Policyholder Behaviour in Extreme Conditions

Please note: these Working Party notes do not constitute a formal research report, and as such, have not been subject to formal peer review.

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Written by: David Graham, Eamonn Phelan, Jean Eu, Jeremy Kent

Section 1 Introduction

1.1 Our Terms of Reference

Our aim is to consider how policyholder responses to an extreme situation might have a significant impact on insurers.

Even two seemingly similar extreme situations may well unfold quite differently. It seems unlikely, therefore, that we will be able to use past experience to predict how policyholders are likely to react in any given situation.

We have therefore sought to understand the drivers of policyholder behaviour and to identify tools that can help senior executives to anticipate unexpected behaviour, and to respond effectively should it occur.

1.2 Potential benefits

Our aim is to improve awareness of the circumstances that might trigger extreme policyholder behaviour and how companies might be impacted. This might in turn help companies (or regulators) to recognise such situations earlier, and to devise appropriate strategies to mitigate some of the potential adverse consequences.

We see potential benefits in the following areas:

- Better capital / risk management
- Avoidance or mitigation of adverse consequences for the insurer
- Avoidance of actions that might inadvertently make things worse and, if possible, identification of actions which might benefit the insurer
- Reassurance and assistance for policyholders to make better decisions in unfamiliar and possibly unsettling circumstances.

1.3 Scope

Our definition of "extreme conditions" is any incidence or major new development that drives the behaviour of policyholders in the relative short term in such a way that it could have a significant impact on a company. This is not necessarily limited to just economic conditions, but could, for example, include the impact of a pandemic or regulatory change. Also, the impact may not necessarily be negative for the company, or solely focussed on the considerations of capital requirements; for example, it could be a reputational impact.

We are interested in behaviour that is different from what the company would expect in the "normal course of events". By "behaviour", we mean any decision to create, amend, cancel or claim on a contract, or the decision to do nothing. Amending a contract refers to any decision the policyholder makes which affects the future of the policy other than the default option of allowing the policy to continue unchanged to the end of the term as per the policy terms and conditions. We are looking to analyse the reactions of policyholders which then lead to one of the above decisions, so that we are able to understand how the same situation might play out in different circumstances in the future.

Our focus is on insurers in who sell life, critical illness and income protection insurance products in the UK (although we have considered other territories in our research). We have also focussed on the individual policyholder, i.e. individuals who hold an insurance contract directly with the company, as opposed to an insured group arrangement as a whole.

1.4 Structure of this Note

Section 2 provides a summary of the key issues around understanding policyholder behaviour that is explored by this paper.
In Section 3, we start with a brief survey of past events where the financial position of insurers had been significantly impaired. While there are some general lessons to be learnt from policyholder behaviour during such events, these are unlikely to be of much help in managing a future event.

Section 4 then reviews a number of insights from different behavioural theories. We believe that the psychological drivers of behaviour remain more or less "constant" even in extreme circumstances, when policyholder behaviour may differ markedly from what we have come to expect.

In the remainder of the Paper, we explain the tools that we believe actuaries will need to navigate the uncharted waters following an extreme event, when they may encounter unusual policyholder behaviour, and give some examples of how these tools can be applied.

We have grouped our navigation tools around three themes:

1. **Understanding how policyholders might react to an extreme situation.** In Section 5 we illustrate how the behavioural insights examined in the previous section might be applied in order to predict policyholder behaviour, using a case study as an example.
2. **Identifying ways to model policyholder behaviour.** This should help to identify how behavioural factors *might* reinforce one another to "drive" untypical behaviour, and how potential interventions *might* play out. This is addressed in Section 6.
3. **Management Information** that is designed to help inform how policyholders *might* behave and to provide credible inputs to models. Some of the issues surrounding this are addressed in Section 7.

Note the multiple use of "*might*." We believe that this is the best we are likely to be able to achieve. Our navigation tools are designed to help actuaries understand how the situation *might* evolve. When – inevitably – real behaviour departs from our predictions, these tools should also help actuaries make sense of what is happening and to adjust their predictions accordingly.

Section 2 Summary & Conclusions

2.1 Making Sense of Policyholder Behaviour

Although there are a range of events (with both negative and positive outcomes for an insurance company) which can be classed as an "extreme event", we felt that insurance company insolvencies were perhaps the easiest events from which to gather data, as they were likely to be publicised more widely than, say, a successful marketing initiative. We reviewed a range of historic insurance company insolvencies from around the world (see Section 3.1). We found little evidence of insolvencies that were triggered by policyholder behaviour, though in some cases it may have exacerbated an existing situation. Moreover, even two seemingly similar extreme situations may well unfold quite differently (we examine some of the reasons for this in Section 3.2). Studying past events is, therefore, unlikely to greatly improve our ability to predict how policyholders might react to future extreme circumstances.

We have therefore considered a number of behavioural approaches that are rooted in *individual psychology*. These are supported by considerable research, and they should remain valid in a wide variety of situations because the psychological responses of each individual change slowly by comparison with the situations we are considering. They should therefore help us understand how policyholders might react in many types of extreme circumstances, whether driven by economic factors or other considerations such as social change or medical advances. We describe some approaches we believe will be particularly relevant in Section 4. Section 5 illustrates how these approaches can be applied to a specific extreme scenario.

While we do not claim that the behavioural psychology approach can accurately predict how policyholders will behave in practice, it should provide insight into the drivers of behaviour, and increase awareness of the range of possibilities. When combined with appropriate and timely management information, this can help make sense of actual behaviours that are observed. Senior management can then take more effective action to protect the interests of both policyholders and the insurers themselves, or to take advantage of opportunities that may arise.

2.2 Modelling Behaviour

Modelling can help deepen our understanding of how behavioural drivers can reinforce or offset one another, and of the financial (and other) consequences. A model can be an effective tool to share insights with a wider audience, such as senior management. A model can also provide a "sandbox" to develop and test possible interventions, since it may no longer be safe simply to rely on our experience of what worked in the past.

As we discuss in Section 6, traditional actuarial modelling approaches (such as stochastic models) are unlikely to be helpful in this type of situation. We have therefore considered two alternative modelling techniques: Agent Based Modelling; and Systems Dynamics. These modelling techniques may be less familiar to most actuaries, but they are widely used in other fields, and they potentially have the power to model behaviour in the extreme situations we are considering.

2.3 Translating Behaviour into Useful Management Information

Access to suitable data in relation to the in-force business can dramatically improve our confidence in policyholder behaviour modelling, in terms of both the power of models that can be built and their credibility.

Equally important, timely management information on actual, emerging policyholder behaviour can help to give early warning of when behaviour patterns have started to change. This will help senior management decide how much attention they need to pay to the potential business risks.

Insurers often have access to a wealth of information available to them which may be used in order to gain a better understanding of how their policyholders might behave in extreme circumstances. However, these data are often not properly recorded or fully exploited. Potentially useful information may be derived from internal data (which may be collected through active engagement with policyholders) to external data (economic and social indices). If combined in a careful and structured way, these can provide meaningful insights into the drivers of customer behaviour.

These issues are explored more fully in Section 7.

2.4 Conclusions

We have proposed an approach based on three pillars:

1. Insights from the psychology of the individual (applied to policyholders)
2. Modelling using appropriate techniques
3. Systematic collection of relevant management information on policyholder behaviour

In combination, we believe these will help senior executives manage the risks – and opportunities – that may arise from unexpected policyholder behaviour in an extreme situation.

As with all aspects of risk management, senior management face the challenge of deciding how much of their attention they ought to divert from the day-to-day running of the business to address risks that may never materialise.

For an extreme scenario with a wide-ranging effect (such as a natural catastrophe), changes in policyholder behaviour will be only one aspect of the impact that senior management ought to consider. In some scenarios though (for example a social change), policyholder behaviour may be the key risk factor. Management will need to decide whether they do indeed face a risk situation that they ought to divert significant resources to address.

Management information, in combination with psychological and behavioural model insights, can help senior executives manage risks effectively in extreme circumstances. Good, timely management information that tracks "leading indicators" of policyholder behaviour can help management distinguish at an early stage between statistical outliers and a genuine change in the underlying behaviour pattern. Supported by an insightful model that shows the potential impact of the change, management will be well placed to take appropriate measures to respond to the potential risks. This could reduce the dangers of assuming previous patterns of behaviour will automatically continue, and also allow senior management to design effective interventions in order to reduce risks and/or take advantage of emerging situations.

Section 3 Making Sense of Policyholder Behaviour

3.1 Evidence from the Past

We reviewed a range of insurance company insolvencies from around the world. (Appendix A contains a detailed summary of our findings.) In general, policyholder behaviour did not, of itself, bring about the demise or near-demise of any insurer, although it did sometimes accelerate the process once a collapse had begun. The main triggers of failure are usually multiple and interconnected, including inadequate pricing, poor investment decisions and too rapid growth. Some form of mismanagement of the business was often the root cause.

There is no evidence that studying historical policyholder behaviour patterns would have helped to avert any of these failures, or near-failures, nor do we believe that it is likely to be much help in averting future problems.

Absence of past examples where policyholder behaviour was a major source of business risk does not however mean that such an event cannot happen in future. Insurance products, the information available to policyholders and the speed with which they can react all contribute to make such a scenario more likely in future.

What we seek are tools that can help insurers recognise emerging situations that have the potential to significantly impact them. This should help them understand better what is happening (and why), and to take appropriate action to mitigate risks or exploit new opportunities.

3.2 The past not necessarily a guide to the future

The range of potential future extreme situations to consider is highly diverse. There are many possible triggers for such conditions, including (but certainly not limited to):

- Catastrophe
- Market dislocation
- Medical advances
- State intervention into markets
- Social changes

Not only this, but even if a scenario seems superficially similar to a past event, key aspects will probably unfold quite differently, for a variety of reasons. For example:

- Products and regulation differ from country to country. Even within a single country, these have evolved over time: products adapt to changing market needs and conditions; and regulators try to learn from past events.
- Policyholders, managers and regulators have also learnt, and have become more sophisticated.
- External social and economic factors will inevitably be different, often in crucial ways.
- The development of the internet and social networks will change how policyholders respond:
    - They may be better informed
    - They may also be more prone to a "herd instinct"
    - Online transactions make translating intentions into action fast and easy
- Today's compliance framework has created a greater need to be able to defend advice given and actions taken, to protect against a social environment that encourages a "hunt for the guilty" and demands for compensation.

Taken together, these factors strongly suggest that we need more robust tools to make sense of unexpected policyholder behaviour than simply relying on past experience of such events.

3.3 How can psychology help?

If policyholder behaviour may abruptly change in extreme situations, we cannot simply rely on analysis of statistics of past policyholder behaviours compiled during more "normal" times. We will need to understand what drives these behaviours if we wish to be able to make sense of policyholder behaviour in unfamiliar, possibly extreme, conditions.

We have therefore considered a number of behavioural approaches that are rooted in *individual psychology*. People's values, beliefs and thinking patterns do not change overnight. Rather, they are likely to use these to make sense of their new, unfamiliar environment. Over time, their values might adapt, but it is likely to take months, if not years, before any change is noticeable.

We should therefore be able to use psychological insights to help us to understand how policyholders might react in a wide variety of extreme conditions, and how their behaviour may depart from its past statistical pattern – i.e. become extreme.

Three approaches seem particularly useful:

1. Buying behaviour models
2. Behavioural economics
3. Psychology of motivation.

These can complement each other when trying to understand how behaviour patterns may evolve.
We describe each of these briefly in Section 4 below, with further information included in Appendices.
Some of these may already be familiar:

- *Buying behaviour models* have been used by retailers to strategically attract certain types of customers to certain areas of their stores. Understanding these behaviours may help in understanding how policyholders may react in different scenarios.
- *Behavioural economics* is increasingly used by governments to influence citizens' behaviour and has also been adopted by the Financial Conduct Authority in the UK. Some insurers also use it in marketing.
- *The psychology of motivation* may be used within Human Resources departments, and also sometimes features in sales training.

There are essentially two ways in which these psychological approaches can be used:

- **Explanatory**: used to understand why policyholders are behaving in a certain way.
- **Predictive**: used to try to foresee how policyholders might respond in a hypothetical extreme set of circumstances.

In whichever way we use them, there is no certainty that our speculations will be correct, although predicting behaviour is clearly even more speculative than trying to explain it. Nevertheless, we do believe that this approach is worthwhile, for the following reasons:

- The psychological traits have been extensively validated by research in a wide variety of settings, and they should strongly influence behaviour even in extreme conditions.
- Both policyholders and actuaries are people. Focusing on our shared psychological traits can help us overcome our own biases and gain a better understanding of how policyholders might behave.
- They help us to broaden our thinking beyond a default position that assumes either that policyholders will behave in a way we judge to be economically rational, or that their behaviour will continue unchanged despite new, extreme conditions.

Section 4 Psychological Drivers of Behaviour

The theories noted below are major subjects in their own right, and further detail is provided in the Appendices. This chapter aims to provide a high level insight into the different behavioural theories which may be helpful in predicting policyholder behaviour.

4.1 Buying Behaviour Models

In buying behaviour models, there are four key areas which influence a consumer's buying decisions:

- Situational - location, social situation, time, reason for purchase and mood
- Personal - personality, gender, age, stage of life, income, education, marital status and lifestyle
- Psychological - motivation, perception, learning and attitude
- Societal - culture, social class, reference groups, opinion leaders and family

Situational, personal and psychological factors influence a person's buying decisions, but only on a temporary basis. For example, a store may strategically play certain music to attract their target audience, or a brand may employ shock advertising to make their product memorable. However, societal factors have a broader and longer term influence on people's beliefs and the way they do things. Understanding these factors may provide much more of an insight into how different groups of people may react to certain circumstances.

Further information can be found in Appendix B.

Buying behaviour models are particularly useful to help think through the various factors that may influence policyholder behaviour as we consider how they may respond to extreme conditions.

4.2 Behavioural Economics

Behavioural Economics is "a method of economic analysis that applies psychological insights into human behaviour to explain economic decision-making"[1].

Following the approach of the Financial Conduct Authority, we have grouped behaviours into three broad categories:

1. **Preferences and Perceptions** that set the behavioural context within which decisions are made. Some of the behavioural drivers that fall in this category include focus on the present, loss aversion, social norms, commitment, expectations, price-value effect, honesty, and emotional drivers.
2. **Biases** that can distort the interpretation of information on which decisions are made. Examples include over-confidence, over-extrapolation, projection bias, hindsight bias, confirmation bias, free offers and ownership bias.
3. **Decision-making** processes through which customers actually make their decisions, such as mental accounting, framing, anchoring, rules of thumb, persuasion and social influences.

Behavioural economics can be used both to explain the drivers of behaviour in a particular extreme situation and to help predict possible behaviours in a hypothetical scenario.

We present a brief summary of some findings in Appendix C to give the interested reader a feel for the field, and also to help answer the question: "Can Behavioural Economics help us to understand better how policyholders may behave when conditions become extreme?"

[1] *oxford dictionaries.com*

4.3 Psychology of Motivation

Perhaps the best-known model of motivation is Maslow's hierarchy of needs[1]. This was first proposed in Abraham Maslow's 1943 paper "A Theory of Human Motivation."

Maslow described six levels of motivation, ranging from physiological (basics such as food and shelter) through belonging and esteem to self-actualisation and self-transcendence. Although everyone responds to some extent at all six levels, Maslow's insight was that each level in turn needs to be broadly satisfied before an individual can move their primary focus to the next level. Thus, each individual can be thought to be operating at a certain level at any given time. People do progress (or regress) from level to level over their lifetime, but this is typically a very gradual process.

The full hierarchy of six levels may be too complex for our requirements, but based on many years of conducting their own research, Cultural Dynamics Strategy and Marketing Limited[2] have effectively restructured Maslow's six levels into three broad groups. Each of these groups represents the current "level" of approximately a third of the UK population. This has the additional advantage that the broad characteristics of each group are more readily distinguishable to non-experts.

These three groups are:

1. **Sustenance-driven**: This covers Maslow's physiological, safety and belonging levels and currently represents about 25% of the UK population. Typical characteristics include:
    a. Family and home, and caring for these, tend to be their central focus. For those living alone, friends take the place of family.
    b. Tradition and family structure are important.
    c. Prefer things to be "normal".
    d. Naturally conservative.
    e. Security conscious – worried about crime, violence and terrorism.
    f. Support tough punishment for criminals.
    g. Wary of change, especially for its own sake.
    h. More comfortable with regular and routine situations.
    i. Concerned about what the future holds.

2. **Outer-directed**: This covers Maslow's esteem level and currently represents about 37% of the UK population. Typical characteristics include:
    a. Success oriented.
    b. Always want to "be the best" at what they are doing.
    c. Welcome opportunities to show their abilities.
    d. Take great pleasure in recognition and reward.
    e. Look to maximise opportunities.
    f. Keen for opportunities for advancement and professional networking.
    g. Trend and fashion conscious.
    h. Like new ideas and new ways.
    i. Generally optimistic about the future.

3. **Inner-directed**: This covers Maslow's self-actualisation and self-transcendence levels and currently represents about 38% of the UK population. Typical characteristics include:
    a. Trying to put things together to understand the big picture.
    b. Concerned about the environment, society, world poverty, etc.
    c. Always looking for new questions and answers.
    d. Strong internal sense of what is right and what is wrong.
    e. Strong desire for fairness, justice and equality.
    f. Self-assured and sense of self-agency.

[1] https://en.wikipedia.org/wiki/Maslow%27s_hierarchy_of_needs
[2] http://www.cultdyn.co.uk

Thinking oneself into the mind-set of each group in turn can help to avoid becoming "locked into" a single outcome. It can also help to avoid unexpected reactions from significant groups of policyholders who see things differently from others. This should allow more targeted actions for particular policyholder segments, to protect the interests of both policyholders and the insurers themselves, or to take advantages of opportunities.

Section 5 Using Behavioural Insights to Predict Behaviour

5.1 Suggested approach

5.1.1 Top level approach

At least initially, it may be sensible to treat policyholders as homogeneous and to focus on the implications of buying behaviour models or behavioural economics for all policyholders without differentiation. For example, this approach might be used as part of an insurer's on-going internal risk-management processes.

5.1.2 Deeper dive

If it is felt that a specific extreme scenario may be developing, it may be appropriate to incorporate the additional insights that can be obtained by considering different groups of policyholders separately, such as the three "summary" groups of Maslow's hierarchy of needs. In this case, we suggest an approach along the lines described below.

1. Identify key issues and questions that might arise for policyholders in the extreme scenario being considered.
2. "Think yourself" into one of the groups by studying the values and attitudes typical of group members.
3. Staying with this "mind-set", identify how you might react to each key issue.
4. Apply these insights to consider their impact on policyholder behaviour, considering each Behavioural Economics insight in turn.
5. Repeat steps 2 to 4 in turn for each of the remaining motivation groups.

We suggest working with each motivation group in turn. This is because, with a little effort, most of us can empathise with each of the groups, whatever our own personal "level" may be. However, there is a danger of losing our focus and allowing our own viewpoint to resurface. We can reduce this risk by staying "in character" for as long as possible by minimising the number of times we need to switch to the persona of a different group.

Admittedly, this approach is not typically actuarial. However, as we have already shown, our usual statistics-based approaches are unlikely to be helpful. Since the suggested process may be most effective if conducted as a group exercise, it also provides an opportunity to get non-actuarial colleagues involved.

In this section, we consider one possible "extreme" scenario. Other scenarios that we considered can be found in Appendix D, though for these we have only considered the behavioural economics aspects (and not the differences across the three Maslow motivational groups).

5.2 Case Study: Medical Advances Scenario and the rational response

This case study considers a scenario where new medical detection or treatment changes (irreversibly) demand, and possibly information flow.

We have already seen how the widespread use of angioplasty has in many cases removed the need for cardiac artery bypass surgery. This, combined with better diagnostic tools and more widespread screening, is having a major impact on deaths from cardiac disease. Further advances in medical science may well lead to earlier diagnosis and effective treatments for other widespread diseases such as common cancers.

This will change perceptions of what is a "critical illness." It may even lead to unforeseen losses if policyholders start to claim for illnesses that are still covered under the contract, but which are more widely diagnosed with fairly routine treatments available hence ceasing to be "critical" illnesses,. or that policyholders may not even have known they had suffered (e.g. a very mild but insured cardio-vascular event that is now diagnosable by the detection of Troponin).

Note that the below example is a hypothetical scenario with hypothetical consequences.

5.2.1 An Example – Diagnostic Testing Advances

Advances in diagnostic (eg genetic) testing techniques result in increasingly affordable ways to detect those who are highest risk of developing critical illnesses such as the more common cancers and heart disease in later life.

These tests are believed to be highly predictive: the mortality (and morbidity) of those screened "negative" is expected to be significantly lower than average; that of those with "positive" screening results will be significantly higher, due to their increased risk of developing a critical illness.

For cost reasons, routine screening through the NHS is limited to groups perceived to be "at risk" due to factors such as family history. In time, however, private clinics spring up offering to perform the tests on a fee-paying basis. This is seen as acceptable ethically, since for those with "positive" screening results there is a preventative regime (regular screening, lifestyle changes, preventative medication etc.) that promises significantly improved outcomes.

This preventative regime for those "at risk" comes at a cost, some of which needs to be met out of people's own resources.

Existing rules on genetic testing are extended to cover this form of testing as well. Insurers are prohibited from requiring a test as part of their underwriting process. Doctors will not need to disclose test results in response to underwriting requests without the patient's specific consent, although if a test has been conducted and the patient themselves is aware of the result, they will be required to say so.

Since the tests are seen as a strong predictor of future mortality and morbidity, insurers introduce significant pricing differentials between: the (as yet) unscreened, those screened "negative", and those "at risk". Funding targets and annuity rates for pensions are also differentiated, with those screened "all clear" needing to make greater retirement provision.

5.2.2 Rational Responses

People will place a high priority on their health, and therefore be keen to take up testing when available (earlier in their lives rather than later), in order to avail themselves of preventative regimes (particularly if they are in a perceived high-risk group for which testing is free).

This would be the case even if it results in higher premiums for certain insurance (for those who test "positive") since:

- Rationally your health is more important than your wealth.
- Also, you will potentially benefit from a lower cost for retirement savings due to reduced life expectancy.

5.3 Insights from Behavioural Economics

5.3.1 Applying behavioural economics theory

First we consider the potential response to the example scenario above using the three behavioural economics categories described in Section 4.2.

Preferences and Perceptions

Those for whom these developments will be most salient will be those who perceive themselves to be most at risk, perhaps because of family history. Those who have had personal experience of someone suffering from a critical illness will also perceive testing as important.

Others may prefer not to think too much about what may happen years in the future. However, as they come to perceive that preventative regimes for those "at risk" are effective, they will gradually come to fear "bad news" less than the risk of missing these preventative treatments. As a result, willingness to be tested will spread.

Attitudes to protection insurance, particular Critical Illness, will change. On the one hand, those who test negative may no longer feel committed to existing policies, now that the original reason for purchase no longer seems as valid. Those "at risk" may also feel that their preventative regime makes their policies superfluous, though, on the other hand, this group now has a much higher chance of benefiting from a (non-life-threatening) claim event.

There is a risk of new policyholders "bending the truth" and not disclosing the (positive) results of testing in certain circumstances, especially if they perceive that this will have a big impact on the cost of cover.

There may be an opportunity for insurers to relate in terms of social, rather than commercial norms, offering help and incentives for "at risk" policyholders to adhere to their preventative regimes. There may also be an opportunity to offer a "pre-testing" package that includes financial help towards the cost of following the preventative regime, should this be needed.

Biases
Extrapolating from medical science's recent successes, projection bias may lead policyholders to believe that they will be immune to all types of serious ill health or early death.

Decision-making
Narrow bracketing (viewing decisions in isolation, rather than as part of the "big picture") may lead policyholders to consider separately the costs of protection insurance and of their preventative regime.

Similarly, increased protection costs may not properly be offset against reduced pension costs.

5.3.2 Key policyholder behaviours in this scenario

We then summarise the above extrapolations into the key policyholder behaviours in both the short and long term.

Short-term response
As the new form of testing spreads, we will see a higher proportion being tested "positive" than the population in general, as this group will be more likely to volunteer for early testing. There will be selective lapsing of protection policies, with both much lower lapses among those testing "positive" and higher lapses among those testing "negative".

Some of those who feel themselves at risk are likely to take out protection cover before being tested, and many of these who subsequently test "negative" may promptly lapse their new policies.

Longer-term changes
The nature of the initial wave of selective lapsing will change. Lapses among those testing "positive" will remain low. However, many of those testing "negative" will seek to exercise a "lapse and re-entry" option to take advantage of the lower rates that apply to this group.

The higher rates for the "tested positive" group will gradually reduce as the efficacy of preventative treatments is confirmed. Preferential terms will be offered to those who can confirm they are abiding by the preventative treatment regime. Pre-testing products will also appear, offering financial help towards preventative treatment combined with more conventional protection benefits.

Adjustments to pension funding requirements according to tested status will gradually be introduced. Insurers will offer policyholders improved terms for combined risk products that cover both early mortality and longevity risks.

5.3.3 Summary

Finally, we pull the above together in a summary of what might be likely to happen from a behavioural economics viewpoint.

In the short (and maybe even longer) term many people are likely to forego the possibility of testing due to: perceiving risks as far away (or "it's not going to happen to me"); the risk of having to pay higher premiums; or simply "not wanting to know". For many there may be a great temptation to get tested, but not disclose positive results.

Social norms may change over time so that people appreciate the benefits of being able to take remedial action to reduce risks long term. However, insurers would need to persuade people that they are prepared to take on higher risks at a fair price, and not just looking for ways to exclude risky policyholders or to make more money.

Insurers will also need a strategy to ensure that they keep existing customers who subsequently test negative, to counteract the better terms they could obtain as a new customer elsewhere, now that their status is confirmed.

By considering behavioural economics theory, we can already see a contradictory outcome to that suggested by the rational response in Section 5.2.2.

5.4 Interaction of Behavioural Economics and Motivation Groups

To demonstrate the effect of overlaying motivation insights on the behavioural economic conclusions, we have reworked the Medical Advances Scenario using the three Maslow groups described in Section 4.3.

5.4.1 How different attitudes and beliefs may express themselves

Issue	Sustenance Driven	Outer Directed	Inner Directed
Am I familiar with new developments?	"I find it hard to keep up with the pace of change. I rely on the experts to tell me if there is anything I need to do something about."	"I like to keep abreast of new developments. It helps me feel smart – and stay one step ahead of the game."	"I find new developments and discoveries fascinating, even when they don't seem particularly relevant to my life."
How do I feel about being tested?	"It's all a bit scary. I have to rely on those in charge putting a suitable programme in place to test people who need it most."	"I would feel great to be one of the first to be tested. I wonder how I can turn it to my advantage?"	"I can see the wider benefits to society. I suppose if I'm at risk it would be best to know, so I can decide what to do about it."
How will I feel after being diagnosed "high risk"?	"I'm devastated. I'll go along with whatever the professionals advise. I always thought life was unfair – I'll just have to make the best of it. I must make sure I do what I can to see my family will be OK."	"Wow – I wasn't expecting that! I will find a way to get the latest treatment. And there's no point straining to save for the future – enjoy life while I can."	"At least now I know. I will discuss the options with my doctors and my family so we can make informed choices for the future."

Issue	Sustenance Driven	Outer Directed	Inner Directed
How will I feel after being diagnosed "low risk"?	"I'm very pleased, of course. I pity the poor blighters who aren't so lucky – I hope the government gives them the support they need. I'll still need insurance of course – could always go under a bus. Glad it will be a bit cheaper for me now."	"Yippee! Maybe I can save some money on my insurances and splash out a bit to celebrate."	"Nice to know where I stand so I can factor it into my planning. Since it looks as if I am set for a long retirement, I ought to start thinking about how to make sure I enjoy it."
Do I understand implications of being tested?	"It all feels a bit scary. I don't really understand all the implications, but I'll go along with whatever the experts decide."	"It will be good to get confirmation that I'm not at risk. Then I can focus on enjoying life."	"I can see both sides of being tested. Sometimes ignorance is bliss. But being tested won't alter the facts, and if I get bad news, at least I'll know where I stand, and maybe I can do something about it."
Is having adequate life / health insurance cover is important to me?	"Buying insurance is a sensible thing to do – so all the experts tell us. Life is tough enough already, and something unexpected always seems to go wrong. Not sure how much I can afford to pay for it, though."	"If anything does go wrong, I would want the best of care, and to make sure my family can live the lifestyle to which we are accustomed. But I need to balance the cost against today's expenses, such as a new house, or exotic holiday"	"I feel it is sensible to plan ahead for some of life's main risks. Then I can get on with what's important to me without needing to worry all the time."
Do I feel that it's "fair" for insurance premiums to reflect test results?	"It's tough enough for those who are 'high risk' without having greedy insurers ripping them off yet more. We should all do our bit to help spread the cost – just as it always was in the past."	"I feel good about paying less now that I'm low risk."	"I can understand why insurers need to do this, though it does seem hard on the 'high risk' group."
How do I feel about changing my insurance plan if I can get my cover cheaper?	"Insurers are always quick to use the rules to their advantage, so, no I don't think people like us should feel bad about using the rules to our advantage a bit. If it's legal and can save me money, why not?"	"Smart operators like me are happy to play the system to their advantage – provided we can get away with it! Loyalty simply doesn't come into it."	"Insurers know what they are doing when they set the rules, so I feel comfortable doing what is to my advantage - provided I stay within the rules and true to my own moral compass. I wonder what my insurer might be willing offer me to keep me as a loyal customer?"

Issue	Sustenance Driven	Outer Directed	Inner Directed
Do I feel loyal to my existing insurer?	"Loyalty is important to me. I've always done business with this company, and I expect them to treat me fairly. I'd be happy to continue with them – but not if it costs me money! I'm all too aware that many companies don't give ordinary folks like us a fair deal."	"I expect my insurer to look after me the way I deserve. If not, or if I can get a better deal elsewhere, I'm off!"	"All companies get things wrong from time to time, so I'm willing to forgive – up to a point."

5.4.2 How beliefs may interact with Behavioural factors

We have then considered how each behavioural economics factor may be further enhanced when considering the responses once overlayed with each Maslow Group. For more detailed information on each Behavioural Factor, please refer to Appendix C.

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Preferences and Perceptions				
Focus on the present	Particularly those who are younger may feel that the risks that may crystallise later in life are not worth considering now.	Strongly present-focused but tempered by ensuring that those near to them are properly looked after.	Main focus will be on what they can do with any savings, on premiums or on dealing with the consequences of an 'at risk' result.	May be willing to sort out insurance issues so that they are free to concentrate on living life today.
Reference dependence and loss-aversion	If they see a "positive" test result producing higher premiums, and a "negative" one producing lower ones, they may place higher weight on the possibility of a loss through higher premiums.	Their reference point is likely to be an 'at risk' result, so they will see testing mainly as an opportunity to lose relative to their current position. They may therefore prefer their current untested state.	Their optimistic outlook may lead them to discount the possibility of being 'at risk', and therefore not to pay much attention to the potential down-side.	They will tend to see the test result as additional knowledge. May be most concerned about losing the opportunity to take preventative measures if 'at risk'.
Social norms	This testing is a "new thing" which people may not be inclined to embrace, but this may change over time as younger people come through who have never known anything different.	Since testing is so new, likely to participate only as part of an officially funded programme. This may help them feel that they are being socially responsible. Over time, testing will start to seem routine, and eventually become normative behaviour.	Always keen to be seen as a trendsetter, and therefore likely to be among those tested early.	The real pioneers likely to be from this group, either because intrigued about the science, or because of concerns about own personal situation.
Commitment	People who test negative (rationally) ought to lapse and re-enter at lower rates. They may (irrationally) feel some sort of commitment to their current arrangement and not do this however.	Believe people should make regular insurance premiums if they can afford it.	There are so many short-term pressures on my finances that I sometimes wonder if I shouldn't cancel some insurances.	Can see the advantage in the discipline of regular insurance premiums.

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Expectations	How they expect their relationship with their insurer to work – people may be influenced by media coverage in terms of feeling whether the insurer is likely to discriminate against them or use this information to reject claims.	Loyalty and commitment is important to this group. Most likely to want to stay with existing insurer – but may feel betrayed if they feel they are not being treated fairly.	Opportunity to do a smart deal likely to override any sense of commitment.	All companies treat their customers badly from time to time. If they apologise and put things right, I'm generally quite forgiving – so long as they don't make a habit of it.
Price-value effect	For those who have tested "negative" and can get lower rates – they may feel that somehow this is a "cheaper" product than the version for those who have not been tested (even though they offer the same benefits), and so may not switch to the lower premiums.	May initially be quite cautious about switching to a lower-priced contract. But once convinced that it is legitimate to do so, the lure of saving on today's premiums is likely to overcome any remaining doubts.	This group is most likely to be sensitive to the 'status value' of the product, rather than its pure financial aspects – if an insurer can find a way of creating this, perhaps through ancillary benefits or some form of exclusivity.	Insurance is not something this group wants to spend too much time and effort thinking about. They are unlikely to chase a modest saving if it involves a lot of hassle.
Honesty	Many may have testing "off the radar" and not disclose negative results to insurers.	Although this group has a strong sense of right and wrong, if they perceive that insurers are acting unfairly towards those tested 'at risk', they may feel that non-disclosure as not really dishonest – it just helps to even up the score.	Perhaps the most likely group to try to 'game the system' - take out insurance before being tested, and then cancel afterwards if not 'at risk'. Also likely to conceal test results if they feel that they will get away with it.	May well see testing and insurance as part of a single picture and sequence the steps in what they see as an appropriate order. Least likely to conceal test results, as doing so is incompatible with their own moral code.

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Regret avoidance	Could drive people not to be tested in case the result turns out negative.	Since this group generally has a pessimistic outlook, they are likely to fear that testing will reveal that they are indeed 'at risk' – something they would rather not know. They are therefore less likely to volunteer for testing until this becomes the norm.	This group is generally optimistic – bad things tend to happen to others, not to them. They may regret not being one of the trendsetters and therefore be eager to be tested early.	Most likely to take a balanced view. If they are 'at risk' then better that they know about it as soon as possible. Otherwise they may regret not having started taking preventative steps earlier.
Other emotions	Other emotions – people may simply not want to know of such risks.	The whole idea may seem quite threatening, and they may prefer simply not to think about it.	Getting tested may take a low profile compared with their other life-style activities.	Although busy with their other activities, they are likely to make time to be tested so that they can cross it off their mental 'to-do' list.
Biases				
Over-confidence	People may feel that they can't possibly be at risk due to healthy lifestyle etc.	Their pessimistic outlook may lead them to over-estimate their chance of being 'at risk'.	Over-confident that they lead a healthy lifestyle so they can't be at risk.	May be over-confident in their ability to handle an 'at risk' outcome.

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Over-extrapolation	Similar to previous point. They may also feel that because their parents have lived to old age that they can't be at risk. Further they may not understand that a "negative" result doesn't necessarily mean that they will not develop a critical illness (and conversely a positive result doesn't necessarily mean that they will.)	Likely to extrapolate from the experiences of parents and other older family members, as well as from "bad news" stories that make the headlines. They may therefore expect that they too will suffer ill health.	Unless someone in their circle is affected, likely to extrapolate that they too aren't at risk. May hear about a few cases they who tested "at risk" but didn't develop the condition, and extrapolate from this that it is not worthwhile for them to adopt uncomfortable life-style changes.	What they hear about medical advances may lead to unrealistic expectations of how much they can really do about an 'at risk' finding. If they adopt recommended life-style changes and do not develop the condition, they are likely to think of this as a sort of 'reward' for their sensible behaviour.
Hindsight bias	If test proves "positive" and person ends up paying more for insurance but, in actual fact, doesn't get a critical illness in the long term, they may feel that they ended up over-paying. (i.e. not understanding the fact that, just because they didn't get an illness, doesn't mean that they weren't at higher risk)	May resent having taken the advice of the experts and given up some of life's pleasures – and in particular to having paid "through the nose" for extra insurance protection they didn't need.	If tested "at risk" but don't go on to develop the condition, may see this as confirmation that the result was wrong and that recommended life-style changes were a waste of time.	Will understand that tests are not infallible. Also likely to attribute failure to develop the critical illness at least partly to their own efforts to adopt a healthy lifestyle and to take sensible precautions.
Projection bias	Projection bias – particularly the young perhaps can't ever imagine being ill	May find it difficult to adjust to any recommended but unfamiliar life-style changes, if it involves activities they can't imagine themselves doing.	May find it difficult to believe that they are truly "at risk", even after an "at risk" test result. Since not all those who receive "at risk" results will develop the condition, they may be resistant to adopting uncomfortable life-style changes.	Even though not all those who receive "at risk" results will develop the condition, they are likely to see the wisdom of adopting recommended life-style changes "just in case".

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Confirmation bias	Confirmation bias – probably similar to above	Since half-expecting an 'at risk' result, may not really accept an 'all clear' finding. So could be more inclined to protect their families anyway "in case they are wrong".	May tend to dismiss an 'at risk' result as a false positive.	Likely to see an 'all clear' result as vindication for their earlier healthy lifestyle choices. If, despite this, they are diagnosed "at risk", they may accept further preventative recommendations as "more of the same".
Decision-making				
Mental accounting and narrow bracketing	People may be put off from having testing because of potential higher premiums, not considering that this may mean that remedial action can be taken to avoid illness later in life if the test result is positive.	May tend to separate the concerns about testing (and the possible adverse results) from what may come after, including any financial implications.	May tend to separate the esteem implications of being tested from the practical implications of for their health and finances.	Most likely to take a broad view of the whole testing issue.
Framing	May see testing as having the "risk of paying higher premiums", rather than the possibility of lower premiums or action to avoid later illness for those testing positive.	May respond best to testing if framed as a socially responsible thing to do.	May respond best to testing if framed being at the cutting edge of a new technology.	May respond best to testing if framed being an opportunity to take preventative actions if 'at risk'.
Anchoring	A person may be anchored to "pre-testing" situation, where they are not aware of potential higher risks.	May be highly influenced by experiences and opinions of immediate family and close friends	May be keen to "be the first" to try out something new, plus may feel that they can't possibly be "at risk" especially if generally healthy.	May be influenced by own views on medical testing in general, how it affects all parties and whether it would be fair to test or not.
Keeping options open	You can't go back if you decide to have the testing.	Likely to defer testing because: "while you can get tested later, once it's done and you know the worst there is no going back."	If concerned they may be "at risk", they may put off testing so they don't have to change their lifestyle just yet.	May volunteer for early testing if the opportunity presents itself, in case the option to be tested vanishes.

Behavioural Factor	Generic Response (for comparison)	Interaction with Maslow Group		
		Sustenance Driven	Outer Directed	Inner Directed
Persuasion and social influences	What are other people doing? May be influenced by views in the media and of their social circle around the testing, particularly while it is new.	Will only want to be tested once it becomes widespread and in seen as the responsible thing to do. Likely to try to follow recommended life-style changes as "the right thing to do" but social pressures may make it hard for them to keep this up.	Want to be seen as an opinion-former, so once people start to be tested, will want to be among the early adopters. May find recommended life-style changes particularly hard if they impact their self-esteem.	May not initially see being tested as important, but those that do are likely to be among the earliest to volunteer. Most likely to rise to the challenge of any recommended life-style changes.

5.5 Possible interventions

It is clear from the analysis of the Medical Advances scenario in the previous sections, that policyholder (and prospective policyholder) behaviour may be very complex, with actions and reactions dictated by factors which go well beyond the typical drivers of behaviour that insurers generally take into account. Understanding how different policyholders are likely to react in a given situation is of key importance when it comes to communication between the insurer and the policyholder. This communication can take a number of forms, including written (personalised) communications, the customer experience when they get in touch with the insurer (either in person, by email or by telephone), and less personal forms of communication such as the use of brochures or advertising.

If the insurer can determine the likely Maslow Group into which its policyholders (individually, or collectively) fall then it can role play to determine the types of action – or potentially inaction – that they are going to observe from policyholders, and tailor their communications accordingly. This can help to either encourage or discourage certain behaviours, in order to lessen any potentially negative impact which might otherwise be brought about through unmoderated policyholder activity.

5.6 Conclusion

When considering the implications of buying behaviour models or behaviour economics it may make sense initially to consider all policyholders as one group. However, additional insights can potentially be obtained by considering different groups of policyholders separately.

A good way of grouping policyholders is via the three "summary" groups of Maslow's hierarchy of needs described in the previous section. The suggested approach, when considering a potential extreme scenario, is to try to "think yourself" into each of the groups in turn and with this "mind-set" identify how you might react to key issues which might arise under that scenario.

Thus we can start with insights from Behavioural Economics using the three main categories, and behavioural factors within each category. Then consider various issues and questions related to the scenario and think about how these might different express themselves for those in the three Maslow groups. Finally consider how the generic responses under Behavioural Economics considerations may vary by Maslow group.

Obviously this requires insurers to have sufficient data to be able to categorise policyholders in this way, as this may not be data that is collected automatically. It may be difficult to engage policyholders in answering questions (either via phone calls or on a website), and only a particular subset may be willing to respond in such a way. Technology is likely to play an increasing part here, for instance being able to record key words from calls, or customer interactions with websites.

As can be seen from the Medical Advances Scenario example described above, such an analysis and thought process can yield rich considerations of potential and diverse behaviours by different groups which may vary over time as well.

Section 6 Modelling Policyholder Behaviour

With modelling, we return to more familiar actuarial territory. However, as we will see, we may need to employ different modelling approaches from those we have typically used.

6.1 Why Model?

Given an understanding of the behavioural drivers derived using techniques from Section 5 above, modelling can help us analyse how these may reinforce or balance one another. A model can be an effective tool to share insights with a wider audience, such as senior management. A model can also provide a "sandbox" to develop and test possible interventions, since it may no longer be safe to simply to rely on our experience of what worked in the past.

Modelling can take us beyond the descriptive approach of Section 5. The benefits of modelling may include:

- Helping to predict behaviour in new situations.
- A deeper understanding of the dynamics, interactions and key drivers of the situation.
    - Do some factors balance one another, leading to a new, more or less stable equilibrium?
    - Do some factors reinforce each other and risk creating an accelerating effect?
    - Are there any "tipping points," passing which could trigger a significant change in behaviour?
- Ensuring that sufficiently wide boundaries are being considered to capture all important interactions and feedback processes. (For example, could heavier than expected surrenders cause deterioration in the company's performance or reputation, triggering a further wave of surrenders?)
- Avoiding biases by exploring a variety of ways in which the situation may evolve, some of which might lead to surprising outcomes.
- Sharing understanding and insights with a wider audience and to allowing others to challenge their own biases and preconceptions.
    - Outputs can be presented graphically.
    - Fast recalculation and presentation of "what if" results in response to users' suggestions.
    - Many people may have informed views of what may happen to model inputs in an extreme situation if the inputs are defined suitably. This may help them to accept outputs that seem counter-intuitive. For example, an investment policy with a maturity guarantee may become more valuable during times of adverse economic conditions. Yet, surrenders may actually increase while such conditions exist, if a key driver of surrender activity is something like unemployment (leading to a need to surrender the investment despite the fact that the maturity guarantee has become more valuable).
- Identifying possible interventions to mitigate or take advantage of the emerging situation and to test their effectiveness in what might be a very unfamiliar environment.

6.2 Features of a "good" behavioural model

To build a model takes a significant investment of time and effort and should not be undertaken lightly.

We set out below what we consider to be the key criteria for a good model of policyholder behaviour in extreme circumstances, focussing on where this may be different from traditional actuarial modelling approaches.

6.2.1 Keep it as simple as possible

"Everything should be made as simple as possible, but not simpler"[1]

[1] attributed to Albert Einstein

An over-complex model is likely to obscure, rather than illuminate the key insights being sought. It will, therefore, almost always be best to build a model for each specific situation.

6.2.2 Clear purpose and scope

It is important to start with a clearly defined purpose for the model and to keep the model as simple as possible, and consistent with this purpose. For example, a 5-year model to study policyholder response to an epidemic should ignore secular trends in mortality and morbidity rates. Age-related effects might be modelled effectively through a few broad age-bands that reflect differences in behaviour as much as different mortality effects.

6.2.3 Model Boundaries

An effective model to explore behaviour under extreme conditions may need to include factors that are not considered in a typical actuarial model, such as company reputation, or policyholders' growing awareness of their ability to move elsewhere for more advantageous terms.

While the model should capture all interactions likely to be relevant for the stated purpose, some factors typically included in actuarial models may safely be left out. For example, the economic environment could be treated as an input, or at least modelled much more simply than in a full stochastic economic model, unless this is crucial to understanding the behaviour being studied.

6.2.4 Beware hidden assumptions and biases in existing models

Existing models may reflect observed behaviours. The resultant model behaviour may then fit past experience well. However, it is impossible to be sure whether this demonstrates that the model will continue to perform reliably even in extreme circumstances – or that it is over-fitted.

For example, the Ptolemaic model of the universe assumed that all planets orbit the Earth in perfect circles. By adding an elaborate system of epicycles to planetary orbits, it was possible to make this model fit observations fairly well. As new observations were made, modellers added ever more complex epicycles – until the Copernican revolution proposed a drastically simpler heliocentric model.

Another example, more familiar to actuaries relates to economic variables, where evidence suggests that they may have greater variance when they are far from their mean values. In response, model-builders have considered making their models heteroscedastic. This may make models fit past observations better, but how can we be sure this will always be a feature of the data? Is there a better theory that might explain the observed data rather than simply adjusting the model to fit the data?

We continually need to remind ourselves that all models simplify reality. The number of parameters and assumptions should be as small as possible while still describing the scenario of interest. Too many parameters reduce understanding and increase the risk of over-fitting. Even if a model fits observed behaviour well in a wide range of situations, it may cease to do so (perhaps spectacularly) in unforeseen or extreme situations. This can have serious consequences, as was seen in the mortgage market, where many decision-makers continued to rely uncritically on their models for pricing secondary mortgage products, even though a key (though often unstated) underlying assumption – that default risks were independent – was increasingly becoming invalid.

6.2.5 Meaningful parameters

Model parameters should, wherever possible, have a clear, real world meaning, so that non-technicians can judge what values are plausible. For instance, it may preferable to use "average time to event" rather than some form of "rate of occurrence," even though one may be the reciprocal of the other.

In the type of scenarios being considered, it will rarely be possible to estimate all parameters from past experience. For parameters with a clear, real world meaning, it should be possible to set plausible,

judgement-based ranges for their values. If a parameter's meaning is not intuitively obvious, this may well not be possible.

Setting key parameter values based on judgement might feel uncomfortable, but there will often be no practical alternative. Where appropriate, the effect of different judgements can usually be assessed via sensitivity analysis, i.e. by varying the assumptions made to assess how critical they are to the conclusions being drawn.

> *"It is better to be vaguely right than exactly wrong"*[1]

A model user may not be able to form an accurate view on how the variance-covariance parameters of an econometric model might change in a given extreme scenario, but may be able to make an "educated guess" based on the results of sensitivity analysis.

6.2.6 Comprehensible

An important modelling objective should be to help create a shared understanding of the processes being modelled – for lay people as well as for model-building technicians. The key mechanisms at work in the model should be clear to all.

Ideally, non-specialists should be able to understand how the model works and satisfy themselves that this is reasonable. This will give confidence that unexpected model predictions are not simply the result of model errors or limitations.

6.2.7 Model Robustness

Generally, actuarial models are fitted to past observed data and ideally their predictions will be compared to an independent set of observations.

For modelling extreme scenarios, this is unlikely to be possible. However, we should at least try to ensure that our model conforms to basic "reality checks" so that it behaves credibly in all conditions in which it is likely to be used.

Examples might include:

1. New business volumes, lapse rates and the number of in-force policies should always remain positive (and not become exponentially large).
2. Sales volume falls as premium rates increase and drops to zero as premium rates get very high.
3. Changes in competitiveness result in believable adjustments to market shares.

6.3 Modelling Approaches

6.3.1 Traditional stochastic modelling is likely to be unhelpful

Actuaries have become accustomed to using stochastic models, particularly for economic variables.
In extreme conditions, we may well experience behaviour that is in the "tail" of our existing stochastic projections. [2]While the stochastic model may produce an acceptable distribution of results across a broad range of possible situations, they are not well suited to explore this extreme type of situation, for several reasons:

1. It may be unsafe to use stochastic models that are derived from behaviour in more normal circumstances. Model parameters may no longer be appropriate, and – even worse – some of the statistical relationships underlying the model may start to break down.

[1] Logic: Deductive and Inductive (Carveth Read 1898) but often (mis)attributed to John Maynard Keynes)
[2] We note that care must be taken when using risk neutral economic stochastic modelling; these are used, for instance for valuing financial options and guarantees by running a large number of scenarios, and individual scenarios are not meaningful by themselves.

2. This may be particularly problematic if model assumptions and boundaries are not clearly understood.
3. Data to build an improved model will be scanty or non-existent.
4. By their nature, traditional actuarial stochastic models often fail to address key aspects of what we seek to study for extreme events:
    a) Model boundaries have usually been drawn to exclude factors such as policyholder behaviour and societal trends. These are treated as exogenous (i.e. they are independently specified outside the model itself) or implicitly allowed for as co-variances between model variables.
    b) Sometimes variables of interest (e.g. employment rates) may not be modelled explicitly at all. Instead, their effect appears implicitly as part of the residual "noise" (i.e. the difference between what the model predicts and what actually happens).
5. Stochastic modelling is essentially descriptive. It does not attempt to explain the causal mechanisms that underlie the statistical relationships modelled. It can therefore offer little guidance as to when the model assumptions might cease to be applicable – though these might be precisely those situations in which we are interested. Nor can it give any guidance as to what might happen if these assumptions do break down.

For example, consider an extreme scenario that might impact lapses. Lapse rates might traditionally be modelled based on past experience, perhaps correlated to some extent with one or more economic variables. But the underlying mechanism that leads to a decision to lapse would not itself be modelled. This makes it impossible to assess to whether the model will remain appropriate in an extreme scenario, and if not, how the model might need to be modified. In addition, we might wish to consider how a change in lapse rates might affect new business pricing, and whether this might counteract or reinforce the trend in lapse rates.

We have therefore sought to explore alternative approaches that might be more appropriate for modelling policyholder behaviour in the types of extreme scenarios we are considering.

6.3.2 Choosing an appropriate modelling approach

We have chosen to present two very different modelling approaches: one approach builds its model from the bottom up; the second takes a top-down approach. Each of these seems to offer some promise for adequately modelling extreme policyholder behaviour.

Whichever approach is used though, it is important to observe the principles set out in Section 6.2 above, concerning the characteristics of a "good" behavioural model.

Note that it is usually helpful to develop a model in a series of iterations, adding extra detail (and if necessary adjusting the model boundaries) as required at each stage. This facilitates both model testing and comprehension. Equally importantly, it helps to ensure that the model is no more elaborate than necessary.

6.3.2.1 Agent-based modelling (ABM)

This is a bottom-up approach, based on the insight that we can often describe complex high-level behaviour in terms of "Agents" (i.e. actors in the modelled scenario – not to be confused with insurance agents) interacting according to fairly simple rules.

Non-financial examples where ABM has been used effectively include:

- predator-prey interactions
- crowd behaviour
- bird-flight
- road traffic

There can be multiple Agent types in a model, each with different rules (e.g. policyholders and insurance companies; sheep and wolves).

Agent-based modelling is likely to be particularly suitable if we can specify simple rules to describe how policyholders (or insurance companies) react to their environment and to each other. This might well be appropriate for policyholder behaviour, which is, after all, the aggregate of the actions of individual policyholders.

The typical steps involved in creating an Agent-based model are as follows:

1. Identify the types of Agent – i.e. the types of individuals whose behaviour will aggregate to that of the system being modelled. (Note that under ABM, Agent behaviour is not allowed to influence exogenous (externally specified) variables. We may envisage that, for example, policyholder behaviour might influence regulator actions. In this case, we will need to include the regulator as a single instance of a specific type of Agent.) Depending on the purpose of the model, types of Agent might include:
    - Existing policyholders
    - Potential policyholders
    - Financial advisers
    - Insurers (us and our competitors)
    - Regulators
    - Government
2. For each type of Agent, define the attributes of interest and suitable initial values, or a suitable distribution of initial values.
3. Define the exogenous variables and their values. (While these might change over time, their evolution cannot be influenced by Agents or the way the model unfolds.)
4. Define the rules by which each Agent will respond to the environment (as described by the exogenous variables) and interact with other Agents of the various types.
5. Configure the model to set up the exogenous variables, create the initial population of Agents and to implement the chosen rules.

6.3.2.2 System dynamics (SD)

This is a top-down approach. It models the key drivers of change and the feedback mechanisms that operate at the system level.
Non-financial examples where SD has been used effectively include:

- manufacturing and distribution systems
- climate change
- epidemics
- adoption of new products

System dynamics may be particularly suitable if we can construct a high-level narrative to describe how an extreme scenario unfolds.

The typical steps involved in creating a System Dynamics model are as follows:

1. Develop a "Causal Loop Diagram" (see Appendix F for more information) showing pictorially the key cause–effect chains and feedback loops within the model. (Note that feedback cannot affect the value of exogenous (externally specified) variables. If such feedback is needed, then the boundary of the model should be adjusted to bring these variables within the scope of the model.)
2. Identify "Stocks" (sometimes called "Levels"). These are variables in the Causal Loop Diagram that maintain their value unless explicitly changed by some modelled "flow" into or out of the Stock in question. The value of a Stock will be its initial value plus the time-integral of its Flows (Flows in minus Flows out). Examples of Stocks might be:
    - Policies in force (flows in: new policies; out: deaths, lapses, maturities…)
    - Premium in force (flows in: premium from new policies; out: premium lost through deaths, lapses, maturities…)
    - Premium rates (flows in/out: premium rate reviews)
    - Policyholders who are impaired (flows in: new substandard-life policies written, existing policyholders becoming impaired; flows out: death, lapses, maturities…)

- Levels of awareness, loyalty and satisfaction (possible flows in: impact of marketing spend; out: decay over time)

3. Develop a (non-numerical) model embodying the "Causal Loop Diagram" showing how each Stock changes its value over time in response to model inputs and other variable values.
4. Select appropriate initial values for the Stocks and the values of exogenous variables and define the equations by which the model evolves over time

6.3.3 ABM and SD Compared

As noted above, it is natural to use ABM models when behavioural rules can be formulated (or intuited) for each individual, even if rules cannot be expressed so simply for Agents as a group. Behaviour will then emerge implicitly as Agents of various types follow the rules (and interact with one another). Such a model may be simple to specify and build (analogous to how using intrinsic coordinates can significantly simplify certain types of mathematical problems), although it may leave aggregate behaviour feeling mysterious. (For example, it is far from obvious how simple rules for bird flight result in the magnificent V-shape formations formed by flocks of migrating birds.)

SD models, by contrast, express rules at a global level, and explicitly allow for feedback loops, both positive and negative. Such a model may be particularly helpful in understanding aggregate behaviour and explaining this to third parties. By its nature however, an SD model does not concern itself with the behaviour of individual Agents. In our context, therefore, it can shed no light on individual behavioural mechanisms that interact to drive the high-level processes.

Since these two modelling approaches appear so different, it was not immediately obvious whether one would be superior to the other in all situations. We therefore modelled a simple scenario using both approaches to assess the strengths and weaknesses of each approach. Details of this work are included in Appendix E. We present here a summary of what we learned in the form of suggestions for effective modelling.

We believe that our conclusions will remain relevant for modelling policyholder behaviour in more realistic extreme situations.

6.4 Suggestions for Effective Modelling

Based on our experience working with Agent Based Modelling and Systems Dynamics, we have drawn some general conclusions that we believe should guide those attempting to model policyholder behaviour in a non-routine or extreme situation.

It is unlikely that any single approach will be suitable for all circumstances. Practitioners will need to select an approach – or combination of approaches – that seems to offer promise for the exercise in hand.

When developing a model, it is important to strike a good balance between simplicity and complexity. For this reason, we recommend building a separate model for each scenario of interest, designed to illuminate the key features of that scenario.

6.4.1 Unnecessary stochastic features should be avoided

In modelling behaviour in extreme conditions, there is likely to be great uncertainty about model parameters, and even about the nature of the behaviours we are trying to model. If so, these uncertainties are likely to dominate natural stochastic variability, possibly by orders of magnitude.

Agent Based models are inherently stochastic so far as Agent behaviour is concerned. This is a good feature, as it is relevant to the issue we are trying to explore. However, including additional stochastic effects (such as for economic factors) risks obscuring the key behaviours within the "fog" of the stochastic effects.

6.4.2 System Dynamics thinking helps understanding

In a simple scenario, there may be little interaction between Agents, so System Dynamics would be the natural approach to use. Systems Dynamics thinking also provides insights into ways to elaborate the model to better reflect a real-life situation.

In a more realistic (and therefore more complex) scenario, there may be a stronger case to use an ABM approach. However, there is a significant risk that important interactions – and therefore important behaviours – will be overlooked if these behaviours are approached solely from a bottom-up perspective.

6.4.3 Building an Agent Based Model feels more intuitive

The Agent Based modelling approach seems a better way to express Behavioural Economics insights, as it preserves the paradigm that overall policyholder behaviour emerges as the result of each policyholder's individual decisions.

Agent Based models seem inherently flexible – they are straightforward to extend and maintain, most agent behaviours can be expressed simply and accurately, and it is relatively easy to "think yourself" into the position of each Agent.

By contrast, System Dynamics models can rapidly become complex. There are many interacting Stocks and Flows, and the model needs "co-chains" of Stocks and Flows to keep track of related variables (e.g. number of policies and premium income) which makes interpretation harder and creates opportunities for variables to get out of step. Further, there may be a temptation to introduce approximations to keep the model manageable, but any such approximations will inevitably cast doubt on model outputs.

Section 7 Translating Policyholder Behaviour into Management Information (MI)

7.1 Benefits of effective MI on Policyholder Behaviour

Systematic collection of MI on policyholder behaviour and its drivers can help in a number of ways.

1. **Improved insight** into how policyholders might respond in unfamiliar or extreme situations.
2. **Better models** and greater confidence in choosing model parameters.
3. **Early warning** of when familiar patterns of policyholder behaviour may be starting to break down.
4. **Effective response** to extreme conditions through appropriate risk management initiatives.

This should result in tangible benefits for the insurer, including:

- Better risk management.
- Increased earnings predictability.
- More efficient allocation and management of solvency capital.

We will first consider the sort of information we need to help achieve these goals. Then we will look at how an insurer might need to augment its existing MI programme to support this.

Some of the MI that may be desirable for considering extreme circumstances may prove quite difficult (or expensive) to collect. There are however a number of potential additional benefits of improved MI on policyholder behaviour, such as information for improved policyholder-focused product design, better management of lapses, more efficient policyholder service and fewer policyholder queries. Insurers will therefore need to consider the total benefits of improved MI against the costs of collecting it.

7.2 Uses for MI

7.2.1 Improved Insight

Before we try to predict policyholder behaviour in as yet unobserved situations, we ought to understand their behaviour in today's familiar conditions. It is not enough to collect data on how policyholders are behaving; we must make the extra effort to understand the behavioural drivers that lie behind this. It may also be helpful to try to get some insight into the mix of motivational factors (Maslow Groups – see Section 4.3) in the policyholder base.

7.2.2 Predicting future behaviour

Once we have some understanding of the factors driving current policyholder behaviour, we can more credibly try to predict how behaviour might change in unfamiliar, possibly extreme circumstances.

We might like to utilise data on historical observed experience during a similar situation. This may be only source of data on policyholder behaviour that is directly relevant, since there is precious little direct information to be had on events which have not yet happened. However, such a past event will reflect a particular combination of circumstances and behavioural drivers that is highly unlikely to ever be repeated. Any such data is must therefore be used with extreme caution.

One useful approach is to establish an expert group to brainstorm what could be the impact of the new scenario on the drivers of policyholder behaviour, and how policyholders are likely to behave in response to these drivers. The group should aim to combine any relevant historical data (either internal to the company, or external if available) with behavioural economics theory and their own expert judgment. An example of this approach is explored in detail in Section 5 of this paper.

7.2.3 Better models

Access to suitable MI can dramatically improve our confidence in policyholder behaviour modelling, in terms of both the power of models that can be built and their credibility.

MI that allows us to understand the relationships between current behaviour and its key behavioural drivers should provide a firm basis to construct a model how of an extreme situation might, through these drivers, impact policyholder behaviour. In this way, our models will be rooted in how policyholders behave in current "normal" conditions. We will also be less reliant on statistical relationships and correlations that may break down in an extreme scenario.

The behavioural drivers themselves will evolve over time, though such changes usually take place on a timescale much longer than that of our models. However, we should consider whether this might change, perhaps in response to the extreme circumstances being modelled.

Our models will include three broad parameter types:

1. Parameters that represent features that we do not expect to change significantly from their current values. These might include policyholders' behavioural drivers or motivational factors. The values chosen for these parameters should be supported by MI.
2. Parameters that describe the extreme situation being modelled. These parameters will be set either on the basis of observation in a developing situation or from the description of the hypothetical scenario under consideration.
3. Parameters that describe how the model responds to the extreme situation. There is likely to be little credible MI to help choose these parameters.

It is clear that expert judgement will be needed to set at least the third type of parameter. Appropriate MI can help to keep the need for this to a minimum. If the "judgement" parameters that remain are chosen carefully (see Section 6.2.5 above), model users can be fairly comfortable that all the model parameters are realistic.

We can employ our panel of experts (see Section 7.2.2 above) to critique model behaviour and our choice of parameters for reasonableness. Care is needed, though, or else bias may creep into the model, and its ability to generate extreme but seemingly implausible outcomes is not systematically removed. These seemingly implausible outcomes may represent precisely the extreme behaviour the model is designed to help us predict (which may later turn out to have been quite plausible indeed).

The use of external data sources, as well as expert judgment, can vastly enhance the quality and credibility of internal data.

7.2.4 Early Warning

It can be difficult to distinguish a genuine change in behaviour from statistical outliers. Raising a false alarm damages credibility and risks diverting management attention unnecessarily; failure to act early enough risks being unprepared for the emerging risk.

Larger quantities of MI may help somewhat, but on its own, this can only take us so far. There is still a risk of missing the change until it is well advanced.

Understanding the drivers of behaviour offers a possibility to mitigate this risk. If seemingly anomalous data does not appear to be explainable in terms of behavioural factors, then it may well be an outlier, although we should always remain open to the possibility that our own biases are blinding us to a possible explanation. If, however, there could be a plausible behavioural explanation for the data then it is more likely to be symptomatic of a genuinely new trend.

7.2.5 Effective Response

To be able to respond appropriately in extreme circumstances, insurers will need to take account of how policyholders are likely to evaluate the situation in behavioural economic terms. Otherwise, well-meaning responses risk being ineffective – or perhaps even counter-productive.

For this, MI that helps to explain the behavioural factors driving policyholder decisions in more normal circumstances will be invaluable.

7.3 Collecting useful management information (MI)

7.3.1 What MI do we need?

A common thread through Section 7.2 is the need to understand the current drivers of behaviour, as well as the key policyholder behaviours themselves. Since, as we saw in Section 5.4 above, different Motivation Groups may well respond in distinct ways, it would be useful to analyse behaviour separately for each Group, or at east to understand the mix of Groups in the policyholder base.

7.3.2 Typical current situation

Understanding day-to-day policyholder behaviour requires systematic collection and appropriate analysis of the data. However, the scope of analysis currently conducted is typically quite limited. More often than not, analysis is limited to quantifying the behaviour, with little or no attempt to understand the factors driving it.

In the case of lapse rate investigations, for example, data is generally analysed by product type and by duration in force, and lapse rates derived accordingly. Rarely is a systematic effort made to identify and analyse information that might uncover drivers of lapse behaviour.

In cases where lapses are clearly affected by external conditions (such as interest-sensitive products) an attempt may be made to assess the correlation between lapses and a relevant external indicator (such as market interest levels). This is a step forward, but still fails to illuminate the reasons for the correlation. The insurer remains unaware of why the correlation works and under what circumstances it might break down.

7.3.3 Better use of existing data

Insurers often have access to a wealth of data which they could exploit to gain a better understanding of their policyholders' behaviour. Many potentially rich sources of additional data, which may explain the key underlying drivers of behaviour, may currently be unused. Useful information could be derived from both internal data (which may be collected through active engagement with policyholders) and external data (e.g. economic and social indices). If combined in a careful and structured way, these can provide meaningful insights into the current drivers of customer behaviour, and therefore enhance our ability to predict likely future behaviour.

There are many reasons why a policyholder may choose to surrender or lapse a contract. The insurer, however, often does not attempt to capture and analyse the rationale for the decision, even though this may have been explored with the policyholder as part of a lapse-reduction programme. Doing so may lead to much greater insight into the rationale for such behaviour, and incidentally help to improve persistency. Where there is no direct interaction with the policyholder, it may be possible to obtain information from the advisor.

Even if a significant quantity of rich data has been recorded, for example to help support the customer service function, this may not get used more widely as a source of MI. Useful information may also be available through existing sales compliance procedures, although its potential value may not be recognised.

7.3.4 Additional sources of MI

Insurers often have access to a wealth of information available to them which may be used in order to gain a better understanding of how their policyholders might behave in extreme circumstances. However, these data are often not properly recorded or fully exploited. Potentially useful information may be derived from internal data (which may be collected through active engagement with policyholders) or from external data (e.g. economic and social indices). If combined in a careful and structured way, these can provide meaningful insights into the drivers of customer behaviour.

Policyholders themselves are an obvious source of MI when it comes to predicting their probable behaviour in future situations. There are many ways in which insurers could more actively engage with policyholders in order to collect valuable information on their likely behaviours. Indeed, this route may be the only option to obtain behavioural and motivational information at a policyholder level. The more interaction there is with policyholders, the more data is generated for data mining, and the more reliable the results are likely to be.

Companies may be able to collect useful information on the drivers of policyholder behaviour by means of a few carefully chosen questions added to existing policyholder surveys. There are other examples of data collection opportunities, such as Vitality (in the UK market) collecting behavioural data via mobile phone apps which track activity, or through links with 3rd party suppliers, e.g. someone entering their gym or using a discount code to go to the cinema. Mobile apps and social media presence provides an opportunity to gain information directly from policyholders and consumers themselves, although an awareness of bias in the information would be needed. Of course, relevant data protection rules and regulations will need to be borne in mind when collecting and retaining any such information.

There is potential to work with external parties such as financial advisors to collect further information for mutual benefit in working towards improving persistency for example. The information that advisors could provide about policyholders' reasons for buying a product and their understanding of how the product meets these needs could be valuable in judging which policies may be particularly vulnerable in extreme conditions.

These data sources could be enhanced by direct policyholder research (for example through focus groups), either as part of some other research activity or as a stand-alone exercise if considered important enough. Qualitative techniques can help to add depth to statistical analysis and to confirm - or otherwise – the behavioural factors influencing policyholder decisions.

7.3.5 External data

Economic data such as unemployment rates, inflation and social indices could be combined with policyholder data to create a better picture of the environment in which events and patterns are occurring. For example, using industry employment rates alongside policyholder occupation data could help predict lapses in retirement savings plans. As pointed out in Neil Cantle and Jennifer Smith's paper, "Lapses in Concentration,"[1] social indices such as levels of international travel could inform the prediction of lapse rates. While they may not be traditionally associated, both are linked to spending capacity in the country and the population's willingness to make "non-essential" expenditures.

There are also useful sources of socio-economic data, often address-based, that can augment the understanding of policyholder behaviour, especially when combined with other, more direct sources of policyholder information described above. Some forms of socio-economic data can give an indication of mix of Motivation Groups (see Section 4.3 above) in a data set, though it may be unsafe to rely on this information at too granular a level. Many insurers already have access to such data sources as part of their marketing activities, though they may not be routinely used as part of MI reporting.

7.3.6 Analysing the MI

Structured MI (which generally relates to quantitative data that is recorded in a structured manner) is easily used by predictive models and there is much of it readily available from internal sources. This is relatively easy to collect and analyse and lends itself to powerful modern techniques such as data mining that can be used to extract new insights. Data mining results in isolation may not be particularly useful for our purpose, unless they are supplemented by insights that can explain the statistical patterns discovered.

On the other hand, unstructured MI (which generally relates to qualitative data and which may not be structured in any particular way) requires more resources, as the information must be transformed

[1] http://uk.milliman.com/insight/2017/Lapses-in-concentration/

from textual formats into something that can be used by a model. The cost of obtaining this information must be justified by the benefits of accessing it. The worth of news article contents, social media posts and policyholders' communications with services and complaints teams must be assessed and, if deemed worthwhile, the sentiments within them transformed into usable MI.

The granularity with which to it is hoped to examine that information must also be considered, both in terms of feasibility of its collection and processing, and in terms of its usefulness.

As we have described in earlier parts of this paper, we should not consider all policyholders as a homogeneous, economically rational group who don't change in their behaviours over time. In some cases, different policyholders may react in entirely opposite ways to a particular situation. Insurers should try to understand these different segments of their current and potential future policyholders who may react differently to each other in different scenarios. Some of these segments are more likely than others to "pioneer" new behaviour patterns.

Therefore, in order to identify trends and changes in behaviour as they are occurring rather than after the fact, its analysis may need to be on a suitably granular level. For many drivers of behaviour, the observable effect will not be immediate and so some data will require appropriate time-lagging.

APPENDIX A LESSONS FROM THE PAST

A.1 Lessons from past company failures.

Based on a review of past company failures in various countries (including the US, Canada, European countries, Argentina, South Africa, Australia, New Zealand and Japan) it is generally the case that policyholder behaviour did not, of itself, bring about the demise or near-demise of any insurer. However, it has often featured as a key catalyst in accelerating such demise once the process is triggered. The main triggers are usually multiple and interconnected, including inadequate pricing and growing too rapidly. In general, mismanagement of the business is often the root cause.

Some specific examples:

- Mutual Benefit Life Insurance Company (US) – The announcement of financial difficulties at Mutual Benefit, arising from the underperforming commercial property investments, generated a surge in policyholder lapse behaviour, as policyholders sought to cash in their policies. This ultimately drove the company to bankruptcy.
- Confederation Life (Canada) – ran into difficulties caused, in the main, by significant, poorly timed and inadequately diversified property investments, together with aggressive expansion into new areas (such as treasury and derivatives) where the company had no prior experience. After a number of failed efforts to rescue the company, it became apparent in late 1994 that a "run" on the company (by its policyholders) was about to occur, as ratings agencies began revising their ratings downwards and sales agents became concerned about writing new business. Shortly afterwards the company entered the liquidation process. In this case, the company seems to have been in terminal decline long before policyholder behaviour (or likely behaviour) became an issue. However, it appears to have hastened the end, or at least the recognition of the end, of the company.
- Equitable Life (UK) – here valuable Guaranteed Annuity Options, based on interest rates from 4%-7%, issued on with profits policies came into the money. The company declared lower terminal bonuses for those policyholders exercising their GAOs, but the Appeal Court subsequent ruled that this was unlawful, resulting in an immediate liability of around £1.5bn, causing the company to close to new business, with certain parts of the portfolio transferred to other companies. This is an example of policyholders taking up a valuable and transparent guarantee which, in combination with various other factors, caused the failure of a major insurer. As an aside it is interesting to note that lapse rates at Equitable increased for all products between 2000 and 2004 to around 10-15%, before reducing to levels of around 5-10% by the end of this period.
- Fedsure Life / Fedsure Group (South Africa) – one of two failures in South Africa in the last twenty years. In the late 1990s it encountered problems of a somewhat similar nature to those experienced by Equitable Life in the UK, leading to its inability to declare more than a zero bonus on its with-profits business. Mismanagement, which had led to excessive historical bonus payments, had attracted new business (and driven better persistency amongst inforce business), such that the situation for the company was ultimately much worse than it might have been when all of these policyholders tried to exit.
- Japan – In the mid to late 1980s Japan's economy experienced an asset boom, with property and stock prices becoming hugely inflated. Life insurers at that time issued long term policies with fixed guarantees of 4-6%, and invested in equities, property and loans to supplement bond investments. In the early 1990s Japan's economy went into recession, with a crash in equity values preceding a long period of low growth, accompanied by an ongoing persistent decline in property and equity values and low interest rates. This resulted in a "negative spread" between portfolio yields and guaranteed interest rates on life insurance policies. Eight companies subsequently failed in Japan, the first of which was Nissan Life in 1997.
  Following the failure of Nissan Life a rehabilitation process was set up to help insolvent life companies, including a cutting of policyholder benefits through reducing reserves and future guaranteed interest rates, high surrender penalties in the years following rehabilitation (e.g. 20% reducing down over 10 years) and the taking over of the insurer by another sponsor

company. Despite the high surrender penalties, lapse rates increased significantly in the period immediately following life insurer failures, settling down to lower levels after a few years.
Policyholder behaviour was not a primary cause of failure (other than in the sense of the high new business volumes which were written in the preceding period). Indeed, it is understood that sponsor companies benefited significantly from the enhanced surrender charges on policies terminating following rehabilitation.
However, after the failure of Nissan there was a clear trend of higher lapse rates on both individual and group business in weak companies prior to their declaration of insolvency (except for Nissan, due to lower public awareness), which would have contributed to deteriorating financial conditions; in particular surrender values were paid out of "good" assets, leaving the remaining portfolio with a higher proportion of "bad" assets than would otherwise have been the case.

- Australia - There are a number of examples in insurer failures in Australia, the most significant being HIH Insurance, which failed in 2001. In this, and some other cases, failure was due to fraud rather than policyholder behaviour.
- New Zealand – policyholder behaviour may have contributed to the collapse of some insurers. For instance Maoriland Life (liquidated in 1951), impaired lives were being underwritten at what had been described as "reasonable substandard rates". In this case, anti-selection on the part of policyholders may have played some part in the eventual downfall of the company.

Lessons learned:

- Beware that guarantees which are not onerous in current conditions may become so in the future, and policyholders take up those options at huge cost.
- Beware of more subtle effects, such as anti-selection
- Don't attract large volumes of new business on terms unfavourable to the insurer. Avoid "selling the family silver"
- Policyholder behaviour may exacerbate other problems in an company; in particular bad publicity causing policyholders to exit
- Press announcements can cause panic.

A.2 Lessons from past extreme events.

Much of the impact of insurance company failures in this section were sourced from the Geneva Association publication "Systemic Risk and Insurance – Special Report of The Geneva Association Systemic Risk Working Group".

We looked at some examples of past events (both those which had a positive impact on a company and those which had negative impacts) from around the world.

Argentina – Following the sovereign debt default, and removal of the currency peg to the dollar (whereby the peso fell from 1 peso/USD to around 3.9) in 2002, the government issued certain decrees to protect insurers. In particular insurers could pay surrender values or convert policies on highly unfavourable terms, or apply waiting periods on surrender values. Whilst insurers were greatly damaged, there were no insolvencies due to such measures. This was similar in Mexico, following the 1982 default.

Following the failure of the German company Mannheimer, all policies were placed with Protektor, a new created guarantee scheme; so that there were no cuts in guaranteed benefits. However, in the year following the transfer lapse rates rose to around 15%p.a. on all life policies, subsequently falling quickly back to a level of around 3%p.a. Thus, uncertainty and loss of confidence drove high lapse rates, despite no policyholder losing any guaranteed benefits.

During 2007 and 2008 there were large outflows from pooled investments, including insurance policies, as policyholders lost confidence in investment markets. UK life products and US fixed annuities saw high

increases in lapse rates (up to 100% increases) in the years preceding the financial crisis, with a significant drop during and after the crisis.

Korean currency crisis (late 1990s) – part of the Asian currency crisis. Local currency (the Won) depreciated with large flight of foreign capital. Interest rates rose from around 12-13% to 30% during 1997; GDP fell 6.7%, with drop of annual personal income of around 40% in USD terms; unemployment rose from 2% to 8.4%. At the time the insurance industry was quite young, with some companies being undercapitalised, valuations based on book values and products dominated by savings products with very low surrender charges. This led to mass surrenders (up to 19% per month for products similar to short-term deposit accounts, and around 6% per month for products similar to long-term savings accounts). 10 out of 33 companies left the market. Subsequent to this the regulatory framework has been reformed, and corporate governance improved in Korea.

Ethias (Belgium) – its flagship product "First", a long-term pension plan, had guarantees on capital and minimum returns, together with profit sharing, but with no surrender penalty and very low fees. The market had complained to the regulator for some time about the risks associated with this product; before reform was made, Ethias faced major asset-liability mismatch in 2008, resulting in the managing director announcing publicly that they needed emergency capital of €1.5bn within 4 days. During 3 days there were €110m of surrenders on the First Product (out of total Ethias liabilities of around €26bn). This was stemmed due to the dismissal of the managing director, a statement from the regulator denying the short timescale for the required capital and confirming that the €100K state guarantee applied to Ethias products. The capital injection was made and corporate governance improved, resulting in Ethias becoming stabilised.

Discovery is a South African insurance company which is credited with revolutionising the South African life and health insurance markets with their Vitality programme. Effectively, the programme became a mass discount club for policyholders, providing discounts on activities aimed at promoting a healthy lifestyle. Ultimately, competitors were forced to try and match the Vitality programme in some way as they could not compete on price/product design alone. Also, policyholders who had become accustomed to the benefits of Vitality were much more likely to remain as loyal customers.

Life insurance surrender rates have risen in recent years in Australia to significantly higher levels that those seen in previous years[1]. Reasons given for this include:

- Reducing need for risk insurance by ageing policyholders
- Stronger competition
- Pressure on household budgets
- Premium rates which automatically increase each year with age
- Churn caused by high up-front commissions on new business

In the 2014 UK Budget an announcement was made of changes that would free up what people can do with their retirement savings. Annuity sales have roughly halved since the announcement. This followed a previous fall of 42% from 2013 to 2014, as many looked to alternatives, such as income draw-down, in the light of unattractive annuity rates. Several annuity providers have stopped selling annuities since the announcement, including Prudential, Standard Life and Friends Life. Just Retirement and Partnership merged in 2016, noting continued interest in impaired life annuities and starting to take on company's pension liabilities.[2]

Lessons learned:

- Extreme movements in the economy can drive mass surrenders.
- Products which are highly liquid (e.g. low surrender penalties) need very careful management.
- Governments may step in in extreme conditions to reflect the industry, e.g. Argentina following the default and currency devaluation. Regulations in Japan and France allow insurers to suspend or limit withdrawals in certain situations [check still the case]
- Loss of confidence can drive policyholder behaviour, even if such a perception is ill-founded

[1] http://riskinfo.com.au/news/2015/01/13/lapse-rates-continue-to-rise/
[2] Financial Times, Telegraph

- Company innovations can change an industry, with policyholders attracted to, and remaining loyal to, arrangements which they may perceive as valuable. This may drive other companies to follow suit.
- Changing demographics can result in damaging policyholder behaviour. Companies need to design products which continue to meet needs
- Regulatory change can have sudden and catastrophic impact on the industry; insurers need to avoid being over-reliant on single product lines.

APPENDIX B FACTORS AFFECTING CONSUMER BUYING BEHAVIOUR

Source: Chapter 3, *Principles of Marketing,* University of Minnesota Libraries Publishing[1]

Situational, personal and psychological factors influence what you buy but only on a temporary basis. Societal factors depend on the world around you and how it works, and therefore have broad influences on people's beliefs and the way they do things.

Understanding these influences can help to explain or determine some of the psychological drivers behind people's actions.

The below captures the key points to note on each of the main factors influencing consumer behaviour.

B.1 Situational factors

1. Physical factors
   - location of store and footfall
   - "Atmospherics" – physical layout of store, music, lighting, temperature, smells
   - Weather – e.g. people may go online more if it's raining
   - Crowding – also linked to "herd behaviour"

2. Social situation
   - More likely to buy from someone you know
   - More likely to try and "conform" to someone else's view of you when buying with others (e.g. what restaurant to take someone to make a good first impression)

3. Time
   - Time of day/year
   - How much time consumers feel they have to shop

4. Reason for purchase
   - Urgency
   - Convenience
   - Necessity

5. Mood
   - Some people see shopping as entertainment
   - "Feeling poor" – after the 2008 stock market crash, while general spending was low, sales of discounted/low-cost products increased. Also sales via TV ads increased, as people didn't spend money on holidays but treated themselves to products while watching TV instead

B.2 Personal factors

1. Personality and self-concept
   - The "Big Five" personality traits that psychologists discuss frequently:
     - **Openness** or how open you are to new experiences
     - **Conscientiousness** or how diligent you are
     - **Extraversion** or how outgoing or shy you are
     - **Agreeableness** or how easy you are to get along with
     - **Neuroticism** or how prone you are to negative mental states

[1] https://open.lib.umn.edu/principlesmarketing/chapter/3-1-factors-that-influence-consumers-buying-behavior/

- The link between people's personalities and their buying behavior is somewhat unclear. Some research studies have shown that "sensation seekers," or people who exhibit extremely high levels of openness, are more likely to respond well to advertising that's violent and graphic. Better link between self-concept and buying behaviour
- "Self-concept" is how someone sees themselves, positive or negative. "Ideal self" (how you would like to see yourself) and others' self-concept (how you think others see you) influences purchase behaviour – it's believed that people buy to enhance themselves and get them closer to their "ideal selves"

2. Gender, Age and Stage of Life
   - Men & Women need and buy different products, shop differently and have different attitudes about shopping. However this may be changing (e.g. younger more educated men may have different views to the older generation)
   - Spending behaviour differs if you are a single new graduate, a newly married couple, a family with children (and where children are toddlers or teenagers), or an "empty nester" (children have left home)
   - Chronological vs cognitive age – buying behaviours more linked to the age people perceive themselves to be
   - Also consider income, education and marital status

3. Income, Education and Marital Status

4. Lifestyle
   - Priorities, values, opinions and general outlook on the world
   - Who do people talk to and what do they talk about
   - Psychographics combines the lifestyle traits of consumers and their personality styles with an analysis of their attitudes, activities, and values to determine groups of consumers with similar characteristics. The VALS framework[1] is one of the most widely used system to classify people.

B.3 Psychological factors

1. Motivation
   - Maslow's Hierarchy of Needs – people need to fulfil basic needs before they seek to fulfil higher level needs.
   - Linked to culture: "While achieving self-actualization may be a goal for many individuals in the United States, consumers in Eastern cultures may focus more on belongingness and group needs."

2. Perception – how you interpret the world around you
   - selective attention (filtering out information based on relevance), selective retention (forgetting information even if relevant, usually because it contradicts a belief), selective distortion (misinterpretation of intended message).
   - Responses include shock advertising (can increase attention, memory and positively influence behaviour), and subliminal advertising. Different people perceive information differently

3. Learning – consumers changing behaviour after gaining information or experience
   - People with limited experience with a product or brand will generally seek out more information than people who have used the product before
   - "operant" or "instrumental condition" – offering rewards, to encourage people to repeat buying behaviour

[1] http://www.strategicbusinessinsights.com/vals/demobehav_lg_2015b.png, http://www.strategicbusinessinsights.com/vals/ustypes.shtml

- Classical conditioning – associating a conditioned stimulus with an unconditioned stimulus to get a particular response

4. Attitude – emotional feelings about a company/product/brand/service/industry
   - Based on people's values and beliefs and generally hard to change
   - E.g. small banks not involved in the 2008 government bailout of banks used this to their advantage in their advertising ("Did your bank take a bailout? We didn't" and "Just say No to Bank Bailouts. Bank Responsibly") to receive new deposits

B.4 Societal factors

1. Culture – shared beliefs, customs, behaviours and attitudes that characterise a society
   - Prescribes the way in which you should live
   - "Even cultures that share many of the same values as the United States can be quite different. Following the meltdown of the financial markets in 2008, countries around the world were pressed by the United States to engage in deficit spending to stimulate the worldwide economy. The plan was a hard sell both to German politicians and to the German people in general. Most Germans don't own credit cards and running up a lot of debt is something people in that culture generally don't do."

2. Subcultures - a group of people within a culture who are different from the dominant culture but have something in common with one another such as common interests, vocations or jobs, religions, ethnic backgrounds, and geographic locations.
   - Marketing professionals can design products or sub-brands to specifically appeal to certain sub-cultures, e.g. college students, or particular ethnic groups in certain areas

3. Social Class - a group of people who have the same social, economic, or educational status in society
   - People in the same social class exhibit similar purchasing behaviour to some degree

4. Reference Groups and Opinion Leaders
   - Reference groups (social groups, work groups, family or close friends) – are groups a consumer identifies with and may want to join. May be aspirational. Also dissociative groups (groups consumer does not want to be associated with)
   - Opinion leaders – people with expertise in certain areas – their opinion can carry a greater weight than any advertising

5. Family
   - One of the most important influences on buying behaviour
   - What people buy are linked to what their parents bought
   - Children have a lot of influence over household purchases ("pester power") – even adult children!

APPENDIX C BEHAVIOURAL ECONOMICS

C.1 Overview

Behavioural Economics is "a method of economic analysis that applies psychological insights into human behaviour to explain economic decision-making". *(www.oxford dictionaries.com)*. This is a major subject in its own right, and it is not the primary focus of this paper. We present here a brief summary of some findings that can help us understand how policyholders might behave in extreme circumstances.

The behaviours below are primarily culled from three sources:

- Applying Behavioural Economics at the Financial Conduct Authority: FCA Occasional Paper No 1 April 2013
- Making Actuaries Less Human - Lessons From Behavioural Finance: Nigel Taylor SIAS 18/01/2000
- Predictably Irrational – The Hidden Forces that Shape Our Decisions: Dan Arieli (Harper Collins 2008 - ISBN 9780061353239)

There is, as would be expected, considerable overlap between these three sources. However, as each approaches the subject from a different perspective, there are some differences too. We have tried to synthesise the insights from all three sources into a single list.
In considering the behaviour described below, it should be borne in mind that they the conclusions are research-based, statistical in nature and seem to be generally applicable. Many of the behaviours interact in real situations. While it may sometimes be difficult to differentiate between them, this is probably unimportant for our purposes.

We have followed the approach of the FCA Paper in grouping behaviours into three broad categories:

1. **Preferences and Perceptions** that set the behavioural context within which decisions are made.
2. **Biases** that can distort the interpretation of information on which decisions are made.
3. **Decision-making** processes through which customers actually make their decisions.

We have tried to indicate a few ways that these behaviours might be expressed. We have chosen examples that should be easily recognisable, though these might not all be directly relevant to the context of this paper. Also, we have tried to avoid Projection Bias (see C.3.3 below) by not limiting our attention to behaviours that seem most relevant to our purpose, since we have no way of knowing a priori which behaviours might turn out to be important in an extreme situation.

C.2 Preferences and Perceptions

C.2.1 Focus on the Present

People tend to prioritise present costs and benefits over future ones, e.g. buying a tablet-PC now using a payday loan without thinking much about how to pay for it.

C.2.2 Reference Dependence and Loss Aversion

People assess outcomes relative to a reference point rather than in absolute terms.

When evaluating alternatives people typically give the risk of loss roughly double the weight of possibility of gain. The choice of reference point can therefore materially affect preferences. For instance, will a given outcome be seen as a loss, or as a smaller gain relative to a lower reference point?

C.2.3 Social Norms

Social norms can be very powerful. People can be more inclined to work harder for a social obligation than for payment. For example, professionals may be more willing to work "pro bono" than for reduced fees.

However, it is important not to "cross the line" and ascribe a financial value for a social service. Once the shift to commercial norms is made, this tends to persist long after the market link is removed.

For example, a kindergarten imposed modest fines for parents who picked up children late. This was intended to encourage them to collect their children promptly. However, it actually made punctuality worse rather than better, as parents were happy to pay to come that bit later! Even after removing the fine, parents didn't revert to their previous behaviour, and the worse punctuality persisted.

To boost employee loyalty and motivation, social norms may be more effective (as well as cheaper) than offering monetary incentives. (Examples might be gifts rather than cash payments; team commitment rather than achievement bonuses)

For an insurer hoping for policyholder loyalty (i.e. policyholder behaviour based on social, rather than strictly commercial norms), the first sign of commercial-norm behaviour by the company (e.g. a penalty for late payment) may destroy loyalty virtually forever. The rapid growth of direct personal lines insurance may illustrate this. Policyholders may previously have been loyal (to a company or their broker), but once it became acceptable to shop around for the cheapest deal, the habit of loyalty was irretrievably broken.

C.2.4 Commitment

Applying some form of disciplinary mechanism (external or self-imposed) helps to maintain commitment to decisions taken.

This applies fields other than finance, for example to on-time delivery and health. Accepting an externally imposed commitment often works work best, but self-imposed commitments may also have a powerful effect.

It ought to have been foreseen that the level of pension saving would decline once – in the name of freedom of choice – compulsory scheme membership was abandoned.

Reminding policyholders of the reasons they bought their policy might help to maintain commitment and improve persistency.

C.2.5 Expectations

People's perception of value (financial, ethical…) is coloured by what they are conditioned to expect.

One way that advertising works is by affecting the expected value of a purchase both before the decision to buy and, once bought, in use. Social stereotypes can be self-reinforcing.

C.2.6 Price-Value Effect

Price can sometimes set value expectations and create its own value "anchor" self-referentially.

Branded jewellery and cosmetics are perceived as worth more than unbranded alternatives that may, objectively, be just as good.

High priced medications may actually perform better than the (identical) low-priced generic medication in clinical trials if patients are aware of the price differential. This seems to be related to the "placebo effect" and to the power of expectations.

C.2.7 Honesty

Even those who think they are honest tend to "bend the rules" a bit – so long as they can still consider themselves honest.

Enforcement and heavy penalties may only help so much. Getting people to recall a moral code (e.g. the Ten Commandments), or to sign up to an Honour Code, immediately before the event seems to help more, even when there is no risk of being caught.

Honesty declarations might be more effective if placed before underwriting questions rather than after.

It is harder to accept bending the rules when cash is involved. Attributing a cash value also helps. Could dishonesty become more of a problem as we continue to move away from cash transactions? Policyholders might be less inclined to make unjustified claims if asked to estimate the cash value of a reported loss.

C.2.8 Regret Avoidance

People prefer to leave things "as they are" to avoid future regret if a positive decision on their part does not turn out well.

For example, people tend to accept the default investment options under a pension scheme, rather than actively choose the alternative that seems most appropriate for their circumstances.

C.2.9 Other Emotions

People tend to avoid ambiguity or stress, and to overreact when fearful. Envy can create dissatisfaction.

An employee may be satisfied with his or her salary in absolute terms, but become dissatisfied once they find out that others are earning more.

In general, people make different (less rational) decisions when they are emotional.

Policyholders may well switch to an untypically risky or seemingly irrational behaviour pattern in response to an emotive or distressing extreme scenario.

C.3 Biases

C.3.1 Over-confidence

In general, people have too much confidence in their own judgment, with those who have more expertise being the most over-confident. (As "Making Actuaries Less Human" makes clear, actuaries are very much like other people in this regard.)

C.3.2 Over-extrapolation

People are too ready to extrapolate from too little, or unrepresentative experience.

C.3.3 Projection bias

There is an innate aversion to predicting negative outcomes. In addition, people find more probable what they find more familiar or easier to imagine.

C.3.4 Hindsight bias

Events that happen will be thought of as having been predictable prior to the event. Conversely, events that do not happen will be thought of as having been unlikely prior to the event.

The absence of any major systems failures due to Y2K issues may be taken as evidence that the risks had been overstated, while neglecting the impact that major remedial programmes may have had.

Consumers of market research tend to feel that the research tells them little new, though – a priori – the findings may be only one of a wide range of possibilities.

C.3.5 Confirmation bias

People tend to look for evidence that confirms their point of view, and to dismiss evidence that is not consistent with it.

Unusually large or small values are too quickly dismissed as "outliers." People tend to choose a data-sample that they feel is typical according to preconceived ideas.

C.3.6 Free offers

Being offered something for free distorts the evaluation process. People act as if, because there is no explicit price, there cannot be a downside. This can even happen if there is a need to give up something of greater value to get the free item.

C.3.7 Ownership bias

Ownership changes people's perspective. Buyers tend to be dispassionate about alternative uses for their money; sellers may have an emotional attachment that causes them to value their asset more highly (perhaps unreasonably so).

House sellers value "their" house more highly than a dispassionate comparison with alternative properties might justify. When combined with "anchoring" after a fall in house prices, this can seriously disrupt the smooth operation of the market.

Free trials and "money back if not satisfied" offers are effective since they allow purchasers to take ownership. This makes it psychologically difficult to cancel or claim a refund later.

The more effort that goes in to owning the product (including effort in deciding to buy), the higher the ownership value-premium is likely to be.

At auctions, there is a tendency to over-bid because as the auction progresses bidders increasingly feel as if the product is "theirs", as they have fought for it. (This is particularly obvious in on-line auctions, where the final price may even exceed the alternative retail cost.)

C.4 Decision-making

C.4.1 Mental Accounting and Narrow Bracketing

People tend to "mentally account" for different "pockets" of money separately and do not balance losses and gains appropriately.

Decisions are often viewed in isolation, rather than being seen as part of the "big picture" (narrow bracketing).

C.4.2 Framing

How a decision is "framed" can affect how it is viewed, especially in combination with Narrow Bracketing and Loss Aversion. Framing can shift focus between long or short term, or upside and downside.

Some examples of differences in framing include:

- "How quickly were you answered?" vs "How long did you wait?"
- "Was it cheap?" vs "How much did they charge?"
- "What level of pension does the plan aim to provide?" vs "How much to do have to pay for a plan like that?"

C.4.3 Anchoring

In the absence of real domain knowledge (and few policyholders can make an informed judgement of a fair price for a financial product), even a spurious contextual "anchor" can help legitimise a certain value. For example, even being asked to recall the last few digits of a telephone number can have this effect.

Then, once an "anchor" has become imprinted, other values will be set coherently round this ("arbitrary coherence").

Once a choice is seriously considered, any new possibilities will be assessed relative to this. Anchoring to past expectations can slow adaptation to changed circumstances.

"Herding" is an initial anchor that can be set due to the behaviour of others, which can cause a chain reaction.

"Self-herding" is where past decisions make it easier to do the same again. (It was fine last time, so there is no need to re-evaluate the options this time.)

Sensitivity to price changes, in the short term at least, may reflect a desire for coherence with past decisions rather than the true economic demand at the new price level.

The herd effect could be important in considering how seemingly irrational behaviour can snowball – e.g. a "run on the bank," or a trend to re-broke existing policies for a relatively minor advantage, or to claim compensation for presumed mis-selling.

C.4.4 Salience and limited attention

People tend to choose the last option mentioned if making a quick decision, or the first option if their decision is deferred. They give greater weight to what they find easy to recall or to imagine.

Graphic reporting of aeroplane accidents, terrorism or risk of identity theft can skew people's assessment of risk by giving these events greater salience than objectively more probable events such as motor accidents.

C.4.5 Keeping Options Open

People are willing to pay, or to give something up, to "keep their options open." This may apply even when the option is clearly inferior, or never likely to be used.

People sometimes buy what they don't really want because otherwise the opportunity will vanish (e.g. in a sale).

People can become stuck between two attractive alternatives, unable to decide between them even if this is far worse than choosing either one.

Some people cannot commit to a partner, because it entails rejecting all the other potential choices!

C.4.6 Decision-making rules of thumb

Below are some examples of "rules of thumb" people tend to follow when making decisions:

- People tend to choose the simplest, or the most familiar options, and generally to avoid risks.
- They tend to choose the middle of 3 choices if they can't really assess their relative worth. Faced with an unfamiliar choice in which they are unable to assess what constitutes good value, the existence of a more expensive option (even if just as unfamiliar) can help validate the choice of the next-cheapest option – e.g. on a restaurant menu.
- Offered a choice of A, A- or B most will choose A since it is clearly better than A-, and they find it too difficult to compare either with B.
- Naïve diversification: people will choose a variety of options if choosing simultaneously, but may choose the same several times if choosing sequentially (see also self-herding in C.4.3 above).
- Myopic loss aversion – With high short-term variability, frequent review of decisions can lead to over-concern about long-term strategy (eg equity variability vs. bonds).

C.4.7 Persuasion and social influences

People tend to trust advice from people who seem likeable. People also tend to choose what they feel will be socially acceptable.

APPENDIX D FURTHER EXAMPLES OF BEHAVIOURAL INSIGHTS IN DIVERSE SCENARIOS

In Section 5, we considered a scenario based on medical advances. Here we present four additional scenarios that could lead to unexpected policyholder behaviour. This list of scenarios is not of course intended to be exhaustive. However, it does serve to illustrate the wide range of situations in which policyholder behaviour may play an important role.

The four extreme scenarios we examine here are:

1. Catastrophe
2. Market dislocation
3. State intervention into markets
4. Social changes

As in Section 5, we have considered:

- The policyholder's rational response to each situation
- The likely responses using behavioural theory

For simplicity (and brevity), we have not considered the three Maslow groups separately for this exercise.

D.1 Catastrophe

War, disease or some other form of non-economic shock could trigger an extreme catastrophe event, causing considerable loss of life. It may also cause economic dislocation, and catalyse major social changes (as did, for example, World War I).

Claims under relevant insured risks will increase – possibly triggering corporate failures, with attendant changes in policyholder attitudes towards insurance companies perceived to be "at risk." The way policyholders perceive the value of insurance cover is also likely to change, while new forms of protection may emerge to meet new perceived needs, or to limit the exposure of insurers in future similar events.

The outcome may well be strongly influenced, positively or negatively, by the response of the government and of regulators, as well as the line taken by opinion formers such as the media.

Example - Epidemic
A major epidemic occurs of a deadly infectious disease (e.g. Ebola) that is largely resistant to current antibiotics. There are thousands of fatalities across all age groups as public health and medical services struggle to cope. With so many people ill, some essential services are disrupted. This, combined with the effect of measures designed to limit the spread of the infection, severely impacts economic activity. It takes several months before life, and economic activity, begins to get back to normal.

There are unusually high claims on in-force protection business as a direct consequence of the catastrophe. This raises concerns for the solvency of some – especially smaller – insurers. A few high-profile cases require intervention or rescue. Self-insured pension schemes also experience difficulties, significantly increasing deficits.

In the aftermath of the epidemic, there is pressure on the Government to provide financial help for the families affected. Despite the difficult economic situation, a degree of assistance is provided – although means-tested to limit the cost. However, this results in less help being made available to those fortunate – or prudent – enough to have adequate life insurance cover.

In response to the greater perceived risk of future epidemics, insurers increase premium rates and seek additional reinsurance protection.

D.1.1 Rational Response

The fact of an epidemic occurring may not actually mean that, over the long term, mortality risks have actually increased. Nor should they think that "lightning doesn't strike in the same place twice" so that just because an epidemic has happened once, that it cannot happen again.

A rational response is to continue to have an adequate mix of protection and longer term savings (subject to affordability), and will have to accept that premium rates may be higher (at least in the shorter term).

D.1.2 Insights from Behavioural Economics

D.1.2.1 Preferences and Perceptions

Focus on present costs and benefits of insurance will be reinforced, so that the importance of protection will increase relative to long-term savings and pensions. The perceived risk of death and illness will be reset to a higher reference point, strengthening the focus on protection benefits.

However, it may take some time for the reference point for the cost of protection cover to adjust to the new reality of increased premium levels. This will encourage policyholders to keep their existing policies in force – assuming they can afford to do so in the aftermath of the economic dislocation.

Those who had not previously bought protection may justify this to themselves since the Government has provided assistance anyway, and they worry that insurance will not pay out when it is needed.

D.1.2.2 Biases

People who have survived the catastrophe unscathed may be over-confident in their ability to manage their way through future problems. Confirmation bias may reinforce this if it helps them to see this as an "outlier" event, rather than perhaps a sign of changed conditions. This may reduce their perceived need for insurance.

Ownership bias will reinforce the value of protection cover to existing policyholders.

D.1.2.3 Decision-making

Decisions to keep or buy insurance will be strongly affected by the focus of media attention, and how this helps to frame the issues.

Decisions will be anchored to existing patterns insurance buying and expenditure, again emphasising the likely gap between behaviour of existing policyholders and those who had not previously bought protection.

On the longer term, a higher level of protection ownership is likely to be seen as prudent this will set a new norm for family expenditure priorities.

D.1.3 Key policyholder behaviours in this scenario

D.1.3.1 Short-term response

Persistency of protection business will improve sharply. However, long-term saving and pension contributions will fall as policyholders adjust their spending priorities in response to the economic dislocation.

Additional protection sales will be sluggish. Rate increases will discourage existing policyholders from buying more cover on what seem expensive terms. There may, however, be a sharp rise in exercise of guaranteed insurability options, especially if these are unaffected by the general rise in rate levels.
Those who had not previously bought protection cover will not suddenly become motivated to buy.

D.1.3.2 Longer-term changes

Assuming there are no repeat events, policyholders will gradually adjust to the new situation. Protection cover will be seen as more important than before, and the new, higher premium levels will become the accepted norm.

Memory of the event will continue to influence behaviour for at least a generation. Penetration of and spending on protection insurance will stabilise at higher levels than before the event. Spending on long-term savings and pensions will also gradually recover as the effects of the economic dislocation fade.

D.2 Market Dislocation

Following a sustained trend of rising prices, an extreme fall in the price of financial or real assets (or an abrupt and adverse change in a key price driver such as inflation) is then cascaded to other asset classes causing a general fall in financial markets. This may well impact the underlying real economy, triggering a severe recession.

In financial markets, we will see increases in the claims cost of investment guarantees, causing short or long-term shifts in the demand for investment guarantees or non-market guarantees (such as policyholder protection).

Example – Asset Price Crash
An asset bubble (e.g. related to property or tulips) eventually pops. Immediate concerns arise about the health of financial institutions. The equity market collapses. The fall in investor confidence leads to increasing unemployment, which further undermines investor confidence, eventually filtering through to a reduction in gross domestic product (GDP). This places further strain on the wider economy and on the financial sector in particular. Due to this volatility, there could be an increased risk of a cycle of insurer insolvencies. Debt defaults (in addition to more general counterparty default) become more widespread, widening the spreads of long-term corporate or even sovereign debt.

This can lead to divergence between different economies. Depending on monetary and fiscal policy, either inflation or deflation may arise in parts of the economy. For economies in a single currency zone (e.g. the Euro-block) not all economies are similarly affected so the currency zone may partially break up. This leads to further loss of confidence and further economic contraction. Equity and debt markets fall further.

Monetary and fiscal policy is used to combat the situation, generating strong inflationary pressures (although this is not inevitable). On the one hand, increased spending can further increases price pressures. This could lead to hyperinflation in extreme cases, at least over a short period of time, as economies seek to inflate their way out of debt difficulties. On the other hand, austerity can generate deflation, causing savings rates to rise as spending is deferred and expectations of continued deflation build, further damaging the economy. This may lead to a deflationary spiral.

D.2.1 Rational Response

A rational response is to take a longer term view of investments, and not to sell simply because markets have fallen (neither to buy after a sustained period of growth), unless it is felt that markets will continue to fall and a safe haven is needed. However for some needing cash this may be their only option.
Nonetheless a long term view of investments should consider having proportion in “safer” asset classes as volatility is a feature of equity markets.

It may well be a rational response to cash in valuable guarantees at such a time.

D.2.2 Insights from Behavioural Economics

D.2.2.1 Preferences and Perceptions

Policyholders will have come to see high and rising markets as the norm, and will be disillusioned when this proves not to be the case. Their reference point for the value of their investment is likely to be at or near the top of the market, rather than at the level at which they originally "bought in".

Loss-aversion means that greater weight will be given to risk of further loss than to possibility of future gains. Even the prospect of a partial recovery will still be perceived as a loss relative to this high reference point. They may therefore prefer to move their money somewhere they perceive as safer. This will incidentally allow them to reset their reference point to a new, perhaps more realistic level.

Regret avoidance ought to work in favour of retaining existing investments so as not to miss out on future gains (e.g. from a recovery). In practice, though, this preference is likely to be overwhelmed by the other factors in play. Until the emotional reaction (to "cut losses" and take their money somewhere perceived as safer) cools off, policyholder may find it difficult to accept even a convincing case for a different approach.

D.2.2.2 Biases

Policyholders may have a degree of ownership bias in favour of their financial products if they feel they have invested effort in choosing them and contributing towards them at the expense of alternative uses for their money. There may be a sense of satisfaction that comes from, for example, having started a pension plan or bought a prestigious investment product.

Previous over-confidence that markets will always rise, and that past gains are a good indication of future performance will be shattered by the crash.

Journalists and other pundits have their own hindsight biases, and will probably create a feeling that the market crash was foreseen (by them at least) and inevitable. The unspoken implication will be that their policy was probably a bad investment in the first place. Policyholders may well tell themselves that they were uncomfortable with the investment all along, and now feel vindicated. This may lead them to distrust advice from their insurer and financial adviser and instead pay attention to other (perhaps less informed) sources that tend to confirm their new convictions.

D.2.2.3 Decision-making

While the crash is making headline news, its salience will be high, and will strongly influence all decision-making. Once the economy and markets stabilise (or new exciting stories start to occupy the headlines) this may fairly rapidly recede into the background. This will allow the post-crash reality to become accepted as the new normal.

Policyholders' attitude to the loss of value of their investment may depend on how they view it relative to other parts of their financial assets. If, for example, it is part of their pensions savings (and they are some way off retirement), they may mentally account for this as a separate pool of assets. As a result, they may not feel that much poorer, especially if attention is focussed on the longer-term pension benefit rather than the current cash value (which is not currently accessible anyway).

D.2.3 Key policyholder behaviours in this scenario

D.2.3.1 Short-term response

In the immediate aftermath of the crash, there is likely to be a flight to what are perceived as safer investments. This will particularly affect policies with an immediate cash value such as Bonds and savings products, and wherever the current cash value of the policy is given (perhaps undue) salience.

Policyholders may surrender, or possibly switch to safer-feeling investment options such as Cash Funds if their policy permits this – and if their confidence in their insurer has not also been shaken.

Exercise of any guaranteed surrender terms or annuity options is likely to peak during this phase.

D.2.3.2 Longer-term changes

As the post-crash situation becomes the new reality, policyholders who have not already cashed their investments will gradually reset their reference points and are likely regain their comfort with their policies. They may even feel pleased with their decision to hold on if markets rally from their low point, as they now feel they can take credit for gains compared with having "bailed out" earlier.

Lapse rates will return to more normal levels – possibly even lower than pre-crash levels, as the least committed investors will already have lapsed.

Those who switched with their policies to eg Cash Funds – and are therefore still policyholders – will gradually revert to less emotional decision-making. Their usual financial advisers will start to regain their trust. Investment choices will gradually cease to be panic-driven and will revert to a pattern more suited to policyholders' long-term financial goals.

It may be possible to regain policyholders who surrendered their policies in the aftermath of the crash. However, any approach to this must recognise that they still feel they lost money due to the crash (for which they may hold the insurer at least partly to blame). Unlike policyholders who "toughed it out," their expectations will probably still be strongly coloured by the crash, and they will need to be offered a different form of investment that recognises this – perhaps one with some downside protection.

D.3 State Intervention in Markets

Changes made by the state or federation, through regulation, fiscal policy or monetary policies, lead to market distortions or expectations of market dislocations.

Example – New Pensions Regime
Government simultaneously introduces compulsory enrolment of the working population in pension arrangements and tax incentives for the same products. If, as a result of this, new products are developed which are perceived as more attractive, yet which, for whatever reason, have thinner margins, insurers will be worse off with the new products and will also face mass lapses on the established products. This could also happen in health care or any other major product category.

D.3.1 Rational Response

A rational response is to weigh up whether the new arrangements (including tax incentives) indeed do represent better value and switch products if they do (allowing for any penalties in doing so).

For those without a pension arrangement they should seriously consider taking advantage of such tax incentives, but take proper advice in making such a long term decision.

D.3.2 Insights from Behavioural Economics

D.3.2.1 Preferences and Perceptions

Policyholders will focus primarily on today's costs and benefits, and they will assess their options relative to their current position. If not already contributing, then compulsory enrolment will be a big extra cost, so they are unlikely to have much appetite for more than the minimum contribution.

If already contributing to an existing plan, then they will tend to focus on what is the best use of their current outgoings. Current tax savings may count more than a difference in income many years in the future. Any perceived "loss" compared to their previous expectations (e.g. due to changed tax treatment)

will weigh more heavily than possible upside benefits (whether of switching to the new, lower charge product or of staying with their existing product).

Lower charges on the new product compared with the existing one may make policyholders feel their existing provider is overcharging them, undermining loyalty. It seems unlikely that policyholders can be convinced that higher charges on "old" products represent better value. An offer to mitigate the effect of higher charges might help to counteract the feeling of resentment. However, such an offer will probably still be judged as a commercial move rather than an altruistic one, and they will decide whether to continue or switch on mainly financial grounds.

Compulsion will certainly help with commitment for those not currently contributing. Regret avoidance may mean that policyholders currently contributing more than the new compulsory minimum can fairly easily be persuaded to maintain their current level of contributions, rather than to cut back to the new minimum level.

Introducing compulsion and setting a minimum contribution level will tend to undermine people's sense of responsibility to plan properly for their own retirement, and to create a norm for what is an appropriate level of contribution. As a result, there may be more temptation to make do with the compulsory minimum, and to rely on the State for any shortfall.

Since people generally find financial decisions stressful, they will tend to go with the easiest option to implement. This may mean keeping existing products, but not if this means extra work to avoid being swept into an employer's new arrangement.

D.3.2.2 Biases

Confirmation bias means that policyholders may be strongly influenced by opinions that validate their previous decisions (choice of company, product, contribution level) or their choice in the new situation.

For those who have already bought a pension product, and especially if they felt involved in the process of starting it, ownership bias may help to maintain to their existing product. They will, however, need reassurance that it is still a good option in the light of the new alternatives.

D.3.2.3 Decision-making

Mental accounting may hinder a proper assessment of alternatives. For example, policyholders may not properly offset the impact of an exit penalty on their existing plan (perhaps attributing this to unfair behaviour by their current insurer) against the benefits of a new one. On the other hand, narrow bracketing might mean that policyholders view what to do about their existing policy and about the new pensions regime as separate decisions.

Decisions will be strongly influenced by how they are framed. This might be in terms of:

- Achieving better pension benefits in future; or lower charges.
- Extra benefit from employer contribution and new tax breaks; or the opportunity to cut back on contributions.
- Quality of life in retirement; or current spending on pensions.

The minimum level set for compulsory contributions may become "anchored" as the normal contribution level, especially for those who have not previously had their own pension plan. The level of mandated charges on the new product may become a benchmark against which charges for all products are assessed (including non-pensions products).

In the absence a clear best choice, policyholders will tend to follow the simplest course of action, especially if they need to make a decision within an imposed timeframe. This is likely to be to join their employer's new compulsory plan. "Herding" will also encourage policyholders to go down this route, since many of those around them seem to be doing the same.

To counter this, companies will need to make it easy for policyholders to keep their existing policies. Policyholders may also be willing to defer cancelling their existing product even if they do choose to join their employer's scheme (if they can afford to do this). This will allow them to keep their options open, as they know that they will not be able to "un-cancel" later.

Offering a choice to move to an enhanced version of their existing policy might be attractive (the choice would then be A+, A or the new product B).

D.3.3 Key policyholder behaviours in this scenario

D.3.3.1 Short-term response

The immediate effect will be that large numbers of people with no existing pension provision will be enrolled in employers' plans for the minimum contribution level.

Most existing pensions policyholders will also enrol in their employers' schemes. A proportion will also maintain their existing policies at either their existing or a reduced level of contribution. Very few will choose to maintain their existing policy instead of their employer's scheme, as this will seem too complex an option for most to contemplate, and will seem to risk losing some or all of tax advantages, employer contributions and lower charges.

D.3.3.2 Longer-term changes

The proportion of those with some form of pensions provision will have risen. However, the vast majority will contribute at the minimum mandated level. Most people will expect that this contribution level will generate an adequate standard of living for them in retirement. There is a concomitant risk of pressure for State assistance for those who end up with inadequate retirement income.

D.4 Social Changes

Sustained and gradual changes to life and society cause unforeseen and far-reaching consequences.

For example, longevity combined with low birth rates will create strains in inter-generational transfers inherent in pension provisions as well as challenges in resourcing and funding health care for the retired. In addition, through their knock-on impact on property ownership and social mobility, this can affect demand for different types of insurance contracts, and therefore underwriting and distribution models.

Other challenges may arise from changes in attitudes to education, work and retirement (perhaps catalysed by technological advances), or from significant immigration, with the potential to affect key demographic variables (population age balance, birth rates) and adding to cultural diversity.

Example – Increasing Longevity
Significant increases over time in life expectancy at older ages will mean that people need to accumulate larger than anticipated sums to fund their desired standard of living in retirement.

To the extent that pensions are funded by defined benefit pension schemes, the costs of increasing longevity will be passed to employers. This is one of the factors leading to the majority of such schemes being closed to new entrants and – increasingly – to future benefit accrual.

For people to meet expectations of pension income through money-purchase arrangements – whether individual or employer-sponsored – they will need to make higher contributions, or to contribute for longer and retire later, or some combination of the two.

Buying an annuity at retirement passes the future longevity risk to an insurer for the phase of life in which the ability to meet shortfalls is most limited. However, the traditional annuity seems both

inflexible and expensive, and recent Government initiatives have made alternatives to a traditional annuity more readily available. This could be a two-edged sword however, if pensioners underestimate how much money they will need to live comfortably in their later years. If they spend too much in their earlier retirement years, those who survive to advanced ages may well find they have used up all their pot.

D.4.1 Rational Response

This is a critical decision for which appropriate advice should be taken.

A rational response is to carry out a budgeting exercises to make realistic assessments of what they may need in retirement, and how much they therefore need to contribute to reach that target. This may include determining the "minimum required" (for which a safer vehicle such as an annuity may be appropriate at retirement) and an amount on top for which some degree of risk may be acceptable.

A long term view of investments should also be taken, with some degree of risk taken over the longer term in order to achieve higher returns, with perhaps a move towards safer investments as retirement approaches.

D.4.2 Insights from Behavioural Economics

D.4.2.1 Preferences and Perceptions

As ever with pensions, the challenge is to overcome focus on the present and to persuade people to forego current consumption to fund their pension plan adequately. Automatic enrolment is a good start, as this is reinforced by regret-avoidance.

Expectations for retirement at a certain age will probably also need to change, encouraged by the Government through changes to State Pension Age and employment law.
Commitment will help to ensure that policyholders continue to contribute the agreed percentage of salary to their plans, once they have started them.

In using flexibility to draw benefits in retirement, focus on the present may lead people to spend too much of their pensions pot early in their retirement, leaving inadequate resources for their old age. This tendency will be exaggerated if their overall pension provision is inadequate compared with their expectations.

It will take time for retirees' reference point to adjust to their realistic =sustainable level of income in retirement. This may reinforce the temptation to dip into their pensions pot early.

Loss aversion may influence investors to "play safe" and keep too much of their pensions pot in cash. This will leave them exposed to potential losses from inflation, and, for those still saving for retirement the "loss" of having to contribute at a higher rate to make up for a lower level of investment returns.

Social norms (or possibly minimum levels mandated by Government) are likely to strongly influence what is regarded as an acceptable level of pension contribution. (If these prove inadequate in retrospect, who will be blamed for mis-selling?)

D.4.2.2 Biases

Pensioners may be over-confident in their ability to manage for the rest of their lives on the pension pot they have accumulated, particularly if the sums involved are much bigger than they are accustomed to dealing with.

They may discount the possibility of living to an advanced age, both as inconsistent with their experience of previous generations and as something they do not want to think about too much.

Confirmation bias may erode the perceived value of buying an annuity. They may know of people who died early (and lost out), but are less likely to know people who have benefited from an annuity due to their longevity.

D.4.2.3 Decision-making

Narrow bracketing may cause policyholders to consider their retirement savings separately from their other forms of saving.

Pension decisions will depend crucially on how they are framed. While saving for retirement, this is likely to be: "How much (or how little) do I need to save out of current income for my retirement?" This will probably be judged relative to an anchor of the minimum mandated level. In retirement, the framing is likely to be in terms of: "How much can I afford to spend now?" anchored, at least initially, at the level of their pre-retirement consumption patterns.

The inability to "recover" money invested in a pension plan or in a traditional annuity will make policyholders wary of investing more than what they perceive as the minimum acceptable in these products.

D.4.3 Key policyholder behaviours in this scenario

Since this is a slowly developing scenario, there will be no clear distinction between a short-term immediate change in behaviour and longer-term changes.

Policyholders will in general accept a mandated level of pensions contribution. However, persuading them to make higher contributions will be more difficult. This places an onus on those setting the mandated level to ensure that this is likely to be adequate.

Given a choice, the traditional fixed annuity will seem unattractive and many policyholders will seek alternatives. As a secondary market in annuities develops, we will see a trend to cashing in existing annuitized pensions as well, in order to access the greater flexibility of alternative arrangements.
Many policyholders, faced with seemingly very large sums at retirement, will be tempted to draw too much of this for immediate spending, leaving those who do experience a long retirement to face a potential income shortfall in their declining years.

To the extent that pensioners' families become aware of their parents' financial difficulties, this will help change perceptions of the importance of making adequate provision for themselves. However, if they are forced to help their own parents financially, this may limit their own ability to do so, perhaps until they are close to retirement.

APPENDIX E COMPARISON OF MODELLING TOOLS AND APPROACHES

E.1 Early Modelling Work

Our initial approach to exploring the two modelling approaches chosen were to examine them independently in two separate subgroups. This exercise helped us start to get familiar with each approach as quickly as possible, and to understand the key advantages and disadvantages of each in a clear, practical manner.

Since at this early stage, we were unsure whether each approach could be applied effectively to all the scenarios we might be interested in, we decided to allow each subgroup to choose a scenario that it felt would be suitable for its assigned modelling approach.

E.1.1 Agent Based Modelling (ABM) subgroup

The ABM subgroup chose to model potential take-up rates based on policyholder circumstances, and subsequent lapse rates, of the following scenario using Excel:

- Government introduces tax relief on certain products
- Insurance company introduces a whole of life product with surrender value payable after the first 2 years, where policyholders benefit from less income tax if they take out the product

The model assumed the group of policyholders being considered only react to the economic environment, and that both government decisions and the economy are independent of the policyholders' individual situations. We also assumed that all of the insurance company's policies are sold through one broker and there are no competitors.

Economic status was defined very simply as either 'Good', 'Normal' or 'Recession'.

Employment status was classified into 'Employed', 'Unemployed' and 'Retired', with retirement age assumed to be 65. Under the 'Employed' category, the individual could also be classed by employment level, as either 'Manager' or 'Worker'.

Marital Status was defined as 'Single', 'Married', 'Divorced' or 'Widowed'.

Simple assumptions were made to relate the following:

- average salary, tax rate, awareness and broker relationship by employment status
- Inflation and interest rate by economic status
- disposable income (as a % of salary) by age band and employment status
- % of cumulative savings spent by age band and employment status

The following transition probabilities were also defined:

- Moving between employment states, by economic status
- Being promoted/demoted
- Moving between marital statuses, by age band
- Dying by age band
- Having children by age and marital status
- Moving between economic scenarios

The relationship between take-up rates and lapse rates with an individual's profile was then defined as a series of probabilities. Take-up rates were assumed to depend on individual awareness (scored on a scale of 0 to 1), broker relationship (scored on a scale of 0 to 1), age, disposable income, cumulative savings and employment status. Lapse rates were assumed to depend on age, disposable income and cumulative savings. Simple assumptions were made regarding the probability of take-up and of lapse by each of the above factors (for e.g. assumed all those aged less than 50 years have a 50% probability of take up).

An Excel VBA code was then written in order to allow the model to run single policyholder projections, multiple policyholder projections and, finally, multiple policyholder projections in multiple scenarios.

E.1.2 System Dynamics ("SD") subgroup

The SD subgroup chose to model the "Medical Advances" scenario (set out in section 5.2) where there is a breakthrough in the availability and use of medical screening such that those screened positive will have a much higher future mortality than those screened negative, with a focus on the following areas:

- The impact that this knowledge might have on potential policyholders' buying behaviour;
- How insurers might react to this; and
- How constraints that society might place on insurers' freedom to make use of the information might affect the outcome.

Further insights into how this model was constructed can be found in Appendix F below, where Causal Loop Diagrams illustrate the way the model was progressively developed.

An SD modelling tool, Vensim PLE (further details in Appendix E.3.3), was used for this exercise, and the time step for modelling purposes was taken as 1 year. A number of simplifications in the scenario were made, such as:

- Ignoring any feedback loops within the model that impacted the availability or take-up of screening, such as the impact on the state of the nation's health and on healthcare costs.
- Exclusion from the model of certain behavioural scenarios, such as anti-selective behaviour (e.g. potential policyholders not disclosing screening results at underwriting stage, or changing their claim behaviour) and company responses (e.g. tightening policy conditions, encouraging impaired policyholders to undertake regular checks)
- Impact on costs of the insurer's business (e.g. from stricter underwriting or changes in business volumes)
- Ignoring the impact of age and duration on lapse and mortality rates

The following "Stocks" (a quantity that will retain its value unless changed in responses to some mechanism defined within the model) were identified:

- Availability of screening;
- Numbers of potential policyholders and actual policyholders unscreened, screened negative and screened positive;
- The level of premium rates;
- Underwriting loadings applied to proposers screened positive and negative (the latter will be a "preferred life discount");
- Perceived unfairness of underwriting being applied; and
- Access to screening results for underwriting.

A Vensim model was then constructed to illustrate the impact on an insurer's mix of policyholders, mortality experience and profitability.

E.1.3 Comparing Modelling Approaches

The conclusions of the two workstreams above were summarised in the following table. We have also included Stochastic Modelling as a benchmark that should be familiar to most actuaries.

				Modelling Approach		
Criterion	**Definition**	**Modelling "extreme conditions"**	**Models should avoid**	**Stochastic**	**System Dynamics**	**Agent Based**
Keep it as simple as possible	Specific to situation. New relationships and formulae can be readily added.	Learn from evolving situation; test possible impact of planned intervention strategies.	Requiring extensive changes, to the extent that it becomes unclear how the new model compares with the old one.	-/+ Depends on the initial model build, how flexible the model is in the first place	+ models readily extendable	-/+ should be fairly simple to add new relationships/formulae but may be complicated by interaction with existing parameters
Clear purpose and scope	Boundaries of model and assumptions behind it clear.	Need to understand when circumstances are becoming too "extreme" for the model to handle.	Hidden assumptions (e.g. inflation cannot be negative).	- not clear when assumptions implicit in fitting the model to historical data will break down	+ explicit boundaries and causal mechanisms	+ assumptions are clear as inputs are defined on an Agent level - not so clear where the boundaries are since this is a "bottom up" approach
Model Boundaries	Provides guidance on possible outcomes in extreme conditions.	Model should give guidance in extreme, but (as yet) unobserved situations.	Not being applicable in extreme conditions.	- applicability to extreme conditions unknown, possibly dangerous	+ applicable while the underlying (explicit) relationships remain valid	+ applicable as long as behavioural parameters have been coded appropriately
Beware hidden assumptions and biases in existing models	Limited number of parameters, assumptions. Avoid overfitting.		Overfitting to agree with observed outcomes.	- prone to overfitting (e.g. adding heteroscedacity) since models are at heart statistical with no underlying causal "narrative"	- although there is a causal "narrative" some of the relationships and parameters may be plausible rather than based on real evidence	- potentially a lot of parameters and assumptions which are difficult to justify because they are behavioural based + however a subset of parameters (e.g. economy / salaries / unemployment) could be justified from historical evidence

				Modelling Approach		
Criterion	**Definition**	**Modelling "extreme conditions"**	**Models should avoid**	**Stochastic**	**System Dynamics**	**Agent Based**
Meaningful parameters	Parameters in the model should have a clear, real world meaning; non-technicians can judge what values are plausible. Readily able to test the impact of changes to key model inputs.	Judgement as to what values are plausible may change as extreme circumstances unfold. Provide learning tool to assess possible outcomes.	Many obscure technical parameters. Testing "what if" scenarios requiring extensive "batch" activity, so that the learning benefits are diluted.	- many relationships and parameters are statistical, not based on comprehensible real world values + scenario testing the norm for many models	+ all assumptions are explicit and intuitively meaningful + easy to vary inputs to test the impact	+ Each individual assumption is easy to understand since assumptions are based on real life behaviours so should be fairly intuitive + easy to vary inputs and test impact
Comprehen-sible	Formulae readily checked and ideally comprehensible to non-specialists. Help create shared understanding of processes for laymen as well as technicians. Mechanisms at work are clear.	Need confidence that unexpected model predictions are "real" and not the result of model errors or limitations. Understanding is vital to avoid blind faith in either the model or in intuition based on past experience.	Large number of formulae to check, with meaning of parameters in formulae not obvious (i.e. the typical Excel spreadsheet!). "Black box".	- large number of formulae to check, not necessarily comprehensible to non-specialists + Monte Carlo approach easy to grasp - underlying processes hidden	+ limited number of formulae (just one for each relationship) + all parameters in formulae can have meaningful names + underlying processes clearly identified via "Causal Loop Diagramming" + can trace causal links in the model to help understand what "drives" the outcome	- large number of formulae to cater for interactions and scenario generation +/- behaviour based actions would be understandable to non-specialists but the number of interactions may complicate it + spreadsheet model not a black box so could be followed + can help to understand overall impact of a group of individuals
Model Robustness	Internally consistent, fit and compare to past observed behaviour. Model behaves credibly in all	May be little or no relevant data	Generating impossible results, such as negative lapse rates.	+ statistical model-fitting well understood - need to test both via formulae and via checking output in a variety of extreme conditions	- may need to "reverse engineer" parameters to obtain fit, with additional constraint that values need to make sense for each parameter	- comparisons may be difficult especially if comparing to a past event outside of the company, for which the company has no / limited data/info + can define and apply a list of "reality tests"

				Modelling Approach		
Criterion	**Definition**	**Modelling "extreme conditions"**	**Models should avoid**	**Stochastic**	**System Dynamics**	**Agent Based**
	conditions (e.g. "if no inforce business then no lapses").				+ can define and apply a list of "reality tests"	

E.1.4 Next Steps

While the above exercise was useful in understanding the workings of the two modelling approaches, it was difficult to provide a true comparison of the two modelling approaches because different scenarios were chosen for each model. On the plus side, our experience gave us confidence that both approaches could at least in principle be applied to a wide range of scenarios of interest.

We therefore decided that the sensible next stage would be to apply the different modelling approaches to the same scenario, and to pare the scenario down to something much more simplistic, in order to better compare the effectiveness of the two approaches.

E.2 Simple Scenario

We considered a scenario of improving mortality, with protection premium rates falling in step. Policyholders in good health therefore have the option to lapse and re-enter, or to lapse and switch to a competitor. This process is modelled very simply by assuming that, of those eligible to do so, a fraction proportional to the saving in premiums choose to do so each year.

E.2.1 Core Assumptions

- 1000 policies (lives) at time 0
- All policies have a Sum Assured (SA) of 1000
- All policies (initially) have a premium of SA * initial mortality rate
- All policies are issued at time 0 for a term of 10 years
- There are no "normal" lapses
- Premium rates for a replacement policy fall in line with mortality improvements (see below)

E.2.2 Mortality

- All lives start as select at time 0
- Initial mortality rate for (select) lives is 0.010
- A constant 5% pa of select survivors become impaired at the end of each year
- Impaired (sick) lives experience 25% higher mortality than select lives
- Mortality is constant by age but improves by 2% (i.e. * 0.98) at the end of each year

E.2.3 Lapse and Re-entry

- The probability of exercising the option to move to a cheaper premium at the end of each year is a multiple (0, 1, 2 or 3) of the % saving that could be achieved (so that no savings = no exercise)
- Policies exercising the option either re-enter at the lower premium, but otherwise unchanged, or lapse completely (no further premiums or claims – they are presumed to move to a competitor).

E.3 Modelling Tools Tested

E.3.1 Excel

Excel is very familiar to actuaries and widely available. However, it has limitations for this type of modelling exercise:

- Need to use VBA to avoid huge worksheets (#Agents * # Variables * # Time Periods)
- VBA obscures one of Excel's main strengths – it is no longer easy to see what is happening.
- VBA also makes debugging much more complex.
- Run times are very long compared with other approaches.

E.3.2 NetLogo

NetLogo is a free tool designed specifically for ABM that will run on most computers running Windows or Mac OSX, or other systems on which Java 6 or later is available.[1]

The programming language is fairly simple and powerful but may be unfamiliar to many actuaries. Documentation is good, and once past the initial learning curve programming becomes fairly intuitive, at least for all the most used functionality.

[1] http://ccl.northwestern.edu/netlogo/index.shtml

E.3.3 Vensim

Vensim is a suite of SD tools of increasing functionality (and price) produced by Ventana Systems. It is available for Windows and Mac OSX.[1]

For the purpose of this paper, we have used the most basic package: Vensim PLE (Personal Learning Edition), as this is available free for personal or educational use and for limited time evaluation.

Programming in Vensim proceeds at two levels:

- Building the Stock-Flow diagram, together with auxiliary, exogenous and summary variables, linked by causal arrows.
- Defining the formulae that control detailed behaviour.

Vensim has an extensive library of built-in functions and also includes functionality for "dimension" checks *(eg "annual premium per policy" * "no of policies" should have dimension "pounds per year")* and run-time warnings if variables go outside pre-set bounds. There is also a Reality Check capability that we have not explored.

E.4 Our Models

In all, four models were created:

1. A deterministic Excel model to provide a benchmark against which to test the results of other models and to assess the effect of stochastic variation.
2. An Agent Based Model built in Excel (*Model X*) using macros to iterate over the policy "Agents".
3. An alternative Agent Based model (*Model N*) built in NetLogo, and designed to replicate as closely as possible the functionality of Model X.
4. A Systems Dynamics model (*Model S*) built in Vensim PLE.

Note that with the parameters specified, sick lives will never exercise (premiums will not fall over 10 years at 2% pa to offset the extra mortality for sick lives). This seems reasonable, and is "hard coded" into Models N and S. However, with a more aggressive mortality improvement assumption, Model X would allow some impaired (sick) lives to exercise, whereas this will never happen (as currently coded) under Models N or S.

Lapse and re-entry in Models X and N is stochastic: in Model S the process is deterministic. While it is possible to introduce stochastic behaviour into an SD model, it adds to the model's complexity and makes it harder to interpret the results. We therefore chose not to do so for this exercise. We discuss this point in our conclusions (see Section 6.3.1).

Also, Agent Based models, by their nature, work with integral numbers (you can't have a fraction of an Agent), whereas it is more natural to work with real numbers (implying a fractional policy, deaths etc.) in the other models.

A further difference is that Systems Dynamics models generally operate in continuous time (Vensim updates values of "Stocks" by integrating their inputs and outputs), whereas Excel and NetLogo operate in discrete time steps. It would be possible to make these models approximate to continuous time more closely by using a shorter time-step instead of years, but with a penalty in terms of model size and run-time.

We initially chose to use Excel for modelling as it is almost universally available and very familiar to actuaries. However, as Excel is an "all-purpose" tool, we wanted to compare this with a modelling tool specifically designed for Agent Based modelling.

Excel seems unsuited to System Dynamics modelling. It could lead to huge models (with a separate cell for each variable at each time-point). Most of the functionality of a specific tool would need to be created

[1] http://vensim.com

in complex macros. Also, Excel lacks the graphic layout of "Stocks" and "Flows" that can be so helpful in visualising how the model works.

E.5 How well did our Models meet our design criteria?

In Section 6.2, we described what we believe are the criteria of a good behavioural model. Here, we consider how well Models X, N and S meet these criteria.

E.5.1 Keep it as simple as possible

Our scenario was very simple, and this was reflected in Models N and S.

However, even in this simple case Model X (Excel) was quite complicated as it needed to use VBM to recreate functionality that is a standard part of ABM software such as NetLogo.

E.5.2 Clear purpose and scope

All the models had the same clearly defined purpose and scope.

E.5.3 Model Boundaries

All the models had the same boundaries.

E.5.4 Hidden assumptions and biases in existing models

This is not really relevant in our simplistic scenario.

E.5.5 Meaningful parameters

Parameters in Excel are identified with specific Cells. Giving these meaningful names can help to make formulae clearer. There are limits to the ability to do this, though. Formulae "copied down" from one time-period to another will no longer reference the named Cells. Also, there may be separate names for related variables within Excel itself and in the VBA used to drive iterations and this can cause confusion.

Within both NetLogo (Model N) and Vensim (Model S), variables are explicitly named, and these variables persist from one time-period to another.

In all cases, the responsibility to choose meaningful names rests with the developer.

E.5.6 Comprehensible

Despite the widespread familiarity of Excel, the Excel Model (Model X) seems hard to follow, especially as key aspects are concealed within the VBA. Excel formulae use Cell references that are often difficult to follow (using Named ranges only helps so far). Once VBA is introduced, it becomes quite difficult to follow exactly what is happening, even for a simple model such as ours

By contrast, NetLogo (and to a lesser extent Vensim) code is relatively readable. Equations within both NetLogo and Vensim are close to "plain English" giving confidence that the model works as expected.
In Vensim (Model S), the overall logic is shown as a pictorial "Stock and Flow" diagram, though this does not extend to the detailed formulae underlying the model. The concept of integrating "inputs minus outputs" may be a barrier to some non-technical users.

E.5.7 Model Testing

All models allow for easy repeat runs with different parameter values. This can be used to turn specific features on or off to check that the results are in line with expectations (eg from the deterministic model).

Intermediate values can readily be extracted in NetLogo and Vensim. This can be more difficult within Excel, especially for values generated within VBA code.

For testing purposes, the Excel-VBA approach raises difficulties. Even seemingly minor updates can introduce unintended – and hard to identify – bugs. NetLogo is modular, and individual functions or

procedures can fairly simply be tested in isolation. This is true to an extent with Vensim, which also contains a set of tools to help track unexpected results back to their causes. Although these tools are designed to help understand model behaviour, they can be equally useful for de-bugging.

In Excel, error trapping must be handled explicitly. For example, it will not be immediately obvious if the number of policies has become negative for some simulations if the aggregated values are positive. Vensim allows bounds to be set for variables and raises warnings if these are violated. In NetLogo, a negative number of Agents is clearly impossible.

E.6 General Comments on Models

E.6.1 Run Time

The code written in Excel took some 400 times as long to run as that that developed in a tool designed specifically for the purpose.

For a typical run (on a Mac Air: 1.3 GHz Intel Core i5, 8Gb memory), with the default 1000 policies:

- Model X - ~7 minutes for Multiple (6) scenarios, say 60 seconds per scenario
- Model N - ~1 second (+ time to run "setup" – virtually instantaneous)
- Model S - ~1 second (+ time to confirm "simulation name")

This suggests that the Excel approach is likely to struggle to cope with a realistic sized portfolio.

E.6.2 Ease of Modification

Models N and S are easy to modify, for example to extract extra model information, or change the rules for exercise of the option, or to implement a different scenario for price changes.

Model X, however, can only be modified with some difficulty. Execution depends on the interaction of the spreadsheet layout and VBA to simulate and aggregates results for multiple Agents. Adding additional variables, for instance, may require VBA programming changes (and re-testing). This may also be the case if the rule for Lapse and Re-entry/Leave were to be changed to something more complex or a different scenario for price changes were implemented.

E.6.3 Deterministic vs Stochastic

Deterministic models (Model S) give no "feel" for the possible variability of outputs, which emerges naturally if key behaviours are modelled stochastically (as in Models N and X).

However, we need to be careful not to give overdue importance to stochastic results – these are only as useful as the underlying assumptions. In the modelling situations we are considering, uncertainty about model parameters, and even about the behaviours we are trying to model, may well dominate stochastic variability, possibly by orders of magnitude.

Neither of Models X or N currently allow for automated repeated runs to assess variability of outcome. (There is a feature in NetLogo that could potentially support repeated runs, but we have not explored this.) This is a particular issue for Model X because of its very long run times.

One possible model feature that a stochastic model might tend to obscure is the existence of "tipping points", at which model behaviour changes quasi-discontinuously. In principle, these can be spotted in a stochastic model too, but repeated runs are necessary to verify the change in behaviour. This underscores the importance of rapid run times.

E.6.4 Single vs Multiple Option Exercise

In the deterministic model, it would be necessary to account separately for each year's option exercisers to allow for multiple exercise.

The ABM approach, by contrast, can handle this elegantly, via a state variable to keep track of how many times exercised.

Adding multiple exercise to Model S would require an approach along the deterministic lines, or some simplifications or approximations. (Multiple exercise might be manageable accurately with a more advanced version of Vensim that supports arrays, but extremely messy otherwise). As can be seen from the deterministic version, however, any change to the projection period (or to the projection interval – eg quarterly instead of annual) might require extensive reprogramming.

Depending on the model's purpose, some simplification or approximation might be acceptable, but we would need to verify that this did not significantly distort key model outputs – even in circumstances where behaviour became "extreme".

E.6.5 Discrete vs Continuous Time

Model S is in continuous time, as is natural for an SD model. This may be more realistic (deaths and exercises do not all occur conveniently at a policy anniversary).

Other models can be made closer to a continuous model by, for instance, changing the time interval to a fraction of a year. However, there are penalties for this in terms of model run times and (for Model X) model size/complexity. (At the very least, extra rows would need to be added, and the VBA amended.)

E.6.6 Agent Based Models vs System Dynamics

ABM models (X and N) are more natural when behavioural rules can be formulated (or intuited) for each individual, and these cannot be expressed so simply for Agents as a group. Any feedback behaviour will then emerge implicitly as Agents interact with one another or with the global environment. In such circumstances, the ABM approach may make the model simpler to specify and build (just as using intrinsic coordinates can significantly simplify certain types of mathematical problems).

In the simple situation being modelled, there is no obvious advantage to an Agent-level specification of rules. There is no interaction between Agents or with the environment, and the simple Agent-by-Agent transition probabilities can equally well be specified in terms of proportions of the Agent population (though this, of course, loses the stochastic behaviour).

SD models, by contrast, express rules at a global level, and explicitly allow for feedback loops, both positive and negative.

This may make an SD Model more helpful as a mechanism to explain modelled behaviour to third parties (or to ourselves), since it may be less clear how Agent-level behaviours are interacting to produce the observed outputs.

E.7 Possible Model Improvements and Enhancements

For the purpose of this exercise, the scope of the model was deliberately kept narrow. However, it is instructive to consider how the model might be improved to be more useful for exploring this, admittedly highly artificial, scenario. We have listed some improvements below – no doubt readers will be able to add to our list.

The Causal Loop Diagramming (see Appendix F) that underlies Systems Dynamics is likely to help both to identify useful model extensions and to think through their consequences. With an SD implementation such as Vensim, extensions may be fairly straightforward to add, although this may necessitate a significant amount of redesign work.

The most promising model for facilitating extensions is NetLogo. All the proposed extensions can fairly simply be accommodated by some combination of:

- Adding extra Agent attributes;
- Elaborating the rules for Agent behaviour;

- Introducing new types of Agents (for example modelling multiple insurance companies as Agents).

The model will only require extensive rework if the existing Agent structure has to be modified.

Some of these suggested enhancements were prompted by the modelling process itself. Considering Causal Loop Diagrams seems a particularly fruitful source of useful suggestions.

1. The opening portfolio of business could reflect a more realistic business mix by age, term to run, health status etc.
2. Normal lapses could be incorporated as well as the lapses triggered by a price-advantage.
3. The decision-rule for switching could be made more realistic. For example, do policyholders who switch influence other policyholders? Once a policyholder has switched once, is he/she more (or less) likely to do so again if a similar opportunity arises? Is the likelihood of switching linear in the potential saving, or would a non-linear function be more appropriate?
4. Instead of considering only policyholders defecting to another company, the model should also allow for the company to gain business from its competitors.
5. What influences a policyholder to defect rather than to re-enter? Is it possible for the company to influence this decision?
6. Premium rates could be decoupled from the underlying mortality rates, allowing the possibility of different pricing strategies.
7. Perhaps not all companies in the market will adopt the same pricing strategy. Some might move faster or slower than others, and some might re-price more or less aggressively. This will allow use of the model to explore of the effect of different pricing strategies on market share and profitability. (In an ABM, we might treat competing insurers as Agents and develop rules for how they might respond to their competitors' pricing moves, or to changes their own position, as measured by defections, market share, profitability etc.)
8. More attention could be paid to financial measures – e.g. margins in premium rates, costs associated with the extra lapses and new (re-entry) business. These might in turn influence pricing decisions, with company (agents) following different strategies.
9. A useful model ought to include new business in order to give a more complete understanding of all the implications for the company. This interacts with pricing strategy: a lower price will risk losing more margins, but potentially gain market share (both genuine new business and defections from competitors).
10. The model could include factors other than price that affect new business market shares. For instance, will losing (or gaining) in force business by churning have any effect on company attractiveness to new policyholders?
11. The model could allow for time lags between events. Lags can create unexpected behaviour such as instability and oscillations. Examples of such lags might include those between:
    - A change in the real mortality or lapse experience and companies becoming aware of this through experience studies
    - Deciding to change premium rates and then implementing the change in the market
    - Changing premium rates and policyholders (and potential policyholders) reacting to the change (in absolute cost and in relative competitive position)
12. Should the model take account of any physical or capacity constraints?
    - Is there a realistic ceiling on the amount of new business that potential policyholders are willing to buy in any given year, regardless of how low prices go?
    - How fast can an insurer – or indeed the market as a whole – grow (or shrink) its distribution and underwriting capacity?

- If a company tries to grow too fast, to what extent will the quality of its underwriting, and therefore (perhaps after a lag) its claims experience, suffer?

APPENDIX F CAUSAL LOOP DIAGRAMS

F.1 Resources

The following is a partial list of resources to help those new to Causal Loop Diagrams get started.

- Vensim has a good introduction at: https://vensim.com/vensim-causal-loop-diagramming/
- Wikipedia has a rather academic summary at: https://en.wikipedia.org/wiki/Causal_loop_diagram
- The Systems Thinker offers a more practical introduction: https://thesystemsthinker.com/causal-loop-construction-the-basics/
- Those looking for a more extensive explanation should refer to Chapter 5 in John Sterman's book: Business Dynamics – Systems Thinking and Modelling for a Complex World (*ISBN 9780071179898*). Sterman's book offers a comprehensive introduction to the whole field of Systems Dynamics.

The rest of this Appendix presents a simple example, using the simple System Dynamics model we constructed as part of our initial exploration of System Dynamics (Appendix E.1.2 above).

F.2 Illustrative Scenario – Medical Advances

The chosen scenario envisages a breakthrough in the availability and use of medical screening, such as genetic testing. This testing will identify predispositions to major causes of mortality and serious illness, such as heart disease, stroke and cancer. Those that screened positive will have much higher future mortality, while those that screened negative will enjoy much lower mortality.

The purpose of the model is to address:

- The impact that this knowledge might have on customers' buying behaviour;
- How insurers might react to this; and
- How constraints that society might place on insurers' freedom to make use of the information could affect the outcome.

F.3 Model Boundaries

Only risk products such as life insurance, critical illness and disability income have been considered. Annuities, including impaired life annuities, and specialist products targeting impaired lives, are beyond the scope of the modelling.

The medical advances and their "roll-out", such as readily available screening procedures, are treated as exogenous (ie specified outside the model) and any possible feedback from within the model that impacts the availability or take-up of screening is ignored.

F.4 Developing a Causal Loop Diagram

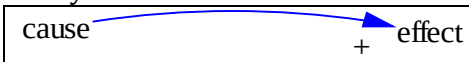
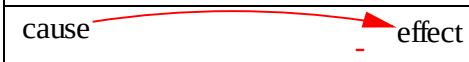
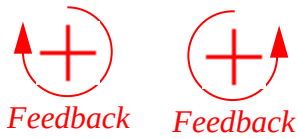
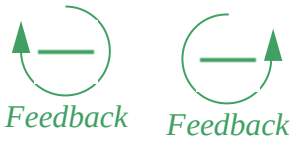
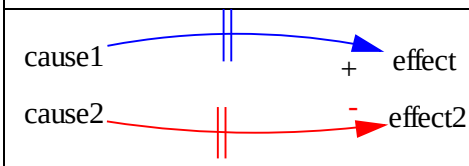
The possible impacts on the state of the nation's health and on health care costs is also ignored, as well as potential feedback from this into the rate of medical advances and the take-up of screening.

The Causal Loop Diagrams have been built up in stages. This helps to ensure that the key interactions have been identified. It also helps those coming new to the model understand the final Diagram.
In the diagrams, arrows indicate a causal relationship or influence.

The names of individual items have been chosen so as to have a definite "sign." Some of these could, of course, be reversed, in which case the direction of the relevant influences will also be reversed. For example, an increase in "fear of anti-selection" will cause the "increase in base rates for NB" to be higher

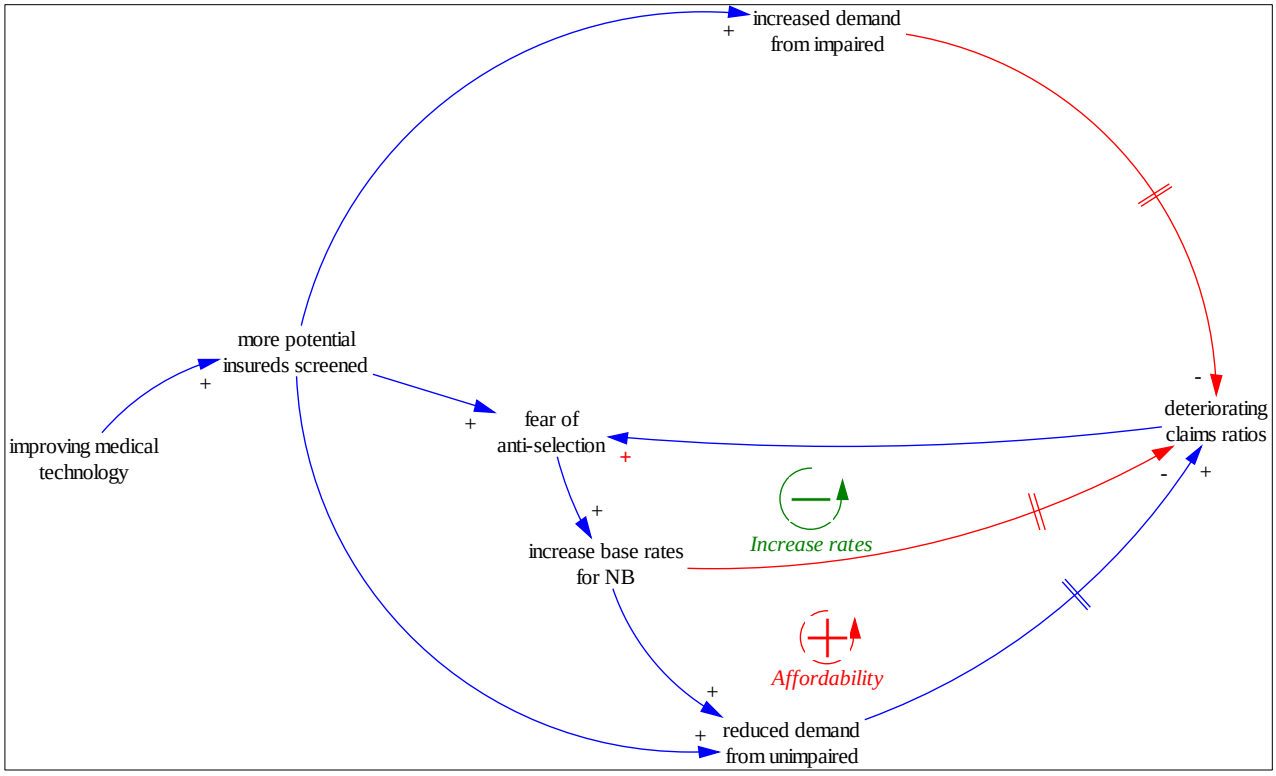
than it otherwise would be. This could equivalently be expressed as causing the "reduction in base rates for NB" to be smaller than it otherwise would be.

The symbols should be read as follows:

	An increase in "cause" results in an increase in "effect" (and vice versa)
	An increase in "cause" results in a decrease in "effect" (and vice versa)
	Reinforcing feedback loops operating in clockwise or anti-clockwise directions. (In a reinforcing loop, there is positive feedback that tends to amplify the effect of any change, other things being equal.)
	Balancing feedback loops operating in clockwise or anti-clockwise directions. (In a balancing loop, there is negative feedback that tends to counteract the effect of any change, other things being equal.)
	Shows a relationship with a significant time lag. (Virtually all causal effects are subject to some degree of lag, but these indicate lags are very much longer than others.)

F.4.1 Initial thoughts: Fear of anti-selection leads to increase in rates

This initial Causal Loop Diagram shows two response mechanisms from insurers: a fairly quick response to the anticipated anti-selection; and a much slower feedback via the observed impact on claims ratios.

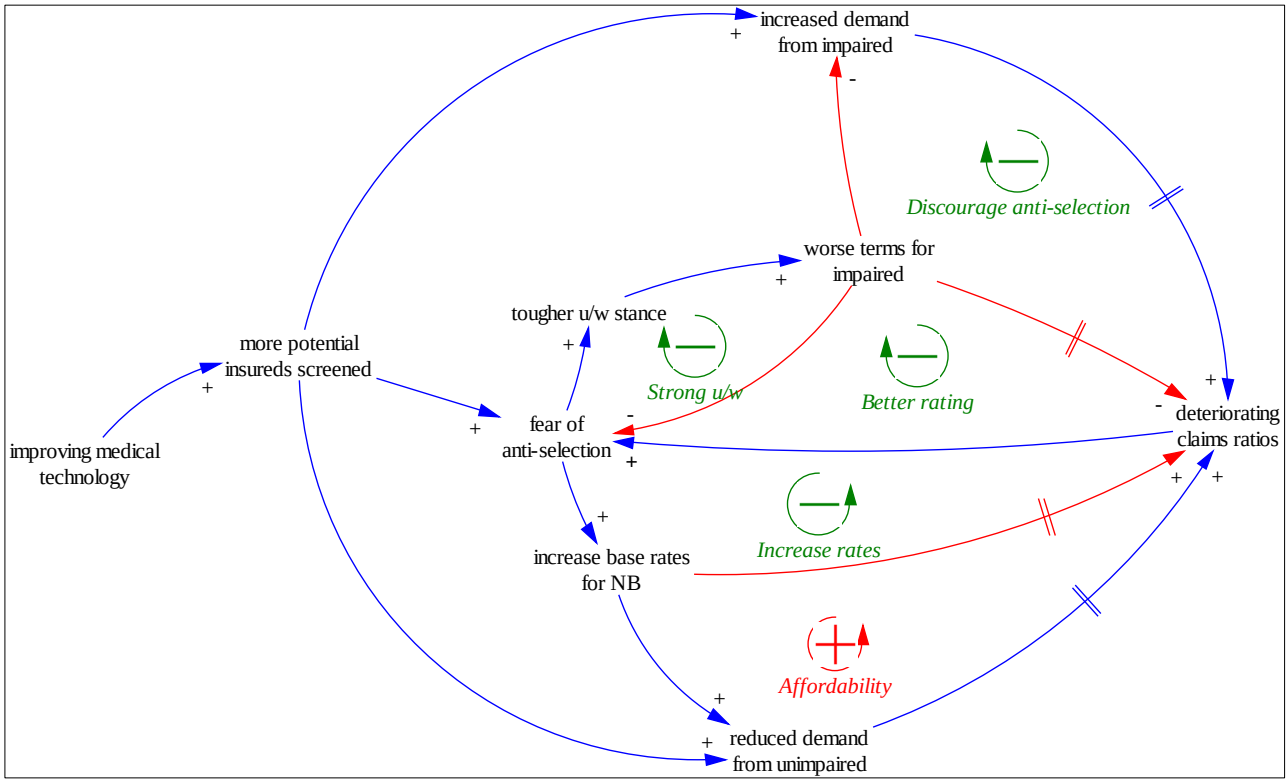


Increasing rates will directly offset deteriorating claims ratios – a balancing feedback.

However, the higher rates will also impact the affordability of cover, reducing demand from (mainly) unimpaired lives. This is a reinforcing feedback loop, causing claims ratios to deteriorate further than they otherwise would have done, and so creating more pressure for rate increases.

F.4.2 Introduce tougher underwriting

Insurers can introduce tougher underwriting, probably using access to the same screening tests and information as those to which customers have access. This looks to be a more promising solution.



Imposing strong underwriting mitigates insurers' fears of anti-selection, and therefore eases the short-term pressure for across-the-board rate increases (a balancing effect). This also helps avoid price increases for non-impaired lives.

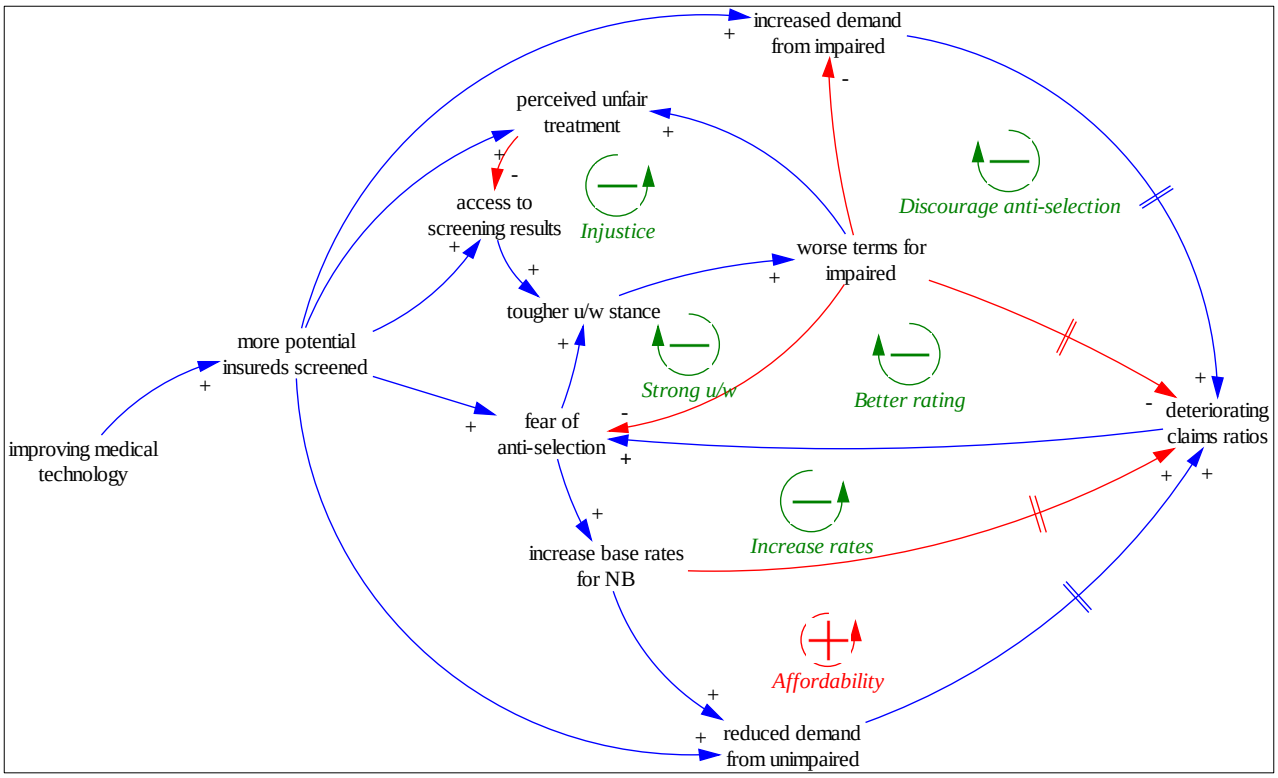
It also helps to discourage anti-selection, or at least imposes a realistic price on those who have discovered that their health is impaired.

In the longer term, the impact on claims ratios will be mitigated, further easing pressure for rate increases.

There may also be an opportunity to introduce "preferred life" rates for those with negative screening results. This will encourage more customers from this group to buy cover. To keep the Maps fairly simple, "preferred lives" has not been shown.

F.4.3 Consider possible impact on freedom to underwrite

Charging higher premiums for impaired lives may be seen as unjust, particularly if the extra premiums are high. This may lead to pressure to limit, or even prohibit, the use of screening information. This will lead to an information asymmetry between proposers and the insurer, and thus dilute – if not completely eliminate – the benefits of stronger underwriting.



Strong underwriting may provoke the reaction that impaired lives are being unfairly treated, leading to limits on access to screening tests and results for underwriting or on the severity of terms that can be applied. This will limit the ability of underwriting to impose realistic charges on impaired lives.

There are six feedback loops explicitly identified in this final Causal Loop Diagram: one reinforcing and five balancing. How this scenario might play out in practice will depend on the relative strengths of the various loops, as well as on how rapidly the various processes act. This, in turn, depends on the parameters.