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THE TEMPORAL LINKS BETWEEN SPOT AND FUTURES CARBON ALLOWANCE MARKETS

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Overview

Climate change is a major challenge faced by the international community. The effects of human-caused greenhouse gases and global warming are becoming increasingly visible from record temperatures to rising sea levels. In an attempt to slow down and stabilise the pace of climate change, most countries, have signed and ratified the Kyoto Protocol. Based on a "cap and trade" system, the protocol sets targets for the reduction of greenhouse gases (GHG), and facilitates the trading of permits to emit GHGs between countries and individual entities. The existence of a trading mechanism allows most GHG abatement to occur in those sectors of the economy in which it is cheapest – achieving the cap with the lowest possible economic impact. So far, several international markets for carbon permits have emerged, with the European Union Emissions Trading Scheme being at the forefront in terms of both the market size and its regulatory organisation. While the existing literature on carbon markets provides sophisticated theoretical arguments for such schemes, in practice the effectiveness of any carbon trading scheme will rely on the ability of the market mechanism to produce prices which accurately reflect the true marginal costs of GHG abatement. In this context, the important question of pricing efficiency of carbon derivative contracts also arises. For adequate risk mitigation the derivative market (futures market in our case) and the spot market must be linked through an equilibrium pricing relationship. If such a link does not exist, then cash and futures prices can follow independent paths and the futures contract will not fulfil its risk management role of offseting unexpected cash price changes. An inefficient futures market has a potential to undermine the efficacy of a carbon trading scheme. Our investigation aims to answer two related questions in this setting. First, do the carbon spot and futures prices follow a no-arbitrage pricing relationship as given by the cost-of-carry model? and if yes, is there a convenience yield associated with holding a spot carbon position? Second, are there any information spillovers between the spot and futures prices, and if there are, which market reflects new information first and hence leads the price discovery process? These two issues have been studied in great detail on a number of commodity and financial contracts, but not in relation to carbon permits. Therefore, we present what is to our knowledge a first attempt at examining the issues of market efficiency and price discovery in the context of the carbon allowance price.

Methods

Our empirical methodology consists of cointegration analysis between the spot and futures carbon prices and interest rates, Granger causality tests and multivariate GARCH volatility methods. We use a dataset on the spot and three futures contracts for the European Union carbon emission allowances (EUAs) listed on Powernext® and European Climate Exchange® respectively. The futures contracts are for the following maturity dates: December 2006, December 2007 and December 2008. The period analysed is determined by data availability and covers the June 2005 – November 2006 time frame.

Results

We find that the futures price for contracts expiring in December 2006 and December 2007 have a stable long-run relationship with the spot carbon price and stochastic interest rates, indicating that these contracts can be used effectively for carbon risk hedging purposes. We also find some evidence for our hypothesis that a convenience yield exists in the market for carbon contracts, but that the yield declines to zero in the last year of the contract life. We explain this finding with the EU ETS rule under which affected installations are required to surrender carbon permits only once every year (31 April) for the emissions produced over the course of the previous calendar year. Thus, for maturities of less than one year, a spot permit will differ from a futures permit only by the time value of money. On the other hand, a positive convenience yield may be associated with a spot position relative to a futures position for longer maturity contracts with expiry dates that follow the settlement month, i.e. April, of each EU ETS reporting period. This is so because the long-term futures contracts cannot be used to offset the current period EU ETS obligations. Although the long-run relationship between the interest rate, the spot contract and the December 2006 futures contract is the one of the cost-of-carry model, we find a violation of this exact relation for the December 2007 contract. The violation is such that it appears that arbitrage opportunities existed on this contract for the duration of the period studied.

On the other hand, the futures contract that expires in December 2008, does not exhibit any kind of stable long-run relationship with the spot price. Even though this finding may, at a first glance, cast doubt on the value of December 2008 contract, we argue that the breakdown of the relationship is due to the unavailability of relevant spot carbon price for the Phase II of the EU Emissions Trading Scheme and in fact is a rational outcome.

In terms of price discovery, Masconi and Giannini (1992) and Toda and Yamamoto (1995) causality tests indicate that in two out of the three cases studied bi-directional Granger causality exists between the spot and futures contracts. This suggests that the price discovery process occurs in both the spot and futures markets and is in contrast with earlier studies carried out on other commodities and financial assets, which credit the futures market with the role of price discovery. However, some support for this argument is provided by our finding that the December 2008 futures contract Granger causes the spot price, while there is no evidence of statistically significant Granger causality in the other direction. This observation coupled with the fact that there is no relevant spot carbon price for Stage II of EU ETS suggests that the December 2008 futures contract in fact acts as a true vehicle of price discovery for the future Phase II ETS spot carbon price.

Our analysis also indicates that the spot and future carbon prices exhibit autoregressive conditional heteroscedasticity (ARCH). Testing for volatility spillovers using a Baba, Engle, Kraft, Kroner (BEKK, 1990) specification, we find that risk generally transfers from the spot market into the futures market and not vice versa, which is also at odds with previous evidence gathered from other commodity markets.

Conclusion

Our empirical findings suggest that some EU carbon futures contracts are priced more efficiently than others and that a positive convenience yield exists in the carbon market, but that it decreases to zero in the last year of a futures contract life. We illustrate that price discovery occurs in both the spot and futures markets, while volatility transfers from the spot to the futures market. We also point out to some additional idiosyncrasies of the carbon market relative to other commodity markets that may have an impact on how carbon risk management is conducted.