

We have problems

Twenty-three issues for investment managers to solve

The supply of problems in mathematics is inexhaustible, the mathematician David Hilbert noted a century ago.

JON GLASS presents a random present-day list worthy of attention in the investment industry.



Jon Glass is senior adviser, AMP Henderson Global Investors. This paper was originally delivered as a talk at an AIC conference in Sydney in February 2000. The author thanks his colleagues David Gentle, Bronwyn Melville and Tim Svenson of AMP Asset Management for their help.

In 1900, in Paris, before the International Congress of Mathematicians, the eminent German mathematician David Hilbert delivered a talk titled “Mathematical Problems”. In that talk, and subsequent published piece, Hilbert outlined 23 “particular definite problems” that mathematicians could work on.

His aim was clearly to inspire research in mathematics; Hilbert was broad enough in his own research interests to be able to comment on most mathematical disciplines, at a time before the demon of specialisation reduced practitioners to a narrow focus.

This paper invokes the spirit of David Hilbert on the 100th anniversary of his talk and presents my own list of particular definite problems that quantitatively minded people with an interest in investment management may choose to tackle and solve.

When I was an undergraduate, my mathematics professor told me that the question of who was the greatest mathematician of the first half of this

century remained an open race between David Hilbert and Elie Cartan. Hilbert probably won that race. In any case, he formulated his 23 problems from the panoramic heights of his command of the subject. I do not claim the same comprehensive scope.

To quote David Hilbert:

“Permit me in the following, tentatively as it were, to mention particular definite problems, drawn from various branches of mathematics, from the discussion of which an advancement of science may be expected.”

1 MEAN VARIANCE ANALYSIS

Mean variance analysis, following Markowitz, is well suited to traditional listed assets such as shares and bonds. However, once unlisted, appraisal-based assets are included (such as venture capital) they present problems because they lack daily pricing. This makes the calculation of standard deviations and correlations difficult, so that integration of these assets into a standard portfolio optimisation becomes quite onerous.

Investors tend to allocate a proportion of the total, say 5% or 10%, to these assets but this is not based on scientific principles. The challenge: to find some analytic framework that can deal with listed and unlisted assets together.

2 ASSET/LIABILITY MODELLING

The central problem faced by a pension or superannuation fund is: will the assets deliver to the liabilities over time?

This problem is normally solved by the creation of a strategic asset allocation or benchmark that, it is hoped, will deliver the desired returns subject to investment

For a pension plan, how many managers is enough? At what point does sensible diversification of risk lead to its opposite, the risk of diversification?

manager performance.

It all boils down to the performance of asset markets relative to inflation (price inflation for accumulation or defined-contribution schemes, wage inflation for defined-benefit schemes). As is in the nature of these things, these relationships are dependent on the time-frame and the specific time in history under consideration. Can there be quantitative techniques that help to further explain the nature of these relationships?

3 THE ILLIQUIDITY PREMIUM AND THE EQUITY RISK PREMIUM

Standard theories of portfolio management say that both illiquid assets and equities command a premium relative to “safe” assets for reasons of illiquidity and volatility, respectively.

These statements sound closer to moral theory than investment theory in that they are couched in language that makes it seem politically correct to receive these premiums. But what is lacking is any complete quantitative explanation.

In the case of the equity risk premium,

Richard Thaler and Shlomo Benartzi (1995) have used prospect theory to justify an equity risk premium of 6.5% pa because investors examine their equity portfolios too often; if only they exhibited stoic disinterest, the premium would diminish.

There remains the challenge to develop a framework for measuring the illiquidity premium and the equity risk premium, so as to continue work already done.

4 HEDGE RATIO

Any investor with an allocation to overseas assets faces a primary consideration: to hedge or not to hedge. In many cases, no decision is made and, as a result, a hedge ratio of zero appears.

Where the investor seeks to manage currency risk actively, then the choice of hedge ratio cannot be evaded. Of course, no hedge ratio can be perfect for all periods into the future. The next stage would be the development of further quantitative tools to dictate the timetable for review of the hedge ratio.

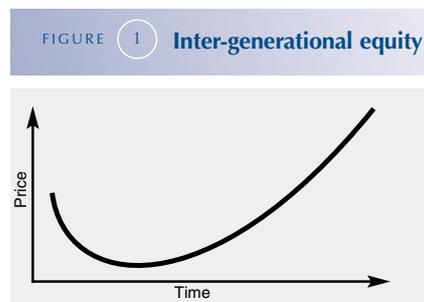
5 UTILITY

Utility functions are critical to an understanding of investor preferences, yet they are rarely deployed in practice. This may have come about through an absence of answers to key questions such as:

- How can utility change over time?
- How is it affected by age and recent asset history?

6 INTER-GENERATIONAL EQUITY

Wherever assets follow a J-curve (such as private capital), reflecting the start-up nature of the investment, a stylised output occurs such as this:



There follows a trade-off between the trough and peak of the J-curve. Long-term gain trades off with short-term loss. An investor in a pool who withdraws in the J-curve

trough may feel that he or she is leaving money on the table “for others to enjoy”. How can the trustees of the pooled arrangement show that justice has been done?

There should be a quantitative measure of that trade-off.

7 BEHAVIOURAL FINANCE

Over recent years there has been a proliferation of academic interest in behavioural finance that has spilled over into conferences and journal debates.

Quite simply, we need a meeting of minds between practitioners of behavioural finance and traditional investment theorists with a quantitative bent, in order to import insights from behavioural finance into the practical realm.

8 PORTFOLIO CONSTRUCTION

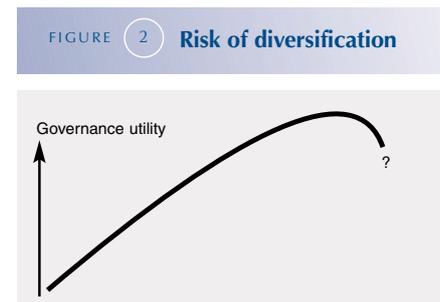
In my experience, equity managers pride themselves on the time that they spend analysing companies, their finances and prospects.

Then, having ranked stocks from best to worst, they spend much less time on portfolio construction. How much value add can come from portfolio construction? Can there be improved quantitative methods for portfolio construction?

9 THE RISK OF DIVERSIFICATION

For a pension plan, how many managers is enough? At what point does sensible diversification of risk lead to its opposite, the risk of diversification?

If “governance utility” represents the value that trustees generate in manager choice, in the broadest sense and not limited to the economic, does this utility follow the pattern illustrated in Figure 2?



Theory tells us that a stock portfolio gains all the benefits of diversification at 30 stocks. Of course, pension plans can have very complex groupings of managers but is there a turning point in the graph above that can be worked out analytically?

10 LEPTOKURTOSIS

Normal distributions fit well into textbooks but many asset markets have fat-tailed distributions. In Jorion's (1999) analysis of the woes of a certain hedge fund, under an assumption of normality disaster would have struck once in every 800 trillion years. However, a fat-tail assumption shortens the odds somewhat, to one in every eight years. Quantitative practitioners need to alert us all to these fat tails.

11 PREDICTABILITY

TABLE 1 Manager performance

Calendar year	Quartile
1990	1
1991	4
1992	1
1993	4
1994	1

Table 1 shows five years of manager performance history in a public survey. It is very confusing.

Can quantitative methods help us to sort out the difference between volatility attached to good performance and volatility that is a precursor to bad performance?

12 INVESTMENT PROCESSES

In problem 8 portfolio construction was discussed. An investment process contains many subjective factors, such as quality of personnel, modes of research, how information and ideas are disseminated, etc. Can quantitative methods help to organise and interpret these factors?

13 ARTIFICIAL INTELLIGENCE

Investment processes can be vague even to the people who run them. Artificial intelligence methods can lay bare human decision-making; for example, it has succeeded in medical diagnostics in this way. It should be applied to each and every investment process to help clients and

investment professionals to understand these processes better.

Of course, it may take time before Hilbert's comments come to pass:

"A mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first man whom you meet on the street."

14 SKILL OR LUCK

Folklore has it that it takes 165 years of data to decide whether an investment manager has achieved results through skill or luck. That is a long time. Quants should be able to run simulations in order to shorten this to a reasonable time-span, that is to say, the time over which an investor can observe a manager in action.

retail ones, need quantitative guidance that will explain style performance and underperformance and the factors that cause it.

18 ETHICAL INVESTING

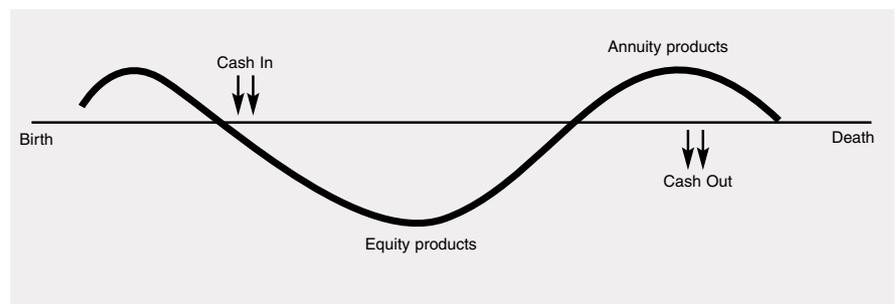
Ethical investing is an intrinsically subjective discipline. This should not inhibit people from trying to introduce quantitative insights, despite the obvious difficulty of gaining purchase at this stage.

As a first step, it would be useful to have the ability to attribute an "alpha" to those subjective aspects of an ethical portfolio that are not part of the usual economic dynamics of markets.

19 TAX

Pre-tax investment returns do not exist. Post-tax is all that matters. Investors want to

FIGURE 3 Lifetime investment



15 BIRTH, LIFE, DEATH

Figure 3 represents an investment product suitable for a whole-of-life investor. Investment managers should think through the structure of such products and bring them to market. They need to be flexible and accurate, which will depend on sophisticated modelling.

16 NEW INVESTMENT PRODUCTS

Where there is a paucity of data and no benchmark, a manager will struggle to sell any product. A recent example is the global small company discipline. Investment managers should devise simulation techniques to help investor understanding.

17 STYLE ANALYSIS

Value versus growth, large capitalisation versus small — these weighty matters of portfolio construction consume a large amount of professional discourse. Investors, particularly

maximise post-tax returns. Investment professionals must spend more time modelling the effects of tax and developing algorithms to aid portfolio construction.

20 INVESTMENT ADVICE

Investment advice has these 2 components:

- Fiduciary/advisory. This is often a "committee" action that involves terms such as comfort, authority, leadership etc.
- Analytic. This is the work done to analyse markets and managers.

This second component of advice should be amenable to quantitative description and hence pricing.

21 THE NEW PARADIGM AND SECURITY VALUATIONS

Textbooks teach stock valuation methods such as the dividend discount model.

continued on page 40

communicating with shareholders and investors. **The new economy: mirage or miracle?**, by Frank Cicutto, Winter. The widespread use of computing and telecommunications technology will bring benefits to businesses able to adapt to the "new economy".

The stockmarket magic of dotcom, by Adam Steen and Keith Turpie, Spring. A study of a decade of IPO performance has a sobering message for those riding the boom in Internet stocks.

VALUATION TECHNIQUES

Hypergrowth: a never-ending guessing game?, by Mike Beaver, Autumn. The gravity-defying success of Internet stocks in the US is reflected, although more modestly, in Australia. But both markets seem to lack a clear understanding of how much risk attaches to all that growth.

Does the future matter?, by James Dick, Winter. The world of investment echoes with warnings against using past performance to predict future returns. The author turns the scenario around and shows that you should not rely too much on future performance to explain a company's NPV.

Digging for dross?, by R.J. McDonald, Spring. The mining industry has given investors poor returns for the past quarter-century. Market forces will not allow this to continue: the industry must lift its game or watch share prices fall to levels reflecting real financial performance.

VENTURE CAPITAL

Venturing into a new era (editorial), Spring.

How to win venture capital funding, by Nicholas Humphrey, Spring. Venture capital is relatively scarce and competition for it is intense. An overview of the venture capital process from the standpoints of the entrepreneur and the investor.

Capital misadventure, by Brendan Shaw,

Spring. Issues in the development of the Australian venture capital industry, with a focus on the need for collaboration by investors to spread risks, skills and opportunities.

AUTHOR INDEX

Alty, Lloyd (with Andy Yang), Fair exchange, Autumn.

Beaver, Mike, Hypergrowth: a never-ending guessing game, Autumn.

Canil, Jean (with Bruce Rosser), How much to hedge – who knows?, Spring.

Carew, Edna, Whose guess is as good as mine?, Autumn; Roslyn Allen: the gift of leadership, Spring; Managing very nicely, Summer.

Chambers, Stephen, Small (and computerised) is beautiful (book review), Autumn.

Cicutto, Frank, The New Economy: mirage or miracle?, Winter.

Deegan, Craig, The triple bottom line, Spring.

Dick, James, Does the future matter?, Winter.

Donald, Scott, Digital déj@ vu, Winter.

Drew, Michael (with James Noland), EMH is alive and well, Summer.

Elimelakh, Simon (with Richard Keary), Defying market gravity, Winter.

Fitzherbert, Richard, Inefficient markets and irrational investors, Autumn.

Frino, Alex (with David Gallagher), The problems of being passive, Winter.

Glass, Jon, We have problems, Summer.

Gallagher, David, Do active funds deliver?, Autumn, The problems of being passive (with Alex Frino), Winter; Index: boring or bountiful? (with Elvis Jarnecic), Summer.

Hall, Leigh, Globalisation – our unstoppable destiny, Autumn.

Headland, Mark, Emission possible: the greenhouse market, Spring.

Heyworth, Amanda, Stand by for an e-mortgage boom, Winter.

Humphrey, Nicholas, Worth the risk, Spring.

Hurburgh, David, The Web: where financial information belongs, Winter.

Hutson, Elaine, Our iron takeover law, Winter.

Jarnecic, Elvis (with David Gallagher), Index: boring or bountiful?, Summer.

Keary, Richard (with Simon Elimelakh), Defying market gravity, Winter.

Kennedy, Rosie, Getting into debt, Summer.

Khoupongsoy, Katrina (with Andy Yang), Getting what you want, Summer.

Le Couteur, Penny, This uncertain world (editorial), Autumn; Challenging year takes shape, Autumn; E-commerce and acts of faith (editorial), Winter; Board stalwarts step down (Spring).

Loneragan, Wayne (with Donald Stokes and Peter Wells), Giving substance to intangibles, Summer.

McDonald, R.J., Digging for dross?, Spring.

Macfarlane, Ian, The art of riding a cycle, Autumn.

Malkin, Geoffrey, Income securities: storm turns to fair weather, Summer.

Noland, James (with Michael Drew), EMH is alive and well, Summer.

Ramsay, Ian, States, commonwealth put on the gloves, Spring.

Rosser, Bruce (with Jean Canil), How much to hedge – who knows?, Spring.

Shaw, Brendan, Capital misadventure, Spring.

Steen, Adam (with Keith Turpie), The stockmarket magic of dotcom, Spring.

Stokes, Donald (with Wayne Loneragan and Peter Wells), Giving substance to intangibles, Summer.

Teh, Jason, Great expectations, Summer.

Turnbull, Shann, Ethics under the carpet, Autumn.

Turpie, Keith (with Adam Steen), The stockmarket magic of dotcom, Spring.

Wells, Peter (with Wayne Loneragan and Donald Stokes), Giving substance to intangibles, Summer.

Yang, Andy (with Lloyd Alty), Fair exchange, Autumn; Getting what you want (with Katrina Khoupongsoy), Summer. J

continued from page 25

These methods appear all at sea with new technology and internet stocks. This may explain some of the exuberant pricing seen there. We need new quantitative valuation methods to help investors and managers with these stocks.

continued on page 40

22 ACADEMICS AND PRACTITIONERS

Academics have gained many insights. Practitioners are aware of this. Sometimes academics enshroud their papers with complex symbolism. The two groups need to cooperate further in order to develop common insights.

23 TRANSACTION COSTS

We live in a period of high nominal returns from assets and this tends to mask the impact of transaction costs. One day these nominal returns will reduce so that transaction costs (including market

FIGURE 4 Don't forget the costs

$$\text{Portfolio performance} = \text{Index performance} + \text{Gross outperformance of stocks} - \text{Transaction costs}$$

impact costs) will become an important factor. There should be portfolio attribution that looks like Figure 4 (in a stylised sense).

In conclusion, more of David Hilbert's words:

"We know that every age has its own problems, which the following age either solves or casts aside as profitless and replaces by new ones."

REFERENCES

Hilbert, David, 1900, "Gottinger Nachrichten", translated in American Mathematical Society *Bulletin*, 1902, Vol. 8, pp. 437-79.

Thaler, Richard, and Shlomo Bernartzi, 1995, "Myopic Loss Aversion and the Equity Premium Puzzle", *Quarterly Journal of Economics*, pp. 73-92.

Jorion, Philippe, 1999, in *Risk*, September, pp. 31-6. J