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The unpaid social cost of carbon

Introducing a framework to estimate "legal looting" in the fossil fuel industry

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Abstract

Purpose – This paper aims to examine the complex issue of the social cost of carbon. The authors review the existing literature and the strengths and deficiencies of existing approaches. They introduce a simple methodology that estimates the amount of "legal looting" in the fossil fuel industry as an alternative approach to calculate an unpaid social cost of carbon. The "looting amount" can be defined as society's failure to charge fossil fuel firms for the damage that their activities cause represents an implied subsidy.

Design/methodology/approach – The methodology used in this paper combines decisions in the form of policymakers setting carbon taxes and rational investors investing in carbon emission markets.

Findings – The authors show that the unpaid social cost of carbon in the fossil fuel industry was US$12.7tn over 1995-2013, but may be as high as US$115.5tn.

Originality/value – Over the same period, the sum of industry profits, emission trading scheme carbon permit and carbon tax revenue totalled US$7tn, indicating the industry would not be viable if it was made to pay for damages to society.

Keywords Carbon accounting, Carbon tax, Emissions trading scheme, Fossil fuel industry, Legal looting, Social cost of carbon

Paper type Research paper

1. Introduction

Industrial activity, in particular the burning of fossil fuels, is an important driver behind climate change and is directly responsible for the increasing carbon dioxide (CO_2) concentration in the atmosphere (IPCC, 2013). Society's failure to charge fossil fuel firms for the damage that their activities cause has contributed to the breaching of critical boundary values for atmospheric CO_2 (Rockström *et al.*, 2009, Steffen *et al.*, 2015). However, energy pricing, and in particular governments' role with respect to it, is a complex and controversial area. Based on a careful review of the literature, this paper provides a framework for analysing the externalities involved in, and for identifying the issues relevant to, the social cost of carbon. We provide illustrative examples on how current government policies may be substantially out of sync with the true costs and benefits of the energy industry[1].

The paper proceeds as follows. First, we review the literature on the social cost of carbon in Section 1 and identify the main integrated assessment models (IAMs) which combine

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science and socio-economic models to obtain the social price of carbon. We point out the difficulties involved in estimating this cost, in particular the uncertainties and difficulties in estimation, and examine alternative approaches suggested in the literature. In Section 2, we introduce the Akerlof and Romer (1993) looting model and assess how it can be applied to the fossil fuel industry. We show that the Akerlof and Romer (1993) looting amount corresponds to the unpaid social cost of carbon. In Section 3, we introduce a simple methodology which combines the decisions made by experts in the form of policymakers setting carbon taxes and rational investors investing in carbon emission markets. The methodology uses estimates of the carbon produced by the fossil fuel industry and values the implied subsidy they receive in the form of unpaid social cost of carbon using prices from carbon tax and emission trading scheme (ETS) markets worldwide. We then compare the amount of the implied subsidy to the fossil fuel industry profits and to the amounts raised through carbon taxes and ETS carbon permit auctions. Our findings show that the unpaid social cost of carbon was US$12.7tn over 1995-2013, but may be as high as US $115.5tn. Over the same period, the sum of industry profits, ETS carbon permit and carbon tax revenue totalled US$7tn, indicating the industry would not be viable if it was made to pay for damages to society. Section 4 concludes the paper.

2. The social cost of carbon

The social cost of carbon estimates the dollar value of reduced climate change damages associated with a one-metric-ton reduction in carbon dioxide (CO_2) emissions. There are a wide number of approaches to estimate the social cost of carbon in the literature which include IAMs, survey approaches and simplified formulas (Greenstone *et al.*, 2013). The major IAMs are the dynamic integrated climate-economy model or DICE (Dell *et al.*, 2012; Nordhaus, 1992), the climate framework for uncertainty, negotiation and distribution or FUND (Tol, 1999) and the policy analysis of the greenhouse effect model or PAGE (Hope, 2006). IAMs combine scientific projections of future climate change and socio-economic variables to form an assessment of the cost of carbon. In practice, a four-step process is followed for any given year. First, a projection is made of future greenhouse gas emissions. Second, an estimate is made of the effects of past and projected emissions on climate. Third, an estimate is made of the effect of climate change on the environment. Fourth, this effect is converted into a monetary amount. The social cost of carbon is the difference in damage costs with an extra ton of CO_2 for the year in question.

The IAMs have found wide applications in the literature and are also used in the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC, 2013). Pizer *et al.* (2014) point out that regular updating and review of these models is necessary if they are to be effectively used in policy discussions and governmental cost-benefit evaluations. The FUND and PAGE models have gross domestic product (GDP) as exogenous variables, whereas the DICE model allows for endogenous capital investment decisions and changes in climate to affect GDP (Moore and Diaz, 2015). Moore and Diaz (2015) use an empirically based version of the DICE damage which allows for changes in climate to affect GDP differently in rich and poor countries. Using there augmented DICE model, Moore and Diaz (2015) estimate a social cost of carbon of US$220 per ton of CO_2.

Other approaches to estimate the social cost of carbon include survey-based methods (Pindyck, 2016; Pindyck, 2013; Stern, 2013) which seek to overcome the limitation that the damage functions of IAMs are *ad hoc* and have little or no theoretical or empirical support. Pindyck (2016) uses expert opinions on the probabilities of possible economic effects of climate change and the costs of avoiding these possible effects. Pindyck (2016)'s initial estimates of the social cost of carbon are similar to those by Moore and Diaz (2015) at over

US$200 per ton of CO_2. However, after eliminating outliers and giving greater weight to experts who were more confident in their estimates, Pindyck (2016) concludes that the social cost of carbon may rather be in the range of US$80 to US$100 per ton of CO_2.

Further to the survey methods, researchers have developed simplified analytical formulas that perform well in practice (Van den Bijgaart *et al.*, 2016), capturing 99 per cent of the within-model variation of the DICE model. Other research efforts have focussed on calculating the direct subsidies paid to the fossil fuel companies (Jakob *et al.* 2015). The International Energy Agency (IEA) estimates that direct subsidies that artificially lowered the end-user prices of fossil fuels totalled US$548bn in 2013 (IEA, 2015). The International Monetary Fund (IMF), using a different methodology, reports that post-tax energy subsidies were as high as US$4.9tn in 2013 (Coady *et al.* 2015), or 6.5 per cent of global GDP. The IMF use a post-tax energy subsidy in the form of the comparison between the price that consumers pay versus the supply cost plus a Pigouvian tax[2] for environmental externalities plus a consumption tax to contribute to revenue objectives. Of these, the IMF acknowledges that the consumption tax is of minor importance. Other research has focused on determining optimal levels of carbon pricing to reach certain mitigation targets such as the 2°C target and a corresponding optimal policy mix (Bertram *et al.* 2015). Carbon policy approaches to reduce emissions and encourage a transition towards renewable energy generation have also been considered (Rogelj *et al.* 2015).

None of these studies, however, fully factor in any indirect subsidies received by the fossil fuel industry as our simple approach does. Here, we introduce a simple methodology for estimating the unpaid social cost of carbon which draws on the choices made by governments in setting carbon taxes by investors in pricing carbon through carbon ETSs. Our methodology, specified in detail below, is most similar to Pindyck (2016) who elicits the opinion of experts, with the difference that our experts are policy setters and rational investors.

3. A looting model

Society's failure to charge fossil fuel firms for the damage that their activities cause represents an implied subsidy, the "looting amount" (Akerlof and Romer, 1993), that society grants to the fossil fuel industry. Looting is a term used in the economics and finance disciplines to refer to a situation in which society, through its government, agrees to an inefficient contract that persists through time. Looting occurs in the fossil fuel industry where companies are not required to fully pay for CO_2 emissions damage. While direct subsidies to the fossil fuel industry are known, the value of the looting amount (the implied subsidy granted by society to the industry by not charging for CO_2 emissions damage) has not yet been quantified.

The issue at the core of looting is one of moral hazard (Kahn and Winton, 2004): profits are privatized, while losses are socialized, allowing investors to undertake risky investments without fully paying for often predictable losses or damages. The term "looting" may seem nefarious, yet there is nothing illegal about this form of contracting. Evidence for looting was first described for several financial crises in the 1980s including the Chilean financial crisis, the US savings and loan industry, the Dallas real estate boom and bust, and the US junk bond market (Akerlof and Romer, 1993). More recently, looting theory was linked to the subprime mortgage crisis and the financial crisis of 2007-2008 (Smith, 2010; Boyd and Hakenes, 2014). A common thread among these cases is that limited liability corporations operating within a lax regulatory environment are encouraged to maximize the current extractable value (i.e. short-term profits or the "present take") rather than long-term value. In all cases, taxpayers (i.e. the government) were left holding the bag.

Looting is not confined to the financial services industry, however. It is widespread. But, perhaps, the most egregious example is the fossil fuel industry. This industry has a social contract (dubbed a "social license to operate") with society under which it implicitly operates (Hall *et al.*, 2015). This contract is inefficient because the fossil fuel industry is not required to fully pay for CO_2 emissions damage. If V represents the value of a typical fossil fuel firm and M represents the firm's implied subsidy from not being charged for the CO_2 emissions damage to society, a tipping point occurs when M is greater than V. At this point, the firm is not viable as a business and should close down (Akerlof and Romer, 1993). In the presence of the subsidy, however, the firm's optimal strategy is to loot, that is, to accept the subsidy and stay in business.

Our simple methodology seeks to quantify the implied subsidy granted by society to the fossil fuel industry by not charging for CO_2 emissions. Using carbon price signals in the form of carbon taxes, ETSs and economic models, we show that the worldwide average looting amount for the fossil fuel industry, the unpaid social cost of capital, over the period 1995-2013 is US$12.7tn, but may be as high as US$115.5tn. In comparison, over the same period, the sum of industry profits as well as ETS carbon permit and carbon tax revenue totalled US$7tn, indicating the fossil fuel industry would not be viable if it was made to pay for damages to society. Our approach is related to the IMF approach in that the carbon taxes and ETSs are a type of Pigouvian tax and in fact our estimates and the IMF estimates of the post-tax subsidy are equivalent at US$4.9tn in 2013 if the carbon price was US$144 (which is just slightly above the level of the Sweden carbon tax). However, our approach is broader in that it estimates the unpaid societal cost of carbon for any carbon price. Thus, we fill an important void in the literature. We anticipate our findings will spur more meaningful debate regarding the design of more stringent policy measures for carbon mitigation and uptake of renewable energy.

4. A simple methodology for estimating the unpaid social cost of carbon

To estimate the value of the unpaid social cost of carbon (Akerlof and Romer's implied subsidy to the fossil fuel industry), we multiply estimates of worldwide CO_2 emissions (from coal, oil, gas and flaring) by the price of CO_2e in US$ per ton. Total worldwide fossil fuel CO_2 emissions are 1,118.7 (1959-2013) and 524.9 billion tons (1995-2013) (Boden *et al.*, 2013). Indicative prices for CO_2 emissions are obtained from all the world's carbon taxes, ETSs (World Bank, 2015), as well as from economic models (Moore and Diaz, 2015). As there is no uniform agreement on the cost of CO_2 emissions, we use all available carbon price signals in form of carbon taxes, ETSs, as well as economic models as proxies for estimating the average looting amount (i.e. the unpaid social cost of carbon).

CO_2 emissions data are computed from the carbon emissions data provided by the Carbon Dioxide Information Analysis Centre (Boden *et al.*, 2013). Total emissions data are available for the period 1751 through 2013; however, more detailed data by country begin in 1959. As we address the issue of carbon tax revenue by country, we use the sample period 1959 through 2013 in our analyses. The sum of annual carbon emissions estimates across the years is then converted to total CO_2 emissions using a conversion factor of one ton of carbon to 3.664[3] tons of CO_2 emissions. For the final looting amount, we use averages of the implied subsidies we computed using the above steps.

To estimate the potential upper/maximum carbon tax revenue raised by each country with carbon taxation in effect, we obtain carbon taxation information from the World Bank (2015). Data on carbon emissions were obtained from the Carbon Dioxide Information Analysis Centre (Boden *et al.*, 2013) and converted to CO_2 emissions. We then multiply the

CO_2 emissions by the country carbon tax and sum to obtain the total possible tax revenue. For purposes of comparability, we limited the analysis to the period of 1995 to 2013.

To determine the estimated revenue from ETSs, we obtain the auction revenues from each of the countries/centres. The auction revenue was very sparse as most schemes freely gave out permits or grandfathered existing polluters. We conducted a detailed search for each country's ETS scheme (or Specified Gas Emitters Regulation in the case of Alberta, Canada) and the resulting revenue for the period 1995-2013. Sources are indicated in Table III. These amounts were then summed to obtain the total amount of revenue from ETSs.

To estimate profits of the fossil fuel industry, we multiply estimates of industry revenue by estimates of industry profit rates. To obtain yearly estimates of industry revenue, we obtain annual output data for oil, gas and coal from the *BP Statistical Review of World Energy 2014* (BP, 2014) for the period 1995-2013 and multiply by their respective market prices. The oil price is represented by the spot crude price per barrel of the West Texas Intermediate (Spot WTI Cushing prices). The gas price used is the price of natural gas per million BTU at US Henry Hub. The coal price used is the US$ price per ton as represented by the US Central Appalachian coal spot price index. To obtain estimates of industry profit rates, we identify the major fossil fuel companies from the Financial Times top 500 companies list, using their classifications of mining and oil and gas (Appendix). We calculate the average profit rates per year for these companies by dividing net income by total operating revenue, and use this as an indicative profit rate for the whole industry (Appendix). Relevant data were obtained from Bloomberg (2015). Profit from 1995 to 2013 is then estimated at the total value of worldwide operating revenue for each of the years multiplied by the respective average profit per year, and summed across years.

Our results are summarized in Table I. Using the carbon tax rates (Panel A), we have computed the looting amount as the tax rate per ton of CO_2 emissions times the total worldwide fossil fuel CO_2 emissions. Resulting estimates of the looting amount range from a low of approximately US$1.1tn (1959-2013) or US$0.5tn (1995-2013) using Poland's carbon tax rate of US$1 per tCO_2e to a high of US$145.4tn (1959-2013) or US$68.2tn (1995-2013) using Sweden's tax rate of US$130 per tCO_2e. Using the ETS market prices (Panel B) as a second proxy, we compute the looting amount as the ETS market price per ton of CO_2 emissions times the total worldwide fossil fuel CO_2 emissions. Estimates range from US $2.2tn (1959-2013) or US$1.0tn (1995-2013) for Chongqing, Guangdong and Shanghai (all China) and Kazakhstan to US$40.3tn (1959- 2013) or US$18.9tn (1995-2013) for Tokyo (Japan).

The looting amount can also be estimated using computer-based models that integrate economics and climate science (Panel C). Recent research examining alternative formulations of the Dynamic Integrated Climate-Economy (or DICE) model found that the marginal cost of an additional ton of emissions may be as high as US$220 (Moore and Diaz, 2015). The corresponding looting amounts are US$246.1tn (1959-2013) and US$115.5tn (1995-2013). The average looting amount across Panels A and B is US$21.0tn (1959-2013) or US$9.8tn (1995-2013). The average looting amount across Panels A, B and C is US$27.0tn (1959-2013) or US$12.7tn (1995-2013). These estimates indicate that the amount of looting by the fossil fuel industry is massive.

The focus now turns to how large the subsidies are in relation to the revenue raised from carbon taxes and ETS carbon permit auctions and the amount raised from industry profits. To answer the former question, we estimate the potential upper/maximum carbon tax revenue by country for the period 1995-2013 to be US$331.0bn (Table II). The figure reflects the potential upper/maximum carbon tax revenue if the country had taxed all (100 per cent)

Country	Year started	Price US$ per tCO_2e (World Bank, 2015)	Looting amount (US$bn) 1959-2013	Looting amount (US$bn) 1995-2013
Panel A: Carbon taxes				
Australia	2012-2014	18	20,136.30	9,448.12
BC	2008	23	25,729.72	12,072.60
Denmark	1992	25	27,967.09	13,122.39
Estonia	2000	2	2,237.37	1,049.79
Finland (transport fuels)	1990	64	71,595.75	33,593.32
Finland (other fossil fuels)	1990	48	53,696.81	25,194.99
France	2014	16	17,898.94	8,398.33
Iceland	2010	8	8,949.47	4,199.17
Ireland	2010	22	24,611.04	11,547.71
Japan	2012	2	2,237.37	1,049.79
Latvia	1995	4	4,474.73	2,099.58
Mexico (upper rate)	2014	3	3,356.05	1,574.69
Norway (upper rate)	1991	52	58,171.54	27,294.58
Poland	1991	1	1,118.68	524.90
Portugal	2015	6	6,712.10	3,149.37
Slovenia	1996	19	21,254.99	9,973.02
Sweden	1991	130	145,428.86	68,236.44
Switzerland (carbon tax)	2008	62	69,358.38	32,543.53
UK (carbon price floor)	2013	28	31,323.14	14,697.08
Scheme	Year started	*Price US$ per tCO_2e* (World Bank 2015)	*Looting amount (US$bn) 1959-2013*	*Looting amount (US$bn) 1995-2013*
Panel B: ETS*s*				
Alberta (Canada)	2007	12	13,424.20	6,298.75
Bejing (China)	2013	7	7,830.78	3,674.27
California (USA)	2012	13	14,542.89	6,823.64
Chongqing (China)	2014	2	2,237.37	1,049.79
European Union	2005	9	10,068.15	4,724.06
Guangdong (China)	2013	2	2,237.37	1,049.79
Hubei (China)	2014	4	4,474.73	2,099.58
Kazakhstan	2013	2	2,237.37	1,049.79
Korea	2014	9	10,068.15	4,724.06
New Zealand	2008	5	5,593.42	2,624.48
Quebec (Canada)	2013	13	14,542.89	6,823.64
Regional Greenhouse Gas Initiative States (RGGI)	2009	7	7,830.78	3,674.27
Shanghai (China)	2013	2	2,237.37	1,049.79
Shenzhen (China)	2013	5	5,593.42	2,624.48
Switzerland (ETS)	2008	9	10,068.15	4,724.06
Tainjin (China)	2013	3	3,356.05	1,574.69
Tokyo (Japan)	2010	36	40,272.61	18,896.24
Model		*Price US$per tCO_2e* (Moore and Diaz, 2015)	*Looting Amount (US$billion) 1959-2013*	*Looting Amount (US$billion) 1995-2013*
Panel C: Economic models				
DICE		220	246,100.00	115,500.00
Overall average (Panels A and B)			*20,913.17*	*9,812.63*
Overall average (Panels A, B and C)			*26,999.30*	*12,669.05*

Note: Prices as of 1 August, 2015. For Australia, the latest (2014) price of A$24.15 was converted into US$ using the exchange rate from 1 August

Table I. Estimates of the amount of looting in the fossil fuel industry based on available carbon pricing and Co_2 emissions data

Country with carbon taxation in effect	Years started	Price US$ per tCO_2e	Emissions in billion tons of carbon	Emissions in billion tons of CO_2e	Possible tax revenue in US$bn
Australia	2012-2014	18	0.19	0.69	12.49
BC	2008	23	0.08	0.29	7.07
Denmark	1992	25	0.26	0.95	23.73
Estonia	2000	2	0.07	0.24	0.48
Finland – upper tax rate	1990	64	0.30	1.10	70.34
France	2014	16	0.00	0.00	–
Iceland	2010	8	0.00	0.01	0.06
Ireland	2010	22	0.04	0.15	3.30
Japan	2012	2	0.68	2.50	5.00
Latvia	1995	4	0.04	0.14	0.57
Mexico	2014	3	0.00	0.00	–
Norway	1991	52	0.23	0.84	43.74
Poland	1991	1	1.64	6.02	6.02
Portugal	2015	6	0.00	0.00	–
Slovenia	1996	19	0.08	0.28	5.32
Sweden	1991	130	0.26	0.96	125.32
Switzerland	2008	62	0.06	0.24	14.63
UK	2013	28	0.13	0.46	12.94
		Total	*4.06*	*14.88*	*331.01*

Note: Data on emissions in billion tons of carbon stems from Boden et al. (2013) and British Columbia (2013)

Table II.
Estimated carbon tax revenue by country in US$bn for countries with carbon taxation in effect (1995-2013)

of its carbon emissions from fossil fuels in years when a carbon tax was in effect (Pezzey and Jotzo, 2013). The estimate is based on the same prices per ton of carbon as in Table I. Table II is not meant to represent actual tax revenue (which in many cases is much lower), but rather represents an indication of maximum tax revenue. Our estimate of the revenue from carbon permits is even more miniscule. In most countries, carbon permits are given freely or are grandfathered rather than auctioned. Estimated revenue from auctions and compliance funding between 1995 and 2013 is US$12.40bn (Table III).

The estimated profit from oil over this period is US$4.4tn; profit from gas is US$1.3tn; and coal is US$1.0tn. This gives a total profit figure of US$6.7tn. Adding the amounts collected worldwide from carbon taxes and ETS auction revenue, we obtain a figure of US $7tn. The average looting amount by the fossil fuel industry for the period 1995-2013 is roughly twice as much at US$12.7tn. Thus, the average loss to society is US$5.8tn. Using the maximum looting figure of US$115.5tn, the societal loss is as high as US$108.6tn.

5. Conclusion

The social cost of carbon is an extremely important and complicated price to compute. It has enormous policy implications in terms of the cost benefit analysis governments and businesses must undergo in order to determine optimal adaptation and mitigation investments. We provide a framework identifying the issues and outlining the approaches to estimating the unpaid social cost of carbon. This paper has offered a simple methodology for estimating the social cost of carbon based on the revealed decisions of policymakers in the form of government carbon taxes and rational investors in the form of carbon emission trading prices. We suggest that perverse incentives are causing the fossil fuel industry to adopt a bankruptcy for profit approach, replacing normal profit maximizing behaviour with

Table III. Estimated revenue from ETSs by country or jurisdiction in US$bn (1995-2013)

Scheme	Year started	Notes	Total amount 1995-2013 US$billion
Alberta (Canada) Specified Gas Emitters Regulation	2007	Compliance funding was pooled into the Climate Change and Emissions Management Fund (CCEMC) from 2009 onwards. Funds received: $316 million over period 2009-2013 (CCEMC, 2013)	0.32
Beijing (China)	2013	Came into effect on 28 November 2013. Free allocation	0
California (USA)	2012	First year of auctions generated revenue of over $525 million (Center for Climate and Energy Solutions, 2014)	0.53
Chongqing (China)	2014	Came into effect on 19 June 2014. Free allocation	0
EU	2005	Revenue from Phase 1 and 2: €5.6 billion (CDC Climat, 2013). Revenue from Phase 3: €3.6 billion (European Commission, 2014.	10.12
Guangdong (China)	2013	Came into effect on 19 December 2013. 3% of allowances auctioned in 2013	0.03
Hubei (China)	2014	Came into effect on 2 April 2014. Mainly free allocation based on grandfathering	0
Kazakhstan	2013	Phase I (2013): 100% free allocation based on emissions data from 2010	0
Korea	2014	Phase I (2015-2017): 100% free allowances	0
New Zealand	2008	No auctioning of allowances has taken place to date	0
Quebec (Canada)	2013	Allowances are allocated and auctioned, first auction in 2014	0
RGGI	2009	ETS revenue from 2008-2013 is U$1.4 billion (World Bank, 2015).	1.4
Shanghai (China)	2013	Came into effect on 26 November 2013. Free allocation	0
Shenzhen (China)	2013	In 2014, 3% of allowances auctioned. No auctioning in 2013	0
Switzerland	2008	Free allocation of allowances 2008-2012	0
Tianjin (China)	2013	Came into effect on 26 December 2013. Free allocation	0
Tokyo (Japan)	2010	Free allocation, grandfathering based on historical emissions	0
Total:			*12.40*

Notes: Exchange rate used as of 1 August, 2015. Data on the schemes stems from ICAP (2015) the "topsy-turvy" economics of maximizing extractable value (Akerlof and Romer, 1993). While this paper has only considered the implied subsidy that society grants to the fossil fuel industry by not charging firms for the damage caused by carbon emissions, similar analyses can be performed for other environmental impacts across all industries. Further research can build on this methodology to develop alternative approaches for estimating the social cost of carbon.

Notes

1. For papers that consider the implications of a carbon tax in the local context, see Kumarasiri and Jubb (2016), Luo*et al.* (2013), Hollindale *et al.* (2017) and, more broadly, Linnenluecke *et al.* (2015) and Luo (2017).
2. A Pigovian tax is a tax on market activity that generates negative externalities.
3. Department of the Environment (2014). The conversion factor comes about because of the difference in the atomic weights of carbon and CO_2, as CO_2 includes two atoms of oxygen in addition to an atom of carbon and hence has higher atomic weight.

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Further readding

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Appendix

Company	Country
BHP Billiton	Australia/UK
Rio Tinto	Australia/UK
China Shenhua Energy	China
Glencore	UK
Vale	Brazil
Exxon Mobil	USA
PetroChina	China
Chevron	USA
Royal Dutch Shell	UK
Sinopec	China
Total	France
BP	UK
ConocoPhillips	USA
CNOOC	Hong Kong
Eni	Italy
Gazprom	Russia
Statoil	Norway
Occidental Petroleum	USA
EOG Resources	USA
Rosneft	Russia
Reliance Industries	India
Anadarko Petroleum	USA
Phillips 66	USA
Suncor Energy	Canada
BG Group	UK
Oil & Natural Gas	India
Lukoil	Russia
Petrobras	Brazil
Imperial Oil	Canada
Canadian Natural Resources	Canada
Valero Energy	USA
TT	Thailand
Marathon Petroleum	USA
Surgutneftegas	Russia
Repsol	Spain
Devon Energy	USA

Note: The table shows the list of companies used to obtain the indicative profit rates for the calculation of profits of the fossil fuel industry

Table AI. Major fossil fuel companies listed in the financial times top 500 companies

Table AII.
Average profit rate per year rate across fossil fuel companies

Year	Indicative average profit rate across fossil fuel companies (%)
2013	13.33
2012	12.63
2011	15.85
2010	15.83
2009	11.07
2008	13.86
2007	20.08
2006	20.01
2005	19.57
2004	17.37
2003	13.46
2002	11.44
2001	9.95
2000	12.76
1999	9.75
1998	2.16
1997	9.47
1996	13.45
1995	13.45

Note: The indicative average profit rates per year across fossil fuel companies were calculated by dividing net income of all companies listed in Table A1, dividing by their total operating revenue (Source: Bloomberg[1]). Insufficient data existed to calculate the 1995 and 1996 average profit rates so the overall average for 1997-2013 (13.45%) was used in these years

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