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Carbon emissions and stock returns: Evidence from the EU Emissions Trading Scheme

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ABSTRACT

This paper provides an empirical investigation of the effect of the European Union's Emissions Trading Scheme on German stock returns. We find that, during the first few years of the scheme, firms that received free carbon emission allowances on average significantly outperformed firms that did not. This suggests the presence of a large and statistically significant "carbon premium," which is mainly explained by the higher cash flows due to the free allocation of carbon emission allowances. A carbon risk factor can also explain part of the cross-sectional variation of stock returns as firms with high carbon emissions have higher exposure to carbon risk and exhibit higher expected returns.

1. Introduction

Since the introduction of the European Union's Emissions Trading Scheme (EU ETS), carbon emissions in Europe are capped, traded and priced. The EU ETS has created a new financial market for trading carbon emission allowances that give firms the right to emit carbon dioxide. During the initial two phases of the scheme, beginning in 2005 and ending in 2012, carbon emission allowances were granted to European firms predominantly free of charge. Firms that chose to pollute more than the allowances they received had to purchase extra allowances in the open market from firms that used less allowances than they received. This has lead to the emergence of the largest multinational carbon market in the world (World Bank, 2014).

This paper is at the cross-section of environmental economics and finance. As the emergence of the European carbon market is a recent phenomenon, there is little work on how environmental regulation on carbon emissions can affect the financial performance of firms. This paper fills this gap in the literature by providing a comprehensive empirical investigation of the effect of the EU ETS on stock returns. Our empirical analysis uses data on monthly stock returns from Germany as well as manually collected data on the number of carbon emission allowances received by each firm in the sample. We focus on Germany because it is by far the largest national market for carbon emissions and accounts for a quarter of Europe's total carbon emissions. For robustness, we also examine data from the UK.

To be more specific, the main question of our empirical analysis is the following: did the free allocation of carbon emission allowances during the initial two phases of the EU ETS generate a "carbon premium" in stock returns? We address this question empirically by designing three carbon portfolios: the "dirty", "medium" and "clean" portfolios. The dirty portfolio is a portfolio of firms that received a high number of free carbon emission allowances, the medium portfolio comprises firms that received a lower number of free allowances, and the clean portfolio includes all firms in the sample that did not receive any allowances. We then define the carbon premium as the abnormal excess return (alpha) of the "dirty-minus-clean" portfolio, which is assessed relative to the CAPM, the Fama and French (1993) three-factor model and the Carhart (1997) four-factor model.

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Our empirical analysis relies on an economic mechanism that attributes the carbon premium to two effects: the cash flow effect and the "carbon risk" effect. In terms of the cash flow effect, we show that the free allocation of carbon allowances can generate significant profits to carbon emitting firms. We use the framework of Goulder et al. (2010) to demonstrate that a cap-and-trade system increases the marginal cost of production since the free carbon allowances constitute an opportunity cost to the firm. Firms tend to respond to the higher marginal cost by increasing output prices, reducing production so that less carbon allowances are used up, switching to less carbon-intensive production technologies or a combination of these options. This is the primary mechanism that justifies the carbon premium as it implies that the free allocation of carbon allowances can lead to large windfall firm profits.

There is also a secondary mechanism that explains the carbon premium based on the carbon risk effect. According to this effect, carbon emitting firms will be subject to carbon risk due to uncertainty about the future price for carbon allowances, which in turn generates uncertainty about future cash flows. For example, a volatile price for carbon allowances will affect the cash flows of firms. Furthermore, an institutional change in the EU ETS, such as a change in the law that initially gives carbon allowances for free but subsequently makes them available in auctions will also affect future cash flows. Finally, recent contributions by Weitzman (2009), Litterman (2013) and Pindyck (2013) suggest that carbon emitting firms are exposed to carbon risk because they might face a higher price for carbon allowances in the future as a result of catastrophic climate change. In short, therefore, carbon risk is based on uncertainty about the future price for carbon emissions. As a result, carbon emitting firms will require higher expected returns relative to firms with no carbon emissions.

Our main empirical finding is that there is a large and statistically significant carbon premium in stock returns, which can be as high as 17% per year. We show that this result holds for the sample period that ranges from November 2003 to March 2009. This sample period begins with the passing of an EU law establishing the initial two phases of the ETS that offered carbon allowances to firms for free. It ends with the passing of another EU law establishing the third phase of the ETS during which carbon allowances are predominantly sold in auctions from 2013 onwards. Hence this is the period over which the market knew with certainty that carbon emitting firms will be receiving free carbon allowances. Our evidence clearly indicates that after March 2009 the carbon premium largely disappears. The timing of the carbon premium based on German data is also confirmed by the UK data. Note that our main sample extends to December 2012, which is the end of the second phase of the EU ETS.

In addition to the free allocation of carbon allowances, another explanation for the large carbon premium over the relevant sample period is the effect of carbon risk on expected stock returns. We assess this effect by constructing the "dirty-minus-clean" (DMC) risk factor, which is a zero-investment portfolio defined as the expected return on a portfolio of dirty stocks minus the expected return on a portfolio of clean stocks. Then, we implement Fama and MacBeth (1973) regressions to show that there is a positive price of carbon risk since dirty firms that have higher exposure to carbon risk exhibit higher expected returns. Overall, for the sample period of November 2003 to March 2009, carbon risk can explain a large part of the cross-sectional variation in stock returns. For this sample period, the significance of the carbon risk factor is robust to the inclusion of a large set of control variables. In short, therefore, a combination of the cash flow effect and the carbon risk effect can provide a basis for explaining the high carbon premium in German stock returns over the relevant period.

In assessing robustness, we find that the carbon premium tends to be higher the dirtier the portfolio, i.e., the higher the number of allowances received by firms included in the dirty portfolio. Furthermore, the carbon premium is not diminished when we condition on changes in the price for carbon allowances and changes in the price of energy indexes such as oil, natural gas, coal and electricity.

The empirical finding that the carbon premium is present for a specific time period indicates that it may have been a one-off event that lasted for as long as the law stipulated that carbon allowances will be given for free. Specifically, this period commences about one year before the beginning of Phase I and disappears about one year into Phase II. At the same time, it is worth noting that the EU ETS is arguably the most significant multinational initiative ever taken to mobilize markets to protect the environment. As such, it has a profound impact on the development and implementation of other emission trading schemes. Over the past few years, many countries or regions have followed the EU in establishing similar cap-and-trade schemes or are currently in the process of doing so. Therefore, even if the carbon premium is a one-off event in Europe, our analysis makes an important contribution to the current environmental policy debate because it informs policy-makers and investors about the design and implications of similar cap-and-trade environmental regulation implemented elsewhere.[1]

The remainder of the paper is organized as follows. In the next two sections we review the relevant literature and the institutional details of the EU ETS. Section 4 discusses the theoretical arguments suggesting a relation between carbon emissions and stock returns. In Section 5 we describe the data used in the empirical analysis. Section 6 provides a framework for measuring the carbon premium in stock returns and discusses the main empirical results. In Section 7 we present empirical evidence on the price of carbon risk. Section 8 reports our findings on robustness and Section 9 extends our analysis by providing empirical evidence on the UK. Finally, Section 10 concludes.

2. Literature review

This paper is related to three distinct lines of research that focus on different aspects of the EU ETS. One line of research evaluates the effect of movements in the price for carbon allowances on the returns of different sets of European electrical power companies. For example, Oberndorfer (2009) and Veith et al. (2009) use data from Phase I (2005–2007), whereas Koch and Bassen (2013) extend their sample to 2010. These studies estimate the sensitivity of stock returns to changes in the price for carbon allowances, while also conditioning on other energy factors such as price changes in oil, gas, coal and electricity. Overall, this line of research establishes a positive relation between movements in the price of carbon allowances and movements in stock prices in the European power sector.

A second line of research uses an event study methodology to isolate the effect of the sharp decline in the price of carbon allowances that took place in April 2006 on the stock returns of carbon-intensive European firms. These studies include Bushnell et al. (2013) and Jong et al. (2014). They find that the drastic drop in carbon prices over a three-day window had a negative impact on the stock returns of carbon-intensive firms. This indicates that carbon regulation plays a significant role in determining the profits of dirty firms.

Finally, a third line of research is based on a simulation methodology that makes assumptions about the technology underlying

[1] There is a number of existing, emerging and potential emissions trading schemes around the world. For example, some of the existing emissions trading schemes include Switzerland, Australia, New Zealand, Kazakhstan, California, several north-east and mid-atlantic US states, Quebec, several provinces of China and some cities in Japan. For more details, see World Bank (2014).