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A flexible CO2 targeting regime

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Abstract

According to EU regulations, CO2 emissions capped by the EU emission trading system must decline by 1.74 percent per year from 2013 and onwards. This paper argues that it is necessary to allow short term fluctuations in emissions in order to avoid unnecessary volatility in the real economy. An analysis of emissions data from the European Union and the United States reveals systematic fluctuations of some +/- 5 percent a year around the long run trend. Hence, the Emission Trading System (ETS) should be modified to better accommodate temporary variations in emissions.

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1. Introduction

One of the European Union's policy objectives is to achieve large reductions of CO_2-emissions. For example, both individual member states and the EU are considering a wide set of policy tools in order to reduce emissions by at least 20% by 2020 (compared to the 1990 emission level). A prominent example of one policy tool is the EU Emissions Trading System (EU ETS), which establishes a cap on emissions and introduces a market for carbon allowances. Installations incorporated under the cap are only allowed to emit CO_2 if they are in possession of emission allowances. The cap currently covers 11 000 installations, which corresponds to about 40% of all CO_2 EU-emissions (European Commission 2009).

EU ETS was established in 2005 and the first trading period took place between 2005 and 2007. The second trading period is between 2008 and 2012 and the third trading period will begin in 2013. Starting with the third trading period, the ETS will undergo several structural reforms. One reform is that fewer of the emission allowances will be allocated to firms and more will be auctioned to the highest bidder, whereby the market will play a greater role in allocating allowances. A second reform is that the EU will begin to reduce the annual ETS caps by 1.74% per year (EU directive 2003/87/EC). This reduction factor has been derived from the Union's long run emission target (European Commission 2009)

Large reductions in emissions and avoidance of a corresponding decrease in aggregate production are only possible if firms invest in new technology and production methods. The EU contends that ETS is designed to create the appropriate incentives for firms to invest in new technology over the long term. However, since only minor considerations are given to short-term fluctuations in the demand for emission allowances, we argue that this may yield large fluctuations in the price of emission allowances, which may damage its important role as a signal for firms to invest in environmental-friendly technology.

We analyze how ETS will work over the short term when variations in economic activity, such as business cycles and varying weather conditions, create fluctuations in the demand for CO_2 emission allowances.

The EU controls the supply of emission allowances and therefore has a governing impact on the market for allowances. In order to meet the long term reduction targets of CO_2 emissions, the EU can choose to operate in the market in two ways. The first alternative is that the EU can supply a fixed level of allowances, which means that the market will determine the price. The other alternative is to fixate the price and let the market determine how many allowances the EU should supply. The EU has currently chosen the first alternative *i.e.* to supply a fixed level of allowances. In economic theory, there should be no principal difference between these two options. If the demand for emission allowances is known, EU can fixate the supply of allowances and generate the same market equilibrium as they would if they chose to fixate the price. However, if the demand function for emission allowances is unknown, the two alternatives will not necessarily generate the same outcome with respect to the price and the sold quantity of emission allowances.

Several authors have analyzed the merits and shortcomings of fixating the quantity vs. the price, and their respective pros and cons are subject to considerable debate. Weitzman (1974) and Hepburn (2006) argue that under uncertainty, fixating the price is better than fixing the supply. Mendelsohn (1984) and Krysiak (2008), on the other hand, suggest that price based regulations may lead to suboptimal investment decisions and they therefore advocate quantity based controls.

However, the literature primarily focuses on the long run and does not take into account the fact that short term factors can cause a variation in the demand for emission allowances. The carbon price will be highly uncertain if short term factors have a large impact on the demand for allowances on the market. If there are great short term variations in the demand for emission allowances, the carbon price will be subject to large fluctuations as well.

As discussed by the ECB (2004); if the price mechanism is to operate properly, relative prices have to be fairly stable over time to make sure that the price mechanism is not misinterpreted. Large price fluctuations make it difficult for agents to determine whether the changes are predominantly permanent or temporary. Empirical studies support the notion that when there is uncertainty and markets are hectic, companies will increase their expected profit margin before investing in certain activities, which will have the effect of reducing the overall level of investments (see *e.g.* Pindyck and Solimano 1993, Servén 2003, and Demir 2009). Understanding the short term variations in CO_2 emissions is therefore essential.

In this paper, we analyze the size of the short term variations in CO_2 emissions and discuss their potential effect on the ETS and the carbon price. In order to analyze the short run, we must consider frequencies including the business cycle. To obtain several observations of the business cycle, we have to go back in time and cannot just consider the official ETS data which begins in 2005. We have therefore collected data from the US energy department, which covers emissions from burning of fossil fuels between 1871 and 2006. Although not matching the ETS completely, our analysis still yields a much needed understanding of how emissions fluctuate over the short term.

The remainder of the paper is organized as follows; Section 2 discusses the design of the ETS, Section 3 presents the empirical analysis and Section 4 discusses the results.

2. The European Trading System

ETS was established by EU directive 2003/87/EC. ETS covers 11 000 energy consuming installations over the entire Union and will expand to also include aircraft aviation within the union during 2012. By 2013, approximately 43% of all EU emissions will be covered by ETS (European Commission 2009).

ETS is divided into three trading periods or phases; Phase I (2005-2007); Phase II (2008-2012) and Phase III (2013-2020). Beginning with Phase III, the system will undergo some major structural reforms; national allocation plans will be replaced by more union-wide directives, and free allocation of allowances will slowly be phased out in favor of more auctioning. From 2013, at least 50% of all emissions must be auctioned compared to less than 4% in Phase II (European Commission 2009).

According to the draft of the auctioning rules, all allowances allowed under the cap must be auctioned annually. Frequent auctioning during the year must furthermore contribute to ensuring that prices of emission allowances in the primary and secondary markets are harmonized. Discussions of a reservation price under which emission allowances are not sold appear redundant, and the continued official policy will be a quantity control rather than a fixation of the price. [1]

To accommodate short term variations in the demand for allowances, ETS is partly designed to tolerate inter-temporal flexibility through a system of banking and borrowing. Agents are allowed to save surplus allowances for future usage (banking) and to borrow allowances from future allocations (Schleich *et al*. 2006). So far, banking and borrowing has proved fairly successful in the sense that there are no signs of abuse of borrowing within the system. Under the current global economic recession, which resulted in a decrease in emissions of carbon dioxide by 11 percent in 2009[2], banking will allow all unused emission allowances to be saved for future use (MIT 2008).

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[1] These documents are available at http://ec.europa.eu/environment/climat/emission/auctioning_en.htm

[2] European Environment Agency Data Service, http://www.eea.europa.eu/data-and-maps/

It is reasonable to assume that banking with allocated allowances will have a stabilizing effect on the price. If unused emissions cannot be sold at a fair price in the secondary market, it will be possible to save them for future use. However, during the current economic recession, it has not been possible to stabilize the price on the future market[3]. In the summer of 2008, before the great fall in the economy, the futures price for December 2009 was around 25 Euros. Following the recession in the fall of 2008, the price declined to almost 10 Euros. The price for futures due December 2013, has declined in a similar manner from 36 Euros to somewhere between 15-18 Euros. This means that the price of emission allowances on the futures market has declined by between 40% and 50%. According to Grubb *et al.* (2009), the price did not fall further only because agents expect Phase III to launch even stricter caps and because of the possibility of banking emission allowances from the second phase to the third. These large price falls indicate that we must consider what happens to emissions not just during a server crisis, but also when there is a normal recession.

3. Empirical Analysis

We analyze short term variability in emissions of carbon dioxide by decomposing CO_2 data into long run and short run components. A complication for the analysis is that ETS has only been in operation since 2005, and that there have been two trading periods with a different set of rules. Furthermore, the third phase will be substantially different compared to the first two phases. Since official records of capped emissions began in 2005, the time is too short to analyze fluctuations over several business cycles. However, due to the importance of understanding short term variability in emissions, we have collected data from the Carbon Dioxide Information Analysis Center (CDIAC), which is an agency under the United States Energy Department (http://cdiac.ornl.gov). This data includes the years between 1871 and 2006 and covers emissions from burning of fossil fuels. The data excludes, for example, emissions from industrial processes.

Compared to 2005 and 2006, our data set contains more emissions than ETS traded emission allowances. As a comparison, the allocated emission allowances in 2005 and 2006 constituted 67% of the emissions in our data set. However, from 2013, several additional sectors will be covered by ETS, and the difference between our data and the official ETS data will therefore be smaller (European Commission 2009).

Emissions generated by the European Union are obtained by summing the emissions from Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom. The other member states have been excluded due to missing observations; however, our data set includes all the major industrial economies.

We calculate the growth rate in CO_2 emissions and decompose these, using a band pass filter,[4] into trend and cyclical components. The decomposition yields an estimate of the trend growth rate and five cycles of various lengths; 1-2 years; 2-4 years; 4-8 years; 8-16 years and 16-32 years. The original growth rates and the decomposed growth rates are plotted in Figure 1 and Figure 2, respectively. Summing all the cyclical components and the trend in Figure 2 for one of the countries, we obtain the original data as shown in Figure 1.

Figure 2 illustrates three important points. First, emissions have become more stable and fluctuate less since the late 1950s. Second, the trend growth rate in emissions has been declining for most of the period, but it is still not close to the European Union's target of

[3] https://www.theice.com/homepage.jhtml and http://www.eea.europa.eu/data-and-maps

[4] We use the Maximal Overlap Discrete Wavelet transform and a Haar wavelet to decompose the data. This band pass filter is chosen due to its mixture of time and frequency resolution, allowing us to control for possible outliers and structural breaks in the data. For more information see Percival and Walden (2006) and Crowley (2007).

reducing yearly emissions by 1.74 percent. Third, most of the variation in the data is due to the shorter cycles (1-8 years) and the size of the longer cycles (8-32 years) is relatively small. In fact, only the first three components representing cycles of 1 to 8 years have a significant effect on our analysis. Excluding the longer cycles of 8 to 32 years does not affect the results. We therefore limit the following analysis to include cycles of length 1 to 8 years, which approximately represents the typical length of a business cycle.

The figures indicate that there is a reduction in volatility in emissions since the late 1950s. When performing a Goldfeld-Quandt test, we find support for a statistically significant decline in volatility between the two periods; 1871 to 1959 and 1960 to 2006. The test-statistic and *p*-value are available in Table 1. We reject the hypothesis that the volatility for the United States as well as the European Union is the same for both periods. Furthermore, a Goldfeld-Quandt does not support dividing the modern period of 1960 to 2006 into even shorter sub-periods. This result holds for the European Union as well as the United States, see Table 1. A Jarque-Bera test confirms that the short term cyclical movements are normally distributed. The distribution of these cycles appears to be stable over the entire period 1960 to 2006.

Since the distribution of the cycles is stable for the modern period, we can calculate a 95% confidence interval for the short term fluctuations. The combined 1 to 8 year cyclical movements since 1960 and the confidence interval are plotted in Figure 3. All cycles have, by definition, a zero mean, such that the confidence interval for the European Union is approximately +/- 6 percent and for the United States +/- 5 percent. It is important to note that the trend growth rate in emissions has declined since the 1960s (see Panel F, Figure 2), but, as our analysis shows, the short term variations in emissions have remained statistically the same. Structural changes in the economy, such as a growing service sector, do not appear to have affected the short term variability in emissions.

If we compare our result with actual ETS data from 2005 and onwards, we find that the annual growth rates have been between +/-3%, *i.e.* similar to our results. The only exception is 2009 when the decline in emissions was 11%.

4. Discussion

Our analysis has shown that dramatic declines in the demand for emission allowances, such as the recent developments of 2008 and 2009, are not uncommon. Between 1959 and 2006, emissions fluctuated by some +/- 5 percentage points in the United States and some +/- 6 percentage points in the European Union. Of course, our data does not fully match those included in the ETS, as previously discussed, but given the results of our analysis, we may still expect large fluctuations in demand and price in the future as well. This raises the important question of price stability.

From 2013, there will be a greater reliance on auctioning and the free market factors to distribute emission allowances. It is questionable whether banking and borrowing will be able to completely stabilize the carbon market. Large price fluctuations may, moreover, disturb the important price mechanism and result in smaller amounts of investments in new technology. There are alternative systems to a fixed supply; Hepburn (2006), for example, has discussed fixating the price, or using a price and quantity based tool. Similar alternatives are also discussed by Jacoby and Ellerman (2004) and Pizer (2002).

It is interesting to note that central banks face a similar problem when they conduct monetary policy in order to keep inflation low. They control the supply of narrow money and indirectly the price of money i.e. the short term interest rate. Rather than fixating the supply of money, as has been proposed by *e.g.* Friedman (1968), they have opted for a fixed price and flexible supply. This way, the interest rate is stabilized (ECB 2004) and unnecessary volatility in the real economy can be avoided (Svensson 1997). ETS can, without jeopardizing the long run reduction target, operate by using a similar flexible policy where greater short term flexibility in the supply of allowances is allowed.

5. References

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Table 1: Test Statistics; Cyclical Component (1-8 years)

	United States	Euro Area
Goldfeld-Quandts - heteroskedasticity test (1871-1959; 1960-2006)	13.701 (0.000)	20.004 (0.000)
Goldfeld-Quandts - heteroskedasticity test (1960-1983; 1984-2006)	1.589 (0.133)	1.660 (0.112)
Durbin-Watson - autocorrelation test (1960-2006)	1.928	2.218
Jarque Bera - normality test (1960-2006)	1.022 (0.600)	0.058 (0.972)

Figure 1: Original CO_2 Growth Rates; United States and the European Union 1871-2006

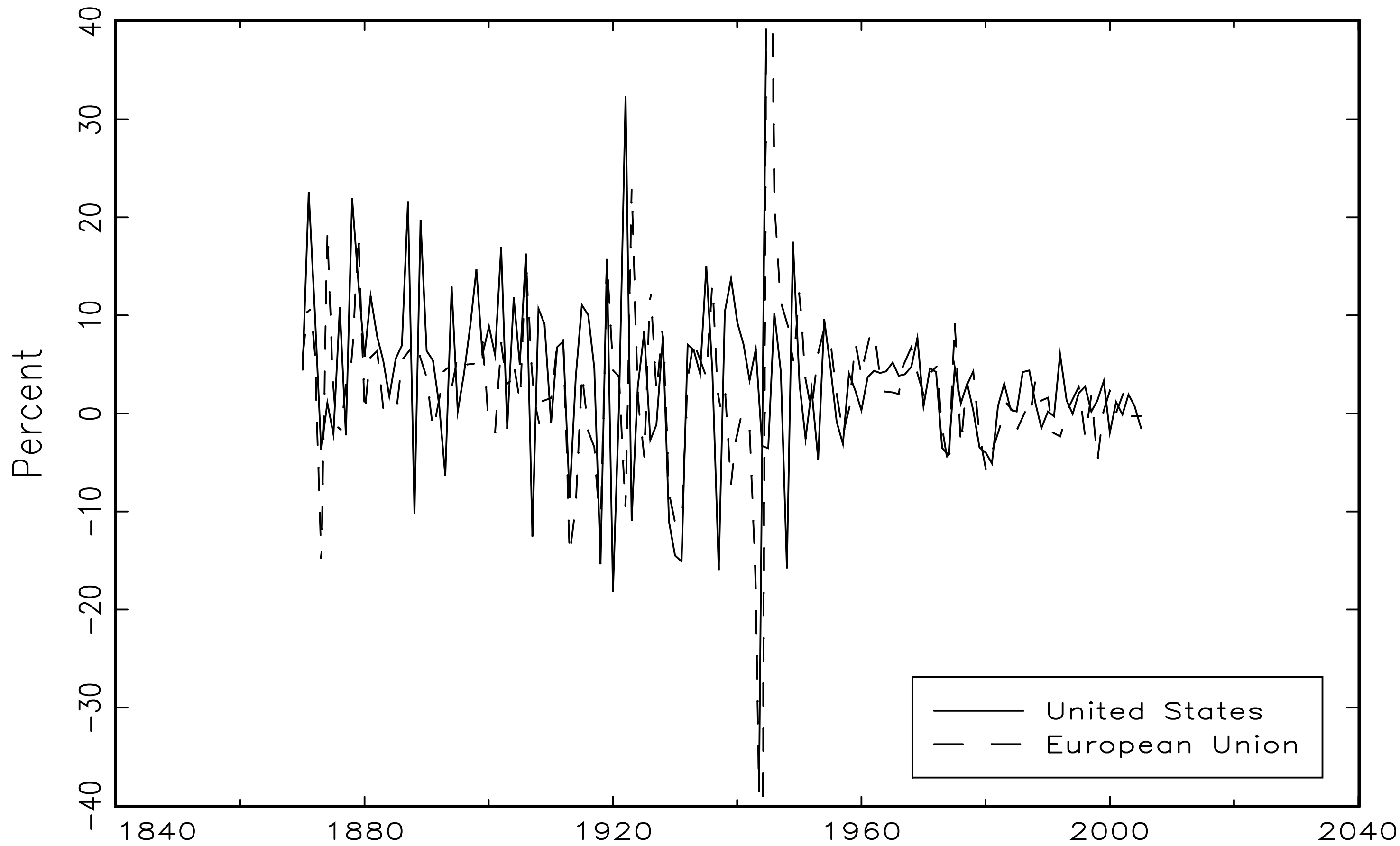

Figure 2: Decomposed CO_2 Growth Rates; United States and the European Union 1871-2006

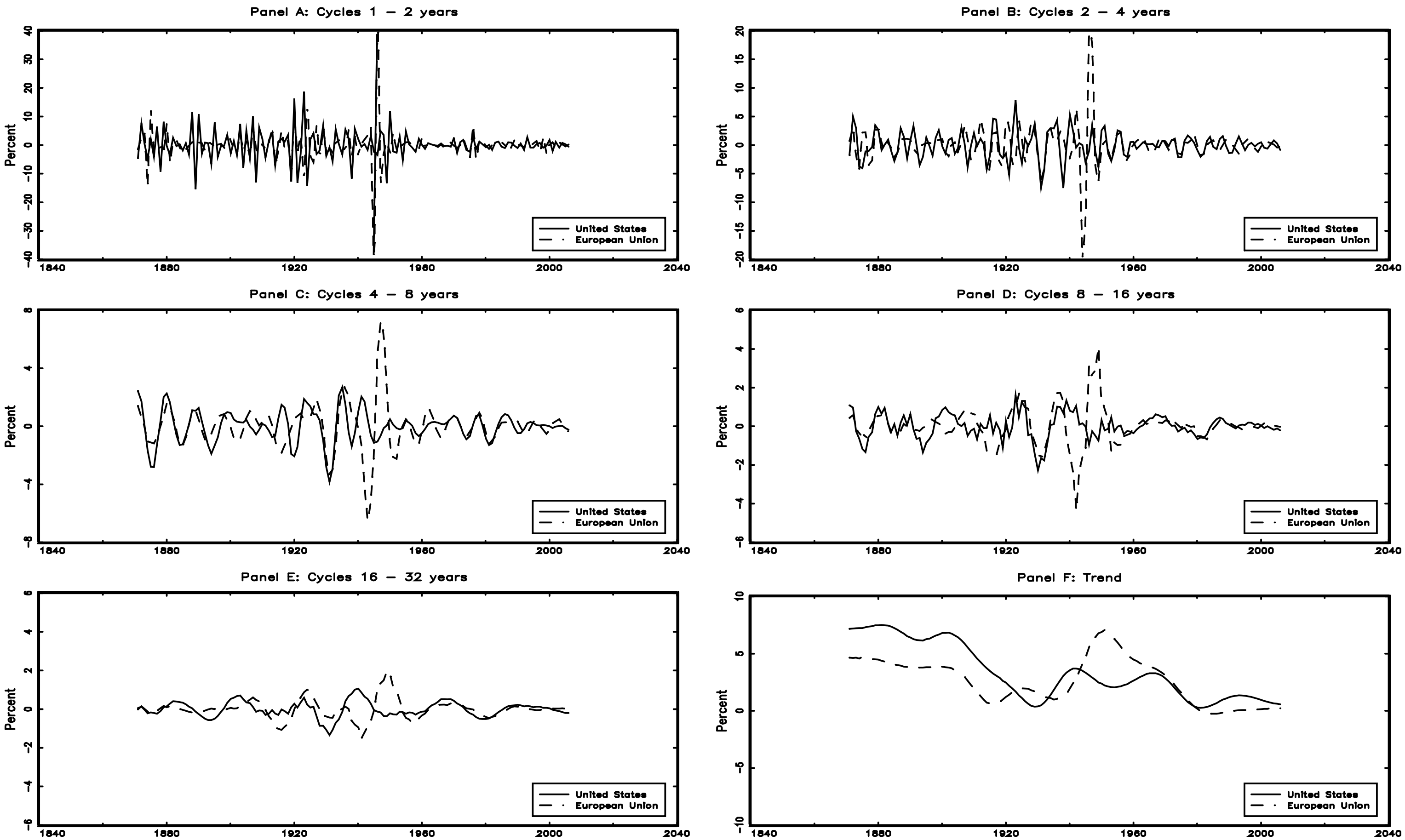

Figure 3: Cyclical Growth Rates and Confidence Interval 1960 – 2006