Data Article

Discounting the distant future—Data on Australian discount rates estimated by a stochastic interest rate model

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Abstract
Data on certainty equivalent discount factors and discount rates for stochastic interest rates in Australia are provided in this paper. The data has been used for the analysis of investments into climate adaptation projects in ‘It’s not now or never: Implications of investment timing and risk aversion on climate adaptation to extreme events’ (Truong and Trück, 2016) [3] and can be used for other cost-benefit analysis studies in Australia. The data is of particular interest for the discounting of projects that create monetary costs and benefits in the distant future.

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Specifications Table

| Subject area                      | Economics                           |
|-----------------------------------|-------------------------------------|
| More specific subject area        | Cost-benefit analysis               |
| Type of data                      | Table, CSV file                     |
| How data was acquired             | Data is output of implemented model |
| Data format                       | Analysed                             |

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**Experimental factors**

Data was derived based on historical government bond yields and an estimated model for stochastic interest rates.

**Experimental features**

Data is used for discounting costs and benefits of investments into climate adaptation projects.

**Data source location**

Australia

**Data accessibility**

Data is available with this article.

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**Value of the data**

- The data is designed to evaluate projects with a very long lifetime.
- The data can be used for the analysis of investments into climate adaptation.
- The data is particularly useful for discounting costs and benefits occurring in the distant future.

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1. **Data**

The data contains certainty equivalent discount rates and discount factors for Australia, estimated based on the prominent Cox-Ingersoll-Ross model [1] of stochastic interest rates (Table 1). The provided rates can be used for discounting costs and benefits of investment projects with a lifetime of up to 200 years.

**Table 1**

Certainty equivalent discount rate (CE) and discount factor (F) estimated based on the applied CIR model. Discount rates and factors are provided for different initial interest rates, including \(r(0)=1\%\), \(r(0)=3\%\), \(r(0)=5\%\), \(r(0)=7\%\) and \(r(0)=9\%\).

| Time (years) | Initial interest rate \((r_0)\) | 1% | 3% | 5% | 7% | 9% |
|--------------|---------------------------------|----|----|----|----|----|
|              | CE    | F    | CE | F | CE | F | CE | F | CE | F | CE | F |
| 0            | 1.00% | 1.0000 | 3.00% | 1.0000 | 5.00% | 1.0000 | 7.00% | 1.0000 | 9.00% | 1.0000 |
| 1            | 2.39% | 0.9826 | 3.63% | 0.9671 | 4.86% | 0.9519 | 6.10% | 0.9369 | 7.33% | 0.9221 |
| 2            | 3.24% | 0.9550 | 3.99% | 0.9309 | 4.74% | 0.9073 | 5.49% | 0.8843 | 6.24% | 0.8620 |
| 3            | 3.74% | 0.9221 | 4.20% | 0.8935 | 4.65% | 0.8657 | 5.10% | 0.8388 | 5.56% | 0.8128 |
| 4            | 4.05% | 0.8867 | 4.32% | 0.8562 | 4.59% | 0.8266 | 4.87% | 0.7981 | 5.14% | 0.7706 |
| 5            | 4.23% | 0.8507 | 4.40% | 0.8196 | 4.56% | 0.7897 | 4.72% | 0.7608 | 4.88% | 0.7330 |
| 6            | 4.34% | 0.8150 | 4.44% | 0.7842 | 4.54% | 0.7546 | 4.63% | 0.7261 | 4.73% | 0.6987 |
| 7            | 4.41% | 0.7801 | 4.46% | 0.7500 | 4.52% | 0.7212 | 4.58% | 0.6934 | 4.64% | 0.6667 |
| 8            | 4.45% | 0.7463 | 4.48% | 0.7172 | 4.51% | 0.6893 | 4.55% | 0.6625 | 4.58% | 0.6367 |
| 9            | 4.47% | 0.7137 | 4.49% | 0.6858 | 4.51% | 0.6589 | 4.53% | 0.6331 | 4.55% | 0.6083 |
| 10           | 4.48% | 0.6825 | 4.49% | 0.6557 | 4.51% | 0.6299 | 4.52% | 0.6051 | 4.53% | 0.5813 |
| 20           | 4.50% | 0.4353 | 4.50% | 0.4180 | 4.50% | 0.4015 | 4.50% | 0.3856 | 4.50% | 0.3704 |
| 30           | 4.50% | 0.2775 | 4.50% | 0.2656 | 4.50% | 0.2560 | 4.50% | 0.2458 | 4.50% | 0.2361 |
| 40           | 4.50% | 0.1769 | 4.50% | 0.1699 | 4.50% | 0.1632 | 4.50% | 0.1567 | 4.50% | 0.1505 |
| 50           | 4.50% | 0.1128 | 4.50% | 0.1083 | 4.50% | 0.1040 | 4.50% | 0.0999 | 4.50% | 0.0960 |
| 60           | 4.50% | 0.0719 | 4.50% | 0.0690 | 4.50% | 0.0663 | 4.50% | 0.0637 | 4.50% | 0.0612 |
| 70           | 4.50% | 0.0458 | 4.50% | 0.0440 | 4.50% | 0.0423 | 4.50% | 0.0406 | 4.50% | 0.0390 |
| 80           | 4.50% | 0.0292 | 4.50% | 0.0281 | 4.50% | 0.0270 | 4.50% | 0.0259 | 4.50% | 0.0249 |
| 90           | 4.50% | 0.0186 | 4.50% | 0.0179 | 4.50% | 0.0172 | 4.50% | 0.0165 | 4.50% | 0.0158 |
| 100          | 4.50% | 0.0119 | 4.50% | 0.0114 | 4.50% | 0.0110 | 4.50% | 0.0105 | 4.50% | 0.0101 |
| 120          | 4.50% | 0.0048 | 4.50% | 0.0046 | 4.50% | 0.0045 | 4.50% | 0.0043 | 4.50% | 0.0041 |
| 150          | 4.50% | 0.0013 | 4.50% | 0.0012 | 4.50% | 0.0012 | 4.50% | 0.0011 | 4.50% | 0.0011 |
| 200          | 4.50% | 0.0001 | 4.50% | 0.0001 | 4.50% | 0.0001 | 4.50% | 0.0001 | 4.50% | 0.0001 |
2. Experimental design, materials and methods

The data provides certainty equivalent discount rates for Australia for different time horizons and various choices of initial risk-free interest rates at the time when the project is invested \((t=0)\). It can be used for discounting cash-flows, costs and benefits of investment projects with a duration between zero and 200 years. Therefore, the data is particularly useful for the evaluation of projects with a very long lifetime that are often characterized by a relatively high degree of uncertainty about interest and discount rates.

The discount rates and factors reported in this paper are derived based on an estimation of the Cox-Ingersoll-Ross (CIR) stochastic interest rate model \([1]\). The data can then be used to evaluate investment projects, even when their cash flows occur in the distant future.

In the CIR model, the dynamic process for the interest rate can be denoted by

\[
dr(t) = \kappa [\bar{r} - r(t)]dt + \sigma \sqrt{r(t)}dW(t),
\]

where \(r(t)\) is the real risk free rate, \(\bar{r}\) is the long run level of the risk free rate to which \(r(t)\) reverts, and \(\kappa\) is the rate of reversion of \(r(t)\). In this model, \(W(t)\) is a Wiener process and \(\sigma \sqrt{r(t)}\) denotes the so-called local volatility. We estimate a CIR model for Australia, using maximum likelihood estimation \([2]\). Data on the real risk free rate \(r(t)\) is obtained by subtracting the inflation rate (provided by the Australian Bureau of Statistics\(^1\)) from nominal yields of long term (10 years) government bonds (provided by the Reserve Bank of Australia\(^2\)). We use quarterly observations on risk free rates for the time period 1970–2010 to estimate the model. For Australia, the estimated parameters of model (1) for the considered sample period are \(\kappa = 0.47, \bar{r} = 0.047, \sigma = 0.152\).

Given the interest rate model (1), the discount factor for discounting monetary costs and benefits occurring at time \(t\) back to present values, i.e. to time \(t=0\), can be estimated as\(^3\):

\[
P(t) = \exp(-a(t) - b(t)r(0)),
\]

where

\[
a(t) = -\frac{2\sigma^2}{\kappa} \left[ \frac{(e^{\gamma t})^2 - 1}{e^{\gamma t}} + \ln \frac{2\gamma}{e^{\gamma t}} \right] \quad b(t) = \frac{2(e^{\gamma t} - 1)}{e^{\gamma t}} \quad c(t) = (\kappa + \gamma)(e^{\gamma t} - 1) + 2\gamma.
\]

The certainty equivalent discount rate is then estimated based on [7]'s definition:

\[
CE(t) = -\frac{dP(t)/dt}{P(t)}.
\]

Table 1 provides data on certainty equivalent discount rates and discount factors for Australia for time horizons between zero and 200 years and selected initial risk-free interest rates at time \(t=0\) between 1% and 9%. The data has been used for the analysis of investments into climate adaptation projects, see, e.g., [3], and can continue to be used for other CBA studies in Australia.

Transparency document. Supplementary material

Transparency data associated with this paper can be found in the online version at http://dx.doi.org/10.1016/j.dib.2016.12.026.

Appendix A. Supplementary material

Supplementary data associated with this paper can be found in the online version at http://dx.doi.org/10.1016/j.dib.2016.12.026.

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\(^1\) See, for example, www.abs.gov.au.

\(^2\) See, for example, www.rba.gov.au.

\(^3\) See, for example [2].
References

[1] J.C. Cox, J.E. Ingersoll, S.A. Ross, A theory of the term structure of interest rates, *Econometrica* 53 (1985) 385–407.

[2] S. Dyrting, Evaluating the noncentral Chi-square distribution for the Cox-Ingersoll-Ross process, *Comput. Econ.* 24 (2004) 35–50.

[3] C. Truong, S. Trück, It’s not now or never: implications of investment timing and risk aversion on climate adaptation to extreme events, *Eur. J. Oper. Res.* 253 (2016) 856–868.