

# The Impact of Instrument Choice on Investment in New Abatement Technologies: A Case Study of Tax versus Trade Incentives for CCS and Biomass for Electricity

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The transition to a low-carbon economy will require both a shift in existing investments from high to low-carbon technologies, and also additional investments in new low-carbon technologies. Creating a price for greenhouse gas emissions is one instrument that is available for incentivising such investment. There are two main methods for creating such a price: through the implementation of a tax on emissions, or through a cap-and-trade regime. The actual incentive to investment that either instrument will produce is an important, but surprisingly little-analysed question in assessing such a choice.

With certainty and complete information there is equivalence between taxes and caps. In the case of climate change however, there are both large uncertainties and incomplete and asymmetric information. Although there is a wide body of literature that discusses the difference between taxes and caps under uncertainty there is little that focuses upon the incentives to investment that each instrument produces. The literature that investigates the different investment incentives from tax and cap instruments neglects the issue of uncertainty.

Our work builds on these two strands of literature in constructing a model that investigates the incentives to invest in a low-carbon technology that arise under a tax, a cap-and-trade scheme and a scheme with price floors and ceilings. Our model focuses on a large diversified energy-producing firm which faces a decision between investing in a low-carbon technology or a high-carbon option. The low-carbon technology generates lower emissions

but is subject to higher costs. We calculate the returns the firm can make in a multi-period world from investing in such technology.

We parameterise our model using the data from the European Union Emissions Trading Scheme, and for two low-carbon technologies, Biomass for electricity and Coal with Carbon Capture and Storage (CCS). We run the model using Monte-Carlo simulations and generate information on the distribution of returns to investment that a firm may obtain, given uncertainties over emission levels and technology costs and effectiveness, under the different instruments.

We find that mean returns are greater under a cap-and-trade scheme than under taxes for both technologies in two out of three cases of tax formation, but the distributions display greater variance. This effect is caused by cases which make a given target more costly than central expectations. Tax regimes do not adjust incentives and thus display a lower mean return.

The introduction of price floors to cap-and-trade schemes increase mean returns and also reduce the distribution in comparison to standard caps. By choosing a level of floor that removes 20% of the frequency distribution of prices, mean returns are raised by approximately 9%. When we introduce ceilings that remove the same percentage of the distribution we find that mean returns fall by 25%.

We find that given the assumptions we make about levels of instruments there are positive mean returns across all instruments from investment in Biomass for electricity. This reflects the relative maturity of the technology and demonstrates that current policy levels may incentivise investment in this technology in the near future.

In contrast for CCS, a more immature and uncertain technology, we find that for all instruments there are large negative mean returns, highlighting the fact that current levels of policy commitment are unlikely to be sufficient to create incentives to invest in this technology in the short-term, implying a need for further support. Although the returns to the technology are negative under both instruments the choice between them may, however, help to determine the scale of additional support required.

In assessing the overall incentive to investment in a low-carbon technology from taxes or cap-and-trade schemes the risk profile of the firm becomes important. Higher mean returns under a cap-and-trade scheme are offset by a much wider variance. Whether the higher

returns are enough to offset the greater risk, especially in the context of risk-averse firms is uncertain.

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