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# **The Dual Function of Financial Market Instruments in an Environment of Climate Change Uncertainty:**

## **Protection and Speculation**

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# Background

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The author, in a number of papers, has explored the role of financial market instruments in the area of climate variability and change.

The current paper updates this previous work, taking advantage of the emergence in financial markets of very long term maturity (100-year) bonds.

# Introduction

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By way of introduction, a 17-Feb-2017 speech by the Australian Prudential Regulation Authority (APRA)'s Executive Member (Insurance), Geoff Summerhayes provides a very nice background to what follows.

Mr Summerhayes said, in part:

## Introduction (*cont.*)

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“While climate risks have been broadly recognised, they have often been seen as a future problem or a non-financial problem ... this is no longer the case.

Some climate risks are distinctly ‘financial’ in nature.

Many of these risks are foreseeable, material and actionable now”.

# Methodology

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The cost of protecting against, and speculating about, global climate change may be established by applying financial market mathematics to data associated with drivers of that change.

This approach is used to derive a risk management model that evaluates the cost of protection.

## Methodology (cont.)

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Data employed to develop the model include long-term time series of measures associated with such drivers.

The data are statistically analysed to establish their relative importance.

Not surprisingly, it is found that Atmospheric Carbon Dioxide is of profound importance, but that other drivers do have an influence.

## Methodology (*cont.*)

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The findings are then applied to derive the statistical distribution of possible future trends out to 2100 of the Global Mean Temperature, based upon a set of Monte-Carlo-generated scenarios.

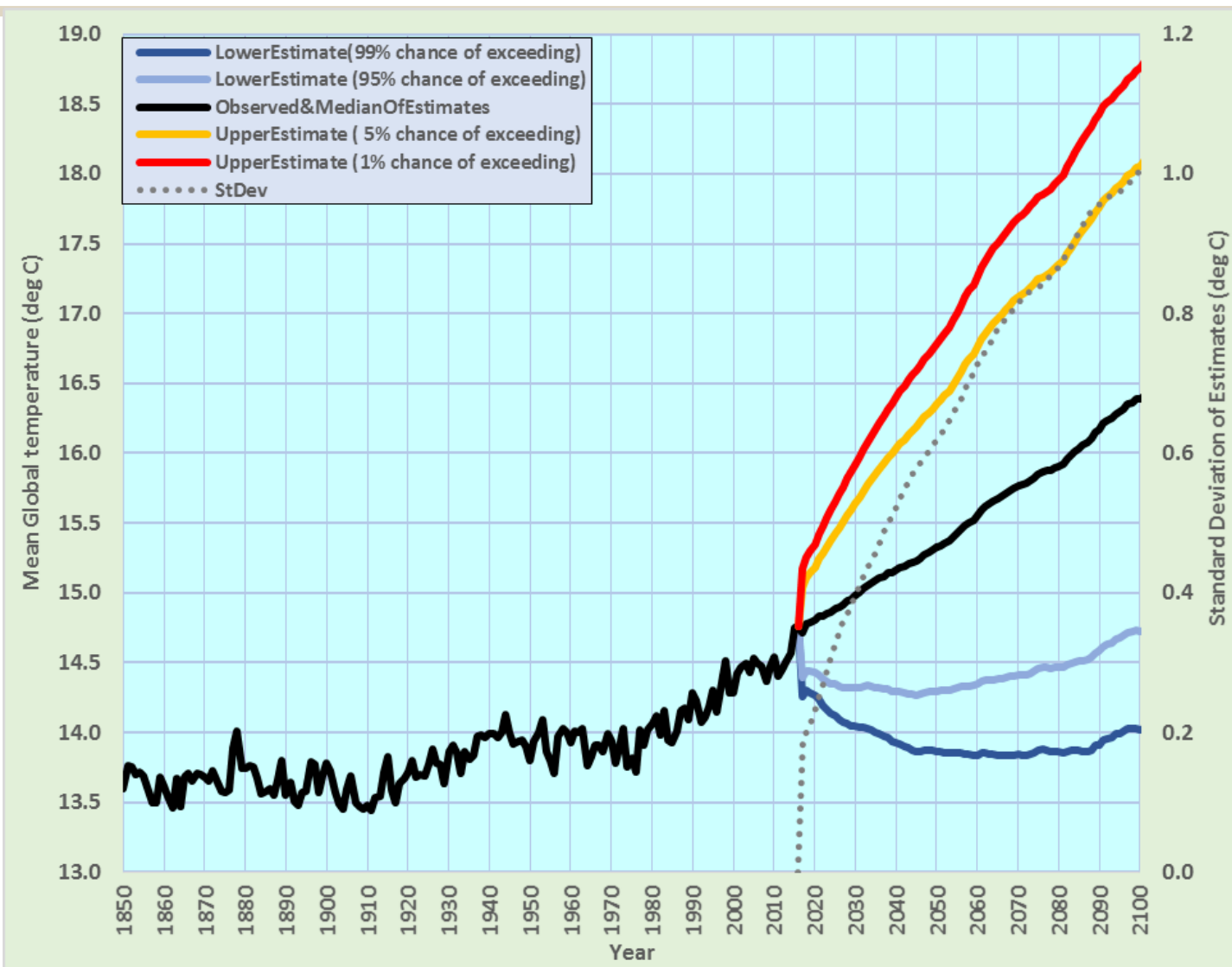
## Results

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These scenarios show that it is *very likely* for the Global Mean Temperature in 2030 to be higher than that in 2015, and *almost certain* to be higher than in 2015, soon thereafter.



# Results (cont.)



# Analysis

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The statistical distribution is then interrogated to provide estimates of what are the 'fair value' prices of put and call options on Global Mean Temperature futures contracts set to expire on Dec-31 in each year out to 2100.

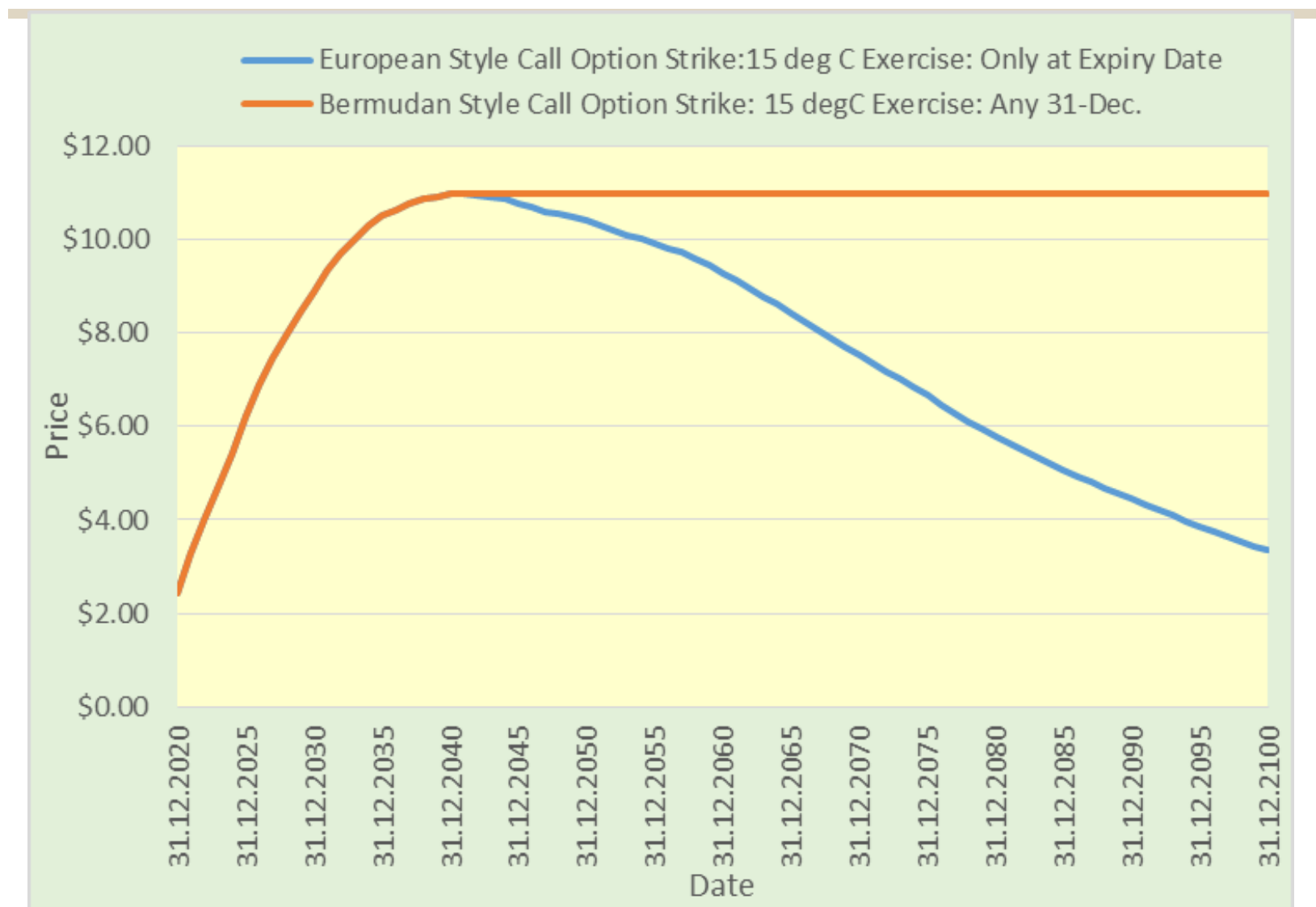
## Analysis (*cont.*)

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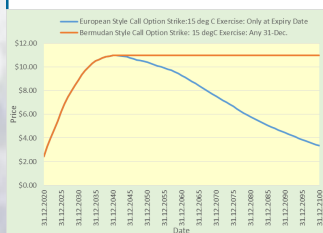
The options considered include:

- European style options (exercise only on expiry date); and,
- Bermudan style options (exercise on any Dec-31 prior to expiry date).

Fair value' premiums (costs) of a set of call options purchased on 31-Dec-2016 with a strike of 15°C and a premium (value) of \$100 per °C at expiry



# Illustrative Example (1)

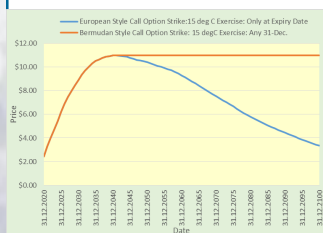


Example for European style call option purchased on 31-Dec-2016 with a strike of 15°C and a premium (value) of \$100 per °C at expiry date of 31-Dec-2100

The 'fair value' cost (premium) of purchasing the option on 31-Dec-2016 is \$3.50. Let us suppose that on 31-Dec-2100, the *Global Mean Temperature* is 18°C, that is, equal to the median of the estimates.

In *2100 dollars*, the option would be worth about \$300 on that date.

## Illustrative Example (2)

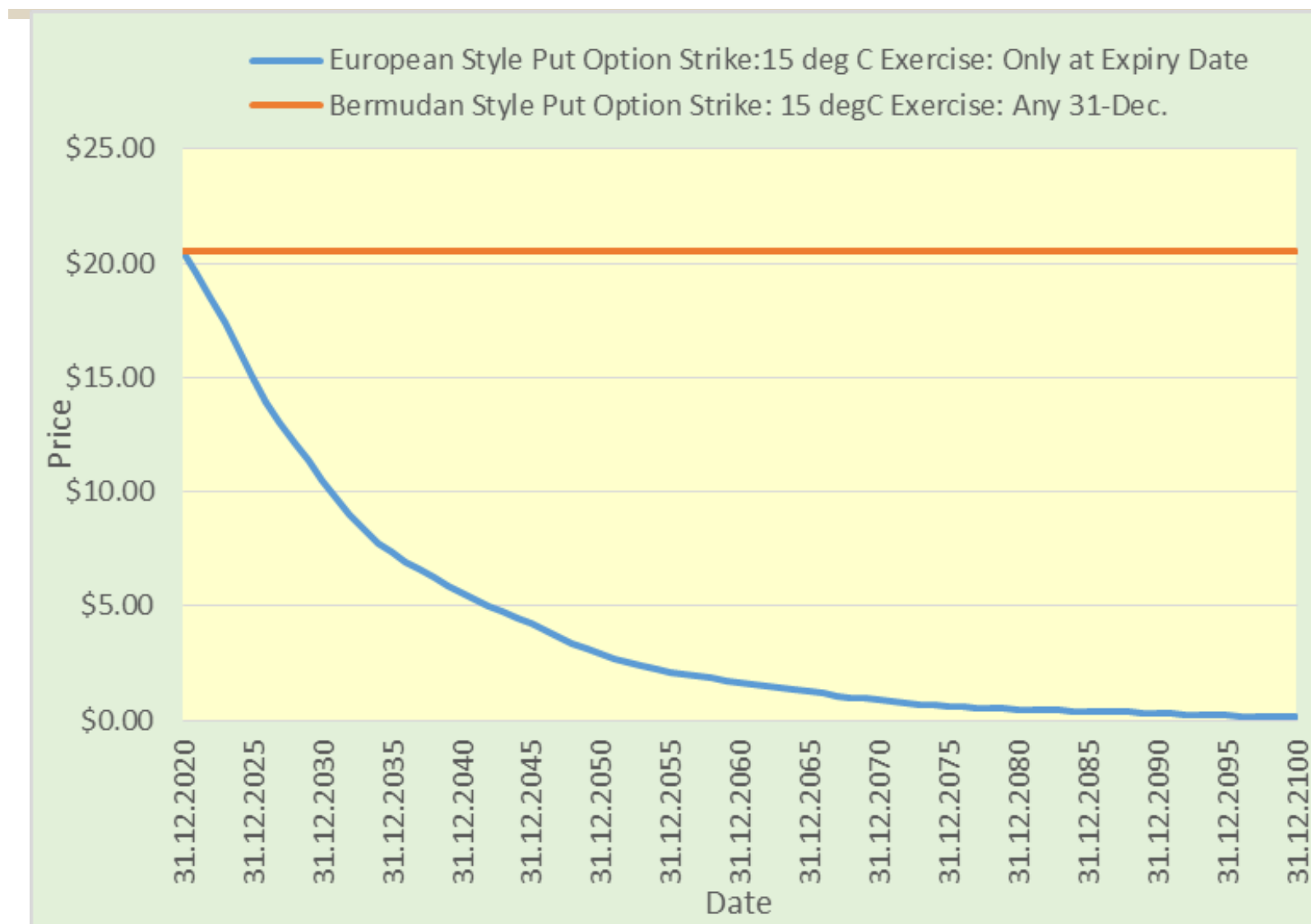


Example for European style call option sold on 31-Dec-2016 with a strike of 15°C and a premium (value) of \$100 per °C at expiry date of 31-Dec-2100

The 'fair value' premium of selling the option on 31-Dec-2016 is \$3.50. Let us now suppose that on 31-Dec-2100, the *Global Mean Temperature* is 15°C or less, that is, below the strike.

With the option now worthless, the seller would keep the premium, which, with the 84-year bond interest rate at 4.538%, would have grown to  $\$(1.04538^{84}) * 3.50$ , that is, \$146 in 2100 dollars, on that date.

'Fair value' premiums (costs) of a set of put options purchased on 31-Dec-2016 with a strike of 15°C and a premium (value) of \$100 per °C at expiry



# Concluding Remarks

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The paper shows how to evaluate the cost of hedging and speculative instruments related to climate change, such instruments providing the opportunity to:

- Protect against costs associated with possible future climate change scenarios.
- Place speculative 'bets' on one's views as to the likely future climate.



***Thank You ...***

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***Any Questions?***