House Price Risk Models for Banking and Insurance Applications

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Introduction

• Research program at CEPAR
  – Risk modelling
  – Products
  – Policy and regulation
• House price risk (equity release products)
House Price Risk

- Banks, Insurers and Regulators
  - Private/institutional real estate investors
  - Providers of housing-related financial products
  - Regulator and risk based capital for lenders/insurers
House Price Risk

• Products and Product Risks
  – Mortgage loans and mortgage insurance
  – Equity release products/reverse mortgages
  – ABS and MBS
  – Property insurance

• Risk management solutions are limited
Reasons for our Study

• Need for better house price risk models
  – Limited detailed analysis of models for quantifying house price risk (publicly available)
  – Limited analysis of housing related financial products based on house price data other than at a market-wide level

• Industry collaboration with Residex
What do we do?

- House price risk and returns are studied based on a large micro-level data set (postcode level)
- Models of house price risk are compared that allow for temporal and cross-sectional risks, and risk factors
- Identify applications for pricing, risk management, and portfolio management of house price products and portfolios
Data

- House price indices for all Sydney postcode areas
- Risk factors
- Sydney market index
House Price Data

• “Non-Revisionary Repeat Sales Indices” provided by Residex
House Price Data

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td>0.73%</td>
<td>1.10%</td>
<td>151.04%</td>
</tr>
<tr>
<td>Quarterly</td>
<td>2.16%</td>
<td>2.42%</td>
<td>111.93%</td>
</tr>
<tr>
<td>Yearly</td>
<td>8.26%</td>
<td>7.21%</td>
<td>87.24%</td>
</tr>
</tbody>
</table>

- Model the growth rates of postcode-level house price indices
  - over time and over the cross-section:
    \[ growth_{it} = f(X_{it}, Y_t) + \varepsilon_{it} \]
Data on Risk Factors

• Macro / financial time series
• Postcode area characteristics
  – Geographic
  – Socio-demographic
Risk Models

- Multivariate time series models
- Panel data (cross sectional time series) models based on
  - House price market index
  - Macro / financial, seasonal, geog. variables
  - Socio-demog. and geog. postcode area characteristics
Multivariate Time Series Models

- Effectively capture observed autoregressive and moving average patterns
  - ARIMA(3,1,1) explains 73.4% of the variability in postcode-level house price growth rates
- **Applications:** Modelling the risk exposure of a house portfolio that is representative of the postcode, simulation using historical data
Panel Data Models: Market Index

\[ \text{growth}_{it} = \alpha + \beta_i \text{market\_growth}_t + \epsilon_{it} \]

- Postcode level “house price beta”
- Heterogeneity:
  - 42-45% of house price risk explained
- Summary statistics for \( \beta_i \)

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean*</th>
<th>Std. Dev.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>0.459</td>
<td>0.105</td>
</tr>
<tr>
<td>CBD</td>
<td>0.518</td>
<td>0.075</td>
</tr>
<tr>
<td>Harbor</td>
<td>0.532</td>
<td>0.060</td>
</tr>
<tr>
<td>Airport</td>
<td>0.511</td>
<td>0.070</td>
</tr>
<tr>
<td>Coast</td>
<td>0.491</td>
<td>0.084</td>
</tr>
</tbody>
</table>
Panel Data Models: Market Index

\[ \text{growth}_{it} = \alpha + \beta_i \text{market\_growth}_t + \varepsilon_{it} \]

- Applications:
  - Risk management: Indexed-based hedging
  - Portfolio management: $\beta_i$ as market betas
Panel Data Models: Macro / Financial, Seasonal, and Geog. Variables

• Impact of exogenous variables on house prices
  – Significant factors: GDP, unemployment rates, real interest rates and the ASX All Ordinaries Index (current and lagged)
  – Significant seasonal effects
  – Significant non-linear effect of distance to CBD
  – Models explain 20.8% - 48.8% of house price risk
Panel Data Models: Macro / Financial, Seasonal, and Geog. Variables

• Applications:
  – RM: Improve hedging
  – Pricing: Risk factor models for pricing
  – PM: Construct portfolios with diversification across asset classes
Panel Data Models: Socio-Demog. and Geog. Postcode Area Characteristics

- Impact of *postcode-level income, unemployment rates, median age, and household size* on house prices
  - Significant effects found for all four variables
  - Lagged variables control for endogeneity
  - Model explains 61.5% of house price risk

- **Applications**: Factor models for risk pricing
Summary and Conclusions

• This paper is one of the first to
  – assess a range of models (time series/panel data),
  – quantify risk both temporal and cross sectional, and
  – to do this at a postcode level for a major city

• Key result: Large proportion of house price risk is due to heterogeneity (not captured in market index models)
Summary and Conclusions

• Research has important applications in banking and insurance
  – Risk assessment and pricing of equity release products, mortgage loans, and mortgage insurance polices
  – Assessment of the basis risk of indexed-linked housing derivatives / home equity insurance

• Topics for current and future projects
Thank you very much!

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Full paper:
Australian School of Business Research Paper No. 2011ACTL11
Discussion Points

• Indexed-based hedging:
  – Product design
  – What type of index should be used?

• Reverse mortgages:
  – How do providers currently manage risks?
  – Which other risk management strategies should be considered?