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Carbon Value-at-Risk

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The global consensus on climate change and growing urgency among governments to take action to reduce greenhouse gas emissions means that carbon is rapidly becoming a liability across all business activities. How does that translate for those making or managing investments? The bottom line is that carbon now represents a risk to the value of holdings and portfolios. It is a dynamic risk whose uncertainties are a function of many factors, including impending carbon taxes or quotas, the nature of the underlying, its location, and so on. But to manage risk it must first be measured, therefore we need a way to quantify the exposure of portfolios to carbon. Building on established best practice, we require a new methodology that can capture the size and probability of the threat – carbon value-at-risk (VaR).



Carbon is shorthand for carbon dioxide (CO₂), the most prevalent of all the greenhouse gases. It has also become a shorthand for all greenhouse gases in general, and their impact is now generally measured in terms of their carbon dioxide equivalent (CO₂e).

How does carbon impact portfolios? Most equities and many commodities, and all derivatives based upon them, will have some degree of carbon exposure. Nearly all industrial and business activities create emissions somewhere along the line. Power generation, logging and cement manufacturing are examples of major emitters, but even banks, software vendors or solar panel manufacturers create emissions as they go about their activities. Before the global consensus on climate change, emissions had no impact on the value of stocks or commodities. But now the world is changing. Gradually, via Kyoto and voluntary agreements, the world is imposing a price on carbon. Already, in places like the European Union (EU) with its emissions quotas and carbon trading, carbon has become a cost for the leading polluters, and quotas or taxes are imminent elsewhere.

But the price of carbon is uncertain. In the few places where there is price discovery, it has been highly volatile. In the EU's Emissions Trading Scheme the price has ranged between \$4 and \$30 per tonne of emissions in its first phase. The price is also liable to hikes, shocks and discontinuities as the world seeks to turn the tide on global warming through agreements under the United Nations Framework Convention on Climate Change. But for now, the price of carbon in many areas is simply unknown as governments have yet to impose any emissions curbs. It is partly to prepare themselves for the inevitable introduction of a price and its impact that so many corporates and other organisations have joined voluntary trading schemes, such as the Chicago Climate Exchange, where last year over 400 entities traded nearly 23 million tons of carbon. Some observers suggest that the price of carbon will have to reach \$80 a tonne or more to achieve current goals of keeping the global average temperature increase below 2 degrees Celsius.

But exposure to carbon in investments is more complex than simply the market price. First, there is the difficulty of calculating or estimating emissions for companies where these are not declared. For example, cement manufacturing is one of the major carbon polluters, responsible for around 12% of global emissions. However, different types of cement manufactured in different locations will produce different levels of emissions. Around 50% of emissions are from the chemical process of cement making, while 40% are from the energy used. Different manufacturers can use different recipes for their cement, often dictated by local raw materials, resulting in different emissions levels. Meanwhile, 1 kilowatt/hour of electricity generated in France, where nearly 80% of power production is nuclear,



produces far less carbon emissions than 1 kwatt/hour generated in China, where over 95% of production is from fossil fuels. And to complicate matters further, emerging markets tend to have cleaner cement plants than Western countries, particularly North America.

The cement industry itself is aware of the potential impact of carbon on its business. As Howard Klee, coordinator of the Cement Sustainability Initiative (CSI) points out, "Most people are not even aware that making cement produces carbon dioxide. It is an incredibly low-profile business and power companies, transportation and airlines get much more attention. But if producing carbon dioxide starts to cost businesses money, it looks like it will have a huge impact on financial performance."

This doesn't just apply to cement. Even industries that at first glance might not appear to be big polluters can have relatively high emissions. A report last year by research and advisory organisation Gartner revealed that information and communications technology is responsible for around 2% of global emissions – roughly the same as aviation. The large data centres that organisations such as banks, pharmaceutical companies and search engines run are major carbon liabilities.

Every manufacturing process, every business activity creates carbon to some degree, and the precise levels can be highly dependent on location, raw materials, manufacturing techniques and so on. Now we are already getting an inkling into one factor that carbon Value-at-Risk shares with conventional VaR methodologies – the need for large amounts of accurate and timely data.

Many of today's portfolios have an international flavour. Investors want the benefits of diversification, the returns of emerging markets, etc. The underlying companies in an investment portfolio could operate in wide range of countries. To begin calculating carbon VaR requires comprehensive databases of average emissions per kilowatt/hour across the globe, emissions by industry or manufacturing process with local variations on these, information on whether countries are covered by the Kyoto agreement and their emissions targets, links to exchanges for carbon prices, etc.

Furthermore, most of this information will be dynamic. Average emissions per kilowatt/hour will change as the energy mix in each country changes. For example, the EU recently set a target of producing 20% of energy across the region by renewable sources by 2020. New technologies are emerging and being implemented. The introduction of carbon capture and storage will make a dramatic difference to the emissions costs of power generation and cement production. New regulations, quotas and taxes will also have an enormous impact.



Gathering and maintaining this wealth of data is a major task, and not one that many investment managers are likely to want to take on board themselves, and it is one reason that they are likely to look for a third-party service provider for their carbon VaR calculations.

Carbon VaR also requires a sophisticated calculation engine. This must be able to handle the futures, options and other derivatives now common in investment portfolios, estimating the likelihood that a firm will own stocks at some point in the future and what the implied impact of the carbon will be on the value of those stocks at that time. With the absence of any historical data at this point, the only method for calculating such values will be Monte Carlo simulation.

Many commodities investments, and derivatives on commodities, will be similarly exposed to carbon. Oil and other fossil fuels are the obvious examples. Aluminium smelting is a highly energy-intensive process. (So much so, that green leaning Alcoa, the world's leading aluminium manufacturer is currently assessing the feasibility of building a low emissions geothermally-driven smelter in Iceland.) Farm livestock are responsible for 18% of global emissions, much of this methane – a potent greenhouse gas. And the price of commodities such as wheat and palm oil have already been hugely affected by the demand for biofuel – a controversial renewable energy source with a highly uncertain future.

Carbon VaR will aim to produce a similar measure to conventional VaR. But instead of an estimate of the maximum likely loss over a given period for a given confidence level, carbon VaR will calculate the maximum likely exposure to carbon over a given period for a given confidence level.

Investors have already shown that they are concerned about the potential impact of carbon on their investments. For the past five years, the Carbon Disclosure Project (CDP), a non-profit collaboration of institutional investors with assets of \$41 trillion under management between them, has been asking companies to reveal their climate change-related risks and opportunities. In 2007, in response to the CDP's request for information, 77% of the FT500 replied, with 79% of those providing quantified emissions data and 27% providing energy costs.

Commenting on the 2007 report, Win J Neuger, chief executive officer of AIG Investments, a CDP member, said, "The CDP supports AIG Investments' efforts to assess and analyse trends in risks and opportunities associated with climate change and its mitigation. Climate change continues to be a major financial and investment concern for us and our clients."



By highlighting quoted company's carbon risks and opportunities, the CDP's reports help guide investors in making their investment decisions, but they don't calculate the fluctuating exposure to carbon once the investments are made (although the reports' disclosure data on emissions, energy consumption, etc., are vital information for carbon VaR calculations.)

Investment and risk managers are becoming increasingly concerned about the implications of climate change and the evolving steps towards pricing carbon on the value of their investments. Like VaR for market or credit risk, carbon VaR offers a mechanism for measuring, and therefore managing, this exposure. Already, a leading European institution has begun calculating the carbon VaR of its portfolios. And because of the challenge of gathering and maintaining all the relevant data and calculation algorithms, it has chosen to use a third-party specialist service provider. As the world starts taking more aggressive steps towards mitigating climate change, carbon VaR could become one of the essential portfolio risk factor measures.

