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Carbon Affect on European Oil and Steel Companies: An Empirical Analysis on the Second Phase EU ETS

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Abstract

This paper uses timer series panel data from Bloomberg to ascertain the affects that carbon prices and other factors have on European oil and steel companies. This paper finds inconclusive evidence of carbon price return correlation with oil and steel company equity return. However it does find a strong positive correlation between the market portfolio excess return, which is the return on the DJS 600 EUR index minus the German three-month T-bill rate, and oil and steel excess equity return.

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I. Introduction

The Mauna Loa Research Laboratory in Hawaii puts the current level of carbon dioxide (CO_2) molecules in the air at three hundred and ninety-four parts per million (ppm)[1]. These molecules contribute to the "greenhouse gas effect" whereby infrared radiation is trapped within earth's atmosphere and returned to earth. The rise in carbon dioxide concentrations from two hundred and eighty ppm, pre-industrial times, to today's levels can be attributed in part say reports from HM Treasury (2006d) to the burning of fossil fuels, deforestation, and other changes in land-use. Taking into account all the greenhouse gasses stipulated in the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro fluorocarbon, and perfluororocarbons) would put the figure closer to four hundred and thirty ppm of carbon dioxide. (HM Treasury, 2006d) The manifestation of these molecules in the air on the earth's climate has been an increase in the global average near-surface temperature of 0.7 degrees Celsius[2]. While this doesn't seem like much the Intergovernmental Panel on Climate Change concluded in 2001 that most of the increase in temperature over the past fifty years is caused by human activities[3] an analysis that has been supported in the Joint Statement of Science Academies in 2005 and the US Climate Change Science Programme in 2006.

The most severe impacts of this climate change are not the warming but its influence on rainfall patterns and extreme weather conditions. Projections are robust but the cost of extreme weather events such as storms, floods, droughts, and heat waves could reach 0.5 – 1% of world

[1] U.S. Department of Commerce, National Oceanic and Atmospheric Aministration, Recent Monthly CO2 at Mauna Loa, http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo.
[2] Brohan (2006), pg. 21.
[3] Folland, 2001. Pg. 59.

GDP and could rapidly increase at higher temperatures. In contrast the cost of limiting GHG emissions could be limited to around 1% of global GDP each year[4] (HM Treasury, 2006d).

Global climate change is unique in that it is a long lasting global problem that requires international and immediate action. Major international commitment to GHG emission policy can be traced back to the United Nations Framework Convention on Climate Change (UNFCCC) an international environmental treaty developed in 1992 at the Earth Summit (U.N., 1992). The defining outcome of this treaty is the Kyoto Protocol which sets a legally binding GHG emissions target for thirty-seven industrialized countries and the European community. The goal is supposed to amount to a 5% reduction from 1990 levels on average over the period 2008-2012 for Annex 1 member states (U.N., 1998). To meet their GHG emission reduction limits the Kyoto Protocol allows for mechanisms such as emissions trading, the clean development mechanisms (CDM), and joint implementation (JI). Examples of CDM reductions, given by World Bank (2010) are done through renewable energy, energy efficiency, and fuel switching. The goal as described by Grubb (2003), is to introduce “flexibility” into the Kyoto Protocol by allowing industrialized, or Annex 1, countries the opportunity to invest in global low cost emission reduction ideas. Joint implementation is where Annex 1 countries can invest in GHG reductions in other Annex 1 countries in return for Emission Reduction Units (ERUs which equal one ton of carbon dioxide emission) which can then be used towards their current domestic cap. Unlike CDM, JI’s are registered in countries that already have emission cap requirements.

Emissions trading is a market-based approach wherein the government creates scarcity of the carbon commodity by placing a cap on GHG emissions that may be polluted. Permits for the emission of one ton of carbon dioxide gas are given or auctioned off to emitters who can then use

[4] Stern remarks that this cost relates to keeping ppm’s below 550.

them in the course of business, sell them if they have excess, or buy more to cover excess emissions. In theory this will give low cost emitters an incentive to reduce emissions and sell surplus tradable credits to higher cost emitters. This also introduces economic incentive to use new reduction technology in order to capture the opportunity cost of retaining carbon permits. Society benefits when the true cost emitting pollutants into the air is placed on producers (Niblock, 2011).

The European Union Emission Trading Scheme was proposed in October 2001 to be the "flagship measure" under which the EU would meet its GHG emissions restrictions under the Kyoto Protocol (Ellerman and Joskow, 2008). The EU ETS was established as one of the first cap-and-trade public policy experiments to see if carbon emission abatement could be realized through a global carbon price. So far the scheme has been broken up into three phases. The first being 2005-2007, second 2008-2012, and the third phase is being 2013 onward. Ellerman and Joskow (2008, 7), posit that the first phase constituted a "trial" period wherein the primary goal was to "develop the infrastructure and to provide the experience that would enable the successful use of a cap-and-trade system to limit European GHG emissions during a second trading period." An empirical analysis of the affects of the EU ETS on certain sectors such as oil, steel, and electricity not only helps to shed light on the current evolution on the EU's rapidly growing carbon emissions trading scheme, which was estimated to have a worth around $30 billion in 2007 and potentially growing to $1 trillion within a decade,[5] but also serves as a measuring stick and guidebook to the U.S. and other nationalities trying to develop successful cap-and-trade systems of their own.

[5] Kanter, Carbon Trading: Where Greed is Green, 2007.

In my research paper my aim is to expand upon the earlier work done by Mohamed Amine Boutaba in his paper *Does Carbon Affect European Oil Companies' Equity Values?* In this paper he looks at the relationship between European Union carbon allowances (EUA) and the equity returns of certain European oil companies in the first phase of the EU ETS. He also looks at EUA price risk across three other sectors, cement, chemicals, and steel. Examining the impact of the EU ETS on certain European sectors is interesting in that it gives investors an idea as to whether or not they should hedge against rising carbon prices. Also it is interesting to note how the global financial crisis (GFC) has impacted the second phase of the EU ETS. Scott Niblock (2011, 119) posits that the "GFC and ensuing global recession may have had a dampening effect on carbon and international equity market investment," among other implications. I am going to answer the question of EUA price risk on oil and steel sectors by running the same generalized least squared cross-sectional time series model used by Mr. Boutaba. However where his data encompasses the first phase of the EU ETS I am mainly looking at the second phase.

II. Literature Review

To my knowledge no studies have addressed EUA price affects during the second phase of the ETS on the equity return of certain European oil companies or steel companies. Using empirical evidence Veith, Werner and Zimmermann (2009) show how returns in the power generation industry are positively correlated with rising prices for carbon emissions. Sijm, Neuhoff, and Chen (2006) examine the effect that the free allocation of carbon dioxide emission allowances on the power sector, finding that power companies realize substantial windfall profits by passing on the perceived cost of allowances to customers. Several studies address the ETS with regard to market efficiency, distributional effects of allocation, and environmental

effectiveness. Scott Niblock (2011) uses a three-way approach of examing investability, dynamic linkages, and Random Walk when questioning whether or not European carbon markets are weak-form efficient. He finds that the European carbon market is weak-form inefficient, by showing poor investability, minimal diversification benefits, and non-random walk behavior, thus "resulting in market failure and uncertain outcomes for the global economy and environmentin long-run. Based on this rationale, the use of market-based mechanism to address climate change must be question."[6] I hope to expand the current literature on green economics by examining implications of carbon price in the EU ETS specifically the second phase.

The rest of the paper is outlined as follows. Section three describes the theory and hypothesis behind the paper. Section four describes the data. Section five discusses the empirical findings. Section 6 concludes.

III. Theory

The hypothesis I am testing is the extent that changes in EUA price have on equity returns of certain European oil and steel companies. The multifactor model used in the paper is the same as the one used in Boutaba (2009). The empirical model is a generalized least squared cross-sectional time series linear model that takes the form:

$$R_{i,t} = \alpha + \beta_{co2}R_{co2,t} + \beta_{oil}R_{oil,t} + \beta_m R_{m,t} + \beta_e R_{e,t} + \beta_{tc}R_{tc,t} + \varepsilon_t$$

Where α is the constant term, ε_t is the residual not explained by the five variables, $R_{i,t}$ is the excess equity return on each company's stock, $R_{co2,t}$ is the return on the EUA price, $R_{oil,t}$ is the return on oil prices, $R_{m,t}$ is the market portfolio excess return, $R_{e,t}$ is the exchange rate return,

[6] Niblock, (2011). 176.

and $R_{tc,t}$ is the interest rate factor. A strong positive significance of the $R_{co2,t}$ factor could indicate the affects of EUA price on the excess return of oil and steel companies. By separating the panel data into monthly and yearly sections I can also assess the impact of the global financial crisis on this relationship. My hypothesis is that we will see a similar relationship between EUA returns and oil/steel company returns that was found in the previous study by Boutaba (2009).

IV. Data Description

In this paper I look at the link between EUA price and certain European oil and steel company equity returns. I aim to update Boutaba (2009) by examining data from the second phase of the EU ETS, specifically daily data spanning Feb. 27th, 2008 to Dec 31st 2011. The oil companies that make up panel data for this study are British Petroleim, Dragon Oil PLC, Ente Nazionale Idrocarburi, ERG SpA, Esso, Hellenic Petroleum, Lundin Petroleum, Statoil, Neste Oil, Osterreichischen Mineraloleverwaltung, Repsol YPF, Royal Deutsh Shell A, Motor Oil and Total. Compania I left out Espanola de Petroleo which was used in the initial study because they had been acquired by another company. A sample of companies is used because aggragete indeces might incorporate oil-related industries not operating in refining[7], thus emitting GHG, also companies included in an aggregate index are restricted on the liquidity of their equities (Boyer and Filion 2007). The steel companies used are Arcelor Mittal, Outokumpu, Rautaruukki, Salzgitter, Saint Gobain, Tenaris, ThyssenKrupp and Voestalpine. Acerinox was not used because it was acquired by another company.

[7] Boutaba, 2009, 5.

Of the variables used in the analysis $R_{i,t}$ is each companies excess equity return defined as the return on each company stock minus the yield on the three-month German Treasury Bill. The German three-month Treasury Bill was used by the previous study as well. $R_{co2,t}$ is the return on the EUA spot price on the Bluenext exchange. $R_{oil,t}$ is the return on oil prices using the Europe Brent spot price. $R_{m,t}$ captures the market portfolio excess return defined as the return on the Dow Jones Euro Stoxx 600 index in excess of the three-month German Treasury Bills yield. $R_{e,t}$ is the exchange rate return of the Euro over the USD. $R_{tc,t}$, the interest rate variable represents the risk free rate and is defined as the return of the yield on the ten-year German government bond minus yield on the three-month German Treasury Bill. All the data in this study was sourced from Bloomberg. Table 1 and 2 explain descriptive statistics for oil and steel company data. Table 3 highlights correlation values between variables. Oil company stock returns are positively correlated with all the variables and EUA returns are negatively correlated with all other independent variables.

As the reader can see from Figure 1 (Appendix), the EUA spot price declines from nearly thirty euros to under ten euros before it stabilizes as a result of the global financial crisis. Specifically the Committee on Climate Change, CCC (2009, 67) identified two causes to the decline in the second phase the reduced output in energy sectors led to less abatement required to meet cap by emitters as well as the market's idea of fossil fuel requirements declined combined to reduce carbon prices. These forces were unseen by the European Comission, committee that divides up carbon allowances among nations, resulting in an oversaturation of carbon permits.

Grubb (2009) highlights that the only thing that sustains the current spot price is the ability to "bank" or store carbon allowances from the second to third phase.[8]

V. Empirical Findings

By dividing the sample into sub-periods by month, Table 4.a., we can see the relationship EUA prices and equity prices change over time. The relationship varies over the course of the sample as the relationship as at least weakly correlated four times with a positive effect and at least weakly correlated four times with a negative effect. Overall the EUA factor is not significant for oil companies or steel companies, Table 4.b. and Table 5, so it does not seem like there is a strong relationship. The most significant indicator excess of equity return for these oil and steel companies is the market portfolio excess return. In the sub-period data this relationship is significantly positive three times while significantly negative one time. Overall market portfolio excess return has a positive effect on oil and steel company excess return suggesting that market portfolio changes are reflected in a similar fashion for these European oil and steel companies.

[8] "Banking" was an ability that firms could not do from the first to second period, contributing to the almost zero EUA price at the end of the first period.

VI. Conclusion

In summary my hypothesis that there would be a positive relationship between EUA returns and oil/steel equity returns did not hold up in my model or data. This could have been due to errors in the model or incalculable affects from the global financial crisis that occurred at the start of the second phase of the EU ETS. However I did find a strong correlation between the market portfolio excess returns, which is the return of the DJS 600 EUR minus the three-month German T-bill rate, and excess equity return of these oil and steel companies.

In terms of research limitations it would have been better to have a larger sampling pool. Intra-day data would have increased effectiveness of econometric analysis. There could've been benchmark errors with the DJS 600 EUR index that led to inaccurate model data. Also further research could've broken down companies in each sector based on size or whether or not they were a "growth" versus "value" equity. Also looking at diversification or hedging benefits gained from EUA futures could be a possible source of future research.

GHG abatement is critical to the future health of the world and subsequent generations of children. There is no "silver bullet" Niblock (2011) for preventing climate change and several market based mechanisms and policy alternatives (carbon tax, abatement purchasing, and other environmental legislation) should be considered collectively as "global citizens" if we are to take climate change seriously.

VII. References

Boyer, M., Fillion, D., 2007. Common and fundamental factors in stock returns of Canadian oil and gas companies. *Energy Economics*, Volume 29.

Brohan, P., 2006. Uncertainty estimates in regional and global observed temperature changes: a new dataset from 1850. *Journal of Geophysical Research*, Vol. 3. 21.

Butaba, M. 2009. Does Carbon Affect European Oil Companies Equity Values?

CCC, 2009. Meeting Carbon Budgets – the need for a step change, *Progress report to Parliament Committee on Climate Change* (October). 67.

Ellerman, Denny and Joskow, Paul. 2008. The European Union's Emission Trading System in Perspective. 7.

Folland, C.K., T.R. Karl, J.R. Christy, R.A. Clarke, G.V. Gruza, J. Jouzel, M.E. Mann, J. Oerlemans, M.J. Salinger and S.-W. Wang, 2001: Observed Climate Variability and Change. In: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 59.

Grubb, M., 2003. The Economics of the Kyoto Protocol. *World Economics*(July). 153.

Grubb, M. 2009. Linking emissions trading schemes, *Climate Policy*, Volume 9.

HM Treasury, 2006d, Stern Review: The Economics of Climate Change. [Online; 24 July 2008]. Avaliable: http://www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sster_review_reports.cfm

Kanter, J. 2007. Carbon Trading: Where greed is green. *The New York Times* (June).

Niblock S, 2011, "A diachronic informational efficiency investigation of European carbon markets", PhD thesis, Southern Cross University, Lismore, NSW.

Sijm, J., Neuhoff, K., Chen, Y. 2006. C02 cost pass-through and windfall profits in the power sector. *Climate Policy*, Volume 6.

U.N., 1992. United Nations Framework Convention on Climate Change. Article 2, 4.

U.N., 1998. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Article 3, 3.

U.S. Department of Commerce, National Oceanic and Atmospheric Aministration, Recent Monthly CO2 at Mauna Loa. http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo.

Veith, S., Werner, J., Zimmermann, J. 2009. Capital market response to emission rights: Evidence from the European power sector. *Energy Economics* (July).

World Bank, 2010, *State and Trends of the Carbon Market* (World Bank Institute, Washington DC, US). 262.

VIII. Appendix

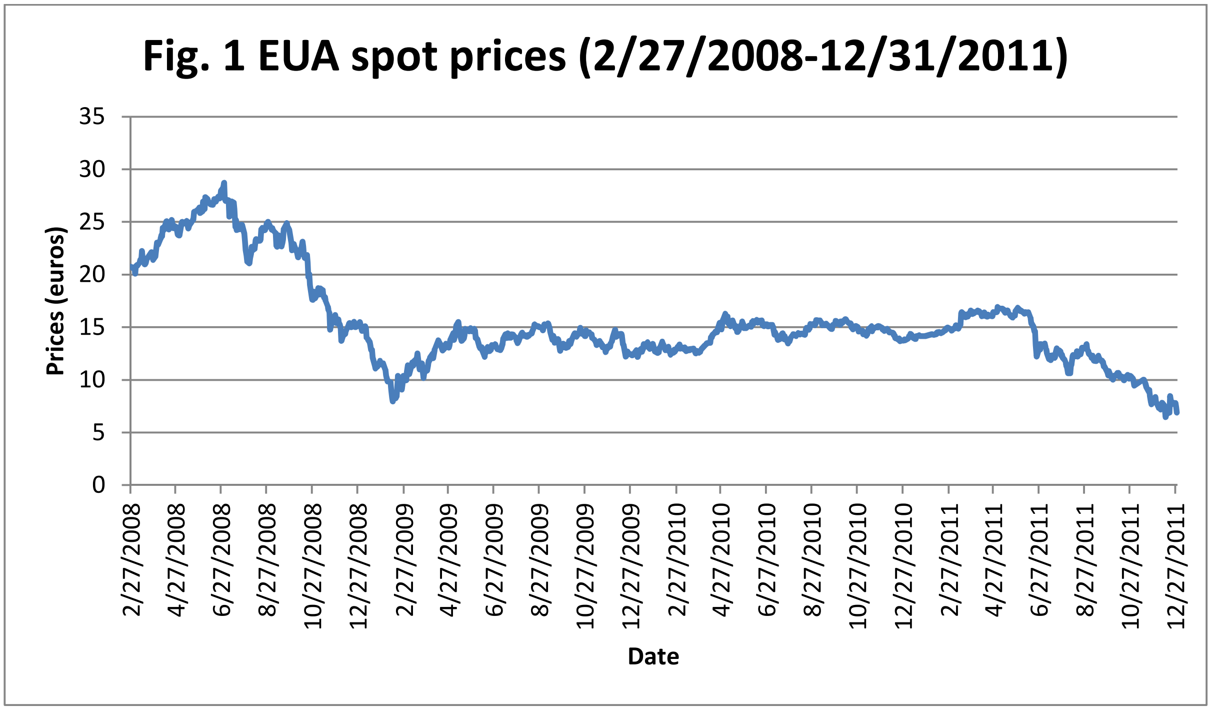

Table 1. Descriptive statistics for oil companies

	$R_{i,t}$(%)	$R_{co2,t}$(%)	$R_{oil,t}$(%)	$R_{m,t}$(%)	$R_{e,t}$(%)	$R_{tc,t}$(%)
mean	-1.135	-0.076	0.045	-1.154	-0.005	-0.054
sd	2.882	2.421	2.589	2.169	0.786	1.864
skewness	-0.308	-0.090	0.063	-0.632	0.159	-0.004
kurtosis	7.564	5.009	5.692	4.447	3.984	4.519

Notes: sample of daily returns from February 27th 2008 to December 31st 2011. The number of observations is 13370.

Table 2. Descriptive statistics for steel companies

	$R_{i,t}$(%)	$R_{co2,t}$(%)	$R_{oil,t}$(%)	$R_{m,t}$(%)	$R_{e,t}$(%)	$R_{tc,t}$(%)

mean	-1.179	-0.076	0.045	-1.154	-0.005	-0.054
sd	3.494	2.421	2.589	2.169	0.786	1.864
skewness	-0.196	-0.090	0.063	-0.632	0.159	-0.004
kurtosis	6.307	5.009	5.692	4.447	3.984	4.519

Notes: sample of daily returns from February 27th 2008 to December 31st 2011. The number of observations is 7640.

Table 3. Correlation matrix

	$R_{i,t}$	$R_{co2,t}$	$R_{oil,t}$	$R_{m,t}$	$R_{e,t}$	$R_{tc,t}$
$R_{i,t}$	1					
$R_{co2,t}$	0.0046	1				
	(0.5921)					
$R_{oil,t}$	0.0126	-0.0098	1			
	(0.1444)	(0.2588)				
$R_{m,t}$	0.3147***	-0.0074	-0.0195**	1		
	(0)	(0.3919)	(0.0242)			
$R_{e,t}$	0.0146	-0.0161	0.1947***	-0.0075	1	
	(0.0925)	(0.0619)	(0)	(0.3851)		
$R_{tc,t}$	0.0078	-0.0105	0.0486***	0.0083	0.2625***	1
	(0.3695)	(0.2255)	(0)	(0.3385)	(0)	

Notes: Numbers in parenthesis are p-values. ***, ** indicate significance at 1%, 5% respectively.

Table 4.a. Model results for sub-period oil company

Sub-period	α	Rco2,t	Roil,t	Rm,t	Re,t	Rtc,t	Adj. R^2
2008-03	-1.721***	0.125	0.042	0.617***	0.554**	0.193	0.291
2008-04	-0.958	0.092	0.055	0.620***	0.544**	-0.269*	0.106
2008-05	-2.073***	-0.129	0.094	0.378**	0.756**	0.051	-0.018
2008-06	-4.171***	0.088	0.034	0.100	0.039	.346**	0.001

2008-07	-3.310***	0.010	0.067	.346***	-0.121	0.037	0.058
2008-08	-4.545***	0.012	0.030	-0.071	-0.362	0.124	-0.039
2008-09	-4.103***	.390**	-0.020	0.181	.-058	-0.259	0.004
2008-10	-3.393***	-0.151	-0.206	0.108	1.350**	-0.565	-0.001
2008-11	-3.31***	0.181	0.052	.293*	-.660**	-.737***	-0.015
2008-12	-2.31***	.133*	0.061	-.402***	0.315	.261**	0.005
2009-01	-.761***	0.053	0.010	0.166	0.036	.278***	0.016
2009-02	-1.18***	-0.053	0.052	0.111	0.045	0.071	-0.039
2009-03	-0.318	-0.018	-0.013	0.144	0.154	0.047	-0.001
2009-04	0.019	-0.074	-0.059	0.082	.607**	0.107	0.009
2009-05	-.4*	-0.006	0.002	-0.052	0.003	0.120	-0.033
2009-06	-4.55***	-0.069	0.007	0.111	0.328	0.030	-0.037
2009-07	-.293**	-0.102	.189**	0.252	-0.268	-.358**	-0.003
2009-08	-0.146	-0.074	-0.049	-0.157	.495*	-0.003	-0.013
2009-09	-0.178	-0.069	0.026	-0.050	0.248	0.078	0.003
2009-10	-0.182	-.081*	0.067	0.077	-0.291	0.138	-0.022
2009-11	-.388***	0.107	-0.025	0.007	0.046	.201*	-0.028
2009-12	-.317***	-0.012	.127*	-0.161	0.144	0.068	-0.028
2010-01	-.305***	-0.042	0.023	0.183	0.234	-0.051	0.000
2010-02	-.349**	0.000	0.080	-0.052	-0.165	0.053	-0.043
2010-03	0.009	0.030	0.057	-0.048	0.082	-0.057	-0.021
2010-04	-0.227	-0.133	0.006	0.219	-0.220	0.205	0.006
2010-05	-.646***	-0.040	0.014	0.122	0.225	-0.119	-0.026
2010-06	-.230*	-0.044	0.030	-0.180	0.101	-0.031	-0.009
2010-07	0.036	-.12**	0.050	-0.164	-0.012	-0.145	0.031
2010-08	-.323***	-0.066	0.072	0.207	-0.146	-0.090	-0.030
2010-09	0.003	0.082	0.017	-0.090	-0.227	0.048	0.004
2010-10	-0.147	0.051	-0.067	.304*	0.111	0.022	-0.033
2010-11	-.331***	.119*	0.059	0.134	-0.080	-0.057	-0.003
2010-12	-0.173	-0.011	-0.115	0.028	0.035	-0.067	0.007
2011-01	0.033	-0.079	-0.068	0.022	0.044	-0.067	-0.011
2011-02	-.292***	-.286**	-0.026	0.129	.325*	-0.127	0.017
2011-03	-.517***	0.104	0.094	-0.044	-0.056	-0.027	0.010
2011-04	-.620***	-.152**	0.115	0.099	0.009	0.036	-0.016
2011-05	-.686***	-0.053	-0.060	0.175	0.340	-0.116	-0.041
2011-06	-1.083***	-0.058	0.032	-0.033	-0.030	0.018	-0.040
2011-07	-1.24***	0.036	0.037	-0.132	-0.174	0.132	0.002
2011-08	-1.29***	0.032	0.082	-0.073	-0.261	0.123	-0.021
2011-09	-.493**	.392***	0.022	-0.159	-.941*	.180*	-0.005
2011-10	0.074	0.016	-0.118	-0.202	0.295	0.065	-0.012
2011-11	-0.135	0.027	0.122	0.037	-0.250	-0.017	-0.030

2011-12	-.315**	0.008	0.077	0.171	0.115	-0.021	-0.008

Table 4.b. Model results for whole period oil companies

Whole-period	α	Rco2,t	Roil,t	Rm,t	Re,t	Rtc,t	Adj. R^2
	-.652***	0.009	0.018	.419***	0.050	0.001	0.099

Notes: Observations = 13370, Panels = 14, *, **, *** indicate significance levels at the 10%, 5% and 1% respectively.

Table 5. Model results for whole period steel companies

Whole-period	α	Rco2,t	Roil,t	Rm,t	Re,t	Rtc,t	Adj. R^2
	-.660***	0.021	0.002	.447***	0.129	0.004	0.077

Notes: Observations = 7640, Panels = 8, *, **, *** indicate significance levels at the 10%, 5% and 1% respectively.