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An emerging equilibrium in the EU emissions trading scheme

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ABSTRACT

The European Union's Emissions Trading Scheme (ETS) is the key policy instrument of the European Commission's Climate Change Program aimed at reducing greenhouse gas emissions to eight percent below 1990 levels by 2012. A critically important element of the EU ETS is the establishment of a market determined price for EU allowances. This article examines the extent to which several theoretically founded factors including, economic growth, energy prices and weather conditions determine the expected prices of the European Union CO_2 allowances during the 2005 through to the 2009 period. The novel aspect of our study is that we examine heavily traded futures instruments that have an expiry date in Phase 2 of the EU ETS. Our study adopts both static and recursive versions of the Johansen multivariate cointegration likelihood ratio test as well as a variation on this test with a view to controlling for time varying volatility effects. Our results are indicative of a new pricing regime emerging in Phase 2 and point to a maturing market driven by the fundamentals. These results are valuable both for traders of EU allowances and for those policy makers seeking to improve the design of the European Union ETS.

1. Introduction

In January 2005 the European Union (EU) Emissions Trading Scheme (ETS) was introduced formally. The scheme has been instigated as part of the EU agreement to cut worldwide emissions of carbon dioxide (CO_2) within the Kyoto Protocol. Under the Kyoto agreement, the EU has committed to reduce greenhouse gas (GHG) emissions by eight percent (relative to 1990 levels) by 2008–2012. The scheme issues a restricted amount of emission allowances to firms on an annual basis. At the end of the year firms must hold the required amount of emission permits to meet their emissions of CO_2 over the previous year. The ETS allows firms to trade the amount of emission permits that they hold and as a result has applied a market value to this externality. In the EU ETS context the first phase of trading was 2005–2007 and the second one, which coincides with the first compliance period of the Kyoto Protocol, is 2008–2012. The third European trading phase will commence in 2013. Non-compliance with the commitments will result in a penalty of 40 (100) euros per tonne of CO_2 produced without allowances for the first (second) commitment period. The aim of the ETS is that this cost will encourage firms to reduce their emissions. Paolella and Taschini (2008) highlight that the ultimate aim of this scheme (as well as the US CAAA-Title IV scheme) must be to create an environment where there is scarcity of allowances which will lead to an upward trend in prices. As a result we might expect to see mean reversion around an upward trend. However, there has been a considerable amount of uncertainty associated with the price of CO_2 emissions over its short life to date.

Concomitant to the recent dramatic fall in allowance prices (spot falling from 30 euro in the summer 2008 to 15 euro at the end of 2009) has been growing calls for intervention by the European Commission into the market. Those calling for intervention seethe low prices as incentivising higher rather than lower carbon based technology.[1] Any intervention is likely to seriously distort the market and may impede investment in low carbon technology in the future. As noted by Lowrey (2006) a centrally important element of the EU ETS is the establishment of a market determined price for EU allowances. In this article, we take account of market uncertainty and examine the extent of the emergence of an equilibrium relationship between the expectation of EU allowance prices and a set of theoretical determinants, including economic growth, energy prices and weather conditions. Unlike the vast majority of previous work in the area, we take account of both structural and time series properties in examining the behaviour of EU allowance prices. Taking account of both structural and time series properties will indicate whether prices, although currently low, are determined by a stable relationship.

The contributions of the paper to the empirical literature on modeling carbon emissions is threefold. Our paper is the first known study to investigate the long-run relationship between theoretically

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[1] Mark Lewis, director of global carbon research at Deutsche Bank, proposed (6 February 2009) to establish a reserve price for EU emissions allowances (EUAs) to avoid a price collapse in the third phase of the EU ETS, which starts in 2013.

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accepted determinants and EU carbon allowances using a battery of cointegration procedures. Cointegration is a powerful econometric approach which can indicate whether a stable relationship exists and whether the behaviour of the variables binding this relationship is consistent with economic theory. Secondly, besides taking account of the potential cointegrating relations, we also address the empirical finding of time varying volatility in the EU ETS and augment time varying volatility into the cointegration tests. Finally, given the relatively small sample of data and the considerable uncertainty, in particular during the pilot phase, we examine the extent of the evolving long-run relationships adopting a recursive cointegration approach.

Given the relative paucity of data available and consistent with the previous literature, our analysis will adopt daily data. The full sample of data covers the period 1st July 2005 to 14th December 2009 and so incorporates both a Phase 1 and Phase 2 sample of data. The expirations on our futures contracts are December 2008 and December 2009 and so are only redeemable in Phase 2 of the EU ETS. Our empirical analysis will examine the full sample of data, as well as two sub-samples corresponding to the 2005–07 and 2008–09 periods.[2] Unlike the vast majority of the previous studies, our focus will be on futures rather than spot contracts. The justification for examining futures is due to the greater volumes being traded on these contracts (see Mansanet-Bataller and Pardo, 2008).[3] These instruments were not exposed to the dramatic structural breaks that have been previously highlighted in the literature and so results in an additional advantage of adopting the futures based analysis. We will adopt the cointegration procedure to identify the existence of a long-run relationship. We also adopt a number of identifying restrictions to further refine our model. Finally, we also carry out a number of sensitivity tests which take account of time varying volatility and the structural breaks in the data. Our results are consistent with previous work in that we find considerable evidence of uncertainty for EU allowances and the range of determinants (see, Paolella and Taschini (2008) and Benz and Trück (2009)). Although, there have been calls for intervention in the market, our results indicate that for a Phase 2 sample a stable relationship has formed between EU allowances and other determinants. A range of cointegration test results report theoretically consistent relationships have emerged in Phase 2 of the ETS. There is no evidence of this stable relationship occurring for the Phase 1 sample. Our empirical results are also consistent when we take account of the time varying volatility in the data.[4]

The remainder of this article is structured as follows, Section 2 discusses the performance of Phase 1 and the implications for Phase 2, along with a detailed analysis of the theoretical and empirical determinants. Section 3 describes the methodologies being adopted, while Section 4 presents the data and empirical results. Finally, concluding remarks are presented in Section 5.

2. Phase 1 empirical evidence and the implications for Phase 2

A number of studies have examined the performance of Phase 1 EU ETS, mainly using data of a daily frequency, given the paucity of data. Recent studies include Paolella and Taschini (2008), Daskalakis et al. (2009) and Benz and Trück (2009) examine the time series properties of a range of different EU ETS instruments. For example, Benz and Trück (2009) adopt a pure time series approach and take account of the non-normality associated with the EU allowance returns and find evidence of regime switching.[5] Unlike the previous cited studies which adopted a pure time series approach, Christiansen et al. (2005), Redmond and Convery (2006), Mansanet-Bataller et al. (2007) and Alberola et al. (2008) examine the behaviour of the price of carbon in relation to energy prices, meteorological factors and a number of other variables.[6] Large installations, in particular power plants, are likely to switch between various forms of energy depending on the associated cost. In particular, power plants pay close attention to the profits from producing electricity depending on whether the input is coal (profits are referred to as dark spread) or gas (profits are referred to as spark spread). Given the costs of CO_2 emissions, dark and spark spreads are adjusted further to take account of the additional cost and are referred to as clean dark and spark spreads. Along with energy prices, weather conditions are considered a theoretically important variable in determining the price of carbon. Studies that have incorporated weather conditions in explaining movements in Phase 1 EU ETS include the Redmond and Convery (2006), Mansanet-Bataller et al. (2007) and Alberola et al. (2008). In all cases the authors take account of temperature extremes and the likely effects with some evidence to suggest the importance empirically of these variables. Redmond and Convery (2006) find no evidence of a statistically significant weather effect, while Alberola et al. (2008) do find evidence but only for certain sub-samples of Phase 1.

The empirical studies to date have highlighted the difficulties in relation to Phase 1 (pilot phase). In particular there was considerable uncertainty and volatility associated with the market price of EUA's. In April 2006, coincident to the unofficial release of the 2005 emissions data by some of the EU member states the price of EUAs collapsed. EU ETS spot prices had reached a high of 30.50 euro prior to April 2006. Following the official release by the EU commission on the 15th May 2006, showing a larger than expected surplus in the market, the spot price fell to 15.63 euro on the 17th May 2006. Given that banking EUA's was prohibited between phases, the price eventually converged to close to zero at the end of Phase 1. As well as the April 2006 break, Alberola et al. (2008) also highlight a break in October 2006. This break relates to an announcement by the European Commission (EC) of considerably stricter policy in relation to the allocation of permits for Phase 2. Overall for Phase 1, it would appear that the cap placed on emissions was far too lax and so downward pressure on the spot and futures (those expiring in Phase 1) price continued.

Clearly a number of difficulties remain. These include the fact that the cap was only aimed at large emitters from the power and heat generation industries and in selected energy intensive industries.[7] As has been highlighted earlier the over allocation of allowances has been problematic. The national allocation plans (NAP) submitted by member states to the European Commission were not reviewed in Phase 1 and these were distributed free of charge by member states to the emitting firms.[8]

[2] Although our futures contracts were not redeemable in Phase 1, the growth in volumes compared to spot, driven not only by compliance participants, but also commercial banks, carbon funds and speculative investors indicates that an analysis from pilot to full implementation stage is informative. The collapse of the spot price in April 2006, along with banking restrictions, further justifies the adoption of futures contracts for the full sample as well as the two sub-samples corresponding to the 2005–07 and 2008–09 periods. An addition implication of our sample set-up is that models relying on standard no arbitrage conditions will not hold during Phase 1.

[3] Mansanet-Bataller and Pardo (2008) report cumulative volumes traded in the different European Carbon markets since the start of the trade in each market until January 2008. The volumes traded in spot is 4%, futures 76% and over the counter (OTC) 20%.

[4] We find no evidence of a structural break in the data. This is not particularly surprising given that our analysis covers futures contracts that expire in Phase 2.

[5] The only study that has addressed the market microstructure issues for this market has been Benz and Hengelbrock (2009) and Bredin, Hyde and Muckley (2009). Both studies find evidence of an increase in market liquidity for Phase 2 expiring futures contracts.

[6] Alberola et al. (2009, in press) have also examined the role of market structure and industrial sectors.

[7] The European Commission (2005) has estimated that these installations account for 45% of CO_2 emissions. Airlines will be included in the next phase of the EU ETS, from 2013–2020.

[8] Member states were allowed to auction up to 5% of their total allowance allocation in Phase 1 (Convery and Redmond, 2007). As of the end of 2009, Denmark, Hungary, Ireland and Lithuania have used auction provisions.