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Econometric analysis of Australian emissions markets and electricity prices

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HIGHLIGHTS

- We analyse two emissions trading schemes in Australia.
- We test for their effect on wholesale electricity prices.
- The test uses generalised forecast error variance decomposition analysis.
- The tests find long run relationship between the variables in both the samples.
- The short run-dynamics indicate that they play a minimal role in electricity prices.

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ABSTRACT

Emissions trading schemes aim to reduce the emissions in certain pollutants using a market based scheme where participants can buy and sell permits for these emissions. This paper analyses the efficiency of the two largest schemes in Australia, the NSW Greenhouse Gas Abatement Scheme and the Mandatory Renewable Energy Trading Scheme, through their effect on the electricity prices from 2004 to 2010. We use a long run structural modelling technique for the first time on this market. It provides a practical long-run approach to structural relationships which enable the determination of the effectiveness of the theoretical expectations of these schemes. The generalised forecast error variance decomposition analysis finds that both schemes' emissions prices have little effect on electricity prices. Generalised impulse response function analysis support this finding indicating that when shocks are applied to electricity by the two schemes it returns to equilibrium very quickly. This indicates that these schemes are not having the effect anticipated in their legislation.

1. Introduction

A major goal of financial markets is to ensure the efficient flow of funds between surplus units and deficit units. This should be achieved in a timely and cost effective manner so that those who can most efficiently use the funds will access them. There has been a great deal of research conducted on different measures of market efficiency since Fama's study in 1970. While there are findings of anomalies Fama (1998) suggests that these are fragile and may disappear depending on which method of measurement is used. Fama states in the introduction to his 1970 paper that "the ideal is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production-investment decisions" (Fama, 1970, p. 383). Emissions trading schemes (ETSs) trade in a context where an ideal market is one in which those who can most efficiently reduce their emissions will be able to sell either their own surplus certificates or those they create. The overriding goal of emissions trading markets is to achieve a reduction in CO_2-e[1] in the most cost effective way. Garnaut (2011, Chapter 11) stated that "Under a carbon price, the market, rather than the government, will be making abatement decisions, which will ensure emissions reductions are delivered at lowest cost".

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[1] A tonne of CO_2-e is a quantity of any greenhouse gas which has the same warming effect as a tonne of CO_2.

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The question of whether or not a market has been efficient may be approached in two main ways. One way is to measure whether compliance has been achieved. The markets under analysis in this paper are the two largest and most actively traded emissions trading schemes in Australia during the period under analysis, January 2004–December 2010. These are the New South Wales Greenhouse Gas Abatement Scheme (GGAS) and the Mandatory Renewable Energy Trading Scheme (MRET). The GGAS was closed in 2012 upon the commencement of the Federal Labor Government's carbon tax in order to reduce duplication. The MRET was split into two separate components in January 2011, the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). Using the level of compliance that has been achieved as the measure, it can be concluded that the markets were efficient. The legislated CO_2-e reductions required under each scheme were achieved to a level of around 99% for the years under review in this paper. The other way of measuring efficiency is by determining if the schemes have had a price effect on the markets with which they have had the greatest connection. This paper aims to separate ETSs from other policies and determine if the markets themselves have contributed to a reduction in emissions in Australia. This paper will test this by determining if the ETS prices have had an effect on the wholesale price of electricity.

The electricity sector is chosen predominantly because this sector is the target for the MRET, the largest and most frequently traded ETS in Australia. The MRET goal is to encourage additional generation of electricity from renewable energy resources thereby reducing greenhouse gas emissions. This increased demand for these renewable energy sources would then assist in ensuring that renewable energy sources are ecologically and financially sustainable. The effect of price changes for renewable energy certificates, the certificates used in the MRET, are therefore most likely to be found in wholesale electricity prices. The expectation is that, as electricity producers move to using more renewable energy sources, the wholesale electricity price will increase. This is because the costs, as described in Fig. 2 and explained later, indicate that using renewable energy sources is more expensive than using coal for the production of electricity. Therefore if the MRET is causing this change in energy source, the electricity price should increase. The GGAS does not have as clear a link as the MRET to electricity prices but there remains an expectation that if it is working efficiently, it too would affect the electricity prices. The goal of the GGAS is to reduce greenhouse gas emissions through the use of benchmarks. The major participants in this scheme include retail suppliers, electricity generators and other suppliers of electricity to a customer and market customers. Additionally, certificate creation involved activities including those which reduce the consumption of electricity and production of electricity which results in reduced greenhouse gas emissions. In a similar way to the MRET we anticipate that if the GGAS is contributing to a change in the energy sources used for electricity generation, then the cost of wholesale electricity would increase.

The electricity sector is by far the largest emissions sector in Australia, with annual emissions increasing by 49.1% from 1990 to 2011 as discussed in the Australian National Greenhouse Gas Accounts National Inventory Report 2010 (Australian Government, 2012). Under the Kyoto Protocol, ratified by Australia in 2007, the allowed emissions for Australia were set at 108% of 1990 levels. While the electricity sector accounts for only a part of these allowable emissions, it produced 35% of Australia's emissions for the year to March 2012 (Australian Government, 2012). After peaking in 2008–20009 at 207.9 Mt CO_2-e, emissions in the sector fell to 193.1 Mt CO_2-e in 2011 (Australian Government, 2012). The electricity sector involves electricity generation from fuel combustion and renewable sources such as wind and solar. We aim to establish whether emissions trading markets have had a long-term effect on wholesale electricity prices in the sector. In particular we want to determine causality. We have used a generalised forecast error variance decomposition (GVD) and generalised impulse response function analysis (GIRF) to determine this. These models are explained fully in our methodology and results in Section 4.

The growing global demand for energy has been beneficial for the Australian economy, due to the country's abundant coal, uranium and gas deposits. In 2012 Australia was the world's ninth-largest energy producer (Enerdata, 2013). Australia's electricity generation is dominated by fossil fuels with 430 Mt coal and lignite being produced in 2012. Coal exports earned $38,581million for the year to June, 2013 which accounted for 15.6% of Australia's exports for the year (Australian Bureau of Statistics, 2013). Coals are the highest CO_2-e emitters of all energy sources and contributed around 79.2% of electricity generation in March 2012 (Australian Government, 2012). The mining lobby is a very strong force in Australia, with coal mining employing around 229,100 full-time and 9600 part-time workers and contributing to the strength of many rural communities. Under current production levels, black coal has estimated economic demonstrated reserves of 111 years with brown coal at 539 years. Australia is the fourth-highest coal and lignite producer in the world and production increased at an average of 2.9% p.a. from 2000 to 2012. While the percentage of renewable energy used as a fuel source for electricity generation has increased, Fig. 1 shows that this is still a very small proportion coming from a very low base.

In dollar terms, coal is the cheapest fuel source in Australia and is likely to remain so for many years to come. Bureau of Resources and Energy Economics, Australian Government (2012) showed the levelised cost of energy by technology in Australian dollars per megawatt-hour (MWh) to be approximately in the ranges shown in Fig. 2.

The ETS endeavours to incorporate into the costs of production an amount attributable to the CO_2-e emissions that occur in generating electricity from non-renewable resources. It does this by reducing the amount of emissions allowed before penalties apply, and creating a market where the surplus and deficit units of the certificates can trade with each other. If this is done efficiently we would initially expect the cost of electricity to increase due to the additional costs for producers. This will occur as they move towards renewable, more expensive sources of energy and away from the cheaper, high emitting fuels. It will also occur due to the increase in the cost of coal which will result from the additional cost to producers of purchasing emissions certificates. Over time renewable energy production is expected to become more efficient, leading to a decrease in costs and hence a decline in the cost of electricity.

The next section of this paper discusses the literature around market efficiency of ETSs with a focus on the use of electricity prices as a measure. It then provides descriptions of the GGAS and

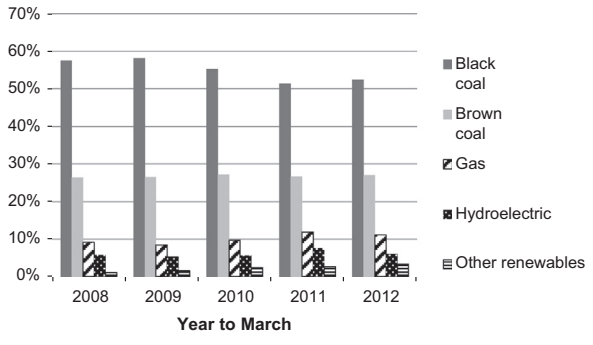

Fig. 1. Electricity generation by fuel source.
Source: Australian Government, Energy in Australia (2011).

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