Science and the stock market: Investors’ recognition of unburnable carbon

August 2014

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Unburnable Carbon

• Fossil fuel energy sources which cannot be burnt if the world is to adhere to a given carbon budget.
  • Some fossil fuels may be used for other purposes which do not involve combustion, eg as petrochemical feedstocks.
  • Hence “unburnable” rather than “unusable”.
Unburnable Carbon
Unburnable carbon and stock market responses

• How well does the press serve the public and company stakeholders when it comes to reporting significant discoveries from science?

• Stock market’s reaction to stranded assets.
  
  • Do “fossil fuel companies’ stock prices hinges significantly on recoverable reserves.”
  
  • Our analysis indicates at best a limited stock price of two percent for our sample of the 63 largest U.S. oil and gas companies.
  
  • Later press discovery of this science still has not translated into loss of significant value.

• What does this mean
Background

• “About three-quarters of the world's fossil fuel reserves must be left unused if society is to avoid dangerous climate change, scientists warn.”
  • Implication of two papers in the April 30, 2009 issue of *Nature* – Allen *et al.* (2009) and Meinshausen *et al.* (2009)
• Meinshausen: “less than one-half of the world’s proved economically recoverable oil, gas, and coal reserves could be emitted during 2007-2050.”
• Effect on energy firms’ balance sheet, and market value largely ignored.
Four year later...

- Meinshausen et al is now one of the most quoted scientific papers.
  - HSBC: 40 to 60 percent of the market capitalization of the world’s top 200 energy companies at risk.
  - $4 trillion market cap (Carbon Tracker 2013)
  - Carbon Tracker’s now claim 85 percent of reserves may be “unburnable”
- Significant increase in media attention.
  - “fossil-fuel investments are destined to lose their economic value”
Accounting reserve disclosure

Unburnable reserves (% of 2P reserves)

- Shell
- BP
- Total
- Statoil
- Eni
- BG

- Oil and associated gas
- Gas and condensate

Source: Company data, Wood Mackenzie, HSBC calculations
Al Gore: “Carbon Bubble” Is Going to Burst – Avoid Oil Stocks (Oct 2013)

• “We have a carbon bubble,”
• “Bubbles by definition involve a lot of asset owners and investors who don’t see what in retrospect becomes blindingly obvious. And this carbon bubble is going to burst.”
• co-founder and chairman of Generation Investment Management
Research Questions

• When and whether the stock market might have recognized the potential loss of value to energy company shareholders due to unburnable carbon.

• Rational response hypothesis
  measureable negative price reaction to the reporting of the science (April 2009).
  • Allen et al. (2009), Meinshausen et al. (2009)
  • Media inattention and investor response to initial news

• Lagged response hypothesis
  • Media attention and limited investor response to later news.
    Huberman and Regev (2001) delayed response to Cancer drug discovery
  • Overreaction: Hill et al (1991) 25% increase in palladium prices on cold fusion breakthrough
  • Does financial statement oil and gas reserve disclosure matter?
What do we find?

- Results support the rational response hypothesis
  - 1.5% to 2% decline around April 30, 2009 date for a sample of 63 of the largest U.S. oil and gas companies.
  - No significant response to later media stories in 2012 to 2013
    - Negative stories, but they conveyed little new information
  - Some evidence of a negative response over longer event window for companies with significant oil & gas reserves on their balance sheets.
Why is this interesting?

• Carbon bubble proponents
  • Dire consequences
  • *Carbon Tracker* estimates up to $4 trillion financial loss.

• Media bias

• Efficient markets and unbiased assessments of future returns
  • Investor anticipation of all future scenarios
  • Investor discounting of uncertain future benefits

• Costs and benefits of financial disclosure
Efficient Markets

• Nobel laurites, Fama (2013) and Kahneman (2002) strongly believe in stock market efficiency
  • Buy index funds (rather than actively manage your investments)
• “the most remarkable error in the history of economic theory.” Robert Shiller, 1987 (2013 Nobel laurite)

"I'd be a bum in the street with a tin cup if the markets were efficient." Warren Buffet
Efficient Markets

“financial markets can be efficient most of the time but every once in a while they break down and then we need to develop better analytics to be able to understand”
Contribution

- Stock market’s possible recognition of unburnable carbon
  - understand how and when significant results from science might eventually be reflected in stock prices, since a delay or miscommunication could suggest profitable arbitrage opportunities
  - the role of the media regarding unburnable carbon
    - compelling story with worrisome implications for many,
    - But rational investors would also consider all potential future scenarios, some of which would have offsetting effects on company.
Sample

• Datastream (GICS code 10120) and CRSP / Compustat
• Final sample
  • 63 Integrated Oil and Gas, and Oil and Gas Exploration and Production including
    • ANADARKO PETROLEUM
    • CHEVRON
    • EXXON MOBIL
    • OCCIDENTAL
# Selected Sample Statistics (table 2)

<table>
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<th>Description</th>
<th>Mean</th>
<th>Median</th>
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<tr>
<td>TA</td>
<td>Dollars, millions</td>
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<td>LOGTA</td>
<td>Natural log of TA</td>
<td>8.28</td>
<td>8.16</td>
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<td>LGMKT</td>
<td>Natural log of market value</td>
<td>8.04</td>
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<td>RBETA</td>
<td>Number</td>
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<td>1.32</td>
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<td>TOTEQ (equity)</td>
<td>Dollars, millions</td>
<td>8,921</td>
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<td>MKTVL (mkt cap)</td>
<td>Dollars, millions</td>
<td>17,558</td>
<td>2,951</td>
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<tr>
<td>CGVSC (governance)</td>
<td>Percent (100=100%)</td>
<td>73.2</td>
<td>72.52</td>
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<tr>
<td>ECNSC (economic)</td>
<td>Percent (100=100%)</td>
<td>50.91</td>
<td>48.6</td>
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<tr>
<td>ENVSC (environmental)</td>
<td>Percent (100=100%)</td>
<td>32.57</td>
<td>16.9</td>
</tr>
</tbody>
</table>
News stories

• *Factiva* Search terms:
  • unburnable and bubble,
  • two degrees (2º) celsius,
  • 560 or 450 ppm (parts per million),
  • 565 gigatons,
  • 2,795 gigatons,
  • Meinshausen,
  • Carbon Tracker, and
  • HSBC and carbon bubble

• We also create a crude oil market control variable
“unburnable” Print stories

• Factiva search
  • Meinshausen result on April 11, 2009
  • 88 other unburnable carbon news stories by 59 different print media sources
  • Mostly between March 23, 2012 and March 5, 2013

General oil /gas stories but also Aus carbon tax (116)
Table 3 (and figures)

- \( \text{ret} = RF + \alpha + \beta_1(Mkt - RF) + \beta_2\text{SMB} + \beta_3\text{HML} + \text{error} \)
- Excess return: market model and a FF calendar regression is also used
Cumulative Fama-French excess returns around unburnable carbon news stories

![Graph showing cumulative daily FF excess return over 10 days relative to unburnable news story (day 0). The graph compares 'No Disclosure' and 'Reserve Disclosure' scenarios.](image-url)
Carbon tax news (4/11/2011)

Cumulative daily FF excess return

Day relative to unburnable news story (day 0)

No Disclosure  Reserve Disclosure
All other unburnable carbon stories (2012/2013)

Cumulative daily FF excess return

Day relative to unburnable news story (day 0)

No Disclosure  Reserve Disclosure
## FF event time regression (table 4)

<table>
<thead>
<tr>
<th>Response window</th>
<th>Day 0</th>
<th>Days -1 to 1</th>
<th>Sum of days -1 to 1</th>
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<tbody>
<tr>
<td>Regression</td>
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<td>5</td>
<td>6</td>
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<tr>
<td>Variable</td>
<td>Coeff.</td>
<td>Coeff.</td>
<td>Coeff.</td>
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<tr>
<td>Intercept</td>
<td>0.0002</td>
<td>-0.0002</td>
<td>0.0138</td>
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<tr>
<td>PercentageChangeOilPrice</td>
<td>0.221</td>
<td>0.24</td>
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<td>CarbonTaxDum</td>
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<td>NaturePublicationDum</td>
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<td>-0.0151</td>
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<tr>
<td>ProvedReserveDum</td>
<td>0.0005</td>
<td>-0.0009</td>
<td>-0.0046</td>
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<tr>
<td>Prob&gt;</td>
<td>t</td>
<td></td>
<td>0.4545</td>
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<tr>
<td>CarbonTaxDum*ProvedReserveDum</td>
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<td>-0.0078</td>
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<tr>
<td>Prob&gt;</td>
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<td></td>
<td>0.014</td>
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<tr>
<td>Corporate/IndustrialNews</td>
<td>0.00001</td>
<td>-0.00001</td>
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<tr>
<td>Prob&gt;</td>
<td>t</td>
<td></td>
<td>0.0008</td>
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<td>CrudeOil/NaturalGasProductMarkets</td>
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<td>ns</td>
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<tr>
<td>Prob&gt;</td>
<td>t</td>
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<tr>
<td>ESPAR</td>
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<td>Prob&gt;</td>
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<td>ANALYST</td>
<td>-0.00002</td>
<td>0.00001</td>
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<tr>
<td>Prob&gt;</td>
<td>t</td>
<td></td>
<td>0.0205</td>
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</tbody>
</table>
Aggregate loss (2.48% of market capitalization) (after controls)

$1,061,565
$27,050

Aggregate capitalization
Unburnable disclosure losses

Dollars in thousands
Most related to the nature article release

- Nature publication: $5,008
- All other unburnable carbon stories: $22,042
Key findings

• Does the stock market recognized the significance of the Meinshausen findings contemporaneous?
  • Yes—around a 1.5-2% loss—consistent with our rational response hypothesis
  • But stands in contrast to the claims of some of a substantial potential loss of energy companies’ shareholder value
    • the value at risk from unburnable reserves would be equivalent to 40-60% of the market capitalization of affected companies.” Spedding et al. (2013)
• Later press releases?
  • At best “media may have contributed to a small negative reaction over the next two weeks”
Explanation of findings

- Why might we have observed only a limited negative stock price reaction to unburnable carbon?
- Are market unaware of the bubble?
- Or is the market a counterforce to the claimed financial impact?
- Investors consider options, dynamics, and future innovation.
  - carbon capture and sequestration (CCS) (Global CCS Institute 2013) and CO$_2$ enhanced oil recovery
Explanation of findings

• Investors use multiple channels of information.
  • Not just information about reserves from financial statements
  • National energy policies,
  • Economic incentives in the form of tax reductions and rebates for firms to internalize the cost externalities of unburnable carbon
  • Ability to regulate (globally)
• Investors would be skeptical about whether the demand for oil can actually be pared back within an economically meaningful horizon
• Investors’ dearth of information in companies’ financial statements
• Potential media bias
The debate

• "**Smart investors** can see that investing in companies that rely solely or heavily on constantly replenishing reserves of fossil fuels is becoming a very risky decision...." **Professor Lord Stern** 24 April 2013

• NEWS: “Should You Follow Warren Buffett Into ExxonMobil?”
  • Purchased $3.45bn worth of shares *in* oil giant *Exxon Mobil* (18/11/2013)
  • Forbes: There are collectively 43 stocks in Berkshire Hathaway’s portfolio, which is valued at $92.04 billion. In total, energy stocks comprise 7.9% of its total.

• NEWS: *Oil’s Future Draws Blood and Gore in Investment Portfolios* (18/11/2013)
Median Price-Earnings Ratio for 29 International Oil and Gas Stocks
Credit spreads logically include climate change risk as a pricing factor. Now less than 150 basis points per $100 of notional value.
More recent events

- 1/3/2014 Norway Government Pension Fund to review fossil fuel investments
- 1/4/14 Exxon-Mobil comments on carbon risk
- 6/5/14 Stanford University to divest from coal
- 7/6/14 New members of the SASB (Economist)
- 9/6/14 Tom Steyer to divest from fossil fuels
  - Farallon Capital to divest from fossil fuel investments
  - Steyer: a member of Stanford University Board of Trustees
- 27/8/14 Sydney University creates waves with investment ban on coal
- Do divestment campaigns serve investors’ needs?
Energy Company responses

- Exxon, forecasts oil demand will remain strong **through 2040 and beyond**. Exxon plans to invest $185 billion in energy projects in the next five years.

*Exxon* says its carbon bubble will not burst

the today - 3 hours ago
That is, that future mandated carbon targets will make its proved reserves of oil and gas unburnable, and as a result seriously impact the company’s value. “All of *ExxonMobil’s* current hydrocarbon reserves will be needed, along with substantial future industry...

*ExxonMobil* remains convinced that the world needs fossil fuels – despite...

Blue & Green Tomorrow - Apr 1, 2014

The company promised in March to prepare a document on the financial risks for investors related to the ‘unburnable’ fossil fuel reserves, given the current climate situation. But William Colton, *ExxonMobil’s* vice-president of corporate strategic planning, said, ...

*Exxon* Mobil not backing down from activist shareholders

Houston Business Journal - Mar 31, 2014
Industry response: NSW Minerals Council

- Stephen Galilee said it was "a shame that Sydney University has caved in to the bullying of environmental activists masquerading as financial advisers".
- "The divestment campaign is environmental activism dressed up as investment advice ....based "on false premises and unsubstantiated claims, and may breach Australian law".

"Australian coal against global coal budgets"

Meinhusen: April 11, 2009

Coal, Australian thermal coal Monthly Price - US Dollars per Metric Ton

<table>
<thead>
<tr>
<th>Month</th>
<th>Price</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>Jan 2009</td>
<td>85.07</td>
<td>0.95%</td>
</tr>
<tr>
<td>Feb 2009</td>
<td>80.76</td>
<td>-5.07%</td>
</tr>
<tr>
<td>Mar 2009</td>
<td>65.36</td>
<td>-19.07%</td>
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<tr>
<td>Apr 2009</td>
<td>68.10</td>
<td>4.19%</td>
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<tr>
<td>May 2009</td>
<td>69.11</td>
<td>1.48%</td>
</tr>
<tr>
<td>Jun 2009</td>
<td>76.48</td>
<td>10.66%</td>
</tr>
<tr>
<td>Jul 2009</td>
<td>79.07</td>
<td>3.39%</td>
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</table>

http://www.indexmundi.com/commodities/?commodity=coal-australian&months=120
AUSTRALIA-DS Coal Index

<table>
<thead>
<tr>
<th>Date</th>
<th>Price</th>
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<tbody>
<tr>
<td>13/03/2009</td>
<td>7831.89</td>
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<td>20/03/2009</td>
<td>8045.07</td>
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<td>27/03/2009</td>
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<td>17/04/2009</td>
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<td>24/04/2009</td>
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<tr>
<td>01/05/2009</td>
<td>9453.89</td>
</tr>
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</table>
AMERICAS-DS Coal - PRICE INDEX COALMAM
Energy Company responses

• National Mining Association, coal use will continue unabated through 2020 as larger, more efficient plants supplant older ones.

• Statoil, Norway's biggest oil company, response to the letter from 70 concerned investors.
  • “even if the world takes aggressive action to limit global warming by 2 degrees, oil will continue to be the primary energy source for decades to come.”

• Royal Dutch Shell, moving to cleaner natural gas
  • “new project, it factors in $40 a ton for the future cost of carbon emissions”

• BP: “We agree that burning all known reserves would probably cause global temperatures to rise by more than 2 °C – and that addressing this issue will require the efforts of governments, industry and individuals. However, we believe that the unburnable carbon approach to assessing the impact of potential climate regulation on a company’s value oversimplifies the complexity of the issue and overstates the potential financial impact.”
Economist (May 2013)

• Unburnable fuel
• Either governments are not serious about climate change or fossil-fuel firms are overvalued
• “But so long as governments are ambivalent about those targets, it seems fruitless to demand more of companies and markets. At the moment neither public policies nor markets reflect the risks of a warmer world.”
Caveats and limitations

• Cannot rule out a carbon bubble.
• Results apply to U.S. companies and markets only.
• May have underestimated the impact of news stories.
• Unforeseeable events may change investors’ calculus of unburnable carbon risk.
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- Results apply to U.S. companies and markets only.
- May have underestimated the impact of news stories.
- Unforeseeable events may change investors’ calculus of unburnable carbon risk.
Thank you!
Model

- Rj regressed on
- RF, Mkt-RF, SMB, HML (Fama French)
- PercentageChangeOilPrice
- CarbonTaxDum
- NaturePublicationDum
- ProvedReserveDum
- CarbonTaxDum*ProvedReserveDum
- Corporate/IndustrialNews
- CrudeOil/NaturalGasProductMarkets
Asset4 scores (0-100)

- From public sources (including company filings).
- Carbon Tracker