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The Bridging Role of Socio-economic Reasoning in "One Health"*

by

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Keywords. — Behaviour; Public Good; Networks; Organization; Interdisciplinarity.

Summary. — The "One Health" concept refers to an integrative approach of health issues, emphasizing the strong interdependencies between human health, animal health and environmental health. This approach defends the need for interdisciplinarity, transdisciplinarity, and intersectorality in health risk management. As regards public and animal health, the role of economics has often been restricted to an accountancy role, mobilizing diversely sophisticated tools to model the cost of diseases, of their control, and of welfare systems. However, as a conceptual framework of decision analysis, economics may bring a lot more to health risk management. This paper deals with the foundations of a so-called socio-economic reasoning, stressing this wider contribution to "One Health" analysis and implementation. Referring to recent applications, this article advocates how the socio-economic framework may constitute an interdisciplinary bridge, linking technical and social sciences.

Mots-clés. — Comportement; Bien public; Réseaux; Organisation; Interdisciplinarité.

Résumé. — *Le raisonnement socio-économique comme pont interdisciplinaire en matière de santé.* — Le concept «Une Seule Santé» renvoie à une approche intégrée des questions de santé, soulignant les interdépendances étroites entre santé humaine, santé animale et santé environnementale. Cette approche met en avant un besoin d'interdisciplinarité, transdisciplinarité et intersectorialité dans la gestion des risques sanitaires. En matière de santé publique et animale, le rôle de l'économie s'est souvent restreint à un rôle comptable, mobilisant des outils de sophistications diverses pour modéliser le coût des maladies, de leur contrôle ou des systèmes de santé. Pourtant, en tant que cadre d'analyse de décision, l'économie peut contribuer bien plus largement à la gestion des risques sanitaires. Cet article décrit les fondements de ce qu'il nomme un raisonnement socio-économique, soulignant ainsi cette plus large contribution à l'analyse et la mise en œuvre du concept «Une Seule Santé». Se basant sur des applications récentes, cet article tend à défendre un rôle potentiel du cadre d'analyse socio-économique comme pont interdisciplinaire, reliant les sciences biomédicales, techniques et sociales.

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Trefwoorden. — Gedrag; Algemeen welzijn; Netwerken; Organisatie; Interdisciplinariteit.

Samenvatting. — *Socio-economische redenering als een interdisciplinaire brug in gezondheid.* — Het „One Health"-concept verwijst naar een geïntegreerde benadering van gezondheidskwesties, waarbij de nadruk wordt gelegd op de sterke onderlinge afhankelijkheden tussen de gezondheid van de mens, de gezondheid van dieren en de gezondheid van het milieu. Deze benadering benadrukt de behoefte aan interdisciplinariteit, transdisciplinariteit en intersectoraliteit bij het beheersen van gezondheidsrisico's. Op het gebied van de volksgezondheid en de diergezondheid is de rol van de economie vaak beperkt tot een boekhoudkundige rol, waarbij verschillende verfijningstools zijn ingezet om de kosten van ziekten, hun controle- of gezondheidsstelsels te modelleren. Maar als kader voor het analyseren van de beslissing kan de economie veel breder bijdragen aan het beheersen van gezondheidsrisico's. Dit artikel beschrijft de grondslagen van wat hij socio-economische redenering noemt, en benadrukt deze bredere bijdrage aan de analyse en implementatie van het One Health-concept. Op basis van recente aanvragen pleit dit document voor een potentiële rol van het sociaal-economische kader als een interdisciplinaire brug tussen de biomedische, technische en sociale wetenschappen.

1. Introduction

The "One Health" concept refers to an integrative approach of health issues, emphasizing the strong interdependencies between human health and animal health within a health ecosystem (Zinsstag *et al.* 2015a). It is closely related to the EcoHealth framework, stressing the same communality of health determinants of life forms on earth. This approach defends the need for inter- or transdisciplinarity and intersectorality in health risk management. The term "interdisciplinarity" is here understood as an integration of various scientific disciplines in tackling these issues, while the use of the term "transdisciplinarity" aims at stressing the crucial role of all stakeholders in solving complex societal issues, thus calling for participatory approaches and citizen science (Keune *et al.* 2013). Intersectorality then stresses the need for different sectors in the society to collaborate in the management of health risk. This will often refer more precisely to interministerial collaborations but without being restricted to this public action sphere.

Over the last two decades, the concept was brought on the forefront as a result of the complexity of emblematic health challenges as influenza viruses presenting a pandemic potential, haemorrhagic fevers as those caused by the Ebola or Lassa viruses, emerging vector-borne diseases as the Rift Valley or West Nile fevers, as well as antimicrobial resistance. Due to the zoonotic nature of most of the health risks tackled under its umbrella, the "One Health" advocacy keeps dominated by the need for interactions between human and veterinary medicines. Environmental and social sciences are still poorly integrated in this scientific movement (Khan *et al.* 2018). Nevertheless, the wider understanding of the concept as presented here calls for an involvement of many domains linked to

health issues, like environmental quality, biodiversity, human behaviour, or social, cultural, economic and political evolutions of societies across the world.

Beside this explicit account of human, animal and environmental dimension of a given issue, the "One Health" approach may also be centrally defined by the complexity it tackles (Zinsstag *et al.* 2015a, Antoine-Moussiaux *et al.* 2017). Complexity here covers a defined set of features of an issue conceived as a system of factors, among which the high number of factors involved with a multitude of interactions, including feedback loops, giving rise to non-linear relations between elements and to emergent properties of the whole system, which cannot be understood by studying its constituents in isolation (Cilliers *et al.* 2013). Complexity, which is then also marked by its part of unpredictability and uncertainty, calls for a careful definition and investigation of the issue with the support of multiple perspectives, hence inter- and transdisciplinarity.

As regards public and animal health, the role of economics has often been restricted to an accountancy role, mobilizing diversely sophisticated tools to model the cost of diseases and their control, the value of health, insurance coverage, welfare systems, health policies (for an example of reviews in animal health, see Rich & Perry 2011; for one in public health, see Brouwer *et al.* 2006). More explicitly considered within the framework of the "One Health" approach, the role of economics is then proposed, in accordance with this accountancy role, to objectify the added value gained from intersectorality, advocating integration with stakeholders and plan for cost-sharing schemes (Zinsstag *et al.* 2015b, Machalaba *et al.* 2017). In fact, a narrow vision of economics associates the discipline with the sole micro-economic theory and financial analysis tools to defend strategic choices and evaluate the efficiency or cost-effectiveness of health actions or programmes (Machalaba *et al.* 2017). Economics is here mainly understood as the science of the optimal allocation of resources, being defined according to one of its practical goals, with a normative ambition, *i.e.* defining what is best to do (Rushton 2009, Howe 2017).

Other authors have advocated a wider application of economics to health issues and health system analysis, then putting forward the economic insights into decision-making rather than a science of "cost-for-value" (Carande-Kulis *et al.* 2007, Antoine-Moussiaux *et al.* 2017, Wolf 2017). Along with the latter view, economics may be described through its means and its basic contribution to knowledge, *i.e.* as a behavioural science studying human decision-making with the help of a diversity of theoretical frameworks, sharing a restricted set of common basic concepts, such as utility. As a conceptual framework of decision analysis at different human organizational scales (micro, meso, macro), economics may bring a lot more to health management than accountancy and a supposedly optimal allocation of resources. At this stage, it is interesting to note how recent works in economics of animal health exemplify the use of accountancy approaches to understand the actual decision-making of farmers, although the tension between a strictly positive approach and a normative one remains at the

very heart of such works as in many economic works (Rojo-Gimeno *et al.* 2016, 2018a). In fact, since it deals with decision-making, the whole discipline of economics appears as embedded in a field of tension between positive and normative goals. As other sciences, however, it may indicate the way to reach some goals, not the goal to be sought, which should remain a social and political issue. The use of the term "socio-economic reasoning" aims here at stressing this wider contribution, taking account of the economic analysis of the diverse nature of motives for decision-making, diverse preferences and relationships between individuals and social groups, then bringing the analysis out of the sole monetary dimension of decision-making. It widens the scope of explaining factors in stakeholders' decision-making, integrating tools from communication, modelling, sociology or anthropology to adequately approach actors' rationality in diverse cultural and social contexts. As such, socio-economic reasoning may constitute an interdisciplinary bridge, linking biomedical, technical and social approaches, as exemplified by the value chain framework (Antoine-Moussiaux *et al.* 2017).

This paper provides to a readership from life and health sciences some keys about socio-economic reasoning in health, highlighting the bridges to other disciplines in the prospect of "One Health" approaches. After addressing the foundations of socio-economics and the mainly handled conceptual frameworks, it will cover a set of applications to health including methodological considerations in relation with the "One Health" concept.

2. Socio-economic Reasoning: From Philosophy to Science, and Back

As already introduced, socio-economic reasoning proposes an analysis of decision-making based on the core-concept of utility, a term referring to overall welfare people may experience, more precisely as a result of their choices. This concept is also the basis of the philosophical view called utilitarianism. Utilitarianism is classically considered as founded by Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873). It sets the attempt to reach the "greatest good for the greatest number" as a criterion for the conduct of public and private affairs. Hence, this maxim directly refers to an idea of maximization of utility, being considered as a sum of the pain and pleasures one experiences and the sum of all these individual utilities to obtain a public utility. This thought may however be considered as finding its roots in earlier works of David Hume (1711-1776), who directly influenced Bentham, but also from French philosophers as Claude-Adrien Helvetius (1715-1771) or Pierre-Louis de Maupertuis (1698-1759). While both Helvetius and Hume indeed mobilized the notion of public utility, Helvetius brought an interesting case in proposing in *De l'Esprit* (1758) a fundamental analysis of human mind, or ways of thinking and acting, based on the notion of self-interest. Let's recall that the predominance of self-interest in analysis does not philosophically exclude altruism as a principle of human

behaviour. Altruism is indeed considered through the diverse works of Adam Smith (1723-1790), the other major founder of economic thinking, understood as this possibility for an optimal public good to be reached through the sum of decentralized individual decision-making (Anspach 2008). On another note, the works of Maupertuis are recognized as the first explicit occurrence of the idea of summing pains and pleasures in an overall calculation, which quite obviously finds its roots in the Epicurus' principle of the calculation of pleasures and pursuing pleasure as the final good.

As a matter of fact, much of the works of these philosophers aim at normative ethics, while socio-economics as a scientific discipline may be thought as positive in nature, aiming at understanding the world and defining ways of action. Beside the case of Helvetius, such a scientific framing of utility also appeared in the 18th century in the works of Daniel Bernouilli (1700-1782), utility here appearing as the objective that people maximize when making decisions, under the term of "subjective utility". Very close to the modern understanding of the concept in the part of economics more precisely dealing with individual decision analysis, this subjective utility is translated into a function joining factors of different natures which affect human decision-making. Interested in decision-making under risk, Bernouilli exposed in his work, *Specimen Theoriae Novae de Mensura Sortis* (1738), how the non-linearity of increase in utility (welfare) with the rise of income translates into a concave utility function that directly explains how one usually tends to avoid or undervalue risky games (Bernouilli 1954). These works may be considered as founding the discipline of economics as a mathematical study of decision-making.

In the 19th and early 20th centuries, although still anchored in the works of these founding thinkers, this emerging discipline of economics was further transformed to leave the ground of a moral philosophy and become a mathematized expression of choices and their societal results, mostly focusing on production, consumption and trade. However, behind an appearance of objectivity and value-neutrality sought through its mathematization, the philosophical and normative background of economics remained strong and has proven a powerful support to legitimate a diversity of policies. The normative facet of economics finds present application in policy evaluation based on welfare economics. Hence, while the utilitarian basis of public health ethics may be tempered by John Rawls' notion of justice protecting individual liberties (Roberts & Reich 2002), the economic tools for public decision-making and policy evaluation (ex-ante or ex-post) are built on a clearly utilitarian philosophical ground. Even when mobilized in an attempt to understand reality, hence with a positive purpose, the philosophical foundations of economics should not be forgotten in order to enlighten the use of its results or to modify its methods to include other philosophical assumptions.

Today, socio-economic reasoning mobilizes the notion of utility as the motive of individual decision-making, which appears as an optimization process of one's own interest (Kahneman & Sugden 2005). However, while neoclassical econ-

omics considers income, profit or consumption as sufficient measures of utility and drivers of decision-making and considers markets as giving a sufficient account of interactions between actors, the socio-economic reasoning calls to explicitly recognize the importance of a diversity of social interactions and processes in shaping individual and collective choices and behaviours, with a particular attention paid to institutions (particularly in the domains called "institutional economics" and "new institutional economics"). Also, other motives may be included in utility functions in an attempt to take account of human behaviour, as altruism or status-seeking behaviour (Gaspart & Seki 2003). As a result of the definition itself, an individual will be always considered rational since he pursues the maximization of his/her utility, notwithstanding its formal definition and the factors upon which it rests. However, the rationality considered here is limited, or say "bounded", by access to information, emotions, perceptions and cognitive abilities of the decision-maker, as highlighted by the seminal works of Herbert Simon, who himself claimed working in the continuity of Alfred Marshall's idea of economics being a psychological science (Simon 1979). Other major authors working along this idea were John Maynard Keynes (Keynes 1936), who built his well-known macro-economic theory on the "animal spirit" of decision-makers, *i.e.* preferences and fear, but also John Von Neumann and Oskar Morgenstern (Von Neumann & Morgenstern 1944), who brought up utility in its decisional understanding that is here mobilized, as well as Amos Tversky and Daniel Kahneman, who put forward the prospect theory of decision-making (Kahneman & Tversky 1979). The latter works led to the setting of a new constituted discipline, called "behavioural economics", with its peculiar application through experimental economics, the popularity of which is now growing fast. While both denominations are often used interchangeably, behavioural and experimental economics differ in that the latter represents more precisely the test of the hypotheses of the former, in controlled and reproductible experimental settings built up to record and analyse factors influencing individual choices. It is interesting here to observe that the *Journal of Behavioral Economics*, created in 1972 and now published under the name of *Journal of Behavioral and Experimental Economics*, has been renamed from 1991 to 2014 *Journal of Socio-Economics*, illustrating the present proposition of socio-economic reasoning as a positive study of human decision-making. Hence, as developed here, socio-economic reasoning offers as much communality with research threads as old and new institutional economics, behavioural economics, political economy, sociology of organizations, or political ecology. So, the term is not aimed here as yet another branding. Rather socio-economic reasoning appears as a more general term in an attempt to clarify for a non-economist readership the extent to which this approach diverges from the dominant understanding of economics as an accountancy discipline studying the optimal allocation of resources in production, distribution and consumption of goods and services, all of which in monetary terms.

3. Conceptual Frameworks of Socio-economics

3.1. From the Individual to the Society

Starting from the notion of utility and its maximization by the individual, socio-economic reasoning builds upon a methodological individualism, *i.e.* by studying decision-making at the level of individuals. However, these individuals are not isolated from society and are characterized by their preferences, subject to a number of bias, constraints and influences, typically within power relationships. While utility may undergo a mathematical formalization — with preferences treated as specific functions of a basic good and parameters defining these functions —, all these concepts may also operate with a qualitative use to characterize the diverse facets of human behaviour. Risk aversion and time preference are major examples of this way of operating. However, other types of preferences are handled, as loss aversion (Kahneman & Tversky 1979), ambiguity aversion (Han *et al.* 2009) or preference for improving sequence (Loewenstein & Prelec 1993, Chapman 2000). Factors driving the decision to or away from a particular outcome are called incentives or disincentives, respectively. These words are understood here in a broad sense, well beyond the sole glow of receiving money and the prickle of paying. A main concern of socio-economic reasoning will then be modelling, quantitatively and/or qualitatively, the structure of incentives framing individual decisions to lead up to collective (in-)action (Kotani *et al.* 2014), as also applied to public health (Siegal *et al.* 2009) and animal health (Gramig *et al.* 2006, Valeeva *et al.* 2011, Alarcón *et al.* 2014).

The socio-economic approach of collective action consists in the modelling of direct interindividual interactions, as opposed to the neoclassic micro-economic framework that mainly considers interindividual interactions as solely mediated through markets (price being the signal influencing behaviours). For a socio-economist, interacting individuals are understood as interacting strategies, the outcome of one's strategy depending on that adopted by the other. This modelling approach is referred to in the wide framework of the theory of games (for founding article, see Nash 1951; for application to health, see Bauch & Earn 2004). This analysis of direct interactions between individual strategies generated a range of concepts and models that proved useful in our understanding of decisions of humans in interaction, as are the asymmetry of information, moral hazard, adverse selection, within agent-principal relationships and an overall theory of contracts or theory of agency (for founding authors, see Akerlof 1970, Williamson 1973, Jensen & Meckling 1976).

Considering any actor of a system as a decision-maker, the different scales may be addressed by studying the decision-making of individuals operating at these different scales, in their different societal roles (Laffont 1999). Classically embedded within this methodological individualism, neoclassic economics does

not consider emergent preference properties of human groups. This represents a limitation in tackling complex systems as health is explicitly handled in the "One Health" framework (Zinsstag *et al.* 2005a), because emergent properties and the needed system thinking is a core concept in complexity theory. Therefore, an opening to sociological frameworks and system thinking is needed, which is here proposed to pertain to a socio-economic reasoning. Hence, networks, stakeholders groups and organizations may be studied as such through adapted tools and usefully complement the individual decision-making analysis.

3.2. Collective Action and Individual Freedom

The theory of games finds a famous application in the so-called tragedy of the commons, which consists in the overuse of common resources as an inescapable result of individual short-term profit maximization strategies (Hardin 1968). This tragedy points to the main theme of externalities, *i.e.* the effect of one's own activity on others' utility that one will neglect in his/her decision-making. This neglect causes an inability of markets to regulate the production of these positive or negative consequences, being part of the different forms of the so-called "market failures" (in this case, free markets would lead to producing too little of the positive externalities and too much of the negative ones). Where markets fail other institutions have to intervene in the framing of individuals and the promotion of favourable collective actions. The latter tragedy of the commons is then a peculiar outcome of an overall issue of collective action, once stated that no cooperation prevails. This issue is framed in economics under the notions of public goods and common goods, which are defined according to criteria of non-rivalry and non-excludability in consumption (Samuelson 1954). The issue is thus one of coordination of individual decision-making within institutional settings. Appearing as incentive structures, institutions are the set of rules, informal and formal, collectively and gradually established to frame — or govern — individual actions within the boundaries of a shared interest, which as a matter of fact is of utmost importance in health governance (Siegal *et al.* 2009). Therefore, the notions of externalities, common and public good, and governance appear central to socio-economic analysis of decision-making. The latter focus on institutions and governance has been widely studied in the domain of natural resource management, against the idea of tragedy of the commons, with founding authors as Elinor Ostrom, who proposed inter alia a multi-tier matrix to analyse collective action within socio-ecosystems (Ostrom 2007). Adopting a multi-agent and multiscale analysis of human behaviour, along a set of categories defined around resource use, *i.e.* resource units and resource systems, users and governance systems, interactions and outcomes, this matrix appears as a major application in line with the here-proposed understanding of socio-economic reasoning.

Another major contribution to the thinking of collective action was brought by Crozier & Friedberg (1977), who built the strategic actor theory on an extensive set of case studies. Born within the tradition of the sociology of organization and influenced by the notion of bounded rationality, this theory adopts an overall framing in accordance with the socio-economic reasoning, *i.e.* a methodological individualism recognizing to the individual action some degree of freedom and what may come close to the economic conception of agent opportunism (Williamson 1973). Distancing itself from the deterministic analysis of organization as resulting from technology or contextual variables, this framework assumes some degree of contingency and freedom within an incentive framework. Through qualitative approaches, the method aims at deciphering complex social situations around the central concept of power, understood as the control particular actors may have on uncertainty zones, inside a system of alliances, conflicts and negotiations. In a more general way, these foundations refer to a wide array of concepts and methods in stakeholder analysis.

A third framework to describe here is that of the capabilities (Sen 1989). Fully endorsing the philosophical and ethical dimension of economics, Amartya Sen brought up the concept of capabilities as a critique of John Rawl's vision of justice. This term refers to the ability of an individual to achieve valuable goals based on available resources. Developing a peculiar terminology (functioning, value-objects, evaluative space), Sen indeed set a unique framework to decipher individual choices, taking account of physical, environmental or cultural determinants. This approach questions the degrees of freedom an individual enjoys, by nature or from institutions, to reach his valued goals, coming close in this to Crozier and Friedberg's posture. The capability concept is of particular interest in tackling health issues and well-being (Sen 2004), with health potentially holding diverse roles in the framework: a valued goal, a capability to transform resources, a resource by itself. Handling together public, animal and environmental health in this framework is of further interest as it helps conceptualize the relations between those compartments in reaching equity, then endorsing an ethical and normative prospect.

This brief presentation of major frameworks and concepts that qualify socio-economic reasoning may already indicate to the reader how, oscillating between mathematical and conceptual modelling, between ethical considerations and positive decryption of reality, socio-economic reasoning constitutes a bridge between quantitative and qualitative approaches, between technical and social science, between individual and collective analyses, and maybe between philosophy and science. The rest of this paper will focus on its application to health and in particular how it may contribute to an integrated management of risks posed to health.

4. (One) Health and Socio-economics

Once defined as a discipline studying human decision-making and organizations, socio-economics may be thought as being pervasive in health issues. In fact, from the side of causes, the role of human behaviour and organizations in determining the health of individuals and populations is obvious. One will for example, starting from the perspective of the individuals, consider the so-called "risky behaviours" that tend to expose each to health risk factors. Others will start from a societal perspective and consider "health determinants", *i.e.* how societal organization affects the overall health risk posed to all or part of its members, through *e.g.* poverty, pollution or food production. This oscillation or conciliation between deterministic considerations and freedom of actions appears as an important feature of a socio-economic reasoning, then calling for complementary methodologies. At the intersection between the two perspectives, one can study the organization of health services, the determinants of access to those and the use made by people of these services, around the notions of behavioural drivers, incentives and resource use in a multilevel systemic approach (for issues analysis, see Ellen *et al.* 2018, Paul *et al.* 2018). Then, from the side of consequences, the many impacts of health issues depending on human decision-making and organizations may be understood — thus not only quantified — with the contribution of socio-economic tools and frameworks. So, the scope of application appears wide, and actually out of reach of cost-benefit analysis or market equilibrium models.

The "One Health" concept may seem to widen even more the perspective, adding to human health issues, animal health and environmental issues. However, the scope remains seemingly the same: one will question human decision-making and organization about causes and consequences around health issues, then more actively aiming to take human, animal and environmental dimensions into account. Socio-economics, as all social sciences, will then hold a role of binding agent inside interdisciplinary approaches joining medical doctors, veterinarians, agronomists, and environmental scientists, by providing frameworks to investigate how human behaviour and organizations constitute one of the drivers and links between all these dimensions of one same issue.

Figure 1 provides a schematic representation of how diverse approaches pertaining to what may be called a socio-economic reasoning intervene in the analysis of health drivers at different levels of human societies.

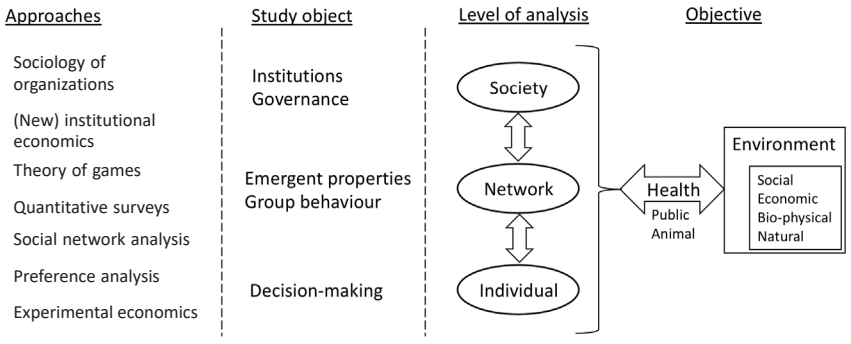

Fig. 1. — Socio-economic reasoning in the understanding of health drivers in humans, animals and their environment. Health appears as the result of the interaction between humans, animals and their environment, which may be considered in its diverse constituents: social, economic, biophysical, and natural. The socio-economic reasoning, as developed within a range of disciplines, allows studying these interactions as a result of human decision-making and behaviour at different levels: individual, groups and networks and the whole society. The list of approaches is not meant as exhaustive.

5. Frameworks and Tools

5.1. Mixed Approaches: Qualitative and Quantitative

As mentioned earlier, socio-economic reasoning rests on both quantitative and qualitative data. When used in combination on a same topic, the approach is said to be mixed, with a whole range of possible repartitions of respective roles of quantitative and qualitative approaches within the study and interactions between the two datasets (Palinkas *et al.* 2011). It may be useful here to comment on the notions of quantitative and qualitative data. In fact, in studying decision-making, two types of data may be pointed as showing distinct natures though both are quantitative. Hence, one could count behaviours and/or measure suspected outcomes or drivers of those, with a statistical approach aiming at an inference about the populational level. On another note, surveys may be designed to learn about the trade-offs people make when deciding, then quantifying (rather than "measuring") elements without a reality outside of the framework that led to their definition. This is the case of stated preference methods. These methods cover a range of survey-based tools to analyse statistically the choices stated by interviewees facing virtual alternatives characterized by distinct qualities. Such methods thus appear as a tool to investigate people's preferences for goods or services for which no market transactions may be observed. Those are increasingly used in animal and public health economics (Sadique *et al.* 2013, Pham *et al.* 2017) and have a long history of application to environmental valuation (Adamowicz *et al.*

1994). In several cases, these values may be considered as quantitative expression of a basically qualitative enquiry, then aiming at providing a quantified expression of individual preferences (Pham *et al.* 2017). Similarly, other quantities, with the typical case of prices, will be measured with an aim of understanding the local case and possible mathematical modelling of it, but without any aim of statistical inference on the wider population to which the "sample" belongs. In the case of prices, the aim might be to link an analysis of pricing with the organization of the system (Tindano *et al.* 2017).

Like many other social sciences, socio-economic reasoning will build upon in-depth analyses of case studies, understood as occasions to confront theory with reality and enrich or improve the theoretical thinking (Flyvbjerg 2006), as exemplified by the building of major socio-economic frameworks (Crozier & Friedberg 1977, Ostrom 2007). The objectives are then to derive basic logics and strategies of actors, preferences and expectations, which as conceptual tools may be deemed appropriate or not to analyse other contexts, without claiming at universal validity. Being interested in human decision-making, socio-economic analysis is highly dependent on cultural diversity, various cultures providing an opportunity to investigate different rationalities. Clearly, this proposition is at odds with a widely shared understanding of economics as putting forward a single rationality for the so-called *Homo œconomicus*.

Socio-economic analysis of health issues may also adopt a more strictly quantitative approach within epidemiological studies. Socio-economic data are then gathered to distinguish between categories of populations and analyse these categories as a risk factor for a particular health outcome (Galobardes *et al.* 2006a,b; Howe *et al.* 2012). The question at stake is one of social inequality, to be objectified to allow for actions, but also to raise the issues of the behaviours explaining the observed difference in risk through socio-economic models of the rationality at play (Contoyannis & Jones 2004, van Kippersluis & Galama 2014).

5.2. Health as a Common or Public Good

The notion of externality has been mentioned here above as part of the central conceptual framework of socio-economic reasoning. Briefly stated, externalities arise when one does not take their effects on others' well-being into account in his decision-making. Since these effects may be either positive or negative, externalities may be termed positive or negative. Public and common goods are matters of externalities. The public good is the one that benefits to all, without a possibility to exclude anyone from its consumption (criterion of non-excludability) and without competition between individuals for its use (criterion of non-rivalry in consumption). Most often, the problem is that public goods are not produced because potential producers do not take the positive externalities of their action into account, hence not facing due incentives to

produce it (Hennessy 2017). The common good is one to which a group of individuals have an open access (non-excludability) but the consumption of the ones will impede or at least affect the consumption of others (rivalry). Most often, the problem is that the common goods are overexploited because users do not take the negative externalities of their action into account (Hardin 1968).

Whether health is a public or common good is an interesting question, to be answered depending on the precise health issue at stake. Communicable disease eradication is a clear matter of public good production, since all will benefit from the absence of the disease, without any exclusion or rivalry. Other cases may appear less clear. Let us consider transmissible diseases that one's practices (vaccination, prophylaxis, biosecurity measures, …) may favour or not. Whether one looks at health-protecting behaviours as a production of "public" safety through positive externalities, or at detrimental behaviours as producing negative externalities gradually affecting the "common" system's equilibrium is a matter of framing. Hence, vaccination or biosecurity measures will be tackled under the scope of positive externalities and the production of a public good (Hennessy 2008, 2017; Vietri *et al.* 2012; Ibuka *et al.* 2014), while the emergency selling of diseased birds upon avian influenza outbreak may be analysed under the scope of negative externalities (Delabouglise *et al.* 2016). Similarly, the efficacy of antibiotics may be seen as a common good that one's (mis- or over-) use will directly affect through the selection of resistant bacteria, which will then be understood as negative externalities (Leal *et al.* 2017).

The framing of health issues within the concepts of public or common good draws our attention to the structure of incentives of individual decision-making and the conditions of collective actions. Regarding the first track of research, bio-economic mathematical modelling has proven a fruitful tool to analyse such issues and gain insights for policy-making or other institutional actions (Hennessy 2008, Althouse *et al.* 2010, Gramig & Horan 2011). The second aspect is more particularly explored within the "One Health" framework, based on Ostrom's notion of socio-ecosystems to analyse the governance of the commons (Binot *et al.* 2015).

5.3. Disease Impact: What did You Expect?

The notion of externality directly invites us to consider the effects of health issues beyond the sole accountancy of monetary impacts. In fact, there is a particular interest, within a complexity framework, to analyse the feedback loops of these effects on behaviours (Gramig *et al.* 2010). Hence, the impact of diseases or of actions aimed at their control will be of interest to understand how they further influence the issue, leading to possible perverse effects or collateral damages to be foreseen and taken into account in policy-making. The impacts are then seen from the viewpoint of actors' expectations, which may be wrong or

partially true. Expectations, together with preferences, are the basis of the modelling of individual behaviours and may be an important lever for policy-making (Nyborg *et al.* 2016).

A concrete example may be drawn here from avian flu management in Vietnam. It is a well-known fact that animal diseases affect market prices, through mortality that affects the supply side and the reaction of consumers that affects the demand side. This has often been studied through market equilibrium models, in order to estimate a total cost of diseases and evaluate policy options. While the actual result of these dynamics of supply and demand may be uncertain, animal keepers formulate expectations, driving their decision. Hence, in Vietnam, in case of outbreaks of avian influenza, farmers said that they expect prices to first drop and then rise (Delabouglise *et al.* 2016). This motivates them to eliminate the on-going batch of broilers at the time of the outbreak, in order to launch new batches of broilers that will be ready when the prices are higher. Also, the same authors have shown that the effect of disease information on prices is also anticipated and manipulated by traders, who tend to take advantage of outbreaks to generate value added based on their bargaining advantage facing the affected farmers. These examples of speculative behaviours will affect the epidemiological dynamics as well as markets (Delabouglise *et al.* 2017). Those should be understood if actions are to be taken to control avian influenza with the assistance of all stakeholders. Beside prices, the impact of control measures is subject to expectations. Stamping out holds a great role in this regard. This has been illustrated in the context of pig raising in Vietnam, where it was shown as a crucial disincentive for disease notification, apart from monetary aspects of this, hence standing beyond reach of compensation policies (Pham *et al.* 2017).

5.4. Analysing Preferences of Actors

To understand the role that incentives will play on decision-making, one needs to understand individuals' preferences. This investigation falls within the scope of experimental economics. Basically, these methods all put individuals in situations of decision-making to observe their behaviour and derive mathematically preferences based on a hypothetic utility function (Brent *et al.* 2017). As already mentioned, the preferences under scrutiny may be diverse, with main cases being risk, ambiguity, and loss aversions. Risk aversion may be defined as the extent to tendency of individuals to prefer sure outcomes to those subject to a probabilistic distribution (Von Neumann & Morgenstern 1944). Ambiguity aversion covers the preference of situations with known probabilities of outcomes (then termed "risks") to unknown probabilities (then termed "uncertainty") (Epstein 1999). Loss aversion refers to the pre-eminence in individuals' decision-making of not losing a good to that of gaining an equivalent good (Kahneman & Tversky 1979). Quite obviously, all these preferences are relevant to health matters, epidemiology documenting probabilities and severity of risks, complex health

"risks" meaning high uncertainties (and even scientific controversies), and all health issues amounting to a feared loss of our well-being.

The use of pesticides by farmers, which is an issue typically handled under the "One Health" or "EcoHealth" approach, illustrates how these preferences may be measured or handled to account for decision-making impacted by and impacting health risks (Liu & Huang 2013). Studying the case of Chinese cotton farmers, the paper highlights how different preferences end up in different uses of pesticides, linking risk aversion to a higher use of those and loss aversion to a lesser use. Risk is here considered as the risk of poor harvest, while loss is interpreted as adverse health effects of pesticides. Regarding ambiguity, it may be interesting here to mention that it is also studied in medical decision-making with psychometric methods, highlighting the role of ambiguity aversion in the use one makes of controversial information (Han *et al.* 2009, Carpenter *et al.* 2016).

The centrality of these three preferences in socio-economic analysis does not preclude other preferences to be studied, as status seeking (Gaspart & Seki 2003), fear of bearing the responsibility for adverse effects on the community (Delabouglise *et al.* 2016), the rejection of culturally unacceptable actions (Pham *et al.* 2017).

5.5. Analysing Networks and Organizations

The study of networks and organizations is needed to understand the place of individual decision-making in the overall effect on a particular health issue in society. Diverse frameworks are mobilized to analyse organizations, referring *e.g.* to organization sociology or institutional economics. In the context of health issues, the reference to systems and system thinking will also be put forward, with direct reference to complexity theory (Adam & de Savigny 2012, Antoine-Moussiaux *et al.* 2017), as already well established in public health and promoted by WHO (de Savigny & Adam 2009) and more recently developed in animal health (Rich *et al.* 2017, Rojo-Gimeno *et al.* 2018b). Again, an interesting point to be made with respect to the aim of this paper is the complementarity between qualitative and mathematical modelling approaches to tackle these systems and contribute to a socio-economic analysis of health issues. We have already mentioned important frameworks of a qualitative analysis of systems, mainly consisting of systematic grids to analyse situations, as proposed by several authors for natural resource management (Ostrom 2007), agricultural innovation (Lamprinopoulou *et al.* 2014), which are important sources of inspiration for the emerging "One Health" approach. From the side of mathematical modelling, among the several methods available, we may stress the cases of system dynamics (Rich *et al.* 2017) and agent-based modelling (Badham *et al.* 2018).

Being part of the system thinking and again covering a range of diverse methodologies, stakeholder analysis has been similarly promoted in public health

(Schmeer 1999, Brugha & Varvasovszky 2000) and is now gaining popularity in the analysis of complex health issues for "One Health" implementation (Mazet *et al.* 2014, Kimani *et al.* 2016). Stakeholder analysis methods include qualitative systematic grids aiming at a classification of stakeholders according to their relation to the issue, *e.g.* whether they have or not influential or decisional power, whether they are in agreement or not with a particular action, the distribution of roles and responsibilities, interactions between them (Namazzi *et al.* 2013). This approach is of particular interest in analysing intersectorality, which is a central feature in the implementation of the "One Health" principles (Bordier *et al.* 2018, Galière *et al.* 2019). Those interactions between stakeholders may also be mathematically modelled using the social network analysis. Based on the theory of graphs, this method analyses the relative importance and roles of actors within a network. Within a "One Health" framework, the methodology appears of growing interest (Delabouglise *et al.* 2015, Kimani *et al.* 2016).

The value chain appears as a peculiar type of network, conceived around a specific product. This term refers to the full set of actors, their mode of interaction, activities, and flows involved in the provision of a good or service on a market. Livestock or game animals value chains are of great importance in the implementation of a "One Health" approach, most directly for zoonotic concerns, food safety and control of antimicrobial resistance (Antoine-Moussiaux *et al.* 2017). However, this classic framework of socio-economic analysis may be applied to a wider range of issues impacting public and environmental health. As in the overall socio-economic thinking, the concept of governance is central in the value chain analysis, aiming at understanding the link between agreements and interactions between actors and the overall effect of this organization on a health issue. A recent case study of biosecurity in the poultry sector in Indonesia is particularly illustrative of this facet of the approach, rather directed to an understanding of actors' behaviour rather than the global value production of the chain (Indrawan *et al.* 2018). Other application may help illustrate how the approach may be mobilized for an in-depth analysis of risk management along a value chain (Delabouglise *et al.* 2015) or for a more operational contribution to health risk management (Alarcón *et al.* 2017).

6. Conclusion

The present overview assumes that considering economics as a behavioural science could help make clear the usefulness of this domain within an interdisciplinary approach as required by the "One Health" concept. Going beyond the sole accountancy role of economics, it tends to promote its use in the scientific prospect of understanding the world rather than in a normative prospect, *i.e.* setting both the goals to be pursued and the optimal allocation of resources to reach these goals.

As presented here, the socio-economic reasoning may be summarized through its primary sourcing in a methodological individualism, on which it builds an attempt to study decision-making at different scales, through the analysis of networks and organizations. An important feature is the recognition of the wide diversity of rationalities of actors and the need to understand those beyond the sole monetary factor, through both qualitative and quantitative studies, both conceptual and mathematical modelling. The following concepts are proposed here to constitute the backbone of the socio-economic framework one needs to understand in order to grasp the domain's contribution: utility, preferences, network effects and system thinking, externalities, governance and collective action. Finally, it can be observed that the array of literature mobilized here to exemplify the proposal is drawn from the different constitutive compartments of the "One Health" or "EcoHealth" issues: public, animal, and environmental health, including agriculture and natural resource management. This is to highlight the tremendous gains to be drawn from cross-fertilization between the various ways socio-economic reasoning has been developed by practitioners in these distinct areas of research. Hence, while the "One Health" implementation should benefit from the socio-economic reasoning, socio-economics is also expected to gain coherence and be enriched through the implementation of the "One Health" concept.

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