Carbon pricing factors: Perspective from demand and supply sides

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Abstract. Currently, global warming became a world focus as its potential impacts on all human beings. To prevent the damages of greenhouse gas emissions, the carbon market established and operated for several years. In this paper, due to an important financial reality that the carbon market should be regarded as a common financial market, this paper briefly reviews the pricing factors of the novel carbon asset to benefit the market when it is time to price the carbon asset. And finally, this paper points out the potential future investigations.

Keywords: Carbon Pricing; Demand; Supply.

1. Introduction

From the last century to the present, human production and living requires a lot of energy such as burning coal and oil, which leads to a large amount of greenhouse gas emissions and thus global warming. Global warming is also causing the balance of the Earth's ecosystem to be disrupted, even affecting the survival of humans. These natural disasters, which are not only brought about by global warming, but also the knock-on effects of natural disasters such as the breaking of biological chains, have spread to every aspect of human existence. In 1992, an important document was signed in Brazil. This also means that controlling carbon emissions is already imminent. Therefore, carbon markets were established and received much attention. An important purpose of forming a carbon market is that it can cost effectively contribute to the process of controlling the reduction of CO2 emissions. With the development of carbon markets with general financial characteristics over a prolonged period of time and the fact that carbon prices are considered to be responsive to abatement costs, the study of carbon pricing factors has become a focus of academic attention, and this paper reviews the factors influencing carbon pricing in two dimensions: demand and supply.

2. Demand Side

2.1 Energy

Carbon pricing has a tight relationship with energy prices. The principle of the relationship is that when the price of energy changes, so does the demand for energy, and as demand for fossil fuel energy sources increases, so do the CO2 emissions from their combustion. Therefore, the demand for carbon credits will be affected by changes in energy demand, which means that changes in energy demand will affect carbon pricing. At the same time, of course, the volatility of carbon pricing also has a reverse effect on the price of energy market. Regarding the fluctuation of carbon pricing in the EU ETS. scholars around the world have conducted studies using a number of methods to arrive at the result that energy prices have a relatively large impact on carbon pricing.

Scholars around the world have conducted studies using a variety of methods and have concluded that the energy market and the carbon market are tightly connected, thus the energy market should be a non-negligible pricing factor to the novel but emerging carbon market. The study by Kanen [1] approved the above-mentioned hypothesis. When the price of petroleum fluctuates, the price of natural gas fluctuates, which in turn affects the cost of electricity, leading to changes in the price of electricity and ultimately to carbon pricing. Kai Wang [2] analyzed the relationship between the two using the threshold cointegration method and obtained the results of the non-linear energy price relationship of petrileum price in the transmission mechanism. The volatility of carbon pricing due to

changes in oil prices varies across mechanisms. Mansanet-Bataller and other scholars [3] also focused on this issue. Fezzi and Bune [4] connected the electricity, natural gas and carbon price and found they are connected. By constructing a state-space model and a VAR model, Yuejun Zhang et al. [5] found that oil price shocks are the main reason for the change of carbon trading price. Chen Xiaohong and Wang Sheyun [6] studied the influence of carbon trading price from three perspectives: supply, demand and market factors, and found that natural gas and coal are the major influencing factors of EUA price. Cointegration of the price of energy with the price of carbon was discussed by Yiming Wei et al [7]. The results show that a permanent equilibrium exists, but the degree of mutual influence varies, with the first stage having a relatively weak relationship with carbon prices, While the second stage is a key driver of carbon price changes. Wang Shuangying and other scholars [8] selected the panel data of carbon trading volume, carbon trading price and WTI international crude oil futures price from 2006 to 2008, and the results displayed that the WTI international petroleum futures price was basically positively correlated with carbon dioxide trading volume and trading price. The possible reason for these findings is that the higher price of crude oil in energy has reduced its demand in the energy market, meanwhile the demand for alternative energy sources increases in the market, such as coal as a substitute for crude oil in energy sources, which produces more carbon dioxide from its combustion than from the combustion of crude oil. Therefore, when the price of crude oil increases, CO2 emissions also increase, resulting in higher carbon pricing. However, some scholars, such as Koch [9], used the least squares method to investigate some of the causes of EUA futures price changes, and found that the degree of influence of coal prices was small and insignificant, and the degree of influence of clean energy prices, such as wind and solar, was larger.

2.2 Weather

Carbon pricing can also be affected by weather extremes, whether colder or warmer weather temperatures increase the demand for energy, and carbon pricing can be affected with such changes. Once the weather changes, CO2 emissions change immediately, and this effect is instantaneous.

Mansanet-Bataller [10] et al. showed that extreme weather conditions may affect the price of carbon emissions. Considine [11] argues that weather affects the price of carbon trading by influencing the demand for energy. The rationale is that extreme weather increases the demand for cooling or heating and thus has an impact on energy, while precipitation and wind speed have an influence on clean energy generation and thus on carbon pricing. Alberola [12] examined the seasonality of carbon price time series variables and indicated that the temperature sensitivity of the carbon market and the effect of extreme weather on EUA is non-linear, with very low temperatures having a greater impact than very high temperatures. Yi, Lan and Yang, Li et al. [13] used co-integration theory and MVI-BP model to analyze the EUA carbon trading system as a sample and found that the effect of extreme cold was significant. Yasheng Zou and Wei Wei [14] studied the influencing factors of CER spot price and applied the long and short causality test under the VEC model and found that macroeconomic and climate factors have a greater degree of influence. Qian Wang and Jingjing Lu [15] selected the carbon trading prices of six Chinese carbon trading pilots as sample data and found that weather was positively correlated with carbon pricing. Zhou and Li [16] studied the association between macroeconomics, energy prices, air quality, and carbon trading prices using the VEC model and found that they are connected in the long term. However, some scholars also believe that weather factors have little to do with carbon pricing. Seifert [17] et al. analyzed the spot price fluctuation of CO2 trading by Dynamic Stochastic General Equilibrium (DSGE) model, but the results showed no seasonality in the spot price. Chen Xiaohong and Wang Sheyun [18] studied the impact elements of carbon trading price under EUA carbon trading system, and the empirical evidence showed that the effects of wind speed, temperature and precipitation on EUA price were not significant. Chen Xin and Liu Ming et al [19] analyzed the impact of daily average temperature deviation from historical average temperature as a representative indicator of weather factors and found that the two does not connect with each other significantly. Ji and Hu [20] used several statistical models to model the dynamics of carbon price.

2.3 Macroeconomic

Carbon pricing is also influenced by macroeconomic factors. Economic development affects the trading of carbon credits. When the economy has an upward trend, enterprises in various fields will expand their production, so the demand for fossil energy will be increased, leading to a sharp increase in carbon dioxide emissions making carbon pricing higher. At this time, the market demand for carbon emission allowances is greater than the supply, resulting in dramatic fluctuations and rising prices of carbon emission allowances. When the economy tends to move downward, the scale of production is reduced, the demand for energy from fossil fuels decreases, and CO2 emissions decrease, so the carbon pricing in the carbon market decreases. In short, higher demand for energy within industrial production results higher carbon emissions. The opposite is true when the demand for energy decreases.

Chevallier [21] introduces an autoregressive conditional heterogeneity model (ARCH) and its two extensions (GARCH, TGARCH) in order to investigate whether there is a link between carbon futures contract returns and macroeconomics and finds that electricity production shows great effects on carbon price. Chevallier [21] considers nonlinearities and uses three methods namely self-excited threshold autoregression (SETA), smooth transition autoregression (STAR), and Markov state transition model (Markov switching autoregression). Jixian Liu and Yilong Su [22] studied the connection between the European debt crisis and carbon prices and showed that the European debt problem would bring credit and price effects to ETS through the empirical analysis of savings and loan rates and bond yields. The inverted U-shaped relationship was found by Holtz-Eakin and Selden [23]. Conrad [24] modeled the adjustment process of EU allowance prices and found that EU carbon allowance futures prices are not only influenced by the current economy, but also closely linked to the future economic conditions of the US and Germany. Using a long- and short-term causality test, Yasheng Zou and Wei Wei [25] used the industrial production index as a proxy for the macroeconomy and concluded that there is a significant positive relationship between the two. Li Yi [26] used six carbon trading pilots as the research subjects and found that the GDP gross domestic product was positively related to the pricing of carbon by building a VAR model and impulse response analysis.

3. Supply Side

The carbon market is a policy-led market, so there is a strong relationship between policy and carbon pricing. The issuance of carbon allowances and the changes in allowances caused by the design of the policy will have an impact on carbon pricing. After selecting the industries and enterprises to be covered by the carbon market, the government will set carbon quotas for these industries and enterprises based on certain measurement criteria. After obtaining a certain amount of carbon quotas, companies are free to trade in the carbon market. At this point, the market will determine carbon pricing. Companies with high carbon emission limits will usually sell their allowances to companies with low carbon emission limits, thus, reducing the cost of carbon emissions. Companies with low carbon allowances will buy carbon allowances in the market according to their demand for them.

Alberola [27] identified two major adjustments in EUA prices between 2005 and 2007, both of which occurred after the EU ETS released important information about quota supply and found that the first adjustment was attributed by EUA over-allocation and the second adjustment can be explained by government policies, respectively. Daskalakis et al [28] argued that the EU ETS policy for period storage quotas had a huge influence on EUA derivatives prices were confirmed by Beat Hintermann [29]. Christian Conrad et al. [30] studied carbon trading prices from an information perspective and showed that the Nation Allocation Plan (NAP), the current state of the economy, and future expectations has significant effects on carbon trading prices. Yiming Wei et al. [31] examined the sudden change in EUA price by Bai-perron model and abnormal returns and concluded that the sharp drop in carbon price was the result of over-allocation of carbon emission target. Guo Fuchun and Pan Xiquan [32] used the same structural mutation model and the univariate model of the capital

asset pricing model to study the prices of carbon futures contracts with different expiration dates and different varieties in the EU, and found that the futures prices underwent significant structural mutations with non-linear characteristics, and the main reasons for the sudden price changes could be attributed to external market information, economic crisis, approved information leakage events, etc. The main reasons for the sudden price changes can be attributed to external market information, economic crisis, and approved information leaks.

4. Conclusion

The carbon pricing is becoming an interesting and important topic of financial area. Thus, this paper reviews the important influences on carbon pricing in terms of demand and supply - energy prices, climate, macro markets and policies - but the role of these traditional influences in carbon pricing remains controversial. In addition, traditional carbon pricing studies have neglected to explore non-traditional emerging factors, which may be an important direction for future research.

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