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It's not the market, stupid: On the importance of non-market economies in sustainability transitions

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ABSTRACT

It has been widely assumed that market mechanisms are central in incentivizing the development of sustainable innovations and that market formation is critical for the diffusion of innovations. We challenge the centrality of markets in understanding and promoting the development and diffusion of sustainable innovations using the case of the System of Rice Intensification. This innovation for sustainable rice cultivation was developed and diffused without relying on market mechanisms yet has been adopted by millions of farmers worldwide. To further our understanding of economic mechanisms beyond markets, we revisit Polanyi's distinction between markets, reciprocity, redistribution, and subsistence. This distinction helps to situate markets in a broader economic context and helps to understand how mechanisms for market exchange intersect with other types of economies in ways that can either positively or negatively affect sustainability.

Abbreviations

ANGRAU	Acharya N.G. Ranga Agricultural University
CSO	Civil Society Organization
CIIFAD	Cornell International Institute for Food, Agriculture, and Development
NWO	Dutch Research Council
NABARD	National Bank for Agricultural and Rural Development
PSI	People's Science Institute
PRADAN	Professional Assistance for Development Action
SRI	System of Rice Intensification
VLRP	village level resource person
WASSAN	watershed support services and activities network
WARDA	West African Rice Development Association

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1. Introduction

Founding frameworks in transition studies have been built on an assumption that markets and market formation are critical for transitions to unfold. Building on insights from innovation studies and evolutionary economics, market mechanisms have been assumed to be central in incentivizing the development of sustainable innovations (Hekkert et al., 2007) and market formation is seen as critical for innovations to diffuse (Geels, 2004; Dewald and Truffer, 2011). Other forms of economic organization are also studied in transition studies but these are often considered important because of their ability to create, complement, or correct markets, like the creation of protective niches that enable innovations to develop sufficiently so as to later be able to survive 'regular' market competition. Conceptualizations of markets have not been elaborate, however, and this special issue rightly unpacks notions of markets, market formation, and market shaping in sustainable transitions.

The assumed centrality of markets in studies devoted to the development and diffusion of sustainable innovations should be challenged, we argue.[1] Recent contributions to transition studies have recognized that markets are only one possible form of economic organization. For example, transitions may be influenced by actors whose behavior is not determined by market incentives, such as grassroots organizations (Feola and Nunes, 2014), civil society organizations (Feola and Jaworska, 2019), and innovative users (Von Hippel, 2005; Baldwin and Von Hippel, 2011). Adjacent fields, such as economic sociology, anthropology of economics, and economic history, have long recognized the importance of forms of economic organization that do not rely on markets, such as charity, taxation, welfare, and producing for one's own consumption. Such economies continue to play a crucial role in organizing production, consumption, and exchanges in contemporary societies around the world, yet these have found only limited application in transition studies.

In this paper, we argue that the focus on markets as a crucial mechanism for sustainability transitions is restrictive and limited. We will develop this argument using the case of the System of Rice Intensification (SRI) - a low external-input method of rice farming, based on ecological principles, which is acclaimed to be significantly more sustainable than conventional (modern) methods of rice cultivation. This method of rice cultivation was formulated in Madagascar during the 1980s by a Jesuit missionary. He specifically sought to develop innovations that could benefit small-scale and subsistence farmers cultivating rice under tight resource constraints and with minimal support from the government. SRI has since reached rice farmers around the world through informal networks of non-governmental and civil society organizations (NGOs and CSOs), agronomic scientists, and development scholars and practitioners. While this innovation has travelled to farmers across the world, it was developed and diffused almost entirely apart from markets. We use the case of SRI to argue that the predominant attention for markets in transition studies ill-equips researchers and analysts to understand and promote sustainable innovations such as SRI.

We contend that more attention is therefore merited to other types of economic relations that play a role in sustainability transitions. In our discussion, we revisit some classical works in political economy and economic anthropology, notably the ideas of Karl Polanyi (2001), to draw attention to the importance and potential of alternative types of economic relations. Complementing market transactions with relationships of exchange that are based on principles of reciprocity, redistribution, and subsistence helps to situate markets in a broader economic context and to understand how mechanisms for market exchange intersect with other types of economic relations in ways that can affect sustainability positively or negatively. Our goal is to encourage transition theorists to incorporate additional forms of economic order that can promote sustainability transitions.

2. Understanding and identifying markets

Key theorists of transition studies have generally assumed that markets and market formation are critical for transitions to unfold (Geels, 2004; Dewald and Truffer, 2011). These systems perspectives emphasize that connections between actors that take the form of market transactions are most effective for transitions.

Although occasionally defined as any set of institutions for engaging in exchange, generally market transactions are understood as exchanges between buyers and sellers that are mediated by some form of money. The Cambridge Dictionary defines a market as "a place or event at which people meet in order to buy and sell things" (2021). It is through such processes of exchange that competition can be organized and prices are established for goods and services. In the classical understanding, markets were understood to be self-regulating and to tend towards equilibrium as the supply and demand are adjusted through the price mechanism (Smith, 1776; Marshall, 1890).

It is important to understand the market as a historically particular institution for the production, consumption and exchange of goods and services. From an alternative starting point, which appreciates 'the economy' as embracing the range of practices, processes and mechanisms by which resources are transformed, distributed and consumed, the market can be understood as one of many types of economic exchange through which resources are allocated. For example, inheritances and unemployment benefits are mechanisms that allocate resources, which cannot be well understood as markets. Anthropologists and economic historians have long pointed out that for most of human history, the production and exchange of goods and services was organized on the basis of principles of economic organization other than markets (Polanyi, 2001; Sahlins, 2017). For example, the institution of giving and receiving gifts is found in societies around the world. As we elaborate in Section 4, gifting is a mechanism for allocating resources but the exchange is not regulated by price or profit-seeking but by various other motives like honor, social standing, status, or magic (Malinowski, 1953;

[1] The article title is intended as a playful allusion to Bill Clinton's famous campaign message "it's the economy, stupid". This slogan portrays the importance of the economy as self-evident. We contrarily argue the importance of the market should *not* be considered self-evident.

Mauss, 1966). Karl Polanyi succinctly summarized these insights in *The Great Transformation*: "though the institution of the market was fairly common since the later Stone Age, its role was no more than incidental to economic life" (1944, p. 45).

Market economists from Adam Smith onwards have propagated the idea that, sooner or later, markets will expand at the expense of other types of economic exchange. This idea is largely credited to the supposed superior efficiency of markets in allocating resources. Historical evidence speaks against this view. The efficiency of markets has been widely questioned (Stiglitz, 2001)[2] and the historical record shows that markets generally did not expand at the expense of these other forms of economic exchange, even in conditions that are usually understood to be favorable for the emergence of markets, such as the introduction of money or the development of long-distance trade (Polanyi, 2001). Whereas the exact origins of markets are subject to debate (e.g. North, 1977), there is a broad consensus that markets emerged as the result of deliberate interventions - an argument that is echoed by recent work in economic sociology on the construction of markets (Mackenzie and Millo, 2003; Mackenzie et al., 2008). The latter work is especially helpful in understanding how markets are constructed. Anthropologists and economic historians, in turn, foreground that markets are only a specific subset of economic life, which capture only part of the mechanisms by which resources are allocated, and whose emergence is not the result of their supposed efficiency (Polanyi, 2001; Sahlins, 2017).

Nevertheless, in transition studies, markets are rather self-evidently put forward as a form of economic organization that is crucial for achieving sustainability (Boon et al., 2020). This is especially evident in some of the central theoretical frameworks, like the Technological Innovation Systems (TIS) framework and the Multi-Level Perspective (MLP) (Markard et al., 2012; Köhler et al., 2019).

The MLP, firstly, argues that socio-technical transitions can occur through the alignment of developments at different levels. Central to this is the level called the socio-technical regime, which refers to the semi-coherent set of rules that function as a selection and retention mechanism for new technologies (Geels, 2002; Rip and Kemp, 1998). While this includes a variety of mechanisms, including both market mechanisms like market standards and export regulations as well as non-market mechanisms like habits and ways of defining problems, the regime that they add up to is often simply described as a market whose rules make it difficult for sustainable innovations to 'compete' (Geels, 2002; Smith et al., 2010). The niches that are supposed to shield innovations from these pressures are similarly understood in terms of market economies. Innovations are said to require protection "from 'normal' market selection in the regime" (Geels, 2002: 1261) because they "fail to successfully *compete* within selection environments embodied in incumbent socio-technical regimes" (Smith and Raven, 2012: 1025 [italics ours]). When alternative forms of economic organization are described, these are hence considered important for their role in making markets work for sustainability transitions.

That markets are considered key in transitions is even more clear in the TIS framework, which argues that innovations can be successfully generated and diffused if different functions of the innovation system are fulfilled. This includes functions like 'entrepreneurial activity' and 'market formulation', both of which imply that actors who seek to make profits are an essential ingredient for generating and diffusing innovations. In their seminal paper Hekkert et al. (2007) note "there is no such thing as an innovation system without entrepreneurs" (p. 421). If entrepreneurship is understood only as a profit-seeking endeavor then their observation precludes the possibility that transitions could also occur through other kinds of economic processes and relations in which profit orientation is not the prime motive.[3]

The centrality of markets is also evident in transition studies scholarship more generally. For example a simple full-text keyword search in this journal (on February 2, 2021) found that the concept of the 'market' is mentioned in title or abstract 88 times since the inception of the journal, while concepts denoting alternative economic forms are mentioned significantly less - including barter (3 times), ceremonial exchange (0 times), reciprocity (3 times), or gifts (4 times).

Even recent literature that highlights the importance of non-market actors in transitions tends to reinforce the centrality of markets. For example, the work of Mariana Mazzucato draws attention to the important role of the state in the development and diffusion of (sustainable) innovation and green growth (Mazzucato, 2013; Mazzucato and Perez, 2015). States can fund, coordinate and align the efforts of innovative actors in ways that markets cannot. Yet the role of the state is ultimately conceptualized in relation to the market - from market-fixing to market creating (Mazzucato, 2016), thus reinforcing the crucial role of markets in achieving transitions. Similarly, others who highlight the important role of civil society have argued that the efforts of civil society nevertheless revolve around the creation of markets. Instead of organizing forms of exchange outside of markets, the efforts of civil society organizations focus on replacing unsustainable markets with more sustainable forms of market exchange (Feola and Jaworska, 2019).

It is beyond doubt that market economies are important for sustainability transitions. Yet there is an increasing body of literature that highlights the importance of other, alternative relations and mechanisms of exchange that also stimulate the development and diffusion of sustainable innovations. This includes literature on users who have been found to develop and share innovations for free (Von Hippel, 2005; Baldwin and Von Hippel, 2011), literature on degrowth that emphasizes the need to move away from dominant capitalist ways of market organization (Feola, 2019, 2020), literature demonstrating the importance of grassroots innovations and civil society organizations in sustainability transitions (Feola and Nunes, 2014; Nicolosi et al., 2018), and work on the importance of

[2] As Nobel Prize winner Joseph Stigliz notes, "Today, there is no respectable intellectual support for the proposition that markets, by themselves, lead to efficient, let alone equitable outcomes" (2018).

[3] As with the MLP, this does not mean that the TIS framework exclusively captures mechanisms for allocating resources (economies) that can be understood as markets. For example, government funding for science (under the function 'knowledge development') or the formulation of clear government policies (under the function 'guidance of the search') are not in and of themselves exchanges between buyers and sellers, nor are supply and demand in these cases adjusted through the price mechanism. Yet the upshot of each of these functions in the TIS framework is to enable technologies to succeed in market economies, where they can be diffused in exchanges between buyers and sellers seeking to maximize profit - in other words, in market economies.

commons-based exchanges for innovation (Beumer et al., 2020; Gamache et al., 2020). This literature sits uncomfortably alongside the central emphasis on markets in leading transition theories. Yet transitions studies have not yet fully engaged with other types of economic exchange, which have largely remained at the margins of sustainability transitions literature.

In this article, we question the centrality of markets in transition studies. Rather than seeing non-market forms of exchange as fringe phenomena for sustainability transitions, as exceptions that prove the rule, we demonstrate that such alternatives are also central to sustainability transitions.

We will develop this argument using the case of the SRI. In analyzing the development and diffusion of SRI, we will draw upon the basic understanding of markets as (i) exchanges between buyers and sellers (ii) that are mediated by some form of money, (iii) through which competition is organized and prices are established.

The SRI case as presented in this paper draws on its promotion and distribution in India. Not only is India one of the largest rice-growing countries, it also has a well-established network of NGOs and CSOs that provide a widespread and effective non-commercial infrastructure for the distribution of SRI. We had the opportunity to study the evolution of SRI in India from about 2007 to 2016 through a book project (Prasad et al., 2007), a small exploratory study funded by the Bill and Melinda Gates Foundation (Berkhout et al., 2015), and a larger study funded by the Dutch Research Council (NWO) involving several partners in India (Glover, 2011a, 2011b, 2011c; Sen, 2015). The projects combined field studies in selected villages in three states with an analysis of the way civil society actors interacted with governmental bodies and agricultural research institutes.

We proceed with this argument as follows. In the first part of Section 3, we introduce the System of Rice Intensification. In 3.2, we relate the development and diffusion of SRI to notions of market exchange. We demonstrate that SRI was developed and diffused outside conventional mechanisms of market exchange and argue that market formation could have obstructed its development and diffusion. Finally, in the discussion section, we will flesh out the implications for transition studies and articulate new directions of research.

3. System of Rice Intensification and the market

3.1. What is the System of Rice Intensification

The System of Rice Intensification (SRI) is a method of rice cultivation that involves a combination of crop management techniques, which diverge from the common practices that are typical of both traditional and modern, irrigated rice production. They involve distinctive methods for establishing the rice crop in the field, suppressing weeds, managing water, and providing nutrients. Notable contrasts with conventional management include transplanting seedlings from a seedling nursery into the main field at a much younger age, arranging them at low density (it is usually recommended to transplant single seedlings in widely spaced rows or a grid pattern) and maintaining moist, rather than flooded, conditions in the field (see Figs. 1 and 2). The idea is to allow each rice plant ample space to grow vigorously in aerated soils. As there is a risk of competition from weeds when the field is not flooded, special emphasis is placed on weed suppression. The preferred method of weed control is by mechanical weeders that churn the soil surface, uproot weeds and trample them into the soil, which adds to the soil organic matter. Additionally, organic fertilizer (green manure, compost or well-rotted animal manure) is also recommended. The SRI methods entail a substantial reorganization and rescheduling of rice farming operations (Berkhout and Glover, 2011).

It is well established that SRI methods are capable of producing sturdy and productive rice plants and a good crop yield, while also conserving seed (because of the low seeding rate) and reducing use of water (Thakur et al., 2018). This is achieved without depending on costly external inputs such as improved seed or chemical fertilizers, although additional fertilizer may be helpful or necessary where soils are degraded and local sources of organic fertilizer are hard to obtain. The physiological and agronomic bases underlying the vigorous growth of rice plants under SRI management are well established (Thakur et al., 2016). What is more uncertain and contested is whether the intensity of management demanded by SRI can make it an economical cultivation method and part of a viable livelihood

Fig. 1. On the left: conventional rice cultivation in flooded paddies with high plant density (Rickman and Bell, n.k., creative commons license).

Fig. 2. On the right: System of Rice Intensification cultivation with moist conditions and spaced seedlings (Styger, 2012, creative commons license).

for different kinds of farmers (Berkhout et al., 2015). Practicing SRI management can certainly yield advantages for some farmers and in some situations; it can also produce ecological benefits in farmer-managed conditions (Gathorne-Hardy et al., 2016).

Features of SRI imply a different innovation trajectory for rice improvement compared to the approach typified by the Green Revolution in India and other rice areas in Asia, where the emphasis was placed on the development and distribution of high-yielding and early-maturing crop varieties and associated technologies, such as improved irrigation infrastructure and mineral fertilizers (Parayil, 2003; Vanloqueren and Baret, 2009). More generally, agricultural innovations typically combine externally produced inputs or technologies that require adjustments of farming routines. Such innovations rely on market mechanisms for distribution of inputs and technologies, often supported by governments with subsidies or legal protection. In recent decades, innovations that reduce the dependency on external technologies have gained attention in light of a transition to more sustainable forms of agricultural production (Glover, 2013). In other words, the arguments we develop in this paper reflect a wider set of issues related to transition debates in the food and agriculture domain.

3.2. The development and diffusion of SRI outside market mechanisms

The invention of SRI is commonly attributed to a French Jesuit priest and trained agronomist, Father Henri de Laulanié, who worked as a missionary in Madagascar between 1961 and his death in 1995. In fact, Laulanié compiled his system of intensive rice cultivation from existing scientific sources as well as direct observations of farmers' practices and the responses of rice plants to different management regimes. The key innovation, which he and others thought was original and resulted from a happy accident, was to transplant rice seedlings from the nursery into the main field when they were just a few days old. When this was done, in combination with the other recommended practices, individual rice plants could grow vigorously and produce a heavy grain yield (Glover, 2011b).

Laulanié's method emphasized improvements to agronomic practices rather than external inputs, such as improved rice varieties, mineral fertilizers or chemical weed control. It was key to Laulanié's engaged scientific practice that he sought to develop affordable and accessible innovations that would improve local farming practices and serve the needs of poor Malagasy farmers planting rice in marginal environments. Specifically, he experimented with methods that could increase farmers' low levels of production without relying on scarce and costly external inputs, in a context where Malagasy farmers had little purchasing power and scant support from the state (Glover, 2011b). Hence, from the outset, the objective was to develop practical solutions for poor farmers, which would not take the form of a commodity whose exchange needed to be mediated by money. As Prasad (2020) puts it, in a recent study on SRI in India:

"As SRI practices involved no miracle seed or herbicides for improving productivity, resource-poor farmers, first in Madagascar and later in other parts of the world, were encouraged to draw on their own potential for experimentation instead of expecting and letting commercial interests drive and dominate agricultural innovation" (Prasad, 2020: 297).

SRI was put in the international spotlight during the late 1990s and 2000s by a political scientist, Norman Uphoff from Cornell University. Uphoff's then role as director of the Cornell International Institute for Food, Agriculture, and Development (CIIFAD), an organization for the promotion of sustainable agricultural and rural development, brought him into contact with SRI in Madagascar and enabled him subsequently to introduce its concepts and principles to the many contacts between CIIFAD and civil society organizations around the world. Uphoff's efforts to have SRI taken seriously by scientists and development organizations were supported by two agronomists, Willem Stoop and Amir Kassam, who were associated with the West African Rice Development Association (WARDA) ,[4] a public international agricultural research institution (Glover, 2011a).

As a result of these efforts, SRI practices were promoted and tested around the world. By 2002, participants in an international

[4] WARDA is known nowadays as AfricaRice.

conference on SRI in Sanya, China reported SRI activities from more than a dozen countries (Berkhout and Glover, 2011). Information collated by SRI-RICE, a sort of international secretariat originally set up by CIIFAD and run on a shoestring budget from offices at Cornell University, indicates that scores of rural development NGOs have since taken up SRI and have promoted the method to an estimated 10 million farmers across 50 countries, who together are estimated to be cultivating about four million hectares of rice. A few years ago, SRI-related activity was present most prominently in China, India, Vietnam, Indonesia and Cambodia (Kassam et al., 2011; Uphoff et al., 2015).

The case of India clearly shows how the principal channels through which SRI knowledge and practices flowed to new places and communities were not market-based. Instead, SRI arrived in India through academic and civil society networks. India has a strong establishment of public agricultural research institutions and a diverse landscape of NGOs and CSOs that work on a non-profit basis in rural and agricultural development. SRI activity in India was initiated in the late 1990s and early 2000s, when several local field trials were started (Berkhout and Glover, 2011; Glover, 2011a). These initiatives were triggered by distinct and uncoordinated events. For example, in 1999, Annapurna organic farm on the border between Tamil Nadu and Puducherry used information provided by a pamphlet from Madagascar to try SRI on small plots. Annapurna farm subsequently promoted SRI, free to use, through organic farming networks In India. Soon afterwards, in an unrelated development, researchers at Tamil Nadu Agricultural University collaborated with Dutch researchers to undertake field trials with SRI and, after promising results, started sharing information with NGOs and government extension. Then, in 2002, researchers at Acharya N.G. Ranga Agricultural University (ANGRAU) in Andhra Pradesh conducted trials with SRI in different agro-ecological settings, after receiving information on SRI from Norman Uphoff, during one of his tours through India, who facilitated a subsequent visit by the university's Dean of Extension to SRI farms in Sri Lanka. Later, a soil microbiologist, O. P. Rupela, an agronomist working on water-efficient rice production, Amod Thakur, and an agricultural economist attached to the Indian Agricultural Research Institute (IARI), B. C. Barah, were prominent among public-sector Indian researchers conducting and coordinating Indian studies into the performance and effects of SRI (Glover, 2011a; Prasad, 2020).

Between 2006 and 2008, a series of three national symposia on SRI were organized in different parts of India. A national SRI 'Learning Alliance' was established in 2007, which linked members of NGOs and CSOs with government bureaucrats and academic researchers in social sciences and agronomy. The exchange of information through publications, meetings and one-to-one interactions among the organizations and individuals that participated in these networks generated enthusiasm from development NGOs and funding bodies to introduce SRI to farmers. Large NGOs, which have offices and run programmes in several places in one or more states of India, were able to introduce SRI widely. For example, WWF,[5] a large international environmental NGO, cooperated with ICRISAT,[6] an international agricultural research center with headquarters near Hyderabad, to study and promote SRI methods across India. Smaller NGOs, CSOs and farmers' associations worked at local levels to promote SRI by printing booklets and folders in local languages and organizing training sessions and field demonstrations. Several state governments and government-funded research institutes invested in field trials and promotional activities. The Dorabji Tata Trust, a philanthropic foundation, and the National Bank for Agricultural and Rural Development (NABARD) provided financial backing to SRI conferences and promotional efforts. SRI promotion was even incorporated within a large World Bank-funded irrigation and water resources rehabilitation programme run by the state government of Tamil Nadu. Knowledge and guidance on SRI was hence brought to farmers around the country free of cost, by various actors whose activities were not driven by the motivation to seek profits. Nonetheless, within a few years, SRI-related activities were reported from the states of Kerala, Karnataka, Tamil Nadu, Puducherry, Andhra Pradesh, Maharashtra, Chhattisgarh, Orissa, West Bengal, Tripura, Punjab, Uttarakhand and Himachal Pradesh (Prasad, 2006, 2020; Glover, 2011a; Berkhout and Glover, 2011).

Another empirical point, which is important for our critique of the market orientation of transitions theories, is that SRI evolved as it diffused. The configuration of social and technical components making up SRI was not fixed or standardized, meaning that different variations were developed locally. The basket of methods and practices was not fixed in the way that commercial and proprietary technology packages are typically offered to markets. As a result, the SRI practices and artefacts that were observable in farmers' fields at the end of an innovation-diffusion process were rarely identical to the practices that had been proposed by Henri de Laulanié or recommended by the organizations that introduced SRI to Indian farmers. What moved in SRI was not a rigidly standardized package, like a commodity, which had the same characteristics wherever it went. Instead, SRI changed as it moved (Glover et al., 2017, Glover, 2011c).

These changes occurred both conceptually and practically. First, conceptually, the definition and principles of SRI were reformulated, so that the system could move across borders and between communities of practice. This happened first in Madagascar, where Laulanié's original thinking on improved methods of intensive rice cultivation (de Laulanié, 1993, 1995, 2003)[7] were codified for promotion to farmers. This was first done through the work of the *Association Tefy Saina*, an NGO founded by Laulanié to promote his improved methods within Madagascar, and it continued as other individuals and organizations took up the ideas and translated them into new formulations and for new audiences. SRI eventually came to be represented as a short list of principles or practices – sometimes three, four, five or six, depending on the context and who was telling the story. Along the way, lively debates have unfolded around aspects of SRI, for example, whether organic fertilizers should be regarded as an essential or an optional feature, or whether chemical fertilizers could also be compatible with SRI cultivation methods (Berkhout and Glover, 2011; Glover, 2011b). These reformulations of SRI were motivated by the need to create a simple message that could spread easily, which echoes a strategy typically

[5] The Worldwide Fund for Nature, formerly the World Wildlife Fund.

[6] The International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Hyderabad, India.

[7] Originally de Laulanié framed and concretized SRI as *le Système de Riziculture Intensive*. This was mis-translated into English as the System of Rice Intensification, retaining the original initials SRI.

applied to the commodification of goods, so that they can be distributed commercially. However, SRI defied commodification because it existed principally as a set of non-excludable ideas, from which any individual could gain an advantage without a corresponding cost to others.

Second, SRI also changed as its principles were translated and adapted locally, through practice and experimentation by NGO staff, farmers and their communities, to suit local institutional and agro-ecological conditions. A study by Sen (2015), for example, shows how different patterns of practice emerged within and between three different villages in a montane district of Uttarakhand, in northern India. SRI was promoted by the same organizations in all three villages, but social relations and technical practices were configured differently in each place. Within the villages, the NGOs worked with the help of a so-called Village-Level Resource Person (VLRP), a farmer they selected to support other farmers to learn and implement the SRI principles. The personality, social status and interactions of the VLRP mattered a lot in shaping local practices. In the three villages studied by Sen (2015), social structures, interpersonal relationships, institutional arrangements and historical processes resulted in three different local practices of SRI-like farming, each of which diverged from the formal SRI guidelines, for example in terms of the age at which seedlings were transplanted, the density of transplanting into the main field, irrigation practices, or the methods and frequency of weeding.

These changes were essential to the diffusion of SRI, which evolved as it spread, because they enabled farmers to adopt only those parts of the system that they deemed suitable and adapt them to their local circumstances. It is hard to imagine these continuous changes could have occurred if SRI had been promoted by commercial organizations with a proprietary interest in it, for example if Henri de Laulanié could have patented SRI and so made the method exclusive to licensed practitioners. Obtaining a patent requires applicants to clearly define and delineate the innovation, thus to some extent standardizing the innovation. Any changes that others make to the innovation, like farmers adapting the principles to their local circumstances, subsequently require a licence from the patent holder. This would have almost certainly made SRI's movement from one setting to another much slower and its spread narrower. Moreover, diffusing innovations through market mechanisms entails turning innovations into commodities or assets - processes that usually favor standardization so as to benefit from economies of scale (Birch, 2019). This sits uncomfortably with the observation that what moved in SRI was not a rigidly standardized package, like a commodity, which had the same characteristics wherever it went. Instead, SRI changed as it moved (Glover et al., 2017). Market mechanisms would likely have hindered the diffusion of SRI by imposing constraints on the continuous evolution of rice-farming practices under the influence of SRI.

To be sure, SRI did not emerge and spread entirely apart from market mechanisms. In some locations, SRI has been viewed as a good complement to, or even an opportunity to promote, modern rice hybrids. These hybrid varieties are more expensive than conventional varieties and must be purchased, usually annually, from seed markets. Because SRI involves a reduction in the seed rate, SRI potentially makes it more affordable for farmers to purchase hybrid seeds, and several seed producers tried to market their hybrid seeds in combination with SRI, thus incorporating SRI into a commodity-like package. However, as noted above, SRI does not require the use of improved varieties and these attempts at commodifying SRI with hybrid seeds have not been conspicuously successful at scale.

Other elements of SRI could potentially be distributed through markets, however. The most prominent example here is the mechanical weeders. These weeders are regarded as an efficient tool for suppressing the weeds that can grow between widely spaced rice seedlings in unflooded paddy fields. A profusion of weeder designs has emerged to provide the necessary control in a convenient way, several of which were for sale on the market. In our observations, however, these markets did not fully come to fruition as they faced both demand and supply issues. On the demand side, farmers and laborers complain of the difficulty and drudgery involved in using the machines, which are often heavy and difficult to manoeuvre. They may not be fully effective in suppressing weeds, so that a supplementary manual weeding is often needed. Supply issues are also common. In practice, our observations (in various states of India, in Nepal and Madagascar) has been that weeders are rarely available to farmers to purchase on the market. Instead, what typically happens is that a small number of weeders is donated to a community (often in practice to a VLRP or similar contact farmer) by an organization or programme promoting SRI, and farmers are expected to share or borrow the equipment (Hansda, 2018) .[8] Other equipment, such as tools for marking out fields with lines or grids to show where seedlings should be transplanted, is also typically provided free of charge and shared, and farmers have also improvised with cheap and simple tools, such as ropes.

When we compare the development and diffusion of SRI to the market mechanisms identified in leading transition frameworks, we see that few of these mechanisms played a role. For example, the market formation function of the TIS framework suggests to promote sustainable innovations by creating niche markets, specific tax regimes, and new environmental standards. In the SRI case, input subsidies were sometimes offered as incentives for participating and SRI-related tools were provided within public and NGO extension programmes, but the aim was to support farmers' production rather than to stimulate a market. We have seen none of the other market-based mechanisms discussed in Section 2, such as the availability of venture capital and private investments, and the proliferation of patents and start-ups. Instead, SRI was developed and diffused almost entirely outside formal markets. This underscores the importance of paying attention to other modes of exchange beside market transactions.

4. Broadening the economics of sustainability transitions

The System of Rice Intensification demonstrates that the predominant attention for markets as the dominant type of economic exchange for sustainability transitions is limited at best, and at worst can prevent sustainability innovations from becoming successful. We therefore argue that we need to broaden our attention to include other types of economic exchange for understanding and

[8] To be sure, also these non-market forms of exchange are also problematic as this creates a bottleneck in farming operations, with the result that farmers often resort to manual weeding, or simply do less weeding than recommended.

promoting sustainability transitions.

To do so, it is helpful to revisit some classical works in political economy, economic anthropology, and economic history (Polanyi, 2001; Malinowski, 1953; Mauss, 1966; Graeber 2011; Sahlins, 2017). These have developed several conceptual tools for moving beyond neoclassical understandings of markets. Specifically, the work of Karl Polanyi offers a fruitful starting point for exploring and organizing different types of economic exchanges for sustainability transitions. In *The Great Transformation* (1944), Polanyi distinguished four types of economic exchange based on markets, reciprocity, redistribution, and subsistence.[9] This typology is based on the different principles of behavior in the production, consumption, and exchange of goods and services (see Table 1).

This typology situates markets as one of several types of economies through which sustainability transitions could occur. Rather than assuming a priori that markets are the best mechanism for promoting transitions, this framework helps to raise the question what type of economy is best suited for the particular transition at hand. Moreover, the framework also helps to understand the relations between different types of economies: even though these types of economic exchange may occur in discrete forms, they often co-exist and interact, implying that they can be either complementary, obstructing, or neutral to one another.

Finally, the framework helps to better appreciate the politics implied in different types of economies, thus offering a tool for critical reflection on the economies at work in sustainability transitions. Key to Polanyi's work is the recognition that each economic type comes with specific social relations in which the economic exchange is embedded.[10] This was a strong departure from the neoclassical understanding of the market as an institution that is entirely separate from politics and society. In that reading, markets are an autonomous expression of an innate human instinct to trade goods and services, which are supposedly directed by the automatic adjustments of supply and demand that are mediated through the price mechanism ('the invisible hand'). Polanyi argued that the opposite is true; that economic systems are "a mere function of social organization" (p. 52) - an argument that has also been put forward by Southern economists like J.C. Kumarappa (Bawa, 1994). While we disagree with the argument that the economic system is fully subordinate to politics, we take from this the important idea that economic systems both give rise to and are shaped by social relations.

Having already covered the market economy in the previous sections, in what follows we will briefly conceptualize and discuss reciprocal, distributional, and subsistence economies in the context of sustainability transitions (see Table 2). The examples in the table will be discussed in these sections.

4.1. Reciprocal economy

Reciprocal economies, first of all, center around the giving and taking of gifts that have to be reciprocated. The exchange of gifts is not based on the market value of the goods and services that are gifted, nor is economic behavior in these systems driven by the motive of profit. Instead, the giving and taking of gifts is regulated by the relative statuses that individuals or groups hold in their society, which create obligations to reciprocate. Gift-giving is thus seen as "a material expression of those socially cohesive relationships" (Dalton in North, 1977), like friendship or kinship with a religious or political group, or membership of a clan.

The classic example of a reciprocal economy is the system of ceremonial exchanges of bracelets and necklaces in the Trobriand Islands of Papua New Guinea (Malinowski, 1953). On these islands, the act of giving bracelets and necklaces displays the greatness of the giver, thus establishing authority over the receiver of the gift, who in turn is indebted through this exchange (Mauss, 1944). These debts eventually have to be paid, either by reciprocating to the gift-giver or by giving gifts to others, who are in turn indebted to the initial receiver of the gift, thus creating long chains of social relations based on debt. Such reciprocal economies are by no means limited to traditional societies. Reciprocity, in the writing of Nobel Prize winner North (1977), "continues to characterize a great deal of resource allocation" (p. 706) in modern economies as well, for example in economies for development aid, foster care, blood transfusions, and organ transplants (Titmuss, 1970; Stirrat and Henkel, 1997).

Following this understanding, reciprocal economies can be expected to play a role in sustainability transitions whenever institutions like kinship and status play an important role in regulating social relations. These conditions are typically found in contexts with strong communal bonds, for example in local communities or in larger communities with strongly shared identities (Anderson, 1983). In the case of the System of Rice Intensification, Prasad (2020: 297) has explicitly characterized SRI as an innovation comprising "open source and non-proprietary knowledge (…) thereby ensuring free access by farmers and researchers to the new ideas and opportunities" (297). Other reciprocal arrangements were common as well and they helped farmers to deal with periods of peak demand for labor that are typical for rice farming and SRI, typically at the beginning (transplanting) and end (harvesting) of the rice season. Such labor sharing arrangements emerge situationally from social bonds, clustering of fields, and the availability of bullocks (for ploughing), seedlings and irrigation water. Such shared labor arrangements often coincide with sharing of seedlings and tools, such as field markers, based on the implicit understanding that work on another farmer's field would be reciprocated (Sen, 2015).

Upon closer inspection, we also find reciprocal gift-taking and giving to play a role in other sustainability transitions. Organizations for nature conservation for example receive voluntary contributions from hundreds of thousands of people around the world, whose

[9] Polanyi uses the term 'householding' which was more common at the time. Nowadays these types of economies are commonly known as subsistence.

[10] The notion of embeddedness also found its way to the geography of transitions literature where it is used to understand locally diverging conditions for successful innovation and transition processes (Truffer and Coenen, 2011; Sillak and Kanger, 2020). Polanyi's original use of the concept is slightly different, however, as it does not relate to the way individuals or economic actors are embedded in something but the form of exchange itself (see Hess, 2004).

Table 1
Types of economies.

Economic type	Principle	Concept
Market economies	Profit	Exchanges between buyers and sellers through which competition is organized and prices are established
Reciprocal economies	Symmetry	Giving and taking of gifts that must be reciprocated
Redistribution economies	Centricity	Grouping of goods and services at a central entity from where they are subsequently redistributed
Subsistence economies	Autarky	Exchanges within groups who produce primarily for their own use and consumption

Table 2
Types of economies for sustainability transitions.

Economic type	Importance for sustainability transitions	Examples
Market economies	When relations regulated by competition and profit-maximization benefit sustainability	Carbon emission trading, photovoltaics applications, meat replacements
Reciprocal economies	When relations regulated by kinship and status benefit sustainability	Mutually exchanged labour, philanthropy, open source software
Redistribution economies	When relations regulated by the collection and redistribution of a central authority benefit sustainability	Public extension services, CIIFAD SRI secretariat, climate funds, international gene/seed banks, green public procurement
Subsistence economies	When relations regulated by self-sufficiency of a closed group benefit sustainability	Community-supported agriculture, timebanking platforms

gifts affiliate them with the organizations' objectives and endow status on the giver, while the recipient organization is subsequently expected to reciprocate the gift to others. Reciprocal economies also play a role in various open source communities that develop open source resources for sustainability, like freely available software for climate modeling, blueprints and designs for sustainable construction projects, or software for managing permaculture farms (e.g. Coenders, 2013). Individuals typically contribute to open source software without financial compensation (that is, outside market economies) and are instead driven by recognition and their kinship to the community, from whom they expect reciprocity by further contributing to the software (Roberts et al., 2006). This has earlier been characterized as a reciprocal gift economy (Bergquist and Ljungberg, 2001; Lakhani and von Hippel, 2003).

Given that reciprocity can be expected to play a role whenever kinship and status regulate social relations, we may hypothesize that these economic exchanges play a role in niches for where participating actors also have strong shared identities, which can promote information to be shared that later has to be reciprocated. Reversely, reciprocal exchanges may hinder transitions in cases where relations between regime actors are characterized by kinship and status, as this, in turn, promotes gift-giving in ways that maintain the status quo.

Market and reciprocal economies can complement or obstruct one another. For example, citizens can decide to donate gifts to nature conservation organizations that campaign against siting wind turbines in remote areas, thus obstructing the formation of wind energy markets, or to organizations that purchase sustainable innovations themselves, thus complementing market formation. Similarly, software companies can either privately appropriate open source software, thus undermining the reciprocal economy that gave rise to these innovations (in which case market economies hinder reciprocal ones). Or, companies in construction or permaculture can use the software to further their own business, in which case markets and reciprocal economies are complementary.

For transition studies, this raises the question under what conditions markets hinder reciprocal exchanges, in which case conventional recommendations to promote market formation for sustainability should be curbed. More fundamentally, this raises the question how reciprocal economies that foster sustainable innovations can be supported and strengthened. This may involve strengthening innovative communities that currently operate under principles of reciprocity, as well as creating new forms of kinship and status in relation to sustainability - relations that promote gift-giving exchanges.

4.2. Redistribution economy

Redistributional economies are characterized by grouping goods and services at a central entity from where they are subsequently redistributed. For example, in many ancient societies, farmers gave up part of their grain produce to the central authority - a king, an emperor, a mayor, or the chief of the clan - who would then redistribute this stock to those under their command. Similar to reciprocal economies, redistribution is not regulated by the price of the goods or services exchanged, as in market economies. Nor does the motive of profit play a prominent role. Instead, redistribution is based on the principle of centricity where redistribution serves to establish and reaffirm relations of authority between center and periphery. These relations can take different forms, depending on the foundations on which the authority of the center rests, which can range from voluntary contributions of game by hunters to religious leaders to please the Gods, to forced contributions of labor to despotic kings under the threat of capital punishment (Polanyi, 2001).

Redistributional economies can be expected to play a role in sustainability transitions whenever central authorities play an important role in regulating social interactions. Whereas the spread of SRI in India can be described as a decentralized and 'horizontal' diffusion via networks of non-market actors, the SRI network also lobbied to convince state and Union governments to provide support to SRI through agricultural research and extension programmes. In some Indian states, such as Tamil Nadu and Tripura, this effort led to SRI being promoted by government-funded extension workers. In this way, SRI became subject to the redistributional mechanisms that states typically employ.

The work of the SRI-RICE secretariat at Cornell University is another example of redistribution in action. SRI-RICE functions principally as a repository of information, research evidence and news on SRI, which is redistributed via a website, social media channels and mailing lists to different organizations around the world. In doing so, SRI-RICE established itself as a leading authority that occupied a central node in the global SRI network[11] (Prasad, 2020).

At local level, redistribution was evident in the activities of the NGOs, trainers and contact farmers (e.g. VLRPs in the cases described by Sen, 2015), who distributed information, training and advice to farmers and laborers. Within villages, the VLRPs often became critical nodes in making SRI work locally, because they performed key operations for SRI practitioners in field preparation and transplanting. They would also hold important equipment, such as weeders, which was to be made available to farmers. In other words, at village level the VLRPs served as central authorities on SRI, who redistributed resources including information, knowledge and equipment to other farmers.

Also in other transitions, redistributional economies can play an important role. The most prominent example concerns the role of the state in collecting taxes and redistributing those for the purpose of sustainability transitions, for example by funding sustainability research, public procurement of green technologies, or directly subsidizing green energy. And redistribution is also present at other scales. At the global level, for example, the Green Climate Fund within the framework of the United Nations Convention on Climate Change agreements serves redistribution purposes.

Just like with reciprocal economies, redistribution and market economies can also hinder or complement each other. Redistribution can take the form of addressing market failure, in which case redistribution is subordinate to market economies. This is for example the case when taxes on unsustainable energy sources are spent to support sustainable energy sources, whose development otherwise would have stalled as a result of market failure, or through 'green public procurement' of sustainable innovations (Rainville, 2017). However, redistribution economies can also operate in ways that are not subordinate to market economies but are driven by different motives, often quite separate from the market. For example, genebanks around the world collect and conserve plant genetic resources that are crucial for the development of climate-resilient crops. The genetic resources are then distributed free of charge. While companies may also make use of these resources, the private appropriation of such genetic material would hinder this redistributional economy that supports sustainability (Halewood et al., 2012).

For transition studies, this raises the question under what conditions markets hinder redistributional exchanges that contribute to sustainability transitions, and, vice versa, under which conditions redistributional economies can hinder markets that facilitate transitions. And just like for reciprocal economies, this raises the question under what conditions redistribution economies foster sustainability transitions. This is in line with the recent trend to pay attention to the role of the state in the development and diffusion of (sustainable) innovation and green growth (Mazzucato, 2013; Mazzucato and Perez, 2015), which urges us to reconceptualize the role of the state from market-fixing to market-creating (Mazzucato, 2016). Redistribution economies are notably broader though, both in the sense that redistribution does not only cover market-failure or market-creation but also redistribution activities that are not related to markets, and in the sense that the economic principles of redistribution cannot only be found in the operation of governments but far beyond.

This specifically points to the need for transition theories to account for relationships of authority and power (Avelino and Rotmans, 2009). Following Polanyi, redistributional economies do not only serve economic functions but also create and maintain particular social relations, for example between the state and its subjects (Beumer, 2019). This can help to explain the failure of several global initiatives whose economic exchanges may have had clear sustainability benefits but that simultaneously gave rise to relations of authority that were resisted. This points to the need for transition theory to account for the conditions under which centralized authority can legitimately be established and raises questions about how central authorities that currently play a role in regulating other social relations can be leveraged for sustainability transitions.

4.3. Subsistence economy

Subsistence economies, finally, are defined as economic exchanges where closed groups produce primarily for their own use and consumption. The economic activities in subsistence economies are not regulated by profit and prices, nor are goods and services produced and exchanged to maintain relations of status of kinship or to reaffirm relations of authority between periphery and center. Instead, subsistence economies are driven by autarky - the "self-sufficiency of closed groups independent from the ruling authority" (Laamanen et al., 2018, 1222). The best known-examples of subsistence economies can be found in farming communities in developing countries and this is usually centered around individual households. Yet subsistence economies also occur at other scales that involve closed groups whose economic activities are directed towards the direct use by members of the group.

We can expect subsistence economies to play a role in sustainability transitions whenever autarky is an important principle of economic activity. This can thus be found in situations where relations can only be maintained if the group remains closed or when closed groups want to maintain relations of independence from outside authority. In the case of SRI, this principle was present from the onset, as Laulanié explicitly sought to improve rice cultivation for poor farmers who lacked access to both markets and government support, with the aspiration that they could better meet their own subsistence needs independently. In India and other locations, farmers often chose to raise seedlings in collectively managed seedling nurseries. By sharing the effort to prepare the seedbed and manage the nursery, then sharing the seedlings that were produced, the farmers pooled their resources and produced enough seedlings

[11] It became a 'center of calculation' (Latour, 1987). The way in which academic institutes create hierarchical relations through the principle of centricity has been elaborately described in literature on Actor-Network Theory.

for a group of households' rice fields (Sen, 2015). No market transaction was involved.

Also in other transitions subsistence can play an important role, and not only in developing countries. For example community-supported agriculture is an increasingly popular form of producing food for one's own consumption that contributes to the transition towards a sustainable food system by shortening value chains and reducing environmental impacts (Van Oers et al., 2018). Also parts of the sharing economy can be understood as subsistence practices, like timebanking platforms where local communities exchange goods and services based on the amount of time it takes to produce and provide them. These exchanges within a closed group may contribute to sustainability by stimulating local economic activity and reducing the need for imports. These platforms are based on the principle of autarky and help to "create self-sufficiency and autonomy from the market economy through informal exchange communities" (Laamanen et al., 2018, 1221).

The examples discussed thus far are mostly at odds with market economies, as they deliberately seek autonomy from markets. Yet subsistence economies can also complement markets. For example, recent work on subsistence farming shows that plantations that tolerate employees cultivating non-commercial crops for their own consumption fare better than plantations that do not (Curry--Machado, 2016). In these cases, subsistence farming effectively sustains commercial plantations by ensuring the necessary food for plantation workers. As such, the production of crops for one's own consumption is shown to be crucial for the maintenance of global food markets, even if proponents of those same markets often cast subsistence farmers as backwards for refusing to commodify their products (Hazareesingh and Maat, 2016).

This raises the question under what conditions subsistence economies foster sustainability transitions and how this can be promoted. And for transition theories that depart from the primacy of the market, here too is it important to ask under what conditions the formation of markets can undermine subsistence economies that benefit sustainability. For example, how can we identify conditions where dependencies on (international) markets hinder sustainability transitions and where the creation of economic activities that are directed towards the direct use by members of the group can benefit sustainability? This tension between markets and subsistence resonates with long-standing discussions on the (un)sustainability of global value chains, the difficulty of curtailing unsustainable markets, and the need to further alternatives based on autarky and local production. Rather than *a priori* favoring one economic type over another, however, the distinction between markets, reciprocity, redistribution and subsistence urges us to ask under what conditions *different types* of economic exchange can favor sustainability transitions. Doing so would broaden the research agenda and analytical repertoire of transitions studies, and enlarge the available options for organizing economic activities to promote sustainability.

5. Conclusion

Founding frameworks in transition studies have privileged markets and market formation as critical concerns. We argue that the focus on markets, as a crucial mechanism for the development and diffusion of sustainability innovations, around which other forms of economic exchange revolve, is limited at best.

While it is beyond doubt that markets matter for sustainability transitions, so do other types of mechanisms by which resources are allocated. This is evident from the System of Rice Intensification, an innovation for sustainable rice cultivation that was developed and diffused without relying on market mechanisms. SRI was developed by a Jesuit missionary who explicitly sought to develop an innovation that would be available for poor farmers who could not purchase products on the market. The innovation resisted commodification and was diffused through networks of researchers, NGOs, CSOs, and government organizations, each of whom made SRI available to farmers free of cost. The market mechanisms identified in leading transition theories were absent, yet the innovation spread internationally and is reported to have influenced the cultivation practices of millions of farmers around the world.

The case of SRI shows that non-market forms of exchange can also be central to sustainability transitions. We further articulate an understanding of these other types of economies by revisiting several classic works that offer conceptual tools to capture economic exchanges outside markets. In particular we draw on the typology suggested by Karl Polanyi, who distinguished four types of economic exchange based on markets, reciprocity, redistribution, and subsistence. Each of these economies played a role in SRI, from the gifts of farmers who help one another in periods of peak labor demand in the expectation that this help will be reciprocated, to the collection and redistribution of information on SRI by the CIIFAD, which in doing so established itself as the leading authority on SRI, to the subsistence farmers adapting SRI in ways that enable them to provide for their own consumption.

This understanding of markets as one of several types of economic order in sustainability transitions has several implications for theory and practice. First of all, rather than starting from the assumption that transitions are best achieved by enabling innovations to compete on the market, this framework helps to take a step back and ask what type of economy is best suited for the transition at hand. The Polanyian understanding of economic exchanges as embedded in social relations can help to identify conditions where social relations are institutionalized in ways that are more or less suited to each economic type (see Table 2). To be sure, in some cases, markets will turn out to be the most suitable form of economic organization for sustainability transitions. Yet in other cases, markets may not play a role at all, as we saw in the case of SRI, in which cases transitions may be better served by leveraging non-market principles that regulate social relations.

Asking how alternative forms of economic organization can benefit (or hinder) transitions also enriches our understanding of actors that do not create, complement, or correct markets. For example, the role of states in transitions does not need to be restricted to market-fixing or market-creating, nor should our understanding of civil society organizations be limited to the ways they make markets more sustainable. As such, this framework also contributes to the call to better understand the governance of transitions and the role of civil society in transitions, which have been prominent themes on the recent agenda for sustainability transitions research (Köhler et al., 2019).

Secondly, the framework is helpful in highlighting that market economies interact with other economies. The economic types are not discrete types that operate in isolation but rather operate concurrently. This implies a continuous interaction and (mis-)alignment between the different economic types, which, as we have shown in Section 4, can at times support transitions or hinder them. This too widens the available options for organizing economic activities to promote sustainability. The framework can for example be used to identify conditions where markets obstruct other forms of exchange in ways that are detrimental to sustainability, as we saw in the case of SRI, or where other forms of exchange hinder markets.

Transition studies should not 'price itself out of the market' by predominantly focusing on market economies. Complementing market transactions with relationships of exchange that are based on reciprocity, redistribution, and subsistence, helps to situate markets in a broader economic context and helps to understand how mechanisms for market exchange intersect with other types of economies in ways that can either positively or negatively affect sustainability. This offers a fruitful starting point for transition theories to incorporate other forms of economic order that can promote sustainability transitions.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

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