

Richard Olsen

The fallacy of the invisible hand

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Since the inception of classical economics over 200 years ago, one of the most sacred assumptions has been the hypothesis that an invisible hand determines market prices and that market prices follow a random walk. Today, there exists significant statistical evidence that this is not the case and we need to acknowledge that financial markets are, indeed, predictable. How is this possible?

Two centuries ago, economics was concerned with more than just economic matters. The economists at the time had a broad perspective and the political environment played an important role in the formulation of their theories. In particular, they were fascinated by the growth potential of industrialisation. They realised that the principle of division of labour would allow for increased specialisation and economies of scale in production. By fostering increased specialisation, they theorised it would be possible to increase economic production and save mankind from its squalor and destitution.

For Adam Smith and his followers, it was clear that division of labour would only develop within the context of a free market economy with competitive prices. At the time, governments had firm control of market pricing. Smith believed that to unleash the forces of the market and foster competition, it would be necessary to free markets from this control.

The 'invisible hand'

Early economists used their theories to argue their policy recommendations, which in turn influenced the very way their theories developed. Under no circumstances did they want to develop a theory of the advantages of the market economy that could be attacked as being unfair, i.e. inequitable to society. Thus was born the concept of the 'invisible hand'.

They argued that an efficient market has such a large volume that any one participant has a negligible impact on the market as a whole. Because any one participant is so small (relatively speaking) and insignificant, it was

¹ The collected works of Olsen and Associates will be published by Academic Press in 2001 under the title *High Frequency Finance*. This comprehensive overview of predictive technology describes the characteristic statistical properties of financial markets, and shows how predictive models can be built.

concluded that everyone behaves in the same way. Economists thus postulated that man behaves like a ‘homo oeconomicus’ who is rational and maximises his utility. From this they inferred that everyone reacts in the same way to market events and that market reactions to outside events are thus homogeneous, with no secondary reactions. Because news events are themselves random and unpredictable, it follows that the market movements are also random and thus unpredictable.

Their argument continued by stating that the overall allocation of resources by financial markets is efficient, because all market participants maximise their utility and this in turn is reflected in the relative pricing of assets and their allocation.

Classical economists thus had good arguments why the governments should free financial markets from their control and how this would raise economic welfare. But all of us remember, I’m sure, how hard it was for us to come to terms with the inference that human beings behave in a consistently rational and homogeneous way. It just sounded strange. Actual life appeared very different with irrational behaviour being common place.

Evidence of heterogeneous agents

If we analyse the reasoning of classical economists, the inference that everyone reacts in the same way is based on the assumption that every market participant has such a small relative impact that his or her specific features are insignificant. From this they concluded that it is fair to assume that every market participant behaves in the same way. This is, however, a fallacy – if market participants share certain characteristic properties, then groups of market participants can be identified. These groups have distinctive properties and together may have a substantial impact on the overall market.

Modern predictive theory states that market participants share two key properties: their degree of risk aversion and the time horizon of their trades. In this context, the trading horizon is the most important. For every time horizon there is a group of traders that share the same time perspective. The traders with a time horizon of one or more days follow market events on a daily basis through the daily newspaper or the evening news.

But they have little or no knowledge of the detailed sequence of events that occurs intra-day. Thus they have a very different perspective of market events and behave differently from an intra-day trader, who has watched the details

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of the events unfolding and maximises his or her trading decisions relative to the intra-day time horizon.

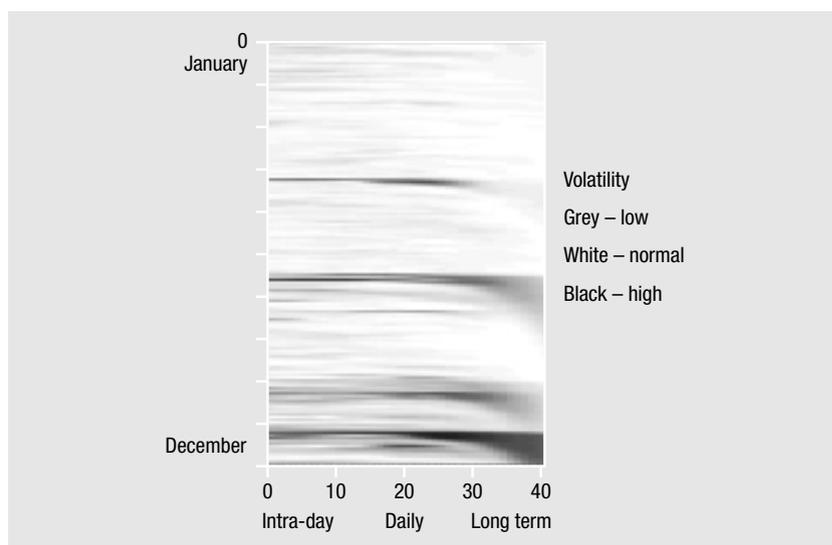
One of the generalised autoregressive conditional heteroscedasticity (GARCH) models that are often adopted to model stochastic volatility² has the specific purpose of proving the existence of market heterogeneity. The HARCH model incorporates a heterogeneity assumption into its mathematical formulation. Overall market volatility is a summation of market components, each focusing on a specific time interval from short to long term. HARCH has been successful in reproducing the key properties of volatility, i.e. the extremely long memory of volatility and the lead-lag correlation of long and short-term volatility.³ A price shock that lasts only twenty minutes has, for a brief period of time, a very strong impact on market volatility. Then over a much longer period (typically up to six weeks) it has a very weak, but persistent market impact. This behaviour of dampening price shocks, but then a long persistence of weak after shocks, is a characteristic feature of heterogeneous market behaviour.

² Engle, R.F., 1982, 'Autoregressive conditional heteroskedasticity with estimates of the variance of UK inflation', *Econometrica*, 50, 987–1008; and Bollerslev, T., 1986, 'Generalized autoregressive conditional heteroskedasticity', *Journal of Econometrics*, 31, 307–327.

³ Müller, U.A., Dacorogna, M.M., Davé, R.D., Olsen, R.B., Pictet, O.V. and von Weizsäcker, J.E., 1997, 'Volatilities of different time resolutions – analyzing the dynamics of market components', *Journal of Empirical Finance*, 4 (2–3), 213–239.

Figure 14 illustrates heterogeneous perceptions of market risk, as measured by the volatility of returns, by different types of traders: by intra-day traders who follow every price move on a second by second level and by longer-term traders that watch the markets at daily or even longer intervals, oblivious of what is happening at an intra-day level.

Figure 14
USD/JPY Volatility Map for 1998



Here we can see how market participants observe different levels of market volatility depending on the frequency with which they follow the markets. The graph shows, from top to bottom, how market participants have viewed the market starting in January at the top to December at the bottom. On the left-hand side of the graph, the market volatility as observed by short-term traders, such as market makers, is displayed. In the middle, we plot the market volatility observed by participants watching markets at a daily frequency and finally on the right-hand side of the graph, we display the volatility observed by long-term traders. Dark grey indicates that market participants are observing a high level of volatility, white means average volatility and light grey indicates low levels of volatility.

The variety in shading along a horizontal section indicates that market participants may have very different perceptions of market risk. The higher concentration of dark grey areas towards the right-hand side shows that long-term traders often perceive a higher volatility than do short-term traders. However there are some periods when all agents have similar views about risk. During the latter months that are depicted near the bottom of the graph the behaviour of all traders would be based on expectations of a highly volatile market. So, contrary to the assumption of classical economics that stipulated homogeneous market behaviour, this analysis suggests heterogeneous market behaviour, with a complex sequence of reaction patterns as the market absorbs new events.

The visible hand

Models that analyse market data and identify the reaction patterns of heterogeneous groups of market participants that trade at different horizons may be used to generate forecasts of prices and volatility. These forecasting models employ large amounts of data; in fact it is necessary to have access to high-frequency, tick-by-tick market data; to analyse the markets and calibrate the forecasting models. Their computational capabilities are comparable to weather forecasting models that also process huge amounts of information.

Sophisticated mathematical tools are employed to identify the behaviour pattern of the market components and analyse their reaction patterns. One of the key elements of these forecasting models is the concept of ‘intrinsic time’, that is, time is rescaled according to the impact of events on market volatility.

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With intrinsic time, periods of high volatility are expanded and thus are more important than periods of low volatility, which are compressed.^{4,5}

Based on this analysis, it is then possible to make probabilistic price forecasts that are comparable with the output of a radar screen in an airplane. How the forecasts are then utilised depends on the specific profile of the trader, i.e. whether he or she is he a long- or short-term trader, whether he has a long or short position in the market, and so on. Just as the radar systems in aeroplanes are universal tools that every large aeroplane uses, the predictive services are universal tools that every trader and market participant will use for his own proprietary purpose. Each market participant interprets the forecasts in his own way, depending on his specific frame of reference, including time scale and risk preference.

Heterogeneous market trading models have been developed that give definite trading recommendations for specific risk profiles. The trading models described by Pictet *et al*⁶ achieve a performance of 2–4% on exposed capital, which is equivalent of an excess return of 2–4% above the risk-free interest rate on an unleveraged basis.

So, although classical economics firmly believed in an invisible hand, the theory and evidence on heterogeneous markets shows that price movements can be predicted with some degree of accuracy. Thus the invisible is visible using modern technology.

Perpetuum Mobile?

Agents in financial markets are not playing a zero-sum game. So can the theory of predictive markets give rise to a kind of *perpetuum mobile*, where it is possible to extract infinite profit? This is definitely not the case. Financial markets are an integral part of the overall economy and generate profits to the extent that the financial markets add value to the overall economy. The markets are linked with the real economy, and they create real value. The question arises: is there an *a priori* limitation to the amount of value they could generate for the economy as a whole?

At this stage, we cannot quantify the added value. We are still at the start of the development of predictive models and, as was the case with the computer industry in the early 1960s, it is extremely hard to quantify the maximum added value that can be attained with future development. Suffice it to say

⁴ Müller, U.A., Dacorogna, M.M., Davé, R.D., Pictet, O.V., Olsen, R.B., and Ward, J.R., 1993, 'Fractals and intrinsic time – a challenge to econometricians.' Invited presentation at the XXXIXth International AEA Conference on Real Time Econometrics, 14–15 October 1993 in Luxembourg, and the 4th International PASE Workshop, 22–26 November 1993 in Ascona (Switzerland); also in *Erfolgreiche Zinsprognose* (ed.) B.Lütjhe, Verband öffentlicher Banken, Bonn, 1994, ISBN 3-927466-20-4; UAM.1993-08-16, Olsen & Associates, Seefeldstrasse 233, 8008 Zurich, Switzerland.

⁵ Ghysels, E., and Jasiak, J., 1995, 'Stochastic volatility and time deformation: an application of trading volume and leverage effects' *Proceedings of the HFDF-I conference*, Zurich, Switzerland, 29–31 March, 1995, 1, 1–14.

⁶ Pictet, O.V., Dacorogna, M.M., Müller, U.A., Olsen, R.B. and Ward J.R., 1992, 'Real-time trading models for foreign exchange rates', *Neural Network World*, 2(6), 713–744

that we have seen the very tip of the iceberg in terms of what can be achieved with predictive technologies.

Predictive technology is as complex, or even more so, than computer technology. Accordingly, large amounts of resources will be invested to refine these technologies, which will accordingly improve the quality of the models. At this stage, we cannot ascertain whether there is an upper limit. Based on our research experience at O&A, we believe the potential is largely untapped and huge advances lie ahead. Thanks to predictive technology, it is possible to trade at lower risk. This, in turn, increases the trading frequency and amount of money allocated to financial market trading and investing. To this extent, predictive technology enhances the efficiency of financial markets and generates additional wealth.

Future developments in predictive technology

Predictive technology gives rise to a broad range of new products. First of all, it is possible to generate continuously updated online market forecasts for price levels, market volatility and correlation. These forecasting services can be developed for virtually any financial instrument from foreign exchange, stock, commodity to fixed income markets. They will be disseminated in graphical format over the Internet. They will cover a broad time horizon, from minutes to several months. Depending on the user profile, different time horizons will be utilised.

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As part of predictive services, it will also be possible to develop an ‘early warning system’ for the financial markets. The system will screen all financial markets and, using complex modelling, analyse the likelihood of potential crises. The early warning system will be utilised by risk managers around the world as an input into their risk management systems.

Predictive technologies will also give rise to a broad range of new investment products that will be managed using these technologies. Today, there is a growing number of investment managers that use quantitative methods to manage assets. We anticipate that there will be strong growth in managers using quantitative tools, i.e. predictive technologies to manage funds. The managers using predictive services can be expected to attain higher performance on a risk-adjusted basis than traditional methods of managing assets. And predictive technology can be used for market-making purposes because it enables market makers to post bid and ask prices at lower risk than would otherwise be possible without such tools.

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Predictive technologies are in their infancy. Due to the categorical statement of classical economics that an invisible hand dictates market prices, economists and financial engineers have failed to develop the sophisticated technology necessary for these technologies. Only a few companies worldwide even invest in collecting high-frequency market data, but without these data it is impossible to develop predictive models that analyse the actions of the market participants and ascertain their overall market impact. We anticipate that this will change rapidly.

One major contributor will be the Internet, which will automatically propel the interest in predictive technologies because the number of traders trading online is increasing dramatically. The appetite for online research of these market participants is huge. Predictive technologies are ideally suited for this demand because, unlike written research commentaries, which are out of date as soon as they are published, online predictive services are continuously updated.

In the coming years, we foresee explosive growth in these technologies, which will transform financial markets as new products and services become available. Potentially, predictive technologies could have as strong an impact on changing the economy as the Internet itself. At this stage, this still appears to be an outrageous claim. But in the coming years we believe it will be borne out.