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Big data, open data and the climate risk market

As the deep structural "uncertainties" that are beginning to define the early twenty-first century continue to unfold (Hay and Payne 2013), the question of how societies should respond to the decline - and the consequences of - the era of carbon capitalism become increasingly pressing. For some, the answer to these challenges is found in a further defining trend of the contemporary era – advances in digital information and communication technologies such as big data analytics, smart cities and social media communications. In this chapter, we critically examine some key developments at one site where three phenomena related to these trends – climate change, big data and financial capitalism – intersect: data-driven climate risk markets. Situating these developments in the context of emergent forms of "informational power" (Braman 2006) and data policy struggles that aim to make meterological data more readily exploitable by climate market actors, the chapter asks what it might mean to turn to climatic uncertainty as a source of profit and growth.

Climatic uncertainty

As many scientists and commentators have observed, planetary ecosystems are in a state of crisis. In a 2009 Nature article, Johan Rockström and colleagues identified the various ways in which human action is stressing the ecological "carrying capacity" of the planet (Rockström *et al*. 2009). In their paper, Rockström *et al.* quantify a range of "planetary boundaries" in order to identify a variety of ecological processes and the "associated thresholds" that could not be crossed without generating "unacceptable environmental change". Their analysis identifies that the boundaries for "climate change, rate of biodiversity loss and interference with the nitrogen cycle" have already been passed – unacceptable environmental change is occurring. Further, in the case of "global freshwater use, change in land use, ocean acidification and interference with the global phosphorous cycle", these boundaries are being quickly approached.

Such warnings about the impact of human action on the Earth's ecosystems are echoed by many expert commentators, including scientists involved in the Intergovernmental Panel on Climate Change (IPCC). The IPCC assessment reports are a collaborative effort involving thousands of researchers and governments from around the world. The report is a systematic review of publications relevant to the scientific, technical and socio-economic aspects of climate change. The aim is to provide a comprehensive view of current knowledge. The most recent report was published in 2014, and its conclusions were unambiguous:

> "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen."

Further,

> "Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects,

> together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century." (IPCC 2014)

Big data and informational power

Scientific knowledge about phenomena such as climate change is highly data dependent. Without the appropriate data it would not be possible to identify the extent to which the global climate has altered over the years or analyse the potential causes. Without the ability to analyse vast amounts of weather observation data, society would only experience the consequences of climate change: extreme weather, rising sea levels, crop failures, and so on.

The meteorological and climate sciences have long been data-driven disciplines (Edwards 2013). The reason we know that the climate is changing, why it is changing, and how we should respond, is the result of decades of complex processes of data collection, cleaning, analysis and modelling by climate scientists. Meteorological organisations around the world hold vast archives of weather observations that can be analysed to predict the weather and understand average weather conditions - the climate - over time. Scientists are also exploring innovate ways to fill in the gaps in their datasets in order to increase their understanding. For example, citizen science projects such as Old Weather (https://www.oldweather.org/) that use the labour of volunteer 'citizen scientists' to transcribe historical shipping records, so that the digitised data can be fed into weather observation databases and climate models.

However, it is not only scientists that are interested in using data in order to understand and respond to changes in the climate. As meteorological data becomes more abundant and fine-grained, it – like many other forms of data - is being increasingly exploited by those who want to use high level data analytics in order to extract profits. This, according to Mayer-Schonberger and Cukier (2014), is the era of "datafication" in which more and more aspects of human existence are being quantified and turned into computerised data. Over the last decade it has become almost cliché to claim that "data is the new oil", or - as the former European Commissioner for Digital Agenda Neelie Kroes' (2011) claimed – "the new gold". Exponential increases in data and computing power, the World Economic Forum argue, are fuelling a "Fourth Industrial Revolution" (Schwab, 2016). While such claims are open to critique, for example, we may draw on Webster's analysis of earlier claims about the revolutionary nature of informationalisation that question the notion of revolutions *within* a capitalist political economy, it is still vital to recognise the deepening dependence of the capitalist mode of production on data.

Sandra Braman (2006) alludes to these developments in her conceptualisation of the "Informational State". In her work, she observes the development of a deepening form of "informational power" beginning in the 1970s and 1980s. She argues that while analyses of power have tended to categorise the concept into instrumental, structural and symbolic forms of power, processes of information intensification in recent decades have brought a further type – "informational power" – to the core of contemporary power relations. This "informational" form of power, she argues, interacts with other forms of power by "manipulating" their "informational bases" (p. 26). She illustrates a number of examples of this developing "informational base" for instrumental, structural and symbolic forms of power with reference to Smart Weapons, internet surveillance, personalised web-services, social profiling and manipulation of public opinion. Braman further argues that the processing and distribution of information are also often key factors in “the transformation of power from potential to actual” (p. 27).

It is important that this informational form of power is addressed as we try and navigate through the complex and uncertain terrain of the contemporary era. It is clear that data analytics will contribute to how societies respond to the significant challenges we face in the 21st century, but also that many of these data-related practices generate deep uncertainties of their own. The different interests that are empowered and disempowered by how data are generated, processed and used will be heavily influenced by the wider dynamics of political economy and culture. It is therefore important to integrate an understanding of datafication into our analysis of the broader processes of change. In order to ‘make real’ some of these issues, the rest of the chapter will now turn to examining such developments in relation to climate risk markets.

The climate risk market

Similar to climate science, financial markets have long been data-dependent. Streams of data are crunched by algorithms and models, and feed into human and automated decision-making processes which have significant impact throughout society. Weather derivatives are a type of climate risk product traded in the global financial markets. These financial products cover businesses for “moderate departures” from expected weather conditions; as opposed to traditional indemnity insurance, which covers for significant departures (e.g. extreme events) and catastrophic loss (Dischel 2002, 8). Rather than insuring against a specific observable loss, payouts on weather derivative contracts are instead triggered when particular meteorological conditions, e.g. the average temperature over a month, are detected in vast indexes of weather observation data. Key actors in the marekts include businesses and governments wanting to hedge against climate risk, re-insurance firms, institutional investors, and exchanges such as the Chicago Mercantile Exchange (CME).

Much of the primary market trading in weather derivatives occurs in the over-the-counter (OTC) market, through which bespoke contracts are negotiated in private between buyers and sellers (Speedwell Weather n.d.). Buyers typically are firms in sectors such as energy, agriculture and construction; while sellers tend to be re-insurance firms such as SwissRe. There is also a secondary market in weather derivatives that trades primarily through the CME (SCOR Global 2012). In this secondary market, primary market contracts are traded in order to manage risk. While many buyers in the primary markets have traditionally been aiming to hedge against climate related risks, a new class of speculative investor in climate risk has emerged post-financial crash. In 2013, the largest source of new trades in the market was from hedge funds speculating on average monthly temperatures (Thind 2014), which essentially means using data-driven techniques in order to speculate, and ultimately profit, on climatic uncertainty.

Weather derivatives were developed within the US energy industry by Enron, Koch Industries and Aquila in the late 1990s when Enron found insurance companies unwilling to insure the company against non-extreme weather events such as the company experienced during a period of mild US winters from 1997-99 (WRMA n.d. (a); Dischel 2002, p. 3). The deregulation of the US energy market had resulted in lower, more competitive energy prices in the USA; a situation which aggravated the problem by restricting energy suppliers’ ability to extract a surplus from consumers in order to cover periods of unexpected weather conditions (Dischel 2002, p. 3). In order to overcome this barrier, Enron created its own financial product – the weather derivative – taking inspiration from the energy futures markets in which it was involved. The development of the product as a derivative (and therefore a financial, rather than insurance, product) allowed Enron to avoid the regulatory constraints placed on energy companies' use of insurance products (Randalls 2010).

While weather derivative contracts are traded across all forms of weather event, by far the most popular contracts have been based on temperature and the divergence of the average daily temperature from 18^{o}C. These products, which are popular with firms in the energy industry, are known as Heating and Cooling Degree Days (HDD and CDD) contracts (WRMA n.d. (b)). Over recent years, however, the primary market which provides derivative contracts to end-user businesses has diversified, and a wider and more complex range of products are being developed across a range of weather conditions. One such product is the quantity-adjusting option, or quanto, derivative which combines weather and commodity price risk within a single derivative contract. For example, a company could receive a pay-out on a contract if the temperature is lower than expected, but the pay-out would be calculated in relation to the price of gas (Risk.net 2010).

Such developments illustrate new innovations in the weather derivatives market, however overall the success of the market over the last two decades has been mixed. The weather derivatives market saw massive growth in the mid-2000s, experiencing both the hedge fund boom of 2005-6 (notional trading value of $45 billion) and the pre-crash boom of 2007-8 ($32 billion) (Randalls 2010). As with other forms of financial product, the vulnerability of the weather derivatives market was highlighted when the market crashed during 2008-9 and 2009-10, with only slow signs of growth by 2011 ($11.8 billion) (WRMA 2009; WRMA 2011). These figures, based upon surveys undertaken by PricewaterhouseCoopers on behalf of the WRMA, cover the period 2003 to 2011. No surveys have been published since 2011, and no up to date figures for the size of the market therefore exist. However, despite the dip in the market, in 2011 the WRMA (2011) was hopeful for weather derivatives, pointing to continuing growth outside the US markets throughout the downturn, growing interest in non-temperature-related weather derivatives, and increasing interest from outside the energy industry, and more recent industry reports suggest the market is beginning to expand again (Thind 2014).

Getting the data to market

As financial products based on vast indexes of weather observations, traders in the weather derivatives markets require access to significant amounts of historical and real-time meteorological data. While there has been significant diversification in the sources of data used by market actors in recent years, data produced by national meteorological agencies is still perceived to be preferable due to its high quality and public agencies' substantial archives of historic data.

In the early days of weather derivatives trading, the right to re-use without charge weather data produced by national meteorological agencies was a prominent discourse at industry events. Over recent years, focus on this issue has reduced, however the ease with which market actors can access and re-use publicly funded meteorological data is still perceived to be a significant issue, and a lack of freely available data in some countries is perceived to be a barrier to market growth. In particular, it has been widely noted that while in the USA weather data has been in the public domain and freely available for anyone to re-use since before the development of weather derivative markets, in some competing markets, such as the UK, the large volumes of weather data required by the climate risk industry have been treated as a commodity to be traded by the national meteorological agency (Weiss 2002).

Those promoting the development of weather derivative markets in the UK, including lobbyists for the UK financial services industry such as Lighthill Risk Network (of which Lloyds of London are a member), have spoken out against this practice for a number of years (Department for Business Enterprise and Regulatory Reform 2008). They have called for Met Office data to be made available to commercial users at marginal cost (which tends to be zero for digital resources), so that traders can freely access and use it and, therefore, compete more effectively with the US markets. In the early days of the markets, for example, Weiss (2002) observed that limited access to weather data in the EU had, by 2002, resulted in a weather and climate risk management industry 13.5 times smaller than the nascent US industry which by this date had built up US$9.7 billion dollars of contract value over 5 years.

These demands have filtered down into UK government policy-making. For example, policy documentation developed by senior policy makers in what was at the time named the Department for Business Enterprise and Regulatory Reform (2008, p. 52) indicates support for the financial industry's demand for free use of weather data in order to boost the UK's weather derivatives market. While policy developments began slowly, the election of the new coalition government in the UK in May 2010 led to the demand for free use of meteorological data being quickly incorporated into the government's flagship Transparency and Open Government Data agenda, in line with Open Data advocates' campaign against the commercialisation of public sector data. In the Autumn Statement of 2011, the policy developments came to a head with the announcement by Chancellor of the Exchequer, George Osborne, that the UK government was opening "the largest volume of high quality weather data and information made available by a national meteorological organisation anywhere in the world" for anyone to re-use without charge (HM Government 2011). Senior politicians advocating for Open Data, such as MP Francis Maude (2012), spoke publicly about the advantages for the climate risk industry, and according to well-placed policy-makers interviewed by the author some hoped these developments would make the UK weather derivative market competitive with the US-based markets (Bates and Goodale 2017). Yet, despite the hopes of these key political actors, opening the UK's meteorological data has faced challenges as the Met Office has struggled to adapt to a fully open data environment (Bates and Goodale 2017). Nevertheless, despite these barriers, the climate risk industry is still able to access and process vast amounts of meteorological data in order to trade weather derivate and related climate risk products – albeit with some charges still in place.

Hedging against the climate and the exploitation of uncertainty

For advocates of these climate risk products, one of the key benefits is considered to be that they reduce firms' exposure to financial volatility resulting from climate instabilities. While in the long term a business should expect to pay more in to climate risk products than they receive in pay-outs, the business should also expect gains due to having a less volatile profit margin (Dutton 2002, p. 208). For example, the business should be better able to secure credit and protect its market value. For this reason, many perceive that climate risk products increase the "resilience" of businesses and other end users as they adapt to climate change

(Michel-kerjan 2013), allowing them to effectively "eliminate the effects of weather and climate from the income statement" (Dutton 2002, p. 209). As Dischel (2002, p. 19) states:

> "The goal of hedging is to be less concerned, or not concerned at all, about the impact of weather on cashflow or return. Management achieves freedom from the weather when it engages in a hedge."

At the same time as increasing the 'resilience' of industries and countries that are vulnerable to climate change, climate risk products, it is claimed, offer a substantial growth opportunity for markets to take advantage of in the coming years. For some, therefore, climate risk products are seen as a double win: helping to stabilise economies as firms navigate the uncertain weather conditions that climate change brings *and* simultaneously making substantial profits that contribute to overall economic growth, particularly in the financial centres of the global economy.

Many liberal economists would argue with Stiglitz (2012, pp. 42-3) that within a capitalist economy market failure occurs when there is either imperfect competition; externalities (when a group is affected – positively or negatively – by others' economic activity); information asymmetry; or when risk markets are absent. Some might therefore argue that the development of climate risk markets and the increasing availability of free meteorological data might counter some of the market failure problems posed by climate change.

However, in relation to the mitigation of climate change there are risks in the development of weather derivative markets that could lead to negative societal outcomes. This is because they enable the finance industry to generate substantial profits from products that aim to create a sense of security for end-users concerned about climate instability, allowing them to be "less concerned, or not concerned at all, about the impact of weather on cashflow or return" (Dischel 2002, p. 19). These climate risk markets in effect risk reducing the incentive of powerful economic actors to take and demand significant action to mitigate climate change. Such a scenario could increase the negative impact of the actions of those benefiting from these markets, at the expense of the majority, particularly those most vulnerable to climate instability. As more speculators enter the market (Thind, 2014), the increase in climatic uncertainty as mitigation efforts fail also presents a growing opportunity to extract profit from the crisis.

While climate risk markets have many interested parties advocating on their behalf, there are others that are more sceptical. Melinda Cooper (2010), for example, argues that weather derivatives are "a claim over the future in all its unknowability – a claim over event worlds that have yet to actualize in space and time" (p. 181). In her analysis of some of these deep seated uncertainties, Cooper (2010) draws on documents produced in 2008 by the US Government's National Intelligence Council and the US non-profit Centre for a New American Security to argue that, in the world of US strategic scenario planning, "turbulence" in relation to financial markets, climate change, and energy (p. 169) is no longer perceived as something that there is a possibility of managing and avoiding; rather, "turbulence…is assumed" (p. 184). She argues that, as US strategists have attempted to understand what these deepening uncertainties mean for US geopolitical power in the context of shifting economic power, they have turned to "turbulence" as a form of "productivity" (p. 170) to be leveraged in order to achieve the key strategic aim of sustaining US geopolitical power. One critical objective of US strategists aiming to navigate through these uncertain waters, she observes, is “to dominate… the securitized risk markets, in which weather turbulence plays an increasingly significant role [and which]…offer one possible exit strategy from the liabilities of the dollar–oil nexus” (p. 170).

To turn to the anthropogenic (human-generated) turbulence and uncertainty that is the outcome of the last few hundred years of economic development as a source of new economic opportunity and growth betrays a rigidity in thinking about how societies might move beyond the challenges posed by carbon capitalism. While the development of new data analytics techniques aimed at exploiting turbulence may buy time in the short-medium term, climate risk and similar markets do not address the fundamental problem of economic growth and ecological sustainability in the long term. Drawing upon Rockstrom et al’s (2009) analysis, political economists Hay and Payne argue (2013) that many of the earth’s ecosystems are already in the ‘red zone’ and further degradation is directly related to “aggregate global [economic] growth rates”. This leads them to conclude that “we face not just a crisis of growth, but, much more significantly, a crisis *for* growth…we will need to wean ourselves off growth if we are to do anything that takes us out of the ‘red zone’” (p. 6).

Their argument that economies must move beyond growth in order to shift towards a sustainable form of development is not new, and has been approached from a number of perspectives. The Club of Rome’s 1972 report on the Limits to Growth (Meadows *et al*. 1972), for example, was the first analysis of the problematic relationship between economic growth and environmental sustainability, and these ideas have been taken up across a range of fields including sustainable development and ecological economics. Further, as Harvey (2011) argues, continued economic growth is not only environmentally unsustainable, but is implausible in the long term given that the rate of profitable investments to be found each year in order to maintain the compound growth that capitalism is dependent upon will at some point become impossible to maintain.

Despite the observed efforts to leverage big data and new forms of data analytics in order to extract economic value from climatic uncertainty, the above arguments suggest that business as usual appears to no longer be an option in the longer term. Of course, while the argument for moving beyond growth as a measure of economic success might be relatively easy to conclude at the abstract level, the actual process of transition towards a new mode of economic development is more fraught and, of course, deeply political.

Conclusion

It is evident that various forms of power – including informational power - are being deployed in the development and promotion of climate risk products which, in part, aim to respond to the uncertainties posed by climate change. It is also apparent that these products benefit established interests, while, perhaps in some cases unintentionally, deepening the threats faced by the majority, particularly the most vulnerable in society. In the case of the UK government’s efforts to open significant amounts of public meteorological data in an effort to leverage the development of the UK’s climate risk market, we can observe an example of data policy being used by a government in an attempt to promote a deeply neoliberal, market-driven response to the conditions of uncertainty that we are facing in the early 21st century.

These developments in data analytics and policy are being shaped to enable particular forms of response to conditions of uncertainty. Still, it would be problematic to argue that increased rights to access and use weather data, and the development of new data analytics techniques are something to be resisted - information is, after all, also necessary for those seeking to establish sustainable, democratic and ecologically sound political economies. However, significant questions remain unanswered about the societal and ecological impacts of climate risk markets, particularly in relation to their potential to disincentivise economically powerful actors' engagement in climate change mitigation activity, and the socio-economic implications of empowering financial elites' efforts to exploit deepening climate uncertainty. There is therefore a need to open up a debate about these forms of financialisation and think critically about how they might, and might not, impact wider efforts to respond to climate change and build more equal and inclusive societies.

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