# 18. Electricity Pricing

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**Project Summary**

Prices for electricity are exceptionally volatile, mainly due to its non-storable nature. Once electricity is generated it is either used or lost in the grid. Traded electricity prices appear to follow a mean reverting process. This is punctuated by exceptionally large spikes, which occur often and are generally attributable to supply shocks such as the failure of some part of the infrastructure. While the extant research has focused on demand effects, this project deals with both supply and demand effects using time series analysis to gain greater understanding of the underlying determinants of electricity prices.

**Discussion**

Developing models to explain and to predict electricity prices is a significant task. This is important both for the market participants who operate in the physical market and for those trading in electricity derivatives. Electricity spot prices are among the most volatile commodity prices in the world and this is because of the special characteristics of the product, namely non-storability, limited transportability and restricted arbitrage. Electricity price time series differ from traditional financial data with a greater incidence of spikes than is generally observed in financial data and this results in fairly extreme volatility and rapid reversion to the mean (Bunn (2004), Alvaro, Peña, and Villaplana (2002), Hadsell, Marathe and Shawky (2004)). Modelling electricity prices and trading in this market is an extremely difficult process and this provides a strong incentive for further research into the electricity price market.

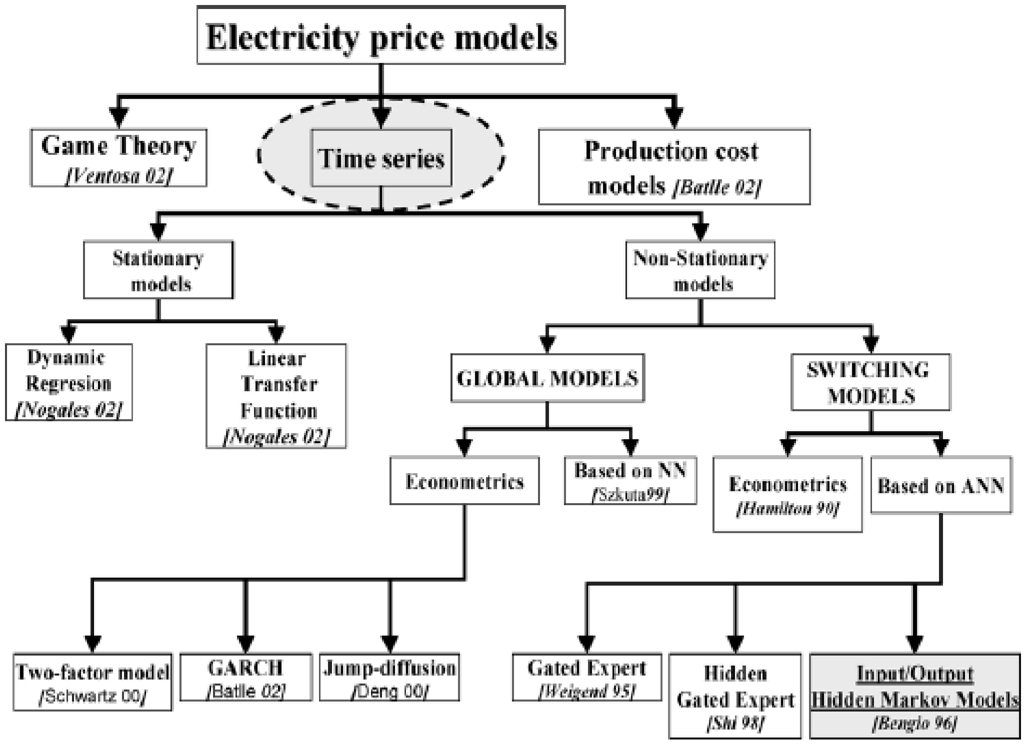
This project focuses on the development of econometric models to explain Australian electricity prices. It extends on Worthington, Kay-Spratley, and Higgs (2003) who analyse price and volatility relationships in the Australian regional electricity markets (NSW, VIC, QLD, SA and Snowy) using National Electricity Market (NEM) daily price averages. They find no significant relationship between price changes in these five Australian spot markets, despite NEM inter-region connectivity. In addition, they observe sizeable spot price differences between regions and these differences persist in the longer term. Further, the electricity markets exhibit strong own ‘persistence’ in volatility with substantial differences between peak and off-peak periods. Goto and Karolyi (2004) also provide some insight into Australian electricity price in their comparison of electricity prices drawn from the US, NORD and Australia with evidence to support the existence of volatility jumps in their data.

While there are differences between the regional electricity markets, the literature also notes the need to model demand shocks as well as the impact of supply shocks (Evans and Green (2005)). Finally, González, San Roque and García-González (2005) emphasize the requirement for accurate forecasting methods and suggest that the sudden changes in the market advocate the need to model prices using some form of regime switching model (Hidden Markov Models or Input-

Output Hidden Markov Models). This is also evident in the work of Goto and Karolyi (2004).

As indicated in Figure 1 there is no universally accepted model for pricing electricity though we propose to use time series models, expanded to include the impact of supply and demand effects with adjustment for regime switching.

**Figure 1**
**Summary of the Approaches Used in the Study of Electricity Prices**




*Source: Gonzalez, San Roque and García-González (2005).*

Electricity price modelling constitutes an important problem because the operation of the physical spot electricity market is different from most other commodities. The highly volatile half hourly spot price is based on bids placed by generators. The generator has the ability to place up to ten different spot prices for each generation unit. Consequently pricing spikes are most likely to be caused by unplanned generation unit outages, generator pool price re-bidding or transmission network failure. Thus while the demand effects appear to be fairly well understood there is still some work to be done ni modelling supply effects.

Generally, the time series analysis of electricity prices focuses on the underlying prices with the possibility of some modelling of the demand effects. Our research will provide further insights into the determinants of the time series behaviour of electricity prices.

## Approach

Time series for actual price, forecast price, quantity demanded, supplier bid and some network outage data will be obtained from NEM. However care will be required in the identification and classification of infrastructure failures. Weather data used in modelling demand is readily available from the Bureau of Meteorology

Research Centre. Once these variables are collected they will be organised into a data set of daily observations.

Supply shocks will be captured using information on actual infrastructure failure obtained from NEM, production data and suppliers' bid information. Demand side data will include weather information as well as a series of seasonal dummy variables and day of the week dummy variables.

Time series analysis of this data will include of estimation of vector autoregressions (VARs) and vector error correction models (VECMs). These models will include the impact of supply and demand shocks as well as deal with the possibility of regime-switches as the prices move between stable and volatile periods. Our analysis will be based on the following model:

$$Electricity\_price = f\left(D - S\right),\ f' \geq 0$$

*Demand (D) = D(time of the day, day of the week, holidays, weather)*
*Supply(S) = S(infrastructure)*
*= S*(NEM infrastructure announcements, previous day usage, suppliers bid data)*

The demand function is fairly well understood. Demand tends to vary across the day and so our daily data analysis will be based initially on peak, off-peak and average prices for the day using the NEM definitions. As prices during these periods are not constant we will also consider finer sub-periods. Demand also varies across the week and according to the weather conditions. We model supply as a function of the infrastructure as unexpected infrastructure failures are critical to pricing spikes. The infrastructure variables of interest will tend to focus on the generators in place and the probability of unexpected infrastructure failure.

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