Matsumura Prakash & Vera-Muñoz (2011): 2006–2008: 1443 S&P firm-years
 - Firm value negatively associated with carbon emission levels

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Why is disclosure of GHG emissions relevant to capital markets?

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The New York Times

Large Companies Prepared to Pay Price on Carbon

“CDP reports that 29 US companies are incorporating a price on carbon into their long-term financial plans. “

- Potential liability
- Climate change risk identification
- Can't manage what you can't measure
- Increasing role of mandatory schemes to address pollution issues (e.g. China)



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Literature review: Australian studies

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- Chappel Clarkson & Gold (2013)
 - 2007, 58 firms expected to be affected by proposed ETS
 - Market penalizes high carbon intensive firms
- Coulton Green & Tao (2012): mandatory disclosure setting under Australia's National Greenhouse & Energy Reporting (NGER) Act
 - 2010, 75 firms:
 - VR: reported GHG emissions priced negatively for companies with relatively small scale of operations and low carbon intensity
 - Event study: companies with relatively low GHG emission & highest GHG experienced significant price declines
 - 2011, 85 firms:
 - VR: only companies with relatively greater exposure to climate change risks are being priced negatively
 - Event study: no significant results

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Extension of prior research & Hypothesis

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- Extends existing research **geographically** to cover the 38 countries in the large CDP dataset to hypothesize:

H1: *Companies with higher GHG emissions (scope 1 or 2 emissions or total emissions) have lower stock prices and returns.*

H2: *Voluntary verification of GHG emissions will have a positive association with stock price and returns.*

H3: *Participation in an ETS, whether voluntary or mandatory will result in a negative association with stock price and returns.*

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Extension of prior research & Hypothesis

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- Extends existing research **geographically** to cover the 38 countries in the large CDP dataset to hypothesize:
 - **H1a:** *The association of GHG emissions and stock price and returns will be more negative in Period 2 as compared to Period 1.*
 - **H2a:** *Voluntary verification of GHG emissions will have a more positive association with stock price and returns in Period 2 as compared to Period 1.*
 - **H3a:** *Participation in an ETS, whether voluntary or mandatory will result in a more negative association with stock price and returns in Period 2 as compared to Period 1.*

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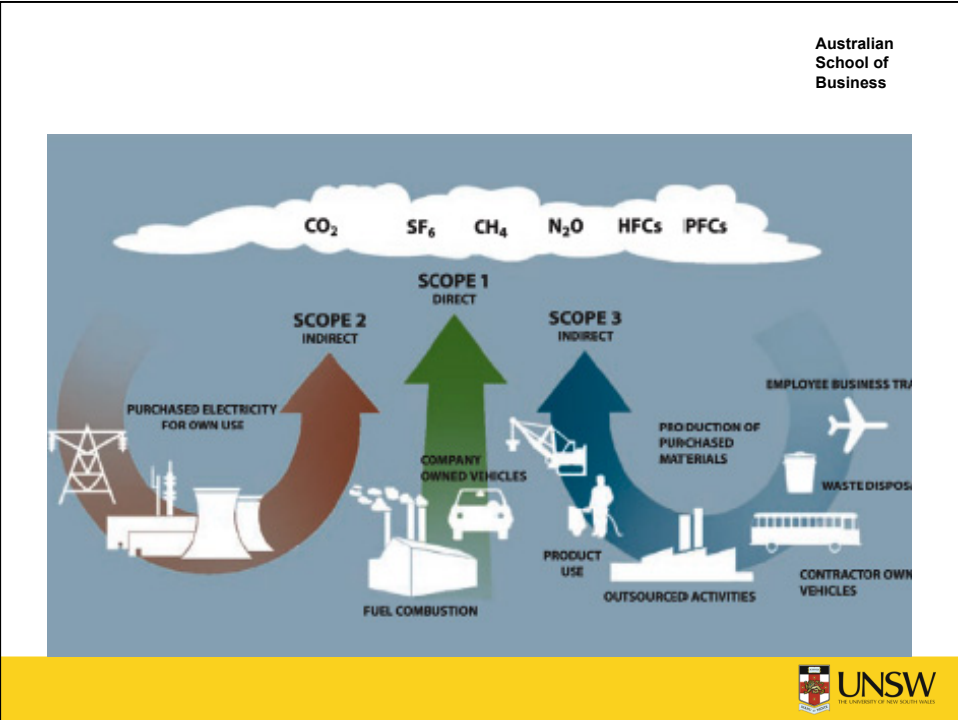
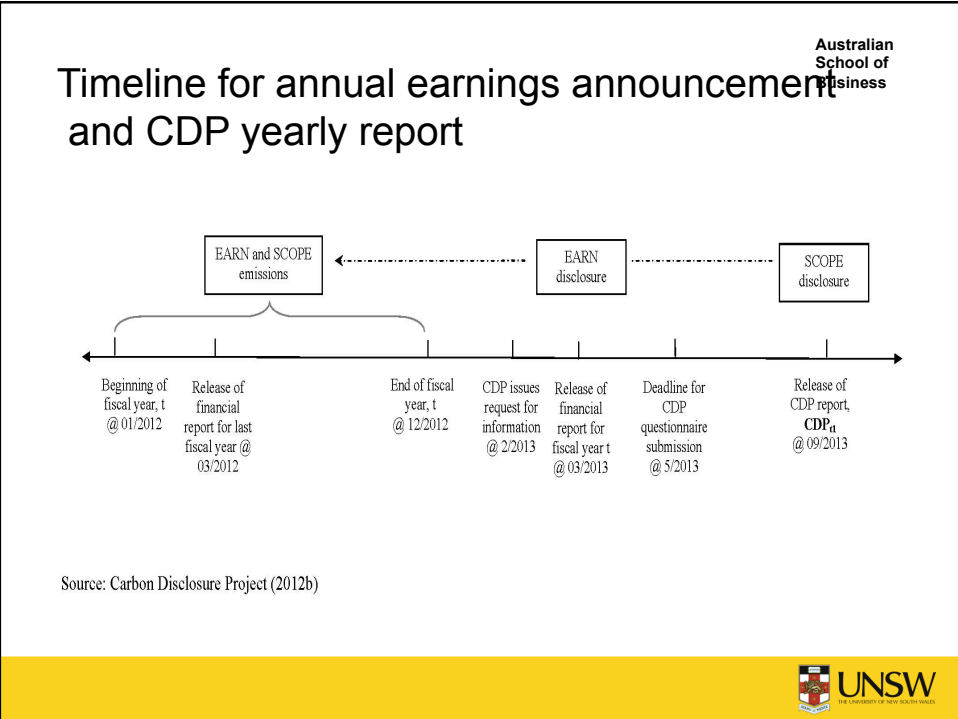
Data

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- Sample Selection:
 - CDP respondents from different countries
 - 4657 (2817) firm-years for price (return) specification
- Time Period Selection:
 - 2006 (CDP 2007) to 2011(CDP 2012)
 - Prior to 2006, CDP data is qualitative
- Partitioning period into time periods: 2006 to 2008; 2009 to 2011
 - 2006-2008: Inconsistency in abatement action between countries, CDP data quantitative
 - 2009-2011: Lack of strong efforts due to massive lobbying activities, CDP data quantitative

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**Research design –
Price-specification model (Barth and Clinch, 2009, 2011)**

$$\text{PRICE_SH} = \beta_0 \text{BVE_SH} + \beta_1 \text{EARN_SH} + \beta_2 \text{PERIOD2} + \beta_3 \text{SCOPE_SALES} + \beta_4 \text{SCOPE_SALES} * \text{PERIOD2} + \beta_5 \text{VERIFY} + \beta_6 \text{VERIFY} * \text{PERIOD2} + \beta_7 \text{VOLUNTARY} + \beta_8 \text{VOLUNTARY} * \text{PERIOD2} + \beta_9 \text{MANDATORY} + \beta_{10} \text{MANDATORY} * \text{PERIOD2}$$

Where:

PRICE_SH= the closing stock prices 3 months after the balance date;

BVE_SH= the book value of equity (total assets less total liabilities) at the beginning of the fiscal period scaled by shares outstanding used to calculate basic earnings per share;

EARN_SH= earnings before extraordinary items scaled by shares outstanding used to calculate basic earnings per share;

SCOPE_SALES= level of GHG emissions; tonnes CO2-e per million sales in millions, which can be the total emission SCOPE12 or decomposed into SCOPE1 and SCOPE2;

PERIOD2= Dummy variable with value 1 if fiscal year is >=2009, 0 otherwise;

VERIFY= Dummy variable with value 1 if the firm stated that it verified

VOLUNTARY= Dummy variable with value 1 if the firm voluntarily participated in an ETS scheme

MANDATORY= Dummy variable with value 1 if the firm stated that participated in a mandatory ETS scheme (even if it also participated in other voluntary schemes)

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**Research design –
Return-specification model (Easton and Harris, 1991):**

$$\text{BHR} = \beta_0 \text{EARN_MV} + \beta_1 \Delta \text{EARN_MV} + \beta_2 \text{PERIOD2} + \beta_3 \text{SCOPE_SALES} + \beta_4 \text{SCOPE_SALES} * \text{PERIOD2} + \beta_5 \text{VERIFY} + \beta_6 \text{VERIFY} * \text{PERIOD2} + \beta_7 \text{VOLUNTARY} + \beta_8 \text{VOLUNTARY} * \text{PERIOD2} + \beta_9 \text{MANDATORY} + \beta_{10} \text{MANDATORY} * \text{PERIOD2}$$

Where:

BHR= 12-months simple buy-and-hold returns calculated to 3 months after the balance date in USD;

EARN_MV= earnings before extraordinary items scaled by market value of equity at beginning of fiscal year;

Δ EARN_MV= change in earnings before extraordinary items scaled by scaled by market value of equity at beginning of fiscal year.

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Table 1 Descriptive statistics

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	N	Mean	Std Dev	Minimum	Median	Maximum
PRICE_SH	4657	43.20537	103.1807	0.005161	20.71	972.8183
BVE_SH	4657	21.71827	53.30555	-2.15636	10.27118	561.0031
EARN_SH	4657	2.408674	5.73261	-7.77673	1.191248	45.38163
SCOPE12_SALE	4657	406.6253	1165.23	0	33.94139	7735.85
SCOPE1_SALE	4657	334.5878	1049.93	0	8.755253	6796.02
SCOPE2_SALE	4657	56.7369	152.5402	0	12.74422	1115.57
BHR	2817	0.097754	0.474741	-0.94731	0.073157	1.863734
EARN_MV	2817	0.066656	0.339232	-2.27416	0.062575	2.678885
ΔEARN_MV	2817	0.00555	0.325404	-1.6393	0.003575	2.910029
ΔSCOPE12_SALE	2817	42.28324	362.2	-968.47	0.244522	2825.55
ΔSCOPE1_SALE	2817	32.26575	279.8228	-756.261	0.00158	2075.98
ΔSCOPE2_SALE	2817	4.463559	48.50482	-249.824	0.023828	288.3402
FY2007	4657	0.133777	0.340449	0	0	1
FY2008	4657	0.190681	0.39288	0	0	1
FY2009	4657	0.193043	0.394729	0	0	1
FY2010	4657	0.230621	0.421275	0	0	1
FY2011	4657	0.251879	0.434139	0	0	1
PERIOD2	4657	0.675542	0.468222	0	0	1
VERIFY	4657	0.419154	0.493474	0	0	1
VOLUNTARY	4657	0.028559	0.166582	0	0	1
MANDATORY	4657	0.176509	0.381293	0	0	1



Table 1 – Descriptive by Sector and by Country

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- Panel B shows that sector is reasonable well distributed with Industrials, Materials, Consumer Discretionary with top spots
- Emissions Intensity are likely to be in the Utilities Sector (490 observations)
- Geographically, Europe and Americas cover 80% of our sample with Japan the largest in Asia /Australasia



Table 2 Correlations

- GHG emissions are negatively correlated with stock price and returns
- GHG emissions are positively correlated with size and sales with scope 1 higher than scope 2 emissions
- GHG emission variables are also highly correlated other GHG emission variables
- Consistent with the literature BV and EPS are highly correlated stock price

Results:
Returns specification

- BV and EARN are significant
- GHG Scope 1&2 are – sig.
- Scope 2 not sig.
- VERIFY and VOLUNTARY + not sig.
- MANDATORY- not sig.

Table 3 Price Specification

	(A)	(B)	(C)	(D)
BVE_SH	0.9789*** (0.0000)	0.9788*** (0.0000)	0.9804*** (0.0000)	0.9801*** (0.0000)
EARN_SH	5.7444*** (0.0000)	5.7512*** (0.0000)	5.7430*** (0.0000)	5.7520*** (0.0000)
SCOPE12_SALE	-0.0024*** (0.0036)		-0.0024*** (0.0031)	
SCOPE1_SALE		-0.0032*** (0.0026)		-0.0032*** (0.0021)
SCOPE2_SALE		0.0088 (0.2526)		0.0095 (0.2152)
VERIFY			0.3044 (0.8899)	0.0937 (0.9659)
VOLUNTARY			5.1161 (0.3148)	5.5523 (0.2753)
MANDATORY			-5.0243 (0.1800)	-5.0786 (0.1753)
CONSTANT	-15.6051*** (0.0029)	-15.7550*** (0.0026)	4.0684 (0.4124)	3.9560 (0.4240)
N	4657	4657	4657	4657
Adj. R ²	0.6648	0.6649	0.6650	0.6651

**Table 4 Price Specification – Comparison
across two periods**

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	(A)	(B)	(C)	(D)
BVE_SH	0.9650*** (0.0000)	0.9647*** (0.0000)	0.9689*** (0.0000)	0.9686*** (0.0000)
EARN_SH	5.8944*** (0.0000)	5.9025*** (0.0000)	5.8654*** (0.0000)	5.8752*** (0.0000)
PERIOD2	4.0398* (0.0651)	3.7913* (0.0882)	2.5215 (0.3411)	2.3931 (0.3680)
SCOPE12_SALE	-0.0020** (0.0445)		-0.0020** (0.0391)	
SCOPE12_SALE*PERIOD2	-0.0002 (0.8227)		-0.0002 (0.7504)	
SCOPE1_SALE		-0.0028** (0.0196)		-0.0029** (0.0139)
SCOPE1_SALE*PERIOD2		-0.0002 (0.7835)		-0.0002 (0.7930)
SCOPE2_SALE		0.0073 (0.3370)		0.0096 (0.2058)
SCOPE2_SALE*PERIOD2		0.0031 (0.6567)		0.0010 (0.8874)
VERIFY			0.5096 (0.8921)	0.4208 (0.9109)
VERIFY*PERIOD2			1.2352 (0.7655)	1.0245 (0.8055)
VOLUNTARY			3.9440 (0.4328)	4.4415 (0.3773)
VOLUNTARY*PERIOD2			-	-
MANDATORY			-20.1525*** (0.0000)	-20.2744*** (0.0000)
MANDATORY*PERIOD2			15.4169*** (0.0005)	15.5100*** (0.0005)
CONSTANT	-6.7083 (0.1658)	-6.7799 (0.1595)	-5.9683 (0.2475)	-6.0720 (0.2375)
N	4657	4657	4657	4657
Adj. R ²	0.6615	0.6616	0.6624	0.6625

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**Results:
Table 4 (Period
results)**

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- Similar to Table
- Period 1 Results dominated by GFC
 - 2007, 2008 market collapse
- Period 2 Results
 - 2009, 2010, 2011 market rebound
 - GHG emissions not significantly different from period 1

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Results: Return specification,

- $\Delta EARN$ ($p < 0.05$)
- GHG_S1 -ve ($p < 0.05$) in 2009–9
- GHG_S2 +ve ($p < 0.05$) but -ve in 2009–10
- Investors price both S1 & S2 negatively in the latter period

Table 5

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	(A)	(B)	(C)	(D)
EARN_MV	0.0549** (0.0248)	0.0553** (0.0248)	0.0554** (0.0243)	0.0558** (0.0242)
$\Delta EARN_MV$	0.0887*** (0.0025)	0.0898*** (0.0022)	0.0886*** (0.0026)	0.0898*** (0.0023)
SCOPE12_SALE	-0.0000 (0.1276)		-0.0000 (0.1268)	
$\Delta SCOPE12_SALE$	-0.0000* (0.0581)		-0.0000* (0.0567)	
SCOPE1_SALE		-0.0000 (0.1893)		-0.0000 (0.1848)
$\Delta SCOPE1_SALE$		-0.0001** (0.0282)		-0.0001** (0.0270)
SCOPE2_SALE		-0.0000 (0.8209)		-0.0000 (0.8441)
$\Delta SCOPE2_SALE$		0.0001 (0.3656)		0.0001 (0.3602)
VERIFY			-0.0021 (0.8844)	-0.0026 (0.8559)
VOLUNTARY			0.0046 (0.8638)	0.0044 (0.8709)
MANDATORY			-0.0100 (0.5217)	-0.0101 (0.5163)
CONSTANT	-0.2675*** (0.0000)	-0.2680*** (0.0000)	-0.2661*** (0.0000)	-0.2664*** (0.0000)
N	2817	2817	2817	2817
Adj. R ²	0.4344	0.4340	0.4339	0.4334

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Results: Price specification, 2 time periods

- Both S1 & S2 generally -ve impact on price ($p < 0.05$) (5&8) - S2 particularly so in 2009–10
- Investors price GHG S1 & S2 negatively, especially in the latter period

	(A)	(B)	(C)	(D)
EARN_MV	0.0619** (0.0343)	0.0635** (0.0313)	0.0649** (0.0264)	0.0660** (0.0247)
$\Delta EARN_MV$	0.1387*** (0.0001)	0.1409*** (0.0000)	0.1358*** (0.0001)	0.1379*** (0.0001)
PERIOD2	0.5439*** (0.0000)	0.5353*** (0.0000)	0.5541*** (0.0000)	0.5491*** (0.0000)
SCOPE12_SALE	0.0000 (0.6859)		-0.0000 (0.9890)	
SCOPE12_SALE*PERIOD2	-0.0000 (0.4159)		-0.0000 (0.6796)	
$\Delta SCOPE12_SALE$	-0.0001** (0.0476)		-0.0001 (0.1354)	
$\Delta SCOPE12_SALE*PERIOD2$	0.0001** (0.0249)		0.0001* (0.0714)	
SCOPE1_SALE		-0.0000 (0.7060)		-0.0000 (0.4431)
SCOPE1_SALE*PERIOD2		-0.0000 (0.8013)		0.0000 (0.8435)
$\Delta SCOPE1_SALE$		-0.0000 (0.3239)		-0.0000 (0.6069)
$\Delta SCOPE1_SALE*PERIOD2$		0.0000 (0.4430)		0.0000 (0.6870)
SCOPE2_SALE		-0.0000 (0.8773)		-0.0000 (0.7494)
SCOPE2_SALE*PERIOD2		0.0001 (0.5721)		0.0001 (0.5411)
$\Delta SCOPE2_SALE$		-0.0000 (0.9391)		0.0000 (0.8896)
$\Delta SCOPE2_SALE*PERIOD2$		0.0005 (0.1631)		0.0004 (0.2236)

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Table 6 (Part b)

	(A)	(B)	(C)	(D)
VERIFY			0.0854*** (0.0091)	0.0887*** (0.0076)
VERIFY*PERIOD2			-0.0417 (0.2835)	-0.0478 (0.2209)
VOLUNTARY			-0.1172*** (0.0001)	-0.1157*** (0.0002)
VOLUNTARY*PERIOD2			-	-
MANDATORY			-0.1168*** (0.0008)	-0.1175*** (0.0007)
MANDATORY*PERIOD2			0.0777* (0.0568)	0.0773* (0.0577)
CONSTANT	-0.2541*** (0.0000)	-0.2488*** (0.0000)	-0.2733*** (0.0000)	-0.2696*** (0.0000)
N	2817	2817	2817	2817
Adj. R ²	0.2239	0.2248	0.2284	0.2292

Conclusion

- GHG emissions disclosures affect both stock prices and stock returns.
- Scope 1 emissions have a significant negative association with stock prices and stock returns
 - Scope 1 emissions signify the operational inefficiency and thus a potential environmental liability for the emitters in the coming future.
- Scope 2 emissions have a significant negative association (not sig) with stock prices, but a positive association with stock returns.
 - Scope 2 emissions being priced more negatively over time and hence they are less positively associated with stock returns in 2009–11
 - An increasing awareness among investors over time of cost of Scope 2
- VERIFY positive but not significant