Using an Evolutionary Agent-Based Simulation to Explore Hedging Pressure in Futures Markets

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ABSTRACT

We have developed a real world application that models a financial futures market. The agent-based simulation includes speculator agents each of which uses a Genetic Algorithm (GA) to improve its profitability in the market. This is a realistic simulation whose rates-of-return distribution is similar to those of real futures markets such as corn.

Categories and Subject Descriptors

I.2.M [**Artificial Intelligence**]: Miscellaneous

General Terms

Algorithms, Experimentation

Keywords

Genetic Algorithms, Finance, Agents, Adaptation

1. INTRODUCTION

The price of a futures contract is rarely equal to the theoretical expected future spot price as given by the cost-of-carry model. Prices can vary either side of this theoretically correct price according to current market sentiment; these variations are known as "risk premia". There is no consensus on the precise composition of these premia, but previous work [1] has analysed historical data and found that systematic risk and hedging pressure (that is, an excess of supply or demand caused by "hedgers" — underlying producers and consumers) seem to play a part.

The simulation contains agents representing hedgers and speculators and tries to evolve accurate pricing rules — that is, pricing rules that can take account of any risk premia present in prices — using a GA.

2. THE SIMULATION

The simulated (generic) futures market contains agents representing both hedgers and speculators, as well as "noise" agents that represent traders with no firm strategy and that help to provide liquidity.

Each speculator agent forms price predictions by using a set of rules, each of which matches a market condition to a set of four weights to combine four pricing models (technical and cost-of-carry, with and without hedging pressure adjustment). Also associated with each rule is a measure of the accuracy (fitness) of that rule, tracking whether the rule has historically made accurate price predictions.

A GA is used by the speculators to try to improve their rules over time by discarding unfit rules and generating replacements from combinations and mutations of accurate ones. Agents make price predictions by taking a weighted average of the prices predicted by their four models. The evolutionary process will favour models that produce accurate predictions at the expense of less accurate ones, so it would be expected that any more accurate model would, over time, emerge with a higher-than-average weight.

The simulation produces a returns distribution similar to real futures markets, and exhibits clear signs of price pressure caused by hedgers. However, examination of the price predictions made by various pricing models in the simulation shows that the models that account for hedging pressure are consistently given *less* weight than their counterparts that make no attempt to account for hedging pressure — i.e. the models that try to account for hedging pressure are no more accurate than the models that do not.

3. SUMMARY AND CONCLUSION

Our evolutionary agent-based simulation of a futures market introduces the possibility of feedback between competing agents. The futures market produced by the simulation is significantly more realistic than previous work, produces a returns distribution similar to real futures markets, and provides a good base for further work in that area.

Our simulation exhibits signs of hedging pressure, as predicted by analysis of historical price data. However, the evolutionary framework has demonstrated that when many competing agents make trades based on price predictions that take account of hedging pressure, any possible benefit disappears.

The ability to see feedback between evolutionary agents goes beyond any analysis that could be performed using historical data. We conclude that hedging pressure does exist, but in a competitive environment trying to take account of it is unlikely to be worth the effort.

4. REFERENCES

[1] H. Bessembinder. Systematic risk, hedging pressure, and risk premiums in futures markets. *Review of Financial Studies*, 5:637–667, 1992.

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