

## The case for a climate futures market

Fully objective probabilistic predictions of climate change based on models and data are not possible, since our models have unquantified errors, which will (even if one takes an optimistic viewpoint) remain somewhat unquantifiable for the indefinite future. Nevertheless, we must make decisions and should do so based on our best (probabilistic) estimates of the future. How can we form these estimates? This poster presents one possibility, based on a futures market for the Earth's climate.

Weather futures are widely used for hedging in the energy markets, and can be shown to have skill at predicting temperature (and therefore energy consumption) at the monthly time scale [1]. However, this market only extends to the seasonal scale at longest. Agricultural commodity markets also relate to expectations of future weather, but are again too short-term to relate to anthropogenic climate change.

There are many reasons why a climate futures market could be useful. Firstly, it would enable us to find the real consensus view. Commentators who act in bad faith (either through exaggerating the chances of climate change, or understating it) might find the likelihood of financial loss would motivate more honesty. Interestingly, economist Julian Simon (of Simon/Ehrlich commodity prices bet fame [2,3]) thought that such a market "would thus no doubt often serve as a corrective to alarmist stories about impending doom" but I have found that climate change sceptics are remarkably reluctant to back their proclaimed beliefs by betting *against* significant climate change.

A climate futures market would enable those who feel vulnerable to climate change to hedge against their perceived risks - betting on sea level rise would have a very real relevance to Pacific Islanders.

The concept of an "Ideas Futures Market" is not new [4,5], but the inherent intractability of the climate prediction problem, together with the importance of the outcome, adds new impetus to the case for a climate futures market.

## How could it work?

The basic idea is very simple. For \$1, you can buy a pair of coupons from the bank, one of which is labelled "Yes, Claim X is true" and one of which is labelled "No, Claim X is false" (where Claim X is some statement about the future, such as "Global temperature will rise by 2C between 2000 and 2100"). These coupons can be bought and sold individually on the open market, and a pair can always be redeemed by or bought from the bank for \$1, so the prices of the individual coupons must add to \$1.

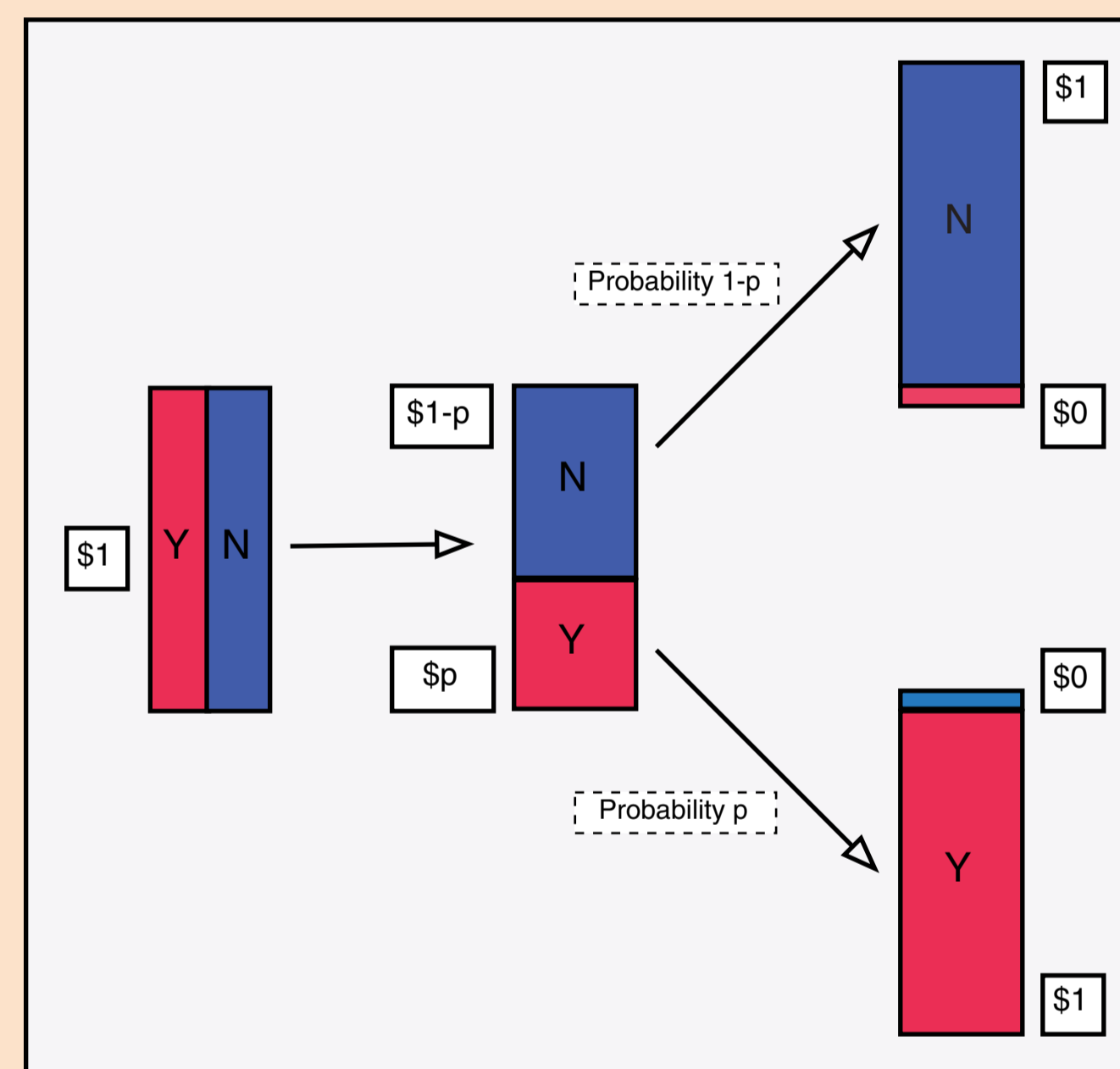


Figure 1: A Y/N pair of coupons is purchased for \$1. The price of individual coupons depends on the market's estimate of the probability of the claim coming true. The true coupon is redeemed for \$1.

Assuming rational players, the price of the "Yes" coupon reflects the market's estimate of the probability of the claim coming true. Once the claim is decided one way or the other, the coupon which is correct is redeemed by the bank for \$1 and the other coupon becomes worthless. Full probability distributions could be generated by a set of claims which sample the range of outcomes. More complex derivatives could also be developed to enhance the returns (and risks).

## Some possible criticisms

It is possible that some rich vested interests would try to distort the market, by backing the "no worries" side of the argument in order to justify that no action was needed. However, this would be a very direct "polluter pays" levy which would transfer wealth to their victims.

Waiting 100 years to get your \$1 back is clearly a non-starter, as it would be virtually worthless by then. Obviously, the money either has to be promised (with the risk of the losers defaulting), or if paid up-front, would have to be invested in a sensible place. That is no problem in principle, the pair of coupons could be worth say one unit in an index-linked investment, or a unit trust, or one share in a blue-chip company.

The climate futures are not just a matter of pure geophysics, but also depend on human behaviour. Still, it is the actual climate (and dependent variables such as food supply) which impact on our lives, rather than the rather theoretical construct of "climate sensitivity".

## A case study - the Foresight Exchange Prediction Market

The Foresight Exchange Prediction Market [6] is an internet-based game which enables players to bet on future events. The "money" is imaginary, due to licensing/legal issues surrounding gambling. Claims can be proposed by any player, and the game provides a marketplace to match willing buyers and sellers. When the due date of a particular claim is reached, the holders of "Yes" coupons receive \$1 for each coupon if the claim is judged true, and \$0 if it judged false (holders of "No" coupons get the opposite payout). There are also scaled claims, where the payout depends on the value of some variable on the due date.

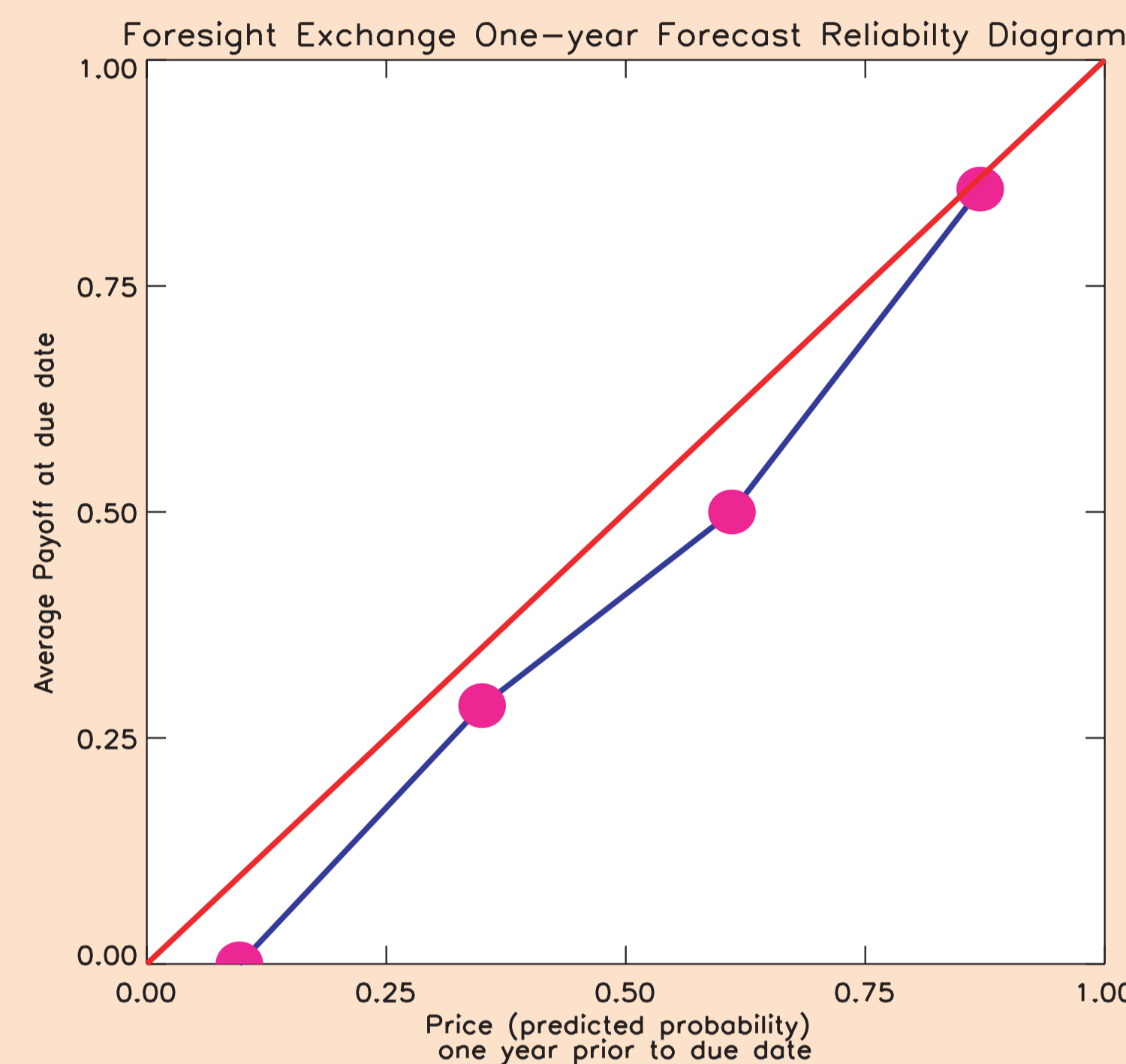


Figure 2: The reliability diagram of one-year forecast skill shows that the market is meaningful.

A minimum requirement for the market predictions to be useful is that the prices should relate to the probability of claims eventually coming true. We can test this by forming a "reliability diagram" which compares the observed frequency of payoffs versus the forecast probability, where the data are binned into discrete intervals. I analysed the price and payoff of all 63 claims which were due by 01/01/2000 and which were alive for at least one year prior to their due dates. Aggregating the claims by their price at due date minus one year, the reliability diagram in Figure 2 is formed.

There is certainly a strong relationship between price and payoff, but also a serious bias for the lower-priced claims. This analysis suggests that a winning strategy would be to buy "No" coupons in all low- to mid-priced short duration claims, absent any inside information on their likely outcomes. It is not possible to judge the skill of the market in any fully objective sense, since there is no prior or climatological background - some claims may have some near-analogues from which to judge probabilities ("Big earthquake in USA prior to 2010"), but many have not ("Cold fusion proved true"). A real money market could of course be expected to do much better, as there would be serious money to be made and lost.

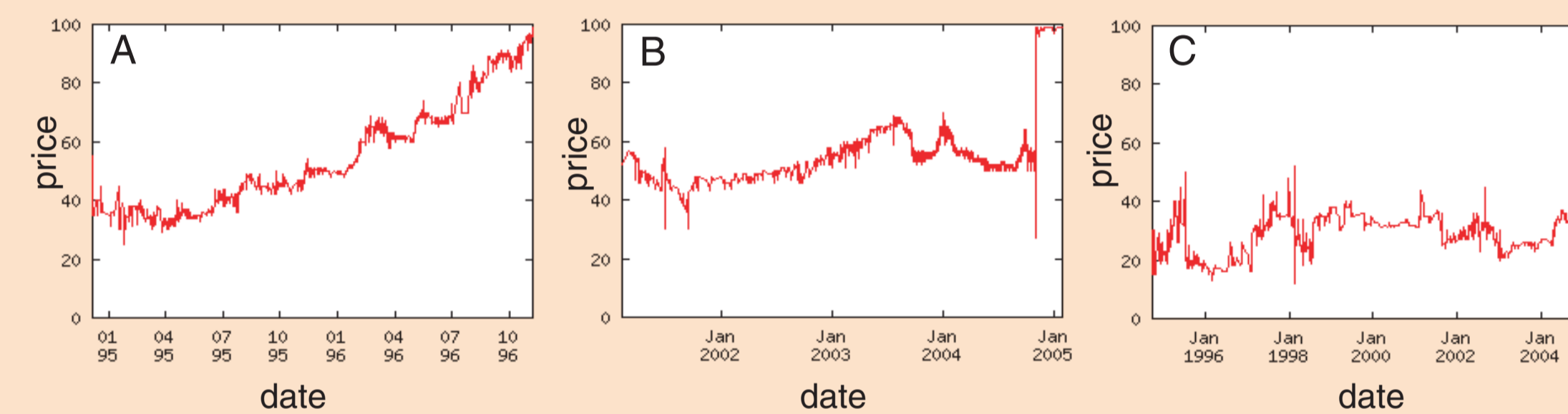


Figure 3:  
A: Some claims are easily predictable well before the event; Bill Clinton re-elected in 1996.  
B: Others are highly uncertain; George Bush re-elected in 2004.  
C: How likely is a sea level rise of 1m by 2030?

This market already trades on some environmental issues:

CO2 level in 2030 - current market prediction is 468ppm ~ >3ppm per year from now on

Sea level rise of 1m by 2030 - current market estimation is 20% chance of this happening!

Global Temperature rise from 2000 to 2030 (5 year centered averages) - current estimate 0.6C

I think all of these are unreasonably alarmist (especially the sea level rise) and have bought "No" coupons.

What do YOU think?

## References, related articles and websites:

- <http://www.cme.com/files/EPSept03.pdf>  
"Using weather futures as weather forecasts", Vishu Kulkarni, 2003. Published by Chicago Mercantile Exchange  
[http://www.artemis.bm/html/weather/about\\_weather/utilities.htm](http://www.artemis.bm/html/weather/about_weather/utilities.htm)  
Information on weather derivatives etc.
- <http://www.dynamist.com/taie/bibliographyArticles/tierneybet.html>  
The story of the bet between economist Julian Simon and Paul Ehrlich ("The Population Bomb"). Specifically, Simon bet in 1980 that commodity prices would drop over the coming decade, and Ehrlich that they would rise. Simon won.  
<http://www.simonmarket.org/>  
Not yet operational, but Tom Bell is hoping to set up a real ideas market in honour of Julian Simon.  
<http://hanson.gmu.edu/press/natureNov02.pdf>  
Wanna Bet by Jim Giles - Nature article concerning the Simon Market etc
- <http://www.forestry.auburn.edu/sfmc/web/bet.html>  
However, Simon lost a second bet on pine saw-timber prices.  
<http://www.longbets.org/>  
Bets with real money, but the proceeds go to the charity of the winner's choice (the betting/licensing issue again). Money is invested in a long-term investment portfolio, so the payoff will be worthwhile.
- <http://hanson.gmu.edu/ideafutures.html>  
Idea Futures by Robin Hanson - some pioneering work on Idea Futures, including [5].  
<http://www.hedgestreet.com/>  
A real money market along the principles of the Ideas Futures, but only working with short-term (mostly economic) claims and with no adjustment for inflation/discount rate.
- <http://hanson.gmu.edu/policyanalysismarket.html>  
The Policy Analysis Market ("Terrorism Futures"), cancelled in a media frenzy - not because it wouldn't have worked, but because it was politically incorrect.  
<http://www.ideosphere.com/fx/>  
Foresight Exchange Market