Actuarial Economics

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Abstract

Over the last 30 years, three parallel developments have taken place: changes in the traditional role of the actuary, the advance of computer technology, and new insights from economic analysis. Each of these provides opportunities for positive developments in actuarial education. While recent changes in the training of actuaries in the period since the 1990s has recognised the importance of the concepts underlying financial economics for mainstream actuarial coursework, there is potential for far more curriculum innovation. In this paper we argue that key insights in economics, particularly labour economics and public and macroeconomics, have made these branches of economics at least as valuable to a practising actuary as financial economics, and should be included in the actuarial curriculum. The 2005 syllabus of the Institute and Faculty of Actuaries is recognition that the development of computer technology and actuarial systems has reached a point where detailed mathematical practice currently emphasised in actuarial training might be replaced with greater exposure to conceptual issues. We believe the economic analysis outlined here is a crucial part of preparing actuaries to handle broad issues relating to long-run planning and risk.

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1 Introduction
The fundamental role of the actuary is to help organisations plan for the future and manage risk using technical models. It follows that as technology and the institutional environment evolve, so will the role of the actuary. At least three sets of developments over the past two decades have impacted on the work an actuary does and might be expected to do. First, computer and information technology has developed to a point where stochastic analysis and mathematical calculation is, in many cases, no longer a matter of actuarial judgement. Second, financial markets – especially through the application of securitisation – have the potential to put market prices on contingencies for which markets did not exist. And third, economic analysis has made huge strides in providing useful frameworks for thinking about and analysing problems involving uncertainty and information asymmetry, as well as pricing risk. This paper argues that these circumstances call for a re-assessment of the content of traditional actuarial training to include elements of advanced economic analysis to capture an understanding of these advances, and the way they may help actuaries in their core role.

The traditional approach to actuarial science (Laurie Dennett, 2004) (James Hickman, 2004) was set out well before the development of modern economic equilibrium theory and finance theory from the flurry of postwar work of (Gerard Debreu, 1959), (William Sharpe, 1964), (Kenneth Arrow, 1970) and many others. From the development in particular of modern financial theory in the 1950s, actuarial practice and economic approaches to valuation grew apart. Economists focused very little attention on the traditional domain of actuarial valuations: pensions and life insurance. And actuaries paid little heed to the developments in economics.

There were clear reasons for this. At the time actuaries worked in arenas without well-functioning markets. Pension liabilities were not traded nor were with profits liabilities. In such an economic environment it made perfect sense to focus efforts on the quality of projections, rather than try to impute market prices in an environment in which there was no anticipation markets would come to exist. There was also considerable scope for discretion and flexibility historically in many pension and life
insurance designs so therefore less need for detailed economic and financial modelling.

There have however been significant changes. Although markets do not exist for many pension and insurance liabilities, there are parts of these liabilities which are now explicitly tradable. The pricing of these liabilities that are tradable is not well handled by traditional actuarial approaches.

Furthermore, over the past twenty years, liabilities have become more mature and there have been a dramatic decrease in the degree to which actuaries can exercise discretion and flexibility. Both the level of exposure to risk and the decline in flexibility over adjustment to the structure of benefits has led those responsible for pension and insurance liabilities to focus much more on risk.

At the same time, it has become clear that corporations and other organisations have broader needs in planning for the future and managing the associated risks than covered by the traditional pensions and insurance areas of the actuarial profession. And in addition to clear business needs, the aging of the population has focused much more public policy interest on the long-run topics on which actuaries specialise and this also places a broader call on actuarial skills.

Hence, for all these reasons, it has become imperative for actuaries to take a broader economic approach. And over the last 30 years, economics as a discipline had developed to a point where there are a wide range of economic contributions relevant for the core actuarial areas of pensions and life insurance.

At the same time, the contribution that economics may make is limited in ways that are often not sufficiently acknowledged in the more recent actuarial discussions of financial economics. Economists have in the past done relatively little work in arenas which interact with the core actuarial disciplines of pensions and life insurance.

We believe that these considerations mean while economics has an important role in actuarial education, it is not sufficient to apply traditional economic methods to actuarial problems. Actuarial approaches developed for good reason in the absence of markets just as economic approaches developed for very good reason to make sense of markets. It is important therefore to blend the two sciences together into the approach of actuarial economics.
This paper defines the realm of actuarial economics and presents a framework by which the strengths of actuarial science and economics can be combined to cast light on key problems in the planning and management of risks, particularly long-run risks. In many respects, our approach mirrors that of (Frederick Menzler, 1951) who makes a strong case for actuaries functioning in wider fields; we differ in our emphasis on economics and indeed at the time of Menzler’s contributions, economics had yet to undergo the renaissance it experienced after the 1950s. (Laurie Dennett, 2004) outlines other contributions by a committee chaired by Sir Ernst Lever in 1946 which called for more economics in the actuarial curriculum.

The Institute and Faculty of Actuaries Planning Joint Committee concluded in 1991 that the mission of the profession was: “To develop the role and enhance the reputation in providing expert and relevant solutions to financial and business problems, especially those involving uncertain events” (Faculty and Institute of Actuaries Planning Joint Committee, 1991). We do not believe it is possible to accomplish this mission without actuaries developing detailed facility in actuarial economics.

The next section defines actuarial economics and discusses why it is necessary for both actuaries and economists. Section 3 discusses required skills and subdisciplines of actuarial economics, most particularly: labour economics, public/macroeconomics and financial economics. Section 4 presents some application areas. Section 5 then proceeds to certain examples. A final section concludes.

2 Actuarial Economics Defined

Actuarial economics might be defined as the economics of long term planning and evaluation of risks. These are arenas in which much is unknown, and where the actuary, with skills in long term projections, has traditionally held sway. But developments in economic theory and applications mean that this kind of work can be carried out with greater precision and insight by taking account of what economics has to say.

Critical economic analysis is the idea that individuals are rational, and optimize their own welfare over time. Equally, firms behave to try to maximise profits over time. These agents are sensitive to changes on the constraints they face, from both
underlying market conditions and policy, and will modify their choices accordingly. They will operate through the mediation of the market where that is possible, and provided that market structures are competitive, the resulting equilibrium allocation will be efficient.

Market efficiency requires that information is common between the contracting parties, that property rights are well defined, and governance has to be adequately structured. Economy-wide allocative efficiency additionally requires complete markets. Of course, it is in the long term that these assumptions break down.

To take a prime application of actuarial economics, retirement incomes, it is easily observed that these conditions are not always met. Annuities provide a famous example of market failure. Because information is asymmetric between buyer and seller, some potential annuitants are unable to purchase annuities at prices that make the purchase worthwhile for them, and must therefore forgo longevity insurance.

But much research by the most recent generation of economists has focused on the implications of relaxing these assumptions. For example, (William Sharpe, 1976) looks at defined benefit pensions in the context of Modigliani-Miller theorem of corporate finance. (Fisher Black, 1980) looks at the optimal asset allocation of a pension fund. (Scott F. Richard, 1975) looks optimal asset allocation with life insurance. Key contributions summarised by (Edward Lazear, 1995) look at optimal benefit and compensation structures in the presence of imperfect information. (Laffont 1989) summarises a broad literature on economics of uncertainty and information which has included key insights into risk allocation and incentive design. These contributions were little noticed in the actuarial literature before the intervention of (Smith, 1996) and (Jon Exley et al., 1997); most have still not been recognised. Hardy (2003) points out that the reluctance of the profession to embrace the Black-Scholes option-pricing theory in the 1970s has meant that actuaries have been marginalised in their participation in the derivatives revolution.

The components of actuarial economics thus comprise, at least, labour economics (which includes the economics of retirement); public economics and macroeconomics (which covers the equilibrium behaviour and responses in the long term, and the economics of public regulation, taxes and social security, and debt; and the economics of information and uncertainty (especially, though not exclusively, in its application
to financial economics). Other possible relevant fields would be Industrial Organisation (especially in oligopolistic insurance markets); development economics; and international trade and finance.

Of the three key areas of application (labour economics, public and macroeconomics, and financial economics, only financial economics has played a prominent role in the actuarial discussion of economics to date. We believe labour economics and public/macroeconomics are just as if not more important for actuaries to master. In addition, we believe the discussion even of financial economics in the actuarial profession to be overly narrow. Actuarial economics covers both decision-making of individual agents and equilibrium outcomes in the market. Much of the application of financial economics in the actuarial profession has focused solely on decision-making and optimality, omitting consideration of crucial notions of equilibrium.

**Labour economics** is the study of human capital and the factors affecting its supply and demand. From the standpoint of both the household which supplies labour, and the firm which demands it, there is much uncertainty and a lack of mediating markets. Information asymmetry is frequently present in these contracts. Pensions, savings and insurance are all areas importantly influenced by human capital. Labour economics looks in detail at incentives and how these affect behaviour. For example, labour economics makes predictions about how individuals respond to employee benefit design, including early retirement incentives, and how these may be deployed to help overcome the information asymmetries inherent in labour contracts.

**Public finance and macroeconomics** analyse the impact of policy and the evolution of markets. Macroeconomics examines topics such as how exchange rates and average wage levels move over time. Public economics focuses on financing public spending and the distortions induced by financing mechanisms such as income taxes. The impact of taxation, in both its economic and legal dimensions, should concern the practising actuary. It has major implications for asset allocation, implicit risk-sharing with government, policy sustainability, and expected long-run returns to investments.

**Financial economics** studies how markets price cashflows and the effect of different corporate structures of corporate finance. Financial economics does not have any definitive conclusions about asset allocation or funding but it instead provides a framework within which tradeoffs can be examined.
In addition to the above three fields, each central to Actuarial Economics, there are other branches of economics which may be relevant. Industrial Organisation can provide insights into the behaviour of rivals in a market where there are a small number of agents. An understanding of at least the major principles of Development Economics seems to be a reasonable requirement for actuaries working in developing economics on policy issues; and as globalization of financial markets accelerates, an appreciation of the economics of international trade and finance will be increasingly vital for actuaries working with internationally traded securities.

In all these areas there have been significant economic contributions relevant for the realm of the professional actuary. Many of these contributions remain imperfect - data could be better and the theory is in need of more development. Actuaries can participate actively in bringing these areas forward but at the same time need to first familiarise themselves with the foundations on which future developments must build. Actuarial economics itself is not a new term but it is also not in common use. Several US universities such as the University of Colorado have courses in actuarial economics. These focus solely on the economics of risk and insurance, whereas the definition of actuarial economics we develop here is broader, focusing on all the aspects of economics and finance which impact on long-term planning and management of risk.

3 Economics for Actuaries
In each of the next sub-sections, we outline the relevant topics from economics for actuarial economics, indicating how economic analysis can be applied to actuarial problems and vice versa.

3.1 Labour Economics
Labour economics is about how employees and employers respond to wages, benefits, other aspects of reward and economic conditions in general (Ronald Ehrenberg and Robert S. Smith, 1997). On the supply side of the labour market, individuals make decisions about participation in the market and how much labour to supply. These decisions depend critically on their wages and external market opportunities.

As part of helping organisations plan for the future, it is critical for actuaries to understand how individuals respond to a variety of types of incentives. Even a
decision as simple as the decision to remain in work near retirement or retire early is quite complex and relies on preferences, taxes and even other aspects of household labour supply. (Olivia Mitchell and Gary Fields, 1982) analyses this decision in a purely static framework and this was later extended to a dynamic option-theoretic approach by Wise. There is a myriad of empirical work on these subjects which can help actuaries in their task of helping organisations model decrements, assess the effect of changes in parameters as well as assess for organisations how markets are likely to evolve going forward. At the same time, economists often oversimplify their models of the structure of benefits and decrements that actuaries have become quite expert at.

Indeed, the ageing of the population in Europe and elsewhere will inevitably have significant effects on labour markets and wages. In Europe the working population will be declining in some cases significantly and this will pose issues for companies and organisations. These considerations are incorporated in labour economics models and the fact that actuarial models typically ignore market considerations places limitations on the actuarial profession’s ability to work in many areas of its core discipline of long term planning.

New questions such as determining the long-term prognosis of the supply of labour of a given type in a specific region would be viewed as outside the scope of actuarial science even though it is exactly the sort of long-term planning problem which actuaries should be expert at. Individuals make all sorts of decisions, including how much to invest in their own human capital and how hard to work in a job or even to move between region, which are a result of their calculation about tradeoffs. Economic approaches and the underlying empirical evidence are critical to apply in actuarial models. Because of a lack of general framework, actuarial practice is limited in large part to pensions and insurance and even there, there is a lack of flexibility to deal with new problems which arise in a broad conceptual manner.

On the demand side of the market, labour economics deals with issues such as how employers set pay and benefits and design contracts (Edward Lazear, 1998). It covers topics such as whether pay should be variable or straight and whether there should be profit sharing. It discusses issues such as seniority-based incentives, promotions, forced early retirement, job evaluation and job design. It also considers issues such as the tradeoff between cash wages and benefits such as pensions and how individuals
respond to different pension designs. The theory and the underlying empirical work should be an important part of the actuarial toolkit. It is indeed quite unfortunate that pay and benefits are all too often set in conjunction with actuarial firms with reference to market benchmarks instead of combined with the fundamental underlying economics, thereby potentially creating market imperfections.

The theory and underlying empirical work are not something which can be covered on the side by actuaries in their spare time in the job; labour economics in its own right is a significant academic and empirical discipline with a vast literature. It is a critical part of helping organisations plan for the future and manage their risks, and in an informed approach to human resource management. Yet very few actuaries know much about this material.

3.2 Public Finance and Macroeconomics

Public finance and macroeconomics have traditionally been treated as separate fields in the Economics lexicon, but have in recent years being moving closer together. Public Finance, or Public Economics, focuses on the role of government in a market economy. In the present context, this is important in at least two broad ways.

First, taxes affect individual decision-making, including their saving and investment decisions, and their labour supply decisions. Equivalently, the decisions of firms are influenced by the tax environment that they face. Income taxes are thought to discourage saving and distort capital asset allocation – the non-taxed status of owner-occupier housing, relative to most other assets, constitutes a famous example.

Taxes also influence choices concerning risk. At the simplest level, if risk premia are taxed and corresponding losses are deductible, governments can be seen as risk sharers. More complex analyses in the impact of taxes on risk and insurance against risk have also been analysed in the public finance literature, and the resulting market equilibrium outcomes worked through. Rather than see this simply as a valuation issue, economics views this as organic to the behaviour of capital markets. Assessments of capital market adjustments following regulatory change are informed by this kind of analysis.

Second, public economics also focuses on what happens when the traditional pillars of a well functioning market – well defined property rights, good and common information, sensible governance – break down. This link occurs because when
markets fail badly, the question arises as to whether the public sector should step in with a publicly provided substitute. Information asymmetry dogs insurance markets, for example, leading to equilibrium outcomes which can be inefficient in the long term, or even, in the worst case, lead to the collapse of the market altogether. Private markets for insurance against mental health disorders, or unemployment, may constitute examples of the latter. Increasingly in many countries, longevity risk products such as whole of life annuities can only be purchased at heavy premiums which have all but eliminated the market. In other cases, markets may fail because property rights are not well defined.

Finally, government intervention may itself constrain market development. In the context of pensions and insurance, this frequently occurs in developing economies, where insurance markets often enjoy heavy protection from foreign competition, curtailing innovation and learning-by-doing which more developed international firms would bring to the domestic marketplace.

Understanding why markets for certain kinds of securities do not exist will help in actuarial valuation, since valuation itself must be undertaken predominantly where a traded product is not available to be priced by the market. Understanding why the security is not traded will alert the practitioner to aspects of the valuation he may not have paid attention to in a more pragmatic approach.

In recent years, macroeconomics has moved away from its traditional focus in the development of relationships between economic aggregates, to what amounts to an economy-wide, dynamic equilibrium approach. State-of-the-art models of this kind are frequently overlapping generations (OLG) models (Peter Diamond 1965) (Maurice Allias 1947). An OLG model is an inter-temporal general equilibrium model with an overlapping generation structure. It focuses on inter-generation redistribution and provides insights into the long term macroeconomic and efficiency impacts of alternative policy reforms. Accordingly, the model provides an effective means for analyzing how tax and transfer policies affect the distributions of consumption and welfare for different cohorts at a particular period of time and a particular cohort in different periods of time.

In such models, households choose their consumption of goods over their lifetimes and, implicitly, their savings and wealth profiles given the prices and policy settings
they face. They make these choices to maximize expected lifetime welfare. Markets for various goods, capital and labour clear to determine market prices. Markets in different time periods are related through the dynamics of the saving and investment decisions. The model thus encompasses the interactions between markets at any one period of time (atemporal general equilibrium) and the interactions between markets over time (intertemporal general equilibrium). Insights into the impacts of demographic change, and of the interactions between demographic change and policy settings of various kinds, can be readily generated with macro-models of this type. It is these general equilibrium and inter-temporal interactions that are important in understanding the implications of ageing and of economic and retirement policies.

3.3 **Financial Economics**

The core areas of financial economics are valuation, portfolio choice, corporate finance and equilibrium analysis. The most basic theories of financial economics assume complete markets, perfect information and perfect governance and these break down most significantly in the long term context in which actuaries operate.

There have been important developments in the literature in the past twenty years on what happens when the most basic assumptions break down but these unfortunately are typically not the focus of actuarial applications of financial economics. The financial economics of imperfect markets is becoming increasingly well developed but is unfortunately isolated from actuarial applications. Actuarial applications in some cases are on the evangelical and without empirical content, whereas the majority of the financial economics literature has at least some empirical focus.

There is a growing empirical behavioural finance literature which reviews some empirical regularities in how economic agents make decisions. At the same time, for portfolio allocation, there is an important literature on background risk and how individuals respond in cases where there is unhedgeable risk such as from labour income. This can alter decisions significantly and is part of a broad literature on the economics of risk and uncertainty which has blossomed in recent years (Christian Gollier 2001). In the case of corporate finance, a broad literature focuses on the effects of imperfect governance and decision-making. In the case of valuation, a literature has developed looking at what are appropriate arbitrage free bounds in incomplete markets. When there are market imperfections, price (or cost) and value
are not equivalent as claimed for instance in some actuarial papers (Tim Gordon and Stuart Jarvis, 2003).

Equilibrium in financial markets is also a broad focus of financial economics, with much effort having gone into testing theories such as the arbitrage pricing theory and looking at whether realised equity premia are consistent with the more basic theories.

Financial economics is a necessary part of economics toolkit actuaries need to cope with long-term planning and risk problems. There are in particular very interesting problems relating to realistic capital for life insurers and market consistent models for pension funds. While undoubtedly important, it is by no means the main branch of economics of relevance for actuaries. We have also noted above concern that the focus in the actuarial profession has been dogmatic and narrow instead of conceptual and broad.

3.4 Other Economics Disciplines

Other areas of economics are also relevant to some actuaries. Development Economics, the field of economics focusing on how countries become richer over time, may be relevant in two ways. First, from a life insurance and pension viewpoint, a majority of the world’s old live in such countries – 40% of the world’s old live in India and China alone - and as these countries strive to join the developed world, financial infrastructure will be just as important and capital infrastructure. Indeed, the two are complementary – without good insurance, capital development is retarded.

As well, such countries will provide some of the most exciting – and perhaps risky – investment opportunities. Emerging markets can almost be thought of as an asset class of its own. An understanding of development economics can enhance a fund manager’s appreciation of the economic forces which will play a crucial role in the rate of development of a given nation.

Industrial organization, the Economics specialization focusing on how firms are structured, and how they operate within alternative market structures – is a rapidly expanding area of economics with increasing relevance to questions of executive compensation and firm hierarchies. These will influence labour market structures, and the risks associated with them.
Finally, international trade and investment is important in understanding global investment strategies and international risk diversification, and in understanding how financial technology might spread from developed to developing economies.

4 Curriculum Design

By and large, with the exception of some financial economics topics, the actuarial economics topics reviewed above have been left out of the actuarial curriculum. There have been over the years a large number of reviews of actuarial curricula and encouragement of actuaries to move into broader fields. In general, though these reviews have not placed much emphasis on economics. (Bernard Benjamin, 1967) for instance discusses training needs for actuaries and does mention economics but only in passing. The 2005 curriculum of the Institute emphasises a broad range of structural changes (Jeremy Goford et al., 2001) but while there is increasing focus on “business awareness”, economics does not play a fundamental role in the curriculum redesign.

The current IAA curriculum and indeed most actuarial curricula include only basic economics (at the level of (David Begg et al., 2005)) as well as some financial economics. This is sufficient for actuaries to do basic, well-defined work in pensions and insurance but insufficient if actuaries want to handle the broader long-run planning and risk issues which are core to the discipline.

There have been fundamental changes in the demands on actuaries. In the past just calculating estimated liabilities was a difficult chore and required actuaries to be conversant with many technical formulae. At the same time, the business context of decisions was not so critical as pensions and insurance funds were relatively small and not mature. Risk was also not such a large issue. Over time, these factors have changed dramatically yet the actuarial curriculum has not evolved sufficiently to match the changing environment.

The technical aspects of the curriculum are in some sense less important now that computers handle most valuation issues. Actuaries need to know the basic formulae, to be sure, but intuition as to whether the computer produces the right number is much more important than the minutiae of formulae connected with payment in advance and arrears.
Some of the purely mechanical aspects of the curriculum can therefore be replaced with more economics as discussed above. In the Appendix, we outline a sample curriculum which adheres to the basic IAA curriculum but at the same time provides a broad introduction to actuarial economics. We believe this is the way forward for actuarial education.

The curriculum we outline does not include specific sections on pensions and life insurance. We have no doubt that in training actuaries to serve the UK market or other markets where pensions and life insurance are dominant actuarial applications there should be such sections; however, we see plenty of scope for actuaries in economies without any pensions and life insurance industry. Actuarial economics is about long-term planning and risk and the need for such planning and risk management is omnipresent in modern economies, regardless of whether there are private pensions and life insurance sectors.

5 Conclusions

In this paper, we have defined the notion of actuarial economics and discussed why it is necessary for both actuaries and economists. We discussed the required skills and sub-disciplines of actuarial economics, most particularly: labour economics, public/macroeconomics, the economics of information and uncertainty, and financial economics. We also discussed other areas of actuarial economics which some but not all actuaries should be familiar with.

Actuarial approaches were developed for good reason in the absence of markets just as economic approaches developed for very good reason to make sense of markets. It is important therefore to blend the two sciences together into the approach of actuarial economics. This has become an even more critical innovation as securitisation and other financial devices have led financial markets to become more complete.

In recent years, liabilities have become more mature and there have been a dramatic decrease in the degree to which actuaries can exercise discretion and flexibility. Both the level of exposure to risk and the decline in flexibility over adjustment to the structure of benefits has led those responsible for pension and insurance liabilities to focus much more on risk. At the same time, companies and organisations increasingly need assistance managing their long-term risks and planning broadly for the future.
The skill sets necessary to handle these problems involve a lot of technical skill mixed with economics. Actuaries are quite capable of handling these problems but actuarial education has fallen short.

To summarise, actuarial economics is a framework by which the strengths of actuarial science and economics can be combined to cast light on key problems in the planning and management of risks, particularly long-run risks. Actuarial economics is a critical part of the skill set actuaries should have.
6 References

Appendix: Sample Outline Curriculum for Actuarial Economics

Actuarial Economics Foundations (8 x 30 teaching hours = 240 hours)
Actuarial Mathematics
Statistics
Stochastic Processes
Survival Models
Contingencies
Accounting
Basic Economics
Legislative Frameworks

Actuarial Economics Core (5 x 30 teaching hours = 150 teaching hours)
Microeconomics
Valuation and portfolio theory
Corporate finance and risk management
Labour economics
Public finance and macroeconomics

Actuarial Economics applications (2 x 30 teaching hours = 60 hours)
Pensions
Insurance

Specialist Options (30 hours each)
Healthcare and its economics
Development economics
Industrial organisation
International trade and finance