N Squared

Public policy and the power of networks

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The RSA

The RSA has a new strapline: 21st century enlightenment. This pays tribute to the eighteenth century founders of the Society and to the pioneering spirit which inspired them. It makes a statement about the role the RSA can play today, as an organisation established over 250 years ago but which believes its best days may yet be to come.

At the heart of the RSA's contemporary mission and public debates about the future prospects for the human race is the question 'can we go on like this?' Will the ideas and values which transformed our world in the last two centuries be sufficient to find solutions to the challenges we now face or do we need new ways of thinking?

The RSA's focus on twenty-first century enlightenment invites us to return to core principles of autonomy, universalism and humanism, restoring dimensions which have been lost and seeing new ways to fulfil these ideals. The Society is committed to stimulating new thinking, social innovation and – among its 27,500 Fellows – a powerful ethos of collaboration. Its strapline underlines not only the RSA's interest in ideas and experiment but in becoming the kind of organisation the twenty-first century needs. The RSA is publishing a series of essays all of which, in their different ways, will contribute to this thinking.

Acknowledgements

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Biography

Paul Ormerod is an economist and the author of three best-selling books, *The Death of Economics* (1994), *Butterfly Economics* (1998) and *Why Most Things Fail* (2005), a *Business Week* US Business Book of the Year. Paul is a fellow of the British Academy of Social Sciences and holds an honorary Doctor of Science from the University of Durham for his original contributions to economics. His main interests are in complex systems and networks, and he publishes in a very wide range of academic journals.[1]

1. Available at www.paulormerod.com

N Squared

For years, there was the basic assumption at the heart of government that the way to improve things in society was to micromanage from the centre, from Westminster. But this just doesn't work. . . . The success of the Big Society will depend on the daily decisions of millions of people: on them giving their time, effort, even money, to causes around them.

Prime Minister, David Cameron 2010[2]

For some, the coalition government's central idea – the Big Society – is a polite way of saying 'the small state', or simply a way of trying to distract the public from dramatic spending cuts. For others – including the RSA – it is as yet an unformed but nonetheless potentially interesting idea that *could* place civic action and citizen empowerment centre stage in British politics.

Whatever we may think about the Big Society's lasting power or its ability to actually drive policy and a new kind of politics, the idea does seem to speak to contemporary pressures to fundamentally rethink the relationship between the citizen and the state and an explicit recognition that government – local or central – cannot 'go it alone' in tackling some of our most persistent and profound social challenges.

Implicit in the government's narrative of change is that ordinary people – as well as local voluntary and community groups – will be incentivised to 'do more' in the civic sphere, supported by new initiatives like the National Citizen Service and the Big Society Network. In opposition, leading Conservatives urged their MPs to put *Nudge* – Cass Sunstein and Richard Thaler's book on policy and behavioural economics – on their summer reading lists. The coalition

2. "Our Big Society Agenda," David Cameron speech, Liverpool 19 July 2010.

government seems to have embraced behavioural economics, at least in relation to encouraging more responsible corporate and consumer behaviour. Its *Programme of Government* states: "Our government will be a much smarter one, shunning the bureaucratic levers of the past and finding intelligent ways to encourage, support and enable people to make better choices for themselves."[3]

Yet it remains unclear to what extent the government's vision is underpinned by deeper thinking about motivation, which is informed by emerging knowledge of both behavioural economics (and how policy can 'nudge' citizens to make different choices) and the role that networks can play.

This essay argues that to be effective, the policy framework for the twenty-first century must not only draw on the new insights that behavioural economics gives us, but also needs to be underpinned by an understanding between this and how networks influence our choices and how these change over time. Indeed, the impact of networks is potentially considerably greater than that of 'nudge'. This makes creating good policy harder while offering huge potential for change.

This is the third in the RSA's series of pamphlets on twenty-first century enlightenment. It aims to deepen understanding and generate public discussion as well as enrich the Society's thinking about its own role in fostering local networks in the name of progress.

The role of the state

A distinguishing feature of the Western world in the twentieth century is the enormous expansion of the role of the state. Gradually, many of the functions previously within the domain of the third or private sectors have been embraced within

3. The UK coalition's government's *Programme for Government*. 2010. www.programmeforgovernment.hmg.gov.uk

the public sector. In the UK, the most avowedly socialist government in our history was that of Clement Attlee (1945 to 1951). Yet the share of the public sector in the economy under Attlee was less than it was during the government of Margaret Thatcher, renowned for her robust approach to privatisation.

For over sixty years generations of policymakers have been raised to have a mechanistic view of the world, and a checklist mentality: to achieve a particular set of aims, draw up a list of policies and simply tick them off. It is a comforting environment in which to operate, being seemingly dependable, predictable and controllable.

This approach is fundamentally different from anything that went before in the Western world, except during the two world wars. A much greater role is assigned to the state across a whole range of functions. Yet deep social and economic problems remain. Both the average rate of unemployment and the range within which it varies were scarcely any different in the six decades since the Second World War to the same period preceding it. Comparing crime rates over time is notoriously difficult, but despite falls since the mid-1990s, the level of crime is much higher now than it was in 1950. There is an intense debate about the rate of social mobility in the UK and whether it rose or fell slightly under New Labour. What is clear is that it has not improved significantly since the 1970s and that the distribution of income and wealth has widened. The combination of large-scale state activity and a mechanistic approach to policymaking has not delivered anything like the success that the founding fathers of the welfare state in the 1940s imagined.

Part of the reason lies with the inefficient use of resources by the state. A substantial proportion of public spending is made up of transfers of income between different groups through the tax and benefit systems. The real measure of the claims of the public sector on the national economy (GDP) is, however, the percentage of the workforce employed by the state. Recent reports from the National Audit Office, for example, highlight the fact that the increase in the state's resources has often led to *lower* productivity in the use of those resources.[4]

But the principal cause of the failure of what we might call the social democratic model to achieve its objectives is not the size of the state but the intellectual framework in which it operates. The Financial Services Authority is a good illustration of this mindset. Clever, rational people believed that clever, rational people could devise written systems of rules and regulation that ensure risks are minimised. The FSA was hailed at its launch in 1997 by Gordon Brown as 'a unique, twenty-first century, one-stop centre, a single supervisor for all providers of financial services'. With a team of over 2,500 people, it is charged with enforcing no fewer than 8,500 pages of regulations. As long as this rulebook was followed by a financial company, the FSA was apparently satisfied. Yet it failed spectacularly to foresee, let alone avert, the financial crisis.

A tragic vignette from 2007 encapsulates the logical consequences of this view of the world. A ten-year old boy drowned trying to save his stepsister in a pond near Wigan. Two police community officers who were present refused to enter the water on the grounds that they had not been trained in water safety. At the inquest a Detective Chief Inspector defended this behaviour: given their lack of training it would, he explained, have been 'inappropriate' for them to try to save the child from death. This was not the reaction of others present at the scene. Two fishermen, both well into their sixties, leapt into the pond without thinking or training, rescuing the girl. The young boy instinctively tried to save his sister and died.

This outcome was tragic but the scenario is a clear illustration of the mindset that led to it happening. After the event, in the cold light of the coroner's inquest, everything is clear and decisions can be rationalised and 'appropriate' behaviour identified. In the moment, there is usually no single best course of action to follow. Jumping in a pond of unknown

4. For example, Office for National Statistics, *Total Public Service Output and Productivity*, 14 August 2009 revision.

depth risks your own life while there is no guarantee that you will save others. Standing by and doing nothing means the girl will die, but you will live.

The future is fraught with risk and uncertainty, an inherent part of the human condition. The world is much more complex, much less controllable than 'rational' planners believe. Policy is very difficult to get right. There are two main reasons for this.

Firstly, human beings do not necessarily behave in rational ways. Indeed, this does not just apply to individuals; in economics, decision-making units – whether citizens, firms or governments – are grouped together under the phrase 'agents'. This is used in this essay for the sake of simplicity of description. Either way, the response of agents when they are confronted by different information or by a different set of incentives, may be hard to anticipate. The RSA's Social Brain project is exploring some of the reasons why this is the case and the implications this may have for policymakers and individuals.[5]

Secondly, tastes and preferences of individual agents are not fixed, as economic theory assumes them to be, but can be altered directly by observing and learning about the behaviour of others. Even if we knew for certain how any given agent would react to a policy change now, there is no guarantee that the result will be the same tomorrow, next week, or in six months' time. The response will depend to a greater or lesser extent on how others react. This may seem obvious, but it is not taken into account in many policy evaluations. The introduction of these features of reality rapidly leads to great uncertainty about the consequences of any given action.

Our scientific understanding of how the human world operates, how societies and economies function, has made great strides forward over the past couple of decades with respect to the two key points made above. Behavioural economics and economic psychology are giving us a better grasp of how agents as individuals really do react to changes. Likewise, the study of

5. M Grist. *Steer*. RSA 2010. www.thersa.org/projects/social-brain

networks, of how decisions made or how behaviour adopted by one agent can either spread or be contained across social networks, has made enormous advances.

It is only by developing these new insights – behavioural economics and networks – that policies can be devised with a consistently higher success rate. The main focus of this paper is on networks, but a brief discussion of the implications of behavioural economics is warranted.

Nudging

There is now a large literature in the field of behavioural economics. The work of the 2002 Nobel Prize winners, Vernon Smith and Daniel Kahneman, makes clear that in general agents do not behave according to the postulate of economic rationality.[6] Their conclusions are reinforced by many studies and, recently, by six distinguished scholars involved in *Experimental Economics: Rethinking the Rules*.[7] The book provides a comprehensive list of almost 500 references, ranging across the entire field of experimental economics and shows that many of the key discoveries were made using fairly simple but effective experiments. For example, consumer preferences appear in general to be 'non-transitive'. In other words, if I prefer A to B and B to C, then transitivity requires me to prefer A to C. But this logical assumption is frequently not observed in reality. This is just one example of where empirical evidence violates key assumptions of conventional economic theory.

Policymakers have seized on the idea that a better understanding of individual agent behaviour enables more

6. See their respective lectures: D Kahneman. "Maps of bounded rationality: psychology for behavioral economics," in *American Economic Review*, 93, 1449–1475, 2003; V Smith. "Constructivist and ecological rationality in economics," in *American Economics Review*, 93, 465–508, 2003.

7. N Bardsley, R Cubitt, G Loomes, P Moffat, C Starmer and R Sugden. *Experimental Economics: Rethinking the Rules*. Princeton University Press 2010.

effective policy to be carried out by 'nudging'.[8] Mainstream economics offers a method of nudging, which has very strong scientific support, namely altering the set of incentives, which agents face. The most obvious way of changing incentives is to change the price.

But behavioural nudging goes far beyond that. For example, back in the 1970s and 1980s, when trade unions were powerful, there was fierce political debate about how individuals should pay their union dues. Should people have the deduction made automatically by their employer unless they specifically asked to be contracted out, or did they have to deliberately contract in for this to be done? Now, the two approaches do require individuals to devote slightly different amounts of time to the decision about whether to be in a union or not, but these costs are very small in terms of a rational analysis of the various costs and benefits. Yet in practice the difference in outcomes between the two methods was substantial. The context in which the question was set, whether the default was to opt in or out, exercised a powerful influence.

While the insights of behavioural economics potentially give more power to policymakers, paradoxically they can also reduce it. For example, if the preferences of agents in any particular context are distinctly non-transitive, nudging them towards the desired outcome will be a tricky challenge. At a deeper level, the implication of behavioural economics is that we abandon the claims which conventional economics makes to a general theory of agent behaviour.[9] This makes explicit the uncertainty that we face in trying to anticipate how agents might react to any given policy change. We might very well make incorrect assumptions about the behavioural rules that agents are actually using in any given context.

A final, and crucial, point to stress about nudging is that the aim of behavioural economics is to try to provide better

8. R Thaler and C Sunstein. *Nudge*. Yale University Press 2008.

9. At least in the current state of scientific knowledge, this is not to say that a new general framework will never be discovered.

descriptions of how people really do behave *as individuals*. The assumption behind mainstream economics is that agents act autonomously and do not take directly into account the behaviour of other agents. Networks, in contrast, do. And their implications can be dramatic.

Networks

Networks introduce an entirely different dimension into the policy picture. There has been an explosion of scientific interest in networks over the past decade or so across a wide range of disciplines.

These intellectual developments are based on the truism that humans are social creatures. In economic theory, individuals operate like so many Robinson Crusoes, taking independent, autonomous decisions that are not directly influenced by the decisions or opinions of others. Network theory allows the social dimension of human activity to be taken into account when trying to understand how agents behave, and when thinking through the policy implications of their behaviour.

The phenomenon of 'social learning' – learning through observation or interaction with others – occurs widely in various forms in the animal kingdom.[10] Natural selection is now believed to favour social learning strategies, mechanisms that specify when agents copy and who they copy.[11] Humans are particularly adept at this sort of behaviour. Many of the decisions we make are based not so much on the independent, rational calculation of the costs and benefits of different actions – the mode of behaviour posited in economic theory – but on observing and copying others.

10. See, for example, W Hoppitt and K Laland. "Social processes influencing learning in animals: A review of the evidence," in *Advances in the Study of Behavior*, 38, 105–165, 2008.

11. For example, L Rendell, R Boyd *et al.* "Why copy others? Insights from the social learning strategies tournament," in *Science*, 328, 208–213, 2010.

There are a variety of concepts which this mode of behaviour reflects. An obvious example is peer pressure; the sense that an agent feels the obligation to conform to the views of his or her immediate peer group. Subtly different is the concept of peer acceptance. This refers to the phenomenon of people continuing in modes of behaviour because other people within their own social groups and environment do so. It is not connected with the intrinsic merits or demerits of any particular behaviour. More generally, there may be a small number of individuals who we particularly trust in a given context, and are willing to copy their decisions.

The phrase 'network' in this context refers to the patterns of connections between individuals. Only those agents to which an agent is 'connected' have the ability to influence the behaviour of the agent *directly*. Of course, the decision by a given agent may cascade across the network, so that someone directly influenced by the agent then goes on to influence someone else who the original agent does not know, and so on. Understanding 'cascades' and the conditions under which they might arise is one of the principal challenges of network theory. I return to this later.

For any individual, the relevant set of connections will vary with context. So, for example, the agents whose behaviour or opinions you take into account when deciding where to put your savings will usually be different from those who might influence you to go out binge drinking. There will be different motivations underlying your willingness to be influenced in these two completely different contexts.

The key point is that in both situations, your behaviour may be affected directly by what other people do, rather than being based on autonomous, independent rational calculation. In social and economic situations where network effects are important, conventional policy instruments and analysis give at best only a partial understanding of the issues. The failure of almost all existing social and economic analysis to take account of potential network effects underlies the apparent failure of the social democratic state. In most situations of course there will be a mixture of these two behavioural motivations

Many of the difficulties and opportunities which networks present to the design of effective policy can be summarised using a simple example. With Amy Heineike of George Mason University, I investigated what happens to the simple demand curves of economic theory when network effects are present in the system.[12]

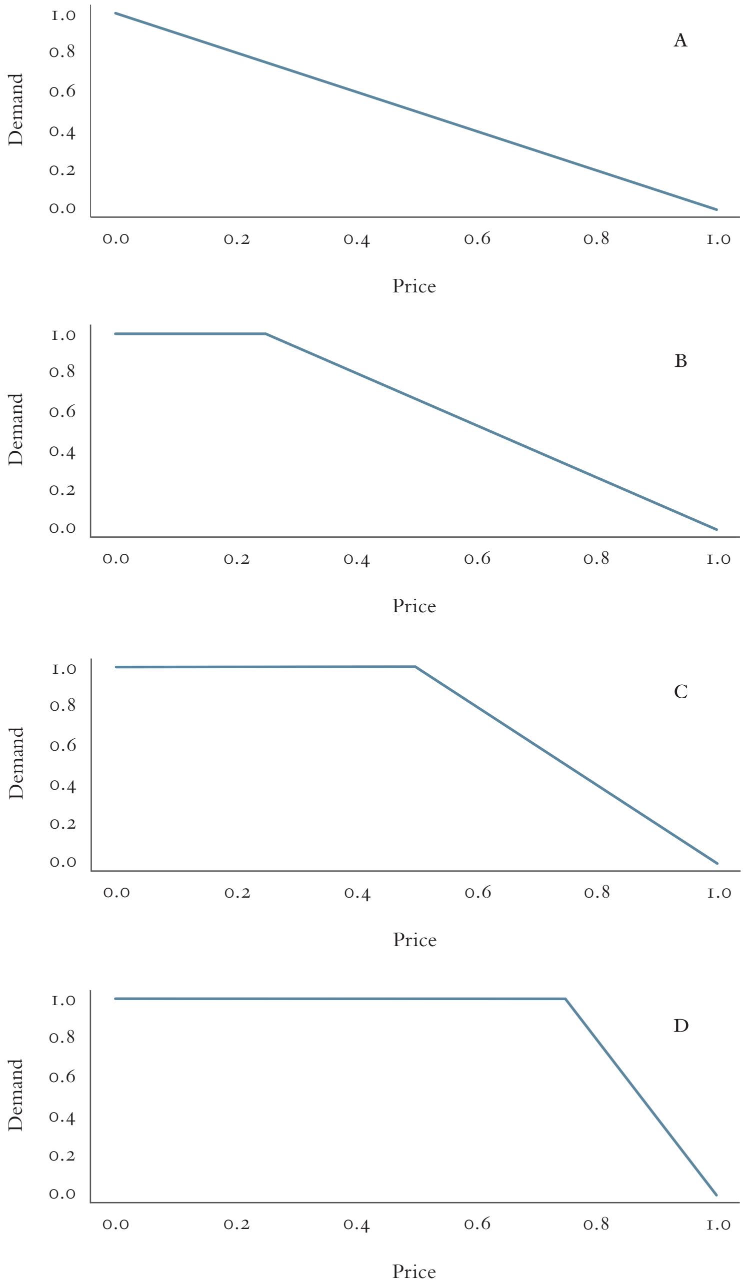
The basic model is very simple; we have a group of individuals contemplating whether or not to buy a particular product. Each has his or her own intrinsic preference for what is on offer, so each will decide to buy at different levels of price. Some are strongly attracted and will pay a high price; others will only buy if it is perceived as being cheap. The usual interpretation of 'price' is of course exactly that: the amount of money you have to pay for it. So, for example, we might examine a brand of shampoo and see how its price affects sales. But 'price' can have a much wider, multi-dimensional interpretation. It essentially summarizes the costs associated, or thought to be associated, with any particular course of action.

From the individual preferences, the prices at which different people will buy the product (or carry out the activity), we can easily obtain a 'market' demand curve. In other words, we add up the individual decisions and see how much is bought, how much of the activity is carried out, at different prices. This is the world not just of standard economic theory, but of nudging, which gives us a broader way of thinking about price, about how to either encourage or dissuade people from different courses of action.

In this very basic model (see Figure 1), chart A represents the classic market demand curve. As price increases, demand falls. We then introduce what in this context we term the 'bandwagon' effect, so that the more people buy the product, at any given price, the more likely any given individual is to buy it as well.

12. A Heineike and P Ormerod. "Non-additive market demand functions: price elasticities with bandwagon, snob and Veblen effects," www.paulormerod.com

Figure 1



Charts B, C and D show the overall demand for the product (degree of participation in the activity) with different strengths of the bandwagon effect. The stronger this effect, the less price can matter. In the charts, both price and demand vary between 0 and 1, a convenient way of plotting them but which requires some clarification. Price does not literally take a value between 0 and 1: rather, a price of 0 corresponds to the actual price in any given market at which everyone who is interested in the product (or concept) will buy it. Similarly, a price of 1 means the price at which no-one at all will buy it. Think of Marmite. Even if it were offered for free, literally at a price of zero, there are many people – including the author – who would still not be interested in it. At the other extreme, there is a price at which even the most ardent Marmite fan will stop buying it. A value of 1 for demand means that everyone who has any interest in the product buys it, and a value of zero means no-one does.

Even this simple model raises many questions. How do we know what the relevant measure of 'price' is? In crime, for example, does the 'price' to the criminal include his estimate of the chances of being sent to prison? There are differing views on this controversial topic. How do we know the distribution of the inherent preferences of agents about the activity and hence how they react to changes in price? How do we know which other agents' actions any given agent takes into account? But many of these questions apply even when there is no network effect present at all. They reflect the difficulties and uncertainties that policymakers face even in an apparently simple world.

But suppose that somehow all these problems are solved in a reasonably satisfactory way. We can see the challenges and opportunities that the existence of network effects brings. Imagine we are near the top left hand corner of chart A. Participation in the activity is high, the costs associated with it being small. Policymakers want to discourage this form of activity and so increase the price.

In a non-networked world, it is easy to see whether or not the policy is working. Put the price up, and demand falls.

But if agents base their actions in part on the actions of others, increasing the price initially has no effect. Then, suddenly, we get not just a reduction, but for any further small increase in price, we get a bigger change in demand than would take place in the absence of network effects.

However, the authorities might well have concluded that the policy of increasing the price had not worked well before this critical point was reached. Equally of course, they might be tempted to use more 'extreme' pricing from the outset in an attempt to overcome network effects, which may well produce adverse reactions.

Studies of past changes in prices which attempted to estimate the impact of price on demand without taking into account network effects might also provide very different stories to policymakers. Often, with evidence taken from only a limited range on the chart, the policy would show no effect at all. But change the starting point (to the right-hand side of chart D, for example) and we see the huge potential gains of encouraging certain types of behaviour if network effects are strong.

The crucial challenge is to understand and respond to the fact that networks are important and arguably becoming increasingly so. Research is telling us more and more about the potential impacts of network effects, while the speed of change, new technologies, global markets and challenges like climate change suggest they are becoming more significant.

The Watts model

The model I have used earlier is almost as simple as you can get, but even it creates both opportunities and difficulties for policy. What happens when we introduce further properties of real world networks?

Duncan Watts, now director of the Human Social Dynamics Group at Yahoo! Research, was a sociology professor at Columbia. In 2002, he published a brilliant article: 'A simple model of global cascades on random networks'.[13] The content and title may be abstract, but the practical implications are enormous. The description of Watts' model is worth taking some time over for his approach is similar to that used more generally in network models, and its implications for policy are surprising and profound. Watts was interested in what happens in a simple model in which, as a deliberate assumption, the *only* thing that affects how agents choose between alternatives are the choices that other agents have already made.

Watts set up a computer model of individual agents who are connected to each other at random. We can usefully think of this model as a game with some simple rules, one of which decides which agents are connected to each other. So, for example, we can choose to have 100 agents in the model and decide that there is a 5 per cent chance of a given agent being connected to any other agent.[14] On average, each agent will be connected to five others. In this context, the fact of being connected means that an agent to which you are connected can potentially influence your behaviour. As we will see shortly, this does not mean that this agent will *necessarily* affect how you behave, but the small group to which you are connected are the only ones that have the *potential* to do so.

This way of connecting agents, by a purely random process, may seem entirely unrealistic but does in fact offer a reasonable approximation to many practical situations. Epidemics, for example, are often spread by random contact. A person who you do not know and who you will never see again sneezes on the tube, and you catch a cold. In a strange city, you go out to eat at night and observe two similar restaurants near each other, one of which has plenty of people in it and the other that is nearly empty. A sensible decision would be to eat at the one with more people in it. You do not know any of them, but the fact that

13. D Watts. "A simple model of global cascades on random networks;" in *Proceedings of the National Academy of Science*, 99, 5766–5771, 2002.

14. In practice, there would usually be a lot more people to avoid small sample problems, but the number 100 is used to keep the arithmetic simple.

more have chosen this restaurant could be an indication that in some way it is better than its immediate rival. In financial markets, one trader may monitor a small number of others closely, but if the market starts to move strongly in one direction as a result of the decisions of many people entirely unknown to the trader, a sensible decision might be to follow this trend.

Watts' game can be played with networks that have more explicit social structures to them. Before we go on to these, I will first describe the rest of the rules of the game retaining the assumption of a random network. In this model, an agent has a choice between two alternatives. These could be a consumer deciding between two competing brands, a firm considering two different technologies or someone considering whether to remain an Anglican or become a Catholic.

In reality, people will take into account a whole range of factors in making these decisions, but in all these cases, no matter how much information is used to make the choice, here we are dealing with either/or. There may be more than two choices (including not choosing either), but this can readily be accommodated in the model. I concentrate on the simplest version where the choice is between two alternatives, which I will refer to as A and B.

Initially, when the game starts, we assume all agents have chosen A. We need now to specify a rule of behaviour that determines whether they stay with A or switch to B. We first of all make the entirely realistic assumption that each agent differs in his or her intrinsic willingness to switch. The more information is available on the persuadability of agents or their willingness to experiment, the more the model can be tuned to any actual situation. But for the moment imagine we have no information on this at all. Lacking any clear information, we can simply allocate at random to each agent a number between zero and one. Slightly confusingly, an agent allocated a number close to one is deemed to be *less* persuadable – *less* willing to switch – than someone allocated a number close to zero. The reason for this will become clear. We call this number the *threshold* of the agent.

How, then, do agents decide whether to switch from A to B? In this game, we assume that the only information used by the agent in making this choice is the choices that the other agents to which he or she is connected have made. If the agent starts with A and the proportion of those relevant agents who have chosen B is above the agent's threshold, the agent will also choose B instead of A. For simplicity it is assumed here that there is equal influence across all connections. In practice this may not always be the case.[15] So, for example, if your threshold is 0.5 and three out of the five agents to which you are connected have chosen B, you will switch (because 3/5 = 0.6, which is greater than 0.5). But if only two have chosen B, you stay with A (as 2/5 = 0.4, which is less than 0.5). It is apparent now why a higher threshold means that the agent is less persuadable than an agent with a lower threshold. Someone with a threshold above 0.8 will need all of his or her network to choose B before being persuaded to switch, whilst if it is less than 0.2, even just one person choosing B will lead the agent to also make this choice.

As noted above, there may be many factors that an agent takes into account in deciding between A and B. The choices made by those people whose opinion or behaviour he or she respects may very well be one of them, but not necessarily the only one. A simple example is if A and B are competing consumer brands, their prices may influence decisions as well as what other people have chosen. The essential features of Watts' model continue to be valid as long as the choices of others remain a key factor.

Indeed, the assumption that the behaviour of others is the only factor may often be a reasonable one. In the restaurant example used earlier, you may have a guidebook to the city that has enabled you to filter down the options to just two alternatives, but the number of people in each may still be the decisive factor. In such situations, you have relatively small amounts of information on

15. An empirical example in which the influence of different agents differs markedly is P Ormerod "Hayek, 'The Intellectuals and Socialism' and Weighted Scale-Free Networks." in *Economic Affairs*, 41–47, March 2006.

which to make a judgment, so relying on the choices made by others makes sense. In other situations, people may be able to acquire large amounts of information about products that are inherently difficult to understand. Understanding the information available on, say, a choice of pension plans is a hard task. So it would be reasonable to rely on the actions or recommendations of people you trust on this matter.

Playing the game

We are now in a position to play the game. Initially, remember, when we start everyone has selected A. The game is started by choosing a small number of agents at random to switch to B. Imagine that we have some sort of policy which induces this behaviour, some sort of nudge factor which does not succeed initially in altering the behaviour of many people.

The purpose of the game is to see how many agents end up selecting B rather than A. The process by which they do this is defined by the 'copying rules': who you are connected to (and could influence you), how persuadable you are, and how many of your potential 'influencers' are making a choice different to your own. In turn, if you are persuaded to switch from A to B, you will potentially influence people who look to you as part of their decision-making processes.

The result of any particular 'play' of the game may be very sensitive to the particular circumstances. For example, suppose the agents selected to make the initial switch from A to B were connected to agents who were very hard to persuade, who required almost everyone who might influence them to choose B before they themselves did. The 'cascade'– the spread across the network of people choosing B rather than A – may well be stopped there and then. No-one else chooses B at all beyond the small group assumed to do so as a result of 'nudge'.

In practice, the more information we have about agents, who they are connected to, how persuadable they are and so on, the more we can start calibrating the model to a real-life situation. But in the abstract way in which Watts played his game such information is lacking. This is not a defect but a strength. By exploring a wide range of initial choices of the 'nudged' agents, by having them connected to different sets of other agents, by giving these different levels of persuadability, we can start to understand the general properties of the model across a wide range of assumptions.

To do this, the game is played many times under identical rules. The only difference is the agents chosen at random to switch to B at the very start.[16] A crucial point is that the same number of agents is selected to switch from A to B each time, so the initial shock to the system, is exactly the same.

A relevant practical example is sentiment about the future; the degree of optimism or pessimism which firms feel at any point in time – Keynes' 'animal spirits' – is an important determinant of the boom and bust of the business cycle. We can think of a firm in state A as being optimistic. The economy receives a small shock, a bit of bad news, and a few firms switch to state B, pessimistic. How many others will abandon their optimism? If enough do so the economy will move from boom to bust. The economy in this case has only received a small adverse shock. Can this really be sufficient to precipitate a full-blown recession?

The answer is both yes and no! The same small initial disturbance can have dramatically different outcomes. Most of the time, the initial switch by a small number of agents from A to B, does not spread very far. But occasionally, there will be a cascade across the system and most agents will end up with B. This is critical for policymakers who are generally schooled in trying to design interventions that will make relatively small predictable changes, with minimal risk.

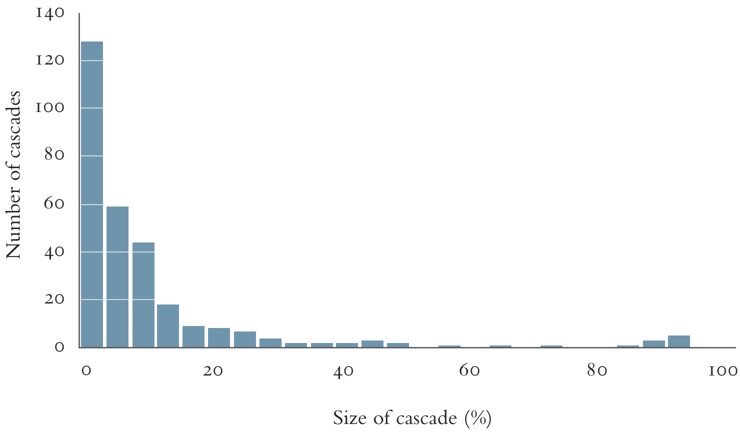
Systems of interconnected agents whose behaviour influences each other are both *robust* and *fragile*. These are key words. Most

16. Theoretically of course, given that they are chosen at random these could be identical in two separate solutions, but the chances of this are vanishingly small.

of the time, the system is robust to small disturbances and these do not spread very far. But occasionally, the system is fragile, vulnerable to exactly the same size of shock that usually it is able to contain. These properties present both difficulties and opportunities to policymakers.

Figure 2 below shows the results of 300 separate solutions of the model, and the distribution of the proportion of all agents who eventually switch from A to B.

Figure 2



Note: The size of cascade is the percentage of all agents eventually switching from A to B. The data is grouped into bands of 4 percentage points, so the first notch on the bottom axis after '0 per cent' is 4 per cent, the next 8 per cent and so on.

Out of the total of 300 solutions, the left hand axis indicates how many of them were in a particular range and the bottom axis shows the range. The first and largest bar shows that on some 130 occasions out of the total of 300, the percentage switching to B was small (in the range of 0–4 per cent in the way we have plotted the data). Next, we see nearly sixty solutions where just 4–8 per cent switch, just over forty where 8–12 per cent switch and so on. So, most cascades are small and the initial disturbance to the system when a few agents switch to B does not spread very far. The system is robust. But we see a few occasions when there are very large cascades, approaching 100 per cent of all agents. It is therefore *at the same time* potentially fragile. Again this has critical implications for policymakers who are usually risk averse.

There are many subtleties even to this simplest version of the Watts model. But its implications for policy, in circumstances where network effects matter, are both disturbing and exciting. If the world operates in anything like the same way as it does in the model, anticipating the impact of a change in policy becomes extremely difficult. The common sense causal link between the size of an event and its eventual impact is broken. Of course, if a large shock were administered to the system so that say one half of all agents made the initial switch from A to B, by definition the eventual outcome would be large. But, equally, a small disturbance can have dramatic consequences.

In some ways, this is good news for policymakers. A desirable policy aim is selected, such as reducing the number of smokers. A policy instrument is chosen, which could be good old-fashioned tax increases on cigarettes to less direct methods such as health education, restricting advertising.[17] Now, to achieve a big reduction in smoking, nudging by itself requires that the policy has a big effect, that it alters the behaviour of large numbers of people. *Nudge plus networks* means that if you have some understanding, albeit imperfect, of the network structure and flows, only a small number of people need to be nudged, yet the number who eventually change their behaviour could be enormous.

This represents a potentially huge increase in the ability of policy to affect outcomes. But in a networked world, things are rarely as clear-cut. Suppose some individuals were indeed induced by a nudge factor to alter their behaviour in the way

17. A cautionary tale illustrating the potentially adverse outcomes of such a policy in the face of non-rational behaviour by individuals is given in J Adda and F Cornaglia. "Taxes, cigarette consumption and smoking intensity," in *American Economic Review*, 96, 1013–1028, 2006.

intended. The perception that the authorities were trying to nudge people might induce others, through the network effect, to become more stubborn or to adopt a completely contrary mode of behaviour.

A dramatic example is given in Bill Buford's fascinating book *Among the Thugs*.[18] Although the book is primarily about the activities of soccer supporters, it is also a deeper reflection on the nature of crowds. Crowds are a good example of a networked system. A collection of individuals becomes a crowd precisely when the behaviour of each individual becomes more strongly influenced by the behaviour of others than by the set of information and incentives that the agent faces as an autonomous individual.

In Sardinia during the 1990 World Cup, the English supporters were feared for their violent reputation. One evening in Cagliari, a large number gathered in the streets. Facing them were the police. Various individuals made attempts to stir the fans into collective action without success; the 'cascade' that was intended by these people did not take place. But in response to the actions of one particular youth, a police captain fired his pistol into the air. The English supporters immediately began to destroy property and attack the police. The action intended to nudge them into quiescence, provoked exactly the opposite reaction across the network of fans.

More generally, networked systems bring problems when it comes to measuring impact. What worked and what did not work? And why? A great deal of policy evaluation is carried out paying little or no attention to the potential impact of network effects. But if these effects are significant, studies that ignore them can generate misleading results. A successful outcome may arise not because of a nudge factor, but because of imitation across the network. The risk is that success can be mistakenly attributed and policymakers left puzzled when a similar policy leads to failure in a different context.

18. B Buford. *Among the Thugs: The Experience, and the Seduction, of Crowd Violence*. WW Norton and Co 1992.

Even identifying the initial cause of a strong effect can be very hard in networked systems. 'Black Monday' of 19 October 1987 is a pertinent example. Suddenly, and apparently inexplicably, stock markets around the world crashed. The Dow Jones lost nearly one-quarter of its entire value, the largest daily fall in its entire history. Various accounts have been given to explain what happened but, over twenty years later, there is no consensus. Traders on stock markets receive large numbers of potential shocks in the form of new information, whether about the overall economy, particular firms, or the actions of other traders. Each piece of new information has the potential to trigger a large cascade. Few do. For the most part, the disturbances are contained by the robustness of the network. Every so often, the system proves fragile.

There are many possible reasons for economic recessions, but the 'animal spirits' of Keynes, the waves of optimism and pessimism as they either spread or are contained across the economy, are powerful factors. Network models seem essential to our understanding of recessions, and especially those involving financial crashes.[19]

A further problem for policymakers, whether in the public or private sectors, is that history is only played once. If networks are important and a 'cascade' might be created, it matters tremendously whether your policy experiences a small or a large cascade as a result of an initial 'nudge'. For example, perhaps the most spectacular brand failure in history was the launch of New Coke in 1985. In the early 1980s, Coke's leading position in the soft drink market was gradually being undermined by Pepsi. The latter built successfully on its 'Pepsi Challenge' campaign, a blind test for consumers on its own product and Coca-Cola. On taste, Pepsi seemed to be winning hands down. After a massive research effort, Coca Cola responded by withdrawing its own product

19. See, for example P Ormerod. "Information cascades and the distribution of economic recessions in capitalist economies," in *Physica A* 341: 556–68, 2004 and A Haldane's speech "Rethinking the Financial Network". http://www.bankofengland.co.uk/publications/speeches/2009/speech386.pdf

and introducing New Coke. Within months this was withdrawn and the old brand re-introduced, because sales had collapsed.

There were many reasons for the failure of New Coke. Undoubtedly one was simple word-of-mouth amongst potential consumers. The Watts model can be solved on the computer as many times as we like. But we only ever get one particular solution in real life. In this case, it was one in which the potential cascade was contained. Despite all Coca-Cola's massive research effort before the launch to investigate the potential for New Coke, in the one play of history the company was permitted, it failed.

'Scale-free' networks

We have already drawn out some general implications for policymakers in a networked world, but the particular model used to illustrate the points was based on a network in which agents were connected at random. As stated, this is not an unreasonable assumption in many circumstances but it does not apply in every context.

In the late 1990s, a group of epidemiologists, sociologists and physicists analysed a database of individuals and their sexual contacts. The results were published in *Nature*, one of the world's leading scientific journals.[20] They found that most people have only a few sexual partners, but that a small number have hundreds or even thousands. Perhaps not surprising. But the real originality of the paper was its finding that the structure of the pattern of the contacts closely reflected a recently discovered type of network called a 'scale-free' (for reasons which need not detain us).[21]

Such networks are important in the natural sciences, and more of them – at least good approximations to the scale-free

20. F Liljeros, C Edling, L Amaral, H Stanley and Y Åberg. "The web of human sexual contacts," in *Nature*, 411, 907–908, 2001.

21. Interested readers should consult the Wikipedia entry http://en.wikipedia.org/wiki/Scale-free_network

pattern – have been discovered in the human world. The World Wide Web, for example, has these properties. A few sites receive a massive number of hits while most sites get very few.

The concept received a huge boost in the popular mindset when Malcolm Gladwell published *The Tipping Point* in 2000.[22] Highly connected agents have enormous potential influence in spreading behaviour across such networks. Indeed, a whole industry has grown up in American marketing circles trying to find these key 'influentials'.

Certainly, in terms of the Watts model, if the network is not random but scale-free, persuading one of these 'hubs' – agents with large numbers of connections – to switch from A to B makes a big difference to the eventual outcome. They have the capacity to influence many other individuals. Because they are connected to such a large number of agents, the chances, for example, of them being connected to others who are easily persuaded is very high.

Such networks might often be important in the spread of ideologies and beliefs, where a small number of charismatic individuals might be decisive in persuading others to adopt their views. For example, the Cathar heresy in the thirteenth century, the first major challenge to Catholic orthodoxy for almost a thousand years, was driven by a few key highly regarded individuals, the *perfecti*. The Dominican friars placed in charge of the first Inquisition spent the best part of a century working to eradicate the heresy.[23]

For policymakers, this type of network again presents both an opportunity and a challenge. If the actual network of interest is approximately similar to a scale-free one, then the task of persuasion, of getting people to adopt different behaviours, make different choices, is made much easier if some of the 'hubs' can

22. M Gladwell. *The Tipping Point: how little things can make a big difference*. Little Brown 2000.

23. See, for example, A Roach. *The Devil's World: Heresy and Society 1100–1300*. Longman, 2001 and A Roach and P Ormerod. "The medieval inquisition: scale-free networks and the suppression of heresy," in *Physica A*, 339, 645–52, 2004.

be nudged into this. There is of course the major problem of identifying who these might be.

And if the network turns out not to be scale-free, then a strategy based on the view that it is will be unlikely to prove effective. In crowd control, for example, the police or military may believe there are a few 'ringleaders', and aim to nullify them in some way. But as a strategy, this is rarely seen to work, precisely because the assumption that a scale-free network underlies crowd behaviour problems is usually wrong.

The real problem arises for authorities where the network is scale-free and the aim is to *prevent* a particular form of behaviour from spreading. Consider, our earlier example, the potential spread of an epidemic, such as sexual diseases. If agents are connected at random, inoculation or influencing people not to take up the riskier mode of behaviour can be very effective. In general, not everyone needs to be inoculated in order to prevent the 'virus' from spreading. There may be occasional local outbreaks, but if a sufficient number of people are inoculated against adopting this mode of behaviour, it will die away.

This is most definitely not the case for scale-free networks. If the hubs are targeted, then literally every single one has to be caught in order to suppress the spread across the system, a very difficult task. The internet provides an example of this. Online viruses have very much longer life spans than would be the case if the system did not have these scale-free properties. Because of this they prove exceptionally difficult to eradicate completely.

'Small-world' networks

A further type of network that has been shown to be of importance and that makes life even more complicated, is the 'small-world' network. When we delve into the maths, there are considerable similarities between a scale-free and a small-world network. But their basic social structure is different. In the scale-free network there are a few agents who have huge potential influence. The small world is much more like overlapping sets of 'friends of friends'. Agents all have a relatively small number of connections, and if X is connected to Y and Y to Z, the chances of X being connected to Z are pretty high. The additional feature is that, whilst no-one has a large number of connections, a few agents may have 'long range' connections to others who are remote from their immediate cliques. But these individuals may be even harder to identify in practice than the hubs of a scale-free network, precisely because they themselves are not distinguished by having an unusual number of connections.

Understanding network structures

Random, scale-free, small-world; each of these networks has been shown to exist in a range of contexts. But do we need to know the exact structure of a network before we can even begin to think we might have some understanding of the effects of policy changes in a networked system?

Certainly, it helps if a complete picture can be obtained. The Framingham Heart Study is a long-term, ongoing cardiovascular study on residents of the town of Framingham, Massachusetts. The study began in 1948 with 5,209 adult subjects and is now on its third generation of participants. Nearly forty years ago, the study began to collect information on the social networks of the relevant individuals. Nicholas Christakis and James Fowler of Harvard Medical School and the Political Science department at San Diego analysed the detailed information on these networks and found strong social effects on both the reduction in smoking over time and the spread of obesity.[24] For example, the chances of a person becoming obese rose by 57 per cent if he or she had a friend who became obese.

24. N Christakis and J Fowler. "The spread of obesity in a large social network over 32 years," in *New England Journal of Medicine*, 357, 370–379, 2007; and "The collective dynamics of smoking in a large social network," in *New England Journal of Medicine*, 358, 2249–2258, 2008.

In practice we rarely have accurate information about the precise nature of these relationships. As so often is the case with social sciences, when it comes to practical policymaking, we have to rely on approximations. The good news is that old-fashioned survey research combined with the modern computer-oriented methodology of agent based modelling often enables us to get a reasonable estimate of the type of network which is relevant in any given context.

With Greg Wiltshire, I recently published an article on binge drinking in the UK.[25] There is a considerable literature on this, most of which neglects the potential role of peer acceptance in the sudden and rapid rise in binge drinking. There is some strong *prima facie* evidence that social networks are important in this activity (Table 1).

Table 1

Proportion of friends thought to be binge drinkers	Percentage for binge drinkers	Percentage for non-bingedrinkers
All or almost all	54	17
Most	31	24
Some	12	36
Hardly any or none	3	22

Source: Ormerod and Wiltshire, 2009. *Op cit.*

There is clearly a dramatic difference between the perceived behaviour of the friends of those identified as binge drinkers and those who are not. It could be argued that we are simply assuming the existence of a 'contagion' effect amongst friends rather than demonstrating its existence. But it would be curious, to say the least, if large numbers of young people had suddenly decided quite independently of each other to binge drink,

25. P Ormerod and G Wiltshire. "Binge drinking the UK: a social network phenomenon," in *Mind and Society*, 8, 135–152, 2009. Details of the survey can be found at www.paulormerod.com.

and then had happened to congregate together in friendship networks. So whilst the existence of a contagion effect amongst friendship networks is not technically demonstrated, it seems a far more likely explanation.[26]

The important point here is that policymakers do not need to be supplied with the full details of a network in order to be provided with information regarding its fundamental structure.

A different example is given by studies of the web of world trade, the import/export connections between the various countries of the world. Such connections are interesting not just for their intrinsic importance, but because the spread of financial crises often follows the pattern of trade flows between countries.[27] The more closely countries are connected by trade, the more likely it is that a currency or financial crisis will spread between them.

Direct bilateral-trade relationships can explain a small fraction of the impact that an economic shock originating in a given country can have on another one, which is not among its direct-trade partners. A network analysis of the world trade web can go far beyond the scope of standard international-trade indicators, which instead only account for bilateral-trade direct linkages.

An understanding of this network does not just provide information to policymakers about how shocks might cascade, it offers a different and powerful way of thinking about the effects of, say, introducing trade barriers, policies of interest to the developing if not the developed world. There are undoubtedly gains from trade and therefore costs to erecting barriers to trade. But a potential benefit might be that currency crises, for example, would become less likely to spread.

To make more effective policies, we do need to have some understanding of the structure of any network that obtains in any

26. The modelling technique used demonstrates that network effects are a sufficient explanation on their own to account for the rise in binge drinking.

27. For example, M Bordo and B Eichengreen. "Crises Now and Then: What Lessons from the Last Era of Financial Globalization," in *National Bureau of Economic Research Working Paper* 8716, 2002 and B Eichengreen, A Rose and C Wyplosz. "Contagious Currency Crises," in *National Bureau of Economic Research Working Paper* 5681, 1996.

given context. How 'nudge' effects can be amplified or contained depends to a considerable extent on this. Progress is being made in getting good approximations about structure, sometimes on the basis of relatively small amounts of information as the earlier example of binge drinking illustrates.

Nudge plus networks

The concept of nudging has gained traction both in the public and private sectors. The more realistic view of behaviour which it offers, compared to that of the classical economics assumptions of rational decision-makers, certainly provides a potential basis for more effective policymaking. But it is not without its problems.

The research in behavioural economics and economic psychology, on which nudge approaches are founded, shows that we have to abandon for the present the idea that there is a universal mode of behavioural decision-making. Some generalisations across similar contexts might be possible, but the same person can use quite different rules in different circumstances. So there is uncertainty in whether we have the correct understanding of behaviour in any given circumstance.

More importantly, network effects can either magnify dramatically the impact of nudge policies, making these harder to understand, giving the impression that the policy has failed, or even set up a powerful movement that is contrary to the intentions of the policy. In short, network effects can dwarf nudges. Nudging provides a potentially valuable insight for the initial task of trying to steer a network in a particular direction, but then the network takes over.

There are circumstances in which the classic approach still has traction. In fast moving consumer goods markets, for example, it is often reasonable to assume that tastes and preferences are fixed and are not relying on the behaviour of others to form those preferences.

However, there is inherent uncertainty about the impact of policy in a world in which network effects are important, which no amount of cleverness can overcome. In this sense, the world is much more like the vision articulated by Hayek than it is that of Friedman and the Chicago school of rational agents and efficient markets. The latter has much more in common with the world of the central planner, where in principle everything is knowable.

This is not a comfortable world for the policymaker. But it is how large sections of the world really are. Ignoring network effects means that we carry on with the same model, spending vast amounts of money, with at best a rather hit-or-miss success rate as the evidence of the past sixty-odd years shows.

One possible implication to be drawn from the networked view of the world is that little or nothing should be done, on the grounds that we have little or no idea of the eventual consequences of introducing any particular policy. Far from it.

The RSA's Social Brain project has started to explore the implications of individuals being more aware of their own cognitive frailties. Early findings indicated that giving people the tools to understand how their brains, behaviours and environments interact helps them make better decisions and tackle habits like smoking, binge-drinking and overeating.[28] The same kinds of questions can be asked about network effects and will inform the RSA's work on the role of social capital in bringing about change in deprived communities.[29] It is arguable that understanding network effects – how other people's behaviour influences our own – can empower people to make different and better choices.

In addition, this work – and this essay – suggest that an emphasis on social networks changes not just the focus and design of public policy, but the whole way we think about success and failure. Social networks are important; understanding

28. M Grist. *Op cit.*

29. See the RSA's Connected Communities project. www.thersa.org/projects/connected-communities

and using them can make a significant contribution to tapping into civic capacity (and delivering the Big Society vision) and meeting public policy goals. But they are also complex and the way they operate is unpredictable. Traditional policy interventions tend to be large scale and expensive and aim for relatively marginal improvement in outcomes. They seek to minimise risk through systems of regulation, audit and accountability. These design features do not fit the characteristics of social networks interventions, which will often fail or have unpredicted results, but where occasionally small interventions will have major impact through contagion effects.

When it comes to contemporary challenges – climate change, for example – it seems clear that we will often need to induce dramatic mass behaviour change. We are unlikely to do so using simple incentive based approaches and need to get better at harnessing the power of networks. Karl Marx once famously wrote 'Philosophers have sought to interpret the world. The point, however, is to change it'. He was completely wrong. Politicians have sought to change the world. The point is that they need to interpret it correctly. The potential gains from more effective policies built on a better scientific understanding of how the world operates are enormous.

RSA pamphlets

This is the third in a series of short essays that the RSA will be publishing over the coming months and which will explore the concept of twenty-first century enlightenment. The RSA is interested in ideas and action and the complex links between the two. With this in mind, we have commissioned a series of essays from leading thinkers and practitioners, looking not only at the history and theory that lies behind the notion of twenty-first century enlightenment, but also at the practical implications of what this may mean today.

Future pamphlets will address a range of questions including what new twenty-first century enlightenment approaches may be needed when approaching the market, economics and sustainability, and what role the arts, a sense of place and social networks may play.

All pamphlets will be available online at **www.theRSA.org** and we would welcome ideas from Fellows and others to:

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