Carbon content of electricity futures in Phase II of the EU ETS

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Thermal electricity from fossil sources generates CO_2 emissions as a by-product, and carbon policies aim to internalize the social cost of emissions by placing a price on them. If emissions are costly, they should be treated like any other input for electricity generation such as labor, capital and fuel. The costs of emitting CO_2 are thus passed through to the ultimate "polluters", i.e. the consumers who demand energy-intensive goods. The degree to which carbon costs are passed forward to electricity prices depends on market conditions (e.g. the degree of competition and consumers' demand response), and is important to determine the full distributional costs of climate policy, as well as its effect.

In this study, we examine the cost pass-through of CO_2 allowance prices from the European Union's Emission Trading Scheme (EU ETS) in electricity prices from various markets across Europe. More specifically, we estimate the relationship between electricity, fuel and carbon prices in Germany, France, the Netherlands, the Nord Pool market and Spain, using one-year futures for base and peak load prices for the delivery period November 2009-2012, corresponding to physical settlement during the second market phase of the EU ETS.

While this study is not the first to examine this question of cost pass-through in the EU ETS, it is distinguished from the others in several ways. First, the study employs multiple estimation techniques to empirically determine pass-through rates, displaying the sensitivity of model selection on estimated rates. Second, the data we employ is futures data and is exclusively over the second phase of the EU-ETS. Importantly, our data is also solely from the period after the major economic downturn in late 2008, thereby avoiding any confounding

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issues the economic collapse may have on our results. Finally, we allow for a high degree of interaction across markets in ways that has not been explored in previous studies.

To estimate this relationship we use several econometric techniques. First, we assume that input prices (i.e., natural gas, coal, and CO_2 allowance prices) are exogenous to electricity prices and each other. We then estimate cost pass-through by regressing electricity prices from each market seperately on input prices, as well as other relevant exogenous variables such as electricity spot prices, factors of economic activity, wind generation, and hydro reservoir capacity, in an autoregressive conditional heteroskedasticty (ARCH) specification. Next we allow for the electricity prices and input prices to be endogenously determined by estimating vector error correction model (VECM) for each market separately (i.e., the vector of endogenous variables includes a specific country's base or peak electricity price and the input prices). Finally, noting that electricity prices across markets may themselves be related, we estimate a VECM system that includes all base-period electricity prices and input prices in the vector of endogenous variables and another VECM that includes all peak prices and input prices in the vector of endogenous variables.

We find that carbon costs are passed through to electricity futures, that electricity and input prices are cointegrated, and that there appear to be further cointegrating relationships between electricity prices of adjacent markets. The results also show how sensitive cost pass through estimates are for model specification. In the specifications that do not allow for cross-market relationships, we find that the CO_2 price affects electricity prices as much during peak as during base load in all countries. This is surprising because the lower carbon intensive gas plants have traditionally been the marginal generators during peak demand periods and, thus, we would expect lower carbon cost pass through during peak. These findings change considerably, in particular for the Nordic and Spanish markets, which are only imperfectly connected to the continental European market dominated by France, Germany and the Netherlands, in the multi-country cointegration framework. In particular if we allow for market cointegration, the results are more in line with expectations that base load pass through is greater than that of peak load.