Energy Economics 52 (2015) 176–182

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Structural breaks and electricity prices: Further evidence on the role of climate policy uncertainties in the Australian electricity market

Nicholas Apergis, Marco Chi Keung Lau *

Business School, Northumbria University, UK

ARTICLE INFO

Article history:
Received 31 May 2015
Received in revised form 18 September 2015
Accepted 25 October 2015
Available online 31 October 2015

JEL classification:
Q41
Q50

Keywords:
Electricity prices
Structural breaks
Climate policy uncertainty
Australia

ABSTRACT

The primary objectives and the strategies of a national electricity market are the efficient delivery of network services and the electricity infrastructure to meet the long-term consumer's interests. Therefore, the objective of this study is to explore whether electricity prices across the six Australian States display instability. Such instability is closely associated with the presence of structural breaks in relevance to policy events on Australian carbon policies. The study makes use of weekly Australian wholesale electricity prices spanning the period from June 8th, 2008 to March 30th, 2014 along with linear and non-linear unit root testing methodologies. The results provide supportive evidence that the Australian electricity market can be described as a less stable electricity market, which implies that a high degree of market power is exercised by generators across regional markets. These findings are expected to have substantial consequences for the effectiveness of carbon dioxide mitigating policies, especially, when there is uncertainty as to whether the planned environmental policy is put in place for the lifespan of undertaken investments.

1. Introduction

Australian electricity markets experienced significant deregulation in the 1990s and policy questions have arisen since. The main domestic network is the *National Electricity Market* (NEM). It was established in 1998 and links regional markets in Queensland, New South Wales, Victoria and, more restrictively, Tasmania and South Australia. The primary objective of the NEM is to provide an efficient and nationally integrated electricity market, which in the long-run should provide similar prices for electricity across all six states and, thus, limit the market power of generators in the regional markets. Most consumers do not participate directly in the NEM; they purchase their electricity through retailers.

The wholesale market of the NEM is a real-time energy market where a centrally coordinated dispatch process is used to match demand and supply instantaneously in real time. Supply bids are stacked from the least price to the highest price and the dispatch price for each 5-min interval is set equal to the last bid needed to meet demand at a given period. The spot price is used as the basis for the settlement of financial transactions for all energy traded in the NEM (AEMO, 2013). Australia's highly emissions-intensive electricity sector is the main reason why Australia's emissions are the highest per capita among advanced economies. Around 75% of Australia's electricity supply is generated from coal, higher than in most other advanced countries, and very high in global comparison (World Bank, 2012). Electricity generation accounts for more than one-third of Australia's overall emissions, and emissions from this sector have grown faster than any other sector over the last years.

Over the period 2009–2010, the Australian government could not implement a key 2007 election commitment relating to the introduction of a greenhouse gas emissions trading scheme by the year 2010. The legislation underpinning the scheme was passed by the House of Representatives but rejected by the Senate. Eventually, this gas emissions trading scheme was adopted in July 2012 to become ineffective in July 2014. Nelson et al. (2010) argue that the lack of policy certainty in relation to climate change policy effectively prevented firms from investing in projects mitigating carbon emissions and in investing in non-fossil energy sources. The authors provide evidence that delaying the provision of policy certainty resulted in firms investing too heavily in open-cycle gas turbines, investments that minimize the risk associated with the investing capital. This led to a significant increase in wholesale electricity prices, thus, imposing a largely deadweight loss cost to society. Their results receive supplementary support by the study of Keating (2010). Garnaut (2011) suggests that without having enough interconnector capacity to cope with the potentially large shifts in interstate flows of electricity, much of the generation capacity must remain within a regional market, even if there are more economic sources

* Corresponding author at: Newcastle Business School, Northumbria University, Newcastle upon Tyne, NE1 8ST, UK. Tel.: +44 191 243 7072.
E-mail addresses: Nicholas.apergis@northumbria.ac.uk (N. Apergis), chi.lau@northumbria.ac.uk (M.C.K. Lau).

http://dx.doi.org/10.1016/j.eneco.2015.10.014
0140-9883/

elsewhere. Thus, interconnector constraints could be reflected in regionally differentiated, volatile und unnecessarily high electricity prices. In addition, Nelson et al. (2012) provide evidence on Australian carbon prices and their impact on the country's electricity markets. Their findings illustrate that there does not exist any unique way to estimate accurately carbon pass-through. This type of inconsistency of pass-through policies in carbon mitigate policies is expected to have important implications for policy makers in terms of households' compensation policies as well as for businesses under the scheme of Clean Energy Future. In that sense, Australian policy makers can easily rely upon other carbon mitigation schemes, such as the European Union Emissions Trading Scheme (ETS). In terms of carbon emissions policy, in 2001, Australia introduced legislation requiring investment in new renewable electricity generating capacity. This particular legislation was significantly expanded in 2009 to give effect to a 20% Renewable Energy Target (RET). The authors argue that the 'stop/start' nature of renewable policy development resulted in investors withholding new capital until greater certainty can be provided. More specifically, they investigate whether capital market efficiency losses could occur under certain policy scenarios. Their findings document that electricity costs definitely increase if the large-scale RET is abandoned, even after accounting for avoided renewable costs. Overall, they conclude that policymakers should be guided by a high level public policy principle in relation to large-scale renewable energy policy.

Given that the objective of establishing a national electricity market is the efficient delivery of network services and electricity infrastructure to meet the long-term interests of consumers, it is worth undertaking a study that explores whether electricity prices across the six Australian States display instability which is primarily associated with the presence of structural breaks arising from particular policy events, such as the uncertainty associated with Australian carbon policies. According to economic theory, the inability to implement carbon dioxide mitigation policies generates detrimental implications for energy and economic growth sustainability since the effect of uncertainty associated with future carbon emission regulations, magnifies the anxiety of risk-averse investors concerning profits (Fan et al., 2010). The elimination of such policy uncertainties is expected to lead to increasing investments in less carbon intensive technologies.

Worthington et al. (2005) examine the transmission of spot electricity prices and price volatility across the regional electricity markets in the Australian case. They make use of a multivariate generalized autoregressive conditional heteroskedasticity model to identify the source and magnitude of price and price volatility spillovers. Their results indicate the presence of positive own mean spillovers in only a small number of markets and no mean spillovers between any of the markets. These findings are directly related to the physical transfer limitations of the present system of regional interconnection. At the same time, their findings illustrate that shocks in some markets affect price volatility in others. Zhou (2009) attempts to explore how environmental policies, e.g. emission trading schemes, impact on the change of market power of generation companies. In particular, the author targets the Australian National Electricity Market and presents a Cournot market equilibrium model which incorporates an emission trading model that studies the potential changes of market power due to the introduction of the proposed Australian National Emission Trading Scheme (NETS). For an excellent review on the Australian electricity the interested reader should turn to the paper by Nelson et al. (2012) (along with the studies referenced there) where the role of climate change mitigation policies is emphasized. The authors argue that the way electricity prices are formed depends substantially on carbon prices and their impact on such electricity prices. Their empirical analysis developed an approach for testing the consistency of a number of methodological approaches in the literature, while their findings document that the literature related findings are inconsistent in terms of the carbon pass-through process. They also conclude that the variation of carbon pass-through estimates has important implications for policy makers, given much of the compensation to be paid to households and businesses under carbon mitigation policies. Overall, their conclusion is that Australian policy makers must be guided by relying upon the numerous a posteriori estimations of pass-through in the European Union Emissions Trading Scheme (ETS) rather than Australian a priori studies. Finally, Cotton and De Mello (2014) analyze 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. Their findings document that both schemes' emission prices have little effect on electricity prices, while when shocks are applied to electricity by the two schemes it returns to equilibrium very quickly, indicating that both schemes are not having the effect anticipated in their legislation.

Therefore, the goal of this paper is to explicitly investigate, for the first time, the stationarity properties of Australian electricity prices, making use of recent developments in panel unit root testing. In particular, the empirical analysis in this paper makes use of both linear and non-linear panel unit root tests. The novelties of our work are related to the advantages of the panel unit root tests this paper employs. In particular, there are certain key advantages in relevance to the issue of size distortions, where this testing procedure takes into account both serial correlation and cross-sectional dependency through the implementation of an autoregressive (AR)-based bootstrap. Moreover, the testing procedure allows for the presence of structural breaks that might arise with, say, changes in environmental policies, e.g. breaking the sample in the pre- and post-adoption of carbon dioxide eras. In this paper, however, we explicitly allow for different endogenously determined breaking dates across the individual electricity prices and across States in the panel.

To foreshadow the empirical findings of this study, the results indicate that Australian electricity prices in four out of six Australian States (i.e., New South Wales, Victoria, Tasmania and Western Australia) document a break type of behavior related to the failure of the Australian government to adopt an election commitment relating to the introduction of a greenhouse gas emissions trading scheme by the year 2010. In the case of South Australia, the break seems to occur in 2013, which coincides with the Senate's decision in March 2013, electricity supply has to heavily come from renewable sources, mainly, wind and solar. Interestingly, the South Australia government, as we are speaking today, has already exceeded its target of generating 33% of the state's electricity needs from renewables and has now set a 50% target by 2025. As a result, constantly since the summer of 2013 there have been several instances when wind energy has accounted for all, or nearly all, electricity demand in South Australia. We could also keep in mind that South Australia has nearly half the country's wind capacity with around 1.5GW of wind energy.

By contrast, the results seem not to be affected by the introduction of the Carbon Pricing Mechanism (CPM) that became effective on the first of July 2012, with a planned transition to an emissions trading scheme (ETS) in July 2015. The intention behind imposing a price on carbon was to encourage producers to switch away from coal-fired generation and move to gas and renewable sources of energy through increasing the costs of fossil fuel combustion. Despite that existing statistics illustrate that power prices within the Australian NEM increased significantly after July 2012, even by more than 100%, our results identified different events that could have significantly impacted electricity prices in Australia. These findings receive statistical support by Nazifi (2015) who provides empirical evidence that the CPM affected significantly electricity prices only in the cases of New South Wales and Victoria.

The findings are expecting to raise substantial interest for market participants in electricity markets since the presence of structural breaks can impact the stationarity properties of electricity prices and generate or delete profitable arbitrage opportunities in electricity prices, not only within the same State and across generators, but also across States. They will be of high interest to all electricity market participants (i.e., running from suppliers to final consumers) since this could increase the forecasting performance of modeling approaches in relevance to future movements in electricity prices based on past behavior.