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Social and psychological factors influences in decision making and incentives for livestock disease control

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Abstract

The economic incentives facing people making decisions in infectious disease control have been given due theoretical consideration within the literature, based on principles of economic rationality. Such deductive models provide important tools for generating hypotheses. However, the application of such models in a predictive capacity has been criticised. Advances in other social sciences have revealed systematic biases in human reasoning which cast doubt on the validity of the rational economic model as a generalisation of human decision making. This paper reviews the characteristics of infectious disease and disease-control interventions and the potential for bias in implementation decision making at primary producer level. Specific focus is given to the generation of externalities, both positive and negative; the perception of risk, relating to disease incidence and technology adoption; and finally uncertainty, and its potential to be moderated by trust in information sources. This information is then used to summarise supplemental psychological constructs which taken holistically may strengthen our ability to quantitatively explore human behaviour in this complex decision-making environment.

1. Introduction

A dynamic interaction exists between disease risk, investment in control strategies and the incentives faced by decision makers (Rich, 2007). In the past, successful disease control programmes have been built on the back of voluntary action to mitigate risk of both endemic (Morgan and Richards, 1974, Lehane, 1996, Cogan and Humphrey, 2003) and epidemic livestock disease (Szmaragd et al., 2010, Webb et al., 2011). State support for disease control programmes can be affected by larger economic and political considerations, and over the course of the 20th century public funding for agricultural initiatives has fluctuated in response to these constraints (Woods, 2011). Following the trend of the 1980s and 90s the current political rhetoric in the United Kingdom encourages

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minimal state intervention (Rushton et al., 2007)¹, with cost-sharing initiatives placing a greater onus on industry-led voluntary programmes for disease control in the UK (EAGRCS, 2010). As a consequence, greater understanding of decision making in livestock disease control is now especially important.

Previous evaluations of the voluntary implementation of disease control measures at farm level have indicated a degree of heterogeneity within the population in terms of participation. The voluntary vaccination campaign against bluetongue in 2008 appears to have achieved success in mitigating the risk of recurrence of the outbreak seen in 2007. At the same time however, vaccination uptake was at a level too low to inhibit transmission but significant enough to indicate a sizeable commitment of resources in areas which were predicted to be at low risk of disease due to climate and vector distribution (Webb et al., 2011). Voluntary biosecurity measures are implemented in differing combinations and by different proportions of the population in different regions (Toma et al., 2013); and bovine paratuberculosis herd level prevalence is estimated to be between 27 and 42%, while only 16% of herds are currently thought to participate in a voluntary control scheme, again implementing a range of possible control strategies (Geraghty et al., 2014).

Given that decision making at ground level has the potential to alter disease transmission dynamics, we review the differing approaches employed to investigate behavioural influences on the uptake of disease control measures. We review the theoretical bases of different approaches, from the strongly quantitative approach of the epidemiological and economic models, to the sociological, and highlight the strengths and weaknesses of each. Finally, we suggest a set of variables to form the basis of future empirical work on these issues.

A pioneering approach to understanding the diverse strategies employed within the farming profession has focused on behaviours which manifest and reflect diverse objectives

¹ It is noted that in times of crisis significant public resources are devoted to the control of animal disease. Cases in point are the FMD outbreak in the UK in 2001 and the emergence of BSE in the 1980s.

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amongst farmers. Gasson (1973) defines objectives as “ends or states in which the individual desires to be, or things which he wishes to accomplish” and goals as the expression of objectives. The translation of goals into action is limited by the availability of resources, the values of the individual and the norms of society relating to possible courses of action. This seminal work in the area of rural decision making first provided empirical evidence of the diversity of goals and values within UK farming. Since then a number of further studies have attempted to standardise measurement of goals and values within farming (Willock et al., 1999), determine a typology of farmers based on associations between goals (Rehman et al., 2006), and to establish associations between goals, values and behaviour (Willock et al., 1999, Rehman et al., 2006, Wilson et al., 2013). None of these studies, however, have made a quantitative exploration of the potential impact of diverse objectives on behaviour relevant to infectious disease control.

In the quantitative domain, mathematical models have become widely used in the management of both human and animal health. These models allow the representation of physical processes and systems by defining underlying parameters in mathematical terms (Thrusfield, 2007), and allow the exploration of system behaviour. Heterogeneity in individual perception of and response to disease risk, and response to incentives to control disease is now being explored within epidemiological modelling frameworks (Ferguson, 2007, Funk et al., 2010).

[Economic rationality in modelling studies](#)

As quantitative disciplines, epidemiology and economics are natural complements; as a result mathematical models integrating the epidemiological and economic characteristics of disease and interventions have been devised in various forms. These models can be a useful tool for selecting between policy options since they produce outputs combining both technical and economic metrics. In recent years, economic models used in animal health have developed from deterministic spreadsheet accounting to computable general equilibrium models (amongst others: Berentsen et al. (1992), Garner and Lack (1995), Mangen et al. (2004), Buetre et al. (2013)). As simulations of resource allocation decision

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making, economic modelling tools provide a route by which human behaviour can be integrated into epidemiological models.

Pioneering work in this area is proceeding with notable contributions published in recent years. Rat-Aspert and Fourichon (2010) simulated transmission of bovine viral diarrhoea virus under voluntary vaccination using an expected utility calculation to define vaccination decision making amongst an economically heterogeneous population of farmers at each time step. Assuming farmers had perfect information regarding disease prevalence, and therefore infection risk, it was found that the externalities of vaccination resulted in the development of an equilibrium which never resulted in disease eradication. Gramig and Horan (2011), in an exploration of economic incentives to increase biosecurity with a dynamic disease prevalence response, base farmer decision making on an expectation of lifetime income taking into account disease risk and the costs of regulatory measures. Boni et al., (2013) present a combined economic-epidemiological analysis of avian influenza transmission on poultry farms. Farmers seek to maximise profit by altering farm size, population turnover and levels of disease control in response to economic and epidemiological incentives. Hennessy (2007) takes a game-theory approach to explore the economic incentives to implement biosecurity where actions are strategic substitutes under differing network topologies and production scales. Assuming farms act rationally to maximise profit, the author demonstrates that centrally located farms have stronger incentives to implement protective measures, as do units with a larger share of total production. Kobayashi and Melkonyan (2011) question the assumed strategic nature of biosecurity actions by producers being substitutes. Using a game-theoretic model supported by empirical data, the authors find that the extent and nature of externalities determines whether biosecurity action acts as either a strategic substitute or complement.

Complementary effects are observed most strongly amongst producers in close geographic proximity, and where actions have internal benefits and long-lasting effects.

Game theory provides an excellent framework for modelling decisions involving risk, and these studies recognise that the risk exposure faced by individuals is dynamic, responding not only to the epidemiology of the disease but also the actions of other individuals within

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the community. A shortcoming however, is the function used to define participation in disease control is assumed to be economically rational; i.e. individuals seek to maximise a particular outcome measure such as profit, and form preferences about the options available based on this specific criteria. Importantly, individuals also have perfect information regarding the risks they face and the outcomes of the set of options available, a situation which is rarely apparent in reality. Similarly, despite the variance in goals and objectives amongst farmers demonstrated by Gasson and others as far back as the 1970s, this diversity is not reflected within current modelling frameworks.

Indeed, the capacity of the rational economic decision-making model to predict empirical results is inconsistent; it has been shown that people deviate from 'rational' behaviour in systematic ways (Allais, 1953, Ellsberg, 1961). To summarise, the neoclassical economic model of decision making allows a prediction of behaviour to be formed from an objective description of the world, and knowledge of the decision maker's utility function. Criticism of this model centres on its failure to take into account the cognitive processes underlying decision making which impose limitations on the calculating capacity of human reasoning (Kahneman and Tversky, 1979, Simon, 1986), as well as the potential for the internal and external environment to shape the perception of reality of the individual decision maker. It is this perception of reality, rather than the objective reality, which then provides the information upon which a reasoned decision is made (Simon, 1986).

Sen (1977) further criticises the definition of economic rationality with respect to the maximisation of self-interest. He writes:

"When act x is chosen by person i and act y rejected, this implies that i 's personal interests are expected by i to be better served by x than by y . There are, it seems to me, three distinct elements in this approach. First, it is a consequentialist view: judging acts by consequences only. Second, it is an approach of act evaluation rather than rule evaluation. And third, the only consequences considered in evaluating acts are those on one's own interests ... It is clearly possible to dispute the claims of each of these elements to being a necessary part of the conception of rationality."

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Sen goes on to argue that two concepts which are excluded from the neoclassical definition of rationality are what he terms sympathy and commitment. Sympathy is defined as a case in which concern for others affects one's own welfare, as such improving others' welfare increases the utility of the decision maker: it maintains a degree of egoism; this is analogous to Andreoni's "warm glow" as a motivation for charitable contribution (Andreoni, 1990). This definition of sympathy can be likened to the valuing of externalities to a transaction. Sen's definition of commitment delineates a non-consequentialist view of decision making, focusing on the means rather than the end result. As a result, the existence of commitment as a factor serves to detach choice from the outcome of a change in economic welfare. Sen proposes that commitment is of particular importance in the consideration of collective action, where societal norms are likely to influence choice.

To summarise the key issues, the assumptions on which the rational economic model of decision making is built raise issues with its application in the field of animal health:

- Profit maximisation may not be the sole universal objective in circumstances involving externalities and collective action due to sympathy and commitment.
- Decision makers are operating with incomplete information and a limited capacity to evaluate risk. This introduces increasing uncertainty in decision making.

Each of these factors will now be considered in turn with a brief review of relevant literature with the objective of determining a framework for elucidating significant factors that influence decision making in an animal health context.

2. Characteristics of disease and disease-control interventions

The presence of externalities

Umali et al. (1994), considering the case for public provision of veterinary services, stress the importance of identifying not only the costs and benefits to the decision maker, but also any costs and benefits accruing externally to the transaction taking place. Particularly in the case of infectious disease, preventive or controlling action produces externalities, that is, costs or benefits to people external to the decision-making process. To provide a relevant example, the concept of herd immunity is an illustration of a positive externality. If a

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sufficient proportion of a population choose to vaccinate against an infectious disease, non-vaccinators are able to free ride, gaining the benefit of reduced infection pressure without paying for vaccination. Conversely, a farmer who takes animals carrying infectious disease to market exposes external parties to an increased risk of infection, a negative externality. In addition to externalities, some animal health interventions require collective action to reach a threshold at which risk is successfully mitigated. These characteristics in the context of animal health have already been described in the literature (Leonard, 2000, Ahuja, 2004, Sumner et al., 2006, Rushton and Leonard, 2009, Bennett, 2012). Of relevance to this paper is the effect these characteristics have on incentives to invest in animal health interventions, where the social context may become influential in decision making.

A considerable volume of work exists on incentives to collective action and social dilemmas. Olson (1965) was one of the first to explore the economic incentives for collective action to provide public goods and concludes that a set of rational, self-interested individuals, unless they are operating in a very small group, will not act to further the group interest over personal gain. This assertion, that people only co-operate when incentives coincide with self-interest, is questioned by Johansen (1977), who argues that the rules and norms of society compensate for conflicting economic incentives in collective action. The fundamental premise of Olson, that self-interest overrides group interest, provides the rationale for government intervention to support the provision of public goods, at least in the UK.

In reality, there is evidence that significant heterogeneity exists in the way people respond to social dilemmas of this nature; this has been demonstrated in both laboratory and field studies. The decision to contribute to collective action is complex and influenced by many factors, generating a wealth of literature reviewed amongst others by Ledyard (1997), Ostrom (2005) and Chaudhuri (2011). Several key points however may be pertinent in the context of disease control:

1. Heterogeneity in strategies is observed with respect to co-operative behaviour in public goods games (Ostrom 2000). Evidence suggests that individuals show a

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predisposition toward certain strategies (co-operation, conditional co-operation, defection) (Kramer et al., 1986, McClintock and Liebrand, 1988), but which strategy is chosen in a given situation is moderated by variables such as perceived efficacy of individual contributions, group size, and the capacity for communication of past actions or reputation. Communication facilitates rewarding or punishing behaviour within the group and provides an incentive to co-operate as individuals are able to build social capital, and facilitates the development of behavioural norms (Hackett et al., 1994, Rege, 2004, Carpenter, 2007, Sefton et al., 2007).

2. The presence or believed presence of free-riders within a system serves to reduce co-operative behaviour across repeated interactions (Isaac and Walker, 1988), this effect can be mitigated by frameworks which allow members of the group to monitor and punish defection (Fehr and Fischbacher, 2002).
3. There is evidence that identification by an individual as being part of a group increases co-operative behaviour with other in-group members (Wit and Wilke, 1992, De Cremer and Van Vugt, 1999) (Tyler and Dawes, 1993, Chen and Li, 2009), this effect is explained as strengthening of both trust in ones peers, and perception of the efficacy of one's contributions to the group effort (De Cremer and Van Vugt, 1998).
4. Institutions play a role in fostering an environment that promotes co-operation. It is believed that conditional co-operation and selfish behaviour are the two behaviours most prevalent in social dilemmas relating to collective action (Fehr and Fischbacher, 2002). If conditional co-operators believe that the majority of society is also co-operating, a co-operative equilibrium can develop. The maintenance of a co-operative equilibrium, rather than a selfish one, can depend on the trust people place in institutions to regulate behaviour in a manner that is robust against abuse by selfish or free-riding individuals (Fehr and Fischbacher, 2004).

To summarise, experimental evidence shows that the way people behave in social dilemmas and in the presence of externalities in experimental settings displays a softening of the process of economic maximisation. In this context people tend to look to formal or informal

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regulation by institutions to stimulate co-operation. As a result further consideration for the social and institutional context in which infectious disease control takes place is encouraged. However, risk and uncertainty further complicate the issues.

Risk and Uncertainty

The prevention or treatment of contagious disease exposes a decision maker to a degree of risk, as well as uncertainty around that risk. In choosing to vaccinate against a particular disease for example, a decision maker has to form an assessment of the likelihood of the disease infecting their herd, and the impact it would have upon infection. The degree to which the decision maker is able to make this assessment is limited by the availability of information available to them, which introduces uncertainty into the decision process. Another source of risk is the intervention itself: the consequences of adoption must be anticipated in advance.

Incorporated in this assessment of outcomes is a degree of temporal uncertainty. Many health-related decisions are prophylactic against a future risk, but the time at which that future risk occurs, if ever, may be unknown. Biosecurity and vaccination are examples. The timing of disease challenge is unknown, and a successful outcome by definition is unobserved, healthy animals remain healthy. Variance in individual time-preference is already documented within the literature (Frederick et al., 2002; Berns et al., 2007), and previous studies in other contexts, such as health behaviour, have shown links between time-preference and behavioural intentions (Story et al., 2014). Programmes to remove infectious disease from populations may take many production cycles to reach fruition; thus the benefits of increased yield may take many years of commitment to the programme at individual-level, and, due to the externalities of infectious disease, also at community-level. To provide an example, although campaigns to remove African animal trypanosomiasis from large regions of sub-Saharan Africa prior to independence in the 1960s were successful, commitment by governments has fluctuated since, leading to a resurgence of disease in areas that were previously cleared (Rogers and Randolph, 2002).

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In the UK, farmers are able to draw on numerous sources of information, including veterinary surgeons, other farmers, professional organisations, and governing institutions (Heffernan et al., 2008, Cresswell et al., 2014). These groups have roles to play in the provision of information relating to risk exposure as well as mitigation strategies, and therefore have the potential to shape risk perception and thus behaviour. There are two major categories of risk in the context of infectious disease control: technological risk, that is, the risk related to the application of a new technology; disease risk, relating to the likelihood and impact of a given disease should it become present.

In order to understand the nature of these two categories of risk, and how risk information is processed, a review of pertinent literature was conducted. On the subject of technology adoption, Jacoby and Kaplan (1972) explore the nature of risk from the perspective of consumer choice and define five categories of risk which are thought to influence risk perception for product selection, with the additional component of time loss (Roselius, 1971) (Tables

Table 1).

Perception of the risk of various natural and man-made hazards has been shown to largely be determined by contributions from two factor dimensions. These are described as unknown risk and dread risk (Fischhoff et al., 1984, Slovic, 1987).

Risk information processing

Where sophisticated risk-analysis techniques attempt to quantify risk and uncertainty, it has been proposed that given limited processing capacity and time, people rely on an intuitive process by which they form risk perceptions (Slovic, 1987). There is a theoretical assertion that actually two complimentary systems operate by which people judge risk (Epstein, 1994). The first is an intuitive, non-verbal system based on affective judgement, the other a deliberative, verbal, rational process. These systems are proposed to complement each other such that people base their judgement of a particular activity based on what they think as well as what they feel (Slovic et al., 2004).

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Finucane et al. (2000) illustrate the effect of this dual processing model. In a series of experiments in which they manipulated people's perception of either risk or benefits of technology adoption in isolation, a negative change in perception of risk related to a given technology resulted in a positive change in perception of benefits, and vice versa. The explanation of this phenomenon refers to the "affect heuristic", which proposes a top-down model of risk and benefit perception where both are simultaneously informed by a holistic judgement of the activity in question.

Siegrist and Gutscher (2008) investigated effect of past experience in the context of risk mitigation behaviour with respect to a natural disaster. Based on the *evaluability* hypothesis of Hsee (1996) the authors present findings which suggest that people struggle to predict the positive or negative emotional consequences of an event. They show that people lacking direct prior experience of the event underestimate the negative affective consequences of a natural disaster in relation to people who have experienced it first-hand. Direct experience was associated with increased risk perception and mitigation behaviour. Therefore, where a risk can be defined as probability and impact, the impact cannot be adequately estimated *a priori* because people cannot accurately estimate the affective component of that impact. The result is that past experience refines this estimation and therefore moderates risk perception.

Trust in information and regulation

Since risk perception is an interpretation of information relating to the state of the world around us, it is clear that the source of information, and the individual's trust in that source have a role to play in determining perceived risk. Trust has been studied as a mediator of risk perception in many risk management contexts, including perceptions of technological risks such as nuclear power e.g.(Whitfield et al., 2009), genetically-modified food e.g.(Poortinga and Pidgeon, 2005), and natural disasters such as fire (Vaske et al., 2008) and flooding (Terpstra, 2011).

In the agricultural sphere, it has been suggested that farmers may invest significant energy in maintaining interpersonal information networks over large distances due to low

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population densities (Murdoch, 2000). Access to multiple information sources has been suggested as an important risk mitigation strategy amongst New Zealand dairy farmers (Sligo and Massey, 2007), while Solano et al. (2003) suggest specific information sources are selected by farmers as being relevant to particular aspects of implementing new technology or interventions. Palmer et al. (2009) take a qualitative approach to explore associations between risk perception, biosecurity and disease reporting amongst a sample of Australian livestock farmers. All these studies incorporate trust as a key variable in the relationship between risk perception and behaviour.

Within the literature several definitions of trust can be found. Rousseau et al. (1998) define trust as “a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another”. This definition allows a mechanism for trust to act upon risk perception to be determined, such that a risky prospect is perceived as less risky when regulated by a trusted authority. Siegrist and Cvetkovich (2000) describe the mechanism of the action of trust as reducing complexity in decision making: trust enables people to select experts whose opinions can be believed as being accurate.

Renn and Levine (1991) define trust in risk communication as “the generalised expectancy that a message received is true and reliable and that the communicator demonstrates competence and honesty by conveying accurate, objective and complete information”. This definition sheds insight into the proposed determinants of trust. Renn and Levine (1991) propose five component factors for trust: competence, relating to the degree of expertise assigned to a source; objectivity, or lack of perceived bias; fairness, or perceived acknowledgement of alternative points of view; consistency, based on past experience; and faith, which is the perception of “good will”. Rousseau *et al.* propose two forms of trust: relational, describing the relationship and intentions of the two concerned parties, and calculative, based on behaviour, both past and future. Factor analysis performed in empirical studies of trust has also reduced trust to two dimensions, which relate to perceived general trustworthiness and accountability (Frewer et al., 1996) or general trust and scepticism (Poortinga and Pidgeon, 2003). The reduced dimension general trust or

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trustworthiness incorporates measures of competence, care, fairness and openness, while the second accountability or scepticism construct reflects concerns over the credibility, reliability and vested interest of risk management authorities. Constructs relating to trust, under various labels, have been operationalised and measured in many different contexts. Earle (2010) reviews 132 empirical studies of trust in the domain of risk management, which provide a wealth of resource in operationalising trust constructs for data collection instruments.

To understand risk and how it is managed by people operating in a boundedly-rational manner, with limited processing power, it is necessary to understand the way in which risk information is processed. How information relating to risk is valued and incorporated in decision making is dependent on the trust people place in information sources, as trust provides a mechanism for simplifying decision making by delegating responsibility for risk management to an external person or body. These relationships are illustrated in Figure legends

Figure 1.

Further to this, the timeframe over which disease control is implemented and produces results introduces the possibility for individual variance in long-term goals to distort the valuation of outcomes, and introduces uncertainty that commitment to disease control will be sustained for the required duration.

4. Social Approaches to Modelling Individual Decision Making

An alternative class of model of decision making developed on principles drawn from the disciplines of psychology and sociology have come to prominence over the past 30 years: social cognition models (SCMs). These models maintain that humans are fundamentally rational decision makers, but attempt to incorporate individual-level differences in perception.

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Individuals perform a complex balancing act in assessing and subjectively weighting multiple utilities simultaneously, such that total utility is maximised. SCMs propose relationships between underlying human motivation, thought and action. These models map out the cognitive process of decision making via a series of linked constructs, focusing on the way in which individual differences in perception affect decision making. External influences, such as the environment and availability of resources, act to moderate or mediate the influence of constructs. SCMs have seen application within many disciplines including human health, reviewed by Connor and Norman (2005), agricultural economics for example, (Lynne, 1995, Bergevoet et al., 2004), and animal health (Gunn et al., 2008, Ellis-Iversen et al., 2010).

The key construct as a predictor of behaviour in SCMs is the formation of intention. As well as having the intention to perform an action, an individual must also have the appropriate skills required to perform that action, and be free from any further constraints on performing the behaviour. Depending on the given theoretical framework, numerous determinants of intention have been proposed.

[The theory of planned behaviour](#)

A special consideration is given here to the theory of planned behaviour (TPB) (Ajzen, 1991). This has been applied widely to analyse a range of behaviours, from health related behaviour e.g (Godin and Kok, 1996) to consumer choice of food products e.g. (Aertsens et al., 2009) and environmental behaviour e.g. (Kaiser et al., 1999). In studies of farmer decision making with respect to disease control, TPB is frequently used to develop data collection protocols and perform analyses (McIntosh et al., 2009; Jansen et al., 2010; Lind et al., 2012; Derks et al., 2013; Espetvedt et al., 2013). Developed from the earlier theory of reasoned action (Ajzen and Fishbein, 1972, Fishbein, 1979), TPB defines behavioural intention as being formed from three belief constructs: behavioural, normative and control. The formulation is based on an expectancy-value model, such that each variable is composed of a product of the likelihood of a given outcome taking place and the value of that outcome. Previously conducted reviews have attempted to synthesise the evidence for the intention and behaviour relationship across a range of behaviours and settings (Sheeran, 2002; McEachan et al., 2011). As such, it is possible to say that the intention-behaviour

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relationship is well established. However, although the theory of planned behaviour provides a framework which has proved to be adaptable to many different behavioural contexts, further developments of the TPB have sought to improve its conceptualisation of the main constructs. Of relevance to infectious disease control in livestock are the criticisms of the way in which affective response, social norms and habitual behaviours are handled by the model. The result is the development of numerous extended TPB models suited to different contexts, such as the integrated behavioural model for health decision making (IBM) (Montaño and Kasprzyk, 2008), and the technology acceptance model (TAM) (Davis et al., 1989; Venkatesh and Davis, 2000) for adopting new technology. In the meantime the animal health discipline appears to be lagging in terms of developing its own frameworks which are context specific.

While TPB extensions have no doubt added explanatory power to the basic theory, a debate has taken place within the last 2 years, as to whether the TPB has achieved all it can to increase our understanding of decision making (Sniehotta et al., 2014).

There are several criticisms of TPB which are especially salient for disease control intervention. First, the normative belief construct might need re-consideration to account for externalities in infectious disease control. Within the TPB the strength of normative beliefs is measured by the subjective norm construct: the sum of the products of motivation to comply and a subjective estimation of the probability of a particular referent holding a given normative belief for n salient referents.

Meta-analysis, however, reveals that this formulation is a relatively weak predictor of behavioural intention (Armitage and Conner, 2001). It has been suggested that this is because, rather than reflecting a real lack of influence of norms over behaviour, the subjective norm construct does not adequately conceptualise reality in two key ways (White et al., 2009). Firstly, the dimensionality of the subjective norm construct has been questioned (Cialdini et al., 1991); it being proposed that the conceptualisation as used in TPB embodies only one dimension of social pressure to perform a given action: the perception of what others would want one to do. Another proposed dimension is what the

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individual perceives key referents to be doing themselves; that is, recognising that what people want to do and what people actually do may differ. These two dimensions are termed injunctive and descriptive norms respectively (Cialdini et al., 1991). Meta-analysis has revealed an additional significant contribution of descriptive norms to explaining variance in behavioural intent (Rivis and Sheeran, 2003), and there is evidence that an interaction exists which increases the contribution of descriptive and injunctive norms (Smith and Louis, 2008). The more recent SCM developments, such as the integrated behavioural model, include separate normative constructs for these two components.

Secondly, the defining formula for subjective norm is additive across all referents, but does not reflect the possibility that all referents may not be weighted equally in their importance to the decision maker. As a result, it doesn't reflect the strength with which individuals identify as being part of, or external to a particular group and the effect that identity perception has on their behaviour (Cialdini et al., 1991). The social identity approach of Hogg et al. (1995), based on social identity theory of Tajfel and Turner (1979) specifies that identity with a particular group drives behaviour toward conformity with in-group stereotypes and norms. There is a growing body of empirical evidence for this moderating role of social identity on the strength of normative influence (Terry et al., 1999; Johnston and White, 2003; Giles et al., 2004; Hamilton and White, 2008; White et al., 2009). Tanis and Postmes (2005) explore the relationship between norms, group membership, trust and anticipation of reciprocated behaviour, producing evidence that social identification increases expectations of reciprocal behaviour between group members when personal identification cannot be established. In essence, social identity is proposed to act as a proxy to replace knowledge of the trustworthiness of a referent, therefore forming a reference point for anticipating reciprocal behaviour. While qualitative studies within agricultural communities support the importance of social components in decision making (Burton et al., 2008; Heffernan et al., 2008) as being relevant, as with many TPB-based studies, the quantitative approach has tended to show a relatively weak response on intentions due to the influence of social norms.

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A second issue to consider is that while intention is associated with behaviour, the difficulty of measuring behaviour empirically has meant most studies cease measurement at the intention level. Furthermore, the addition of increasing numbers of constructs to social cognition models (e.g. the TAM and IBM referred to above) places greater strain on the data collection process. The empirical testing of TPB-based frameworks relies on attitude elicitation through a survey instrument. The design and development of a reliable and valid data collection instrument for TPB studies therefore have many inherent pitfalls which necessitate a lengthy development process to mitigate (Oppenheim, 1992; Rattray and Jones, 2007).

Although the subject of maximising response rate has been extensively studied, the issue of systematic bias in the data collection instrument requires careful management (Edwards et al., 2002; Podsakoff et al., 2003). This is compounded in this case by the requirements for multiple questionnaire items for each variable being measured in order to ensure internal validity. As the number of variables increases, so too does the number of questionnaire items and the time required for the respondent to complete the task, as well as the requirement for a larger sample size. There is therefore a trade-off between the gain in explanatory power and the addition of supplemental variables.

The need for appropriate qualitative work within the target population is emphasised, to elicit the constructs most likely to be influential for the particular action under consideration. It is quite probable that the combination of constructs with significant effects will vary between actions and populations, as the internal and external costs, benefits and perceptions of risk vary between actions. Although a questionnaire produced in such a way will still require an appropriate method of validation, it should be stripped down to minimum length whilst retaining explanatory power.

With this in mind, we propose a set of variables on which to focus data collection to further our understanding of the adoption of disease control interventions, following from the social cognitive approach (Table 2). Following the methodology for operationalising theoretical constructs for quantitative data collection (Oppenheim, 1992; Rattray and Jones,

2007), we emphasise that an important element should be the reduction of variables based on sufficient prior qualitative work within the context and population that is being studied, specifically relating to the behaviour which is of interest.

5. Conclusion

The approaches taken by economists and epidemiologists investigating individual behaviour within the domain of infectious disease control in animals have a strong mathematical and rational basis. This facilitates modelling, which is important in terms of generating testable hypotheses, although it lacks in predictive capacity. Empirical behaviour studies tend to employ social cognitive approaches, principally employing models such as the theory of planned behaviour. These models have a long history of application across numerous contexts and have been through many developments to improve their context-specific explanatory power. Their utility in the veterinary sciences has been in understanding likely barriers to adoption of new interventions, when those barriers fall within the domains covered by the model. However, for livestock disease control, relatively little has been done to establish a context-specific framework for farmer decision making with greater explanatory power. It is argued that the presence of externalities, risk and uncertainty associated with infectious disease present challenges which require consideration of the theoretical and empirical evidence which exists to underpin the development of such a framework. Arising from this consideration, it is hypothesised that trust between information sources and consumers serves to mediate the risk perception of farmers as far as disease likelihood and impact, and the outcomes of new interventions are concerned. Attention is also paid to the potential for interaction between farmer's long-term goals and time preference to affect the perceived value of interventions which may take many production cycles or yields to achieve results. Finally, because of the externalities that exist with infectious disease management, the social setting in which disease control is taking place has to be considered since collective action may be required to produce a meaningful reduction in disease burden.

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Tables

Table 1. Components of risk in consumer choice (Roselius, 1971, Jacoby and Kaplan, 1972).

Type of risk	Definition
Financial	The chance of losing money by selecting a given product
Time Loss	Failure of a product leads to a loss of time, effort and convenience
Performance	The chance that a product will not perform to expectations
Physical	The risk of harm or injury being caused by a given product
Psychological	The chance that a product does not conform with self-image
Social	The chance that usage of a particular product will affect the way others think of you

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Table 2. Variables proposed for qualitative investigation of decision making in the context of animal disease control determined through literature review

Social environment	Risk perception	Attitudinal components	Mediator variables	Control components
Injunctive norms	Disease risk	Perceived costs	Trust in information sources	Control beliefs
Descriptive norms	Technological risk	Perceived benefits	Trust in regulatory institutions	Self-efficacy beliefs
Institutional rewards and punishments		Experiential (affective) attitudes	Time preference	Environmental constraints
Social identity		Resonance with long-term goals		

Figure legends

Figure 1. Path diagram for processing of risk and benefit information

