





Facilitating adoption of responsible innovation in business through certification

Miklós Lukovics ^a, Benedek Nagy ^a, Zenlin Kwee ^b and Emad Yaghmaei ^b

^aUniversity of Szeged, Faculty of Economics and Business Administration; ^bTechnische Universiteit Delft, Faculty of Technology, Policy and Management

ABSTRACT

In this paper, we use an economic approach to demonstrate why 'rational' businesses are not likely to implement responsible innovation (RI) unless it is economically profitable. The lack of sufficient insights into economic impacts of RI is often induced by information asymmetry. Such asymmetry would hinder consumers who would otherwise be willing to pay higher prices for products or services that are assumed to be associated with RI from actually paying a higher price. We consider the introduction of a certification scheme of RI that would act as a signaling proxy to reduce information asymmetry thereby help increase economic benefits of RI implementation that can further lead to firm profitability. Furthermore, we argue that certification can help facilitate the more effective spread of RI in the business sector by broadening the focus to include not only the ethical engagement of researchers/innovators but also the profit motives of the company.

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Introduction

To embed societal needs and values in innovation processes and reduce the unintended negative effects of research and innovation (R&I) processes and outcomes, recent scholarship and policy proposals have advanced the concept of responsible innovation (RI) (Stilgoe, Owen, and Macnaghten 2013; Sutcliffe 2013; von Schomberg 2013). In a nutshell, the framework for RI aims to encourage firms/actors engaging in R&I processes to act in the present for the future by minimizing negative and maximizing positive effects of innovation outcomes.

Although both academics and business actors have attempted to put the idea of RI into practice, there is currently still limited experience with the implementation of RI dimensions in business (Lettice et al. 2017; Van De Poel et al. 2017; Yaghmaei 2018), as well as limited evidence of the benefits of RI in business (Flipse and van de Loo 2018; Long et al. 2020; Van De Poel et al. 2020; Yaghmaei and Van De Poel 2021). Correspondingly, the normative RI guiding principle for innovation and techno-science needs to be better understood and

CONTACT Benedek Nagy  nagy.benedek@eco.u-szeged.hu  H-6722 Szeged, Kálvária sgt. 1. Hungary

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further advanced with substantive assessment of potential added (economic) values of implementing RI in practice. The lack of sufficient insights into the economic impacts of RI is often induced by information asymmetry between firms and their customers.

In this paper, we employ an economic perspective on the problem of implementing RI in the business sector. We describe how information asymmetry between innovators and consumers can prevent the collection of the benefits thought to be associated with RI and thereby render the implementation of RI less profitable than not implementing it. We investigate whether a certification scheme of RI is able to act as a signaling proxy to reduce information asymmetry. In essence, an RI framework opens up many possibilities of aligning RI-deliberated choices of socially desirable practices with the profit-motive of innovative companies. We argue that this will help increase economic benefits of RI implementation that can further lead to firm profitability. As such, there will be a more effective spread of RI in practice.

The paper is organized into six sections. First, we present a review of responsible innovation and its current state of implementation within the business sector. The next two sections address the apparent issue of businesses' rationale from an economic perspective that may help explain why businesses may be reluctant to implement RI. We explain how it might appear economically disadvantageous for businesses to undertake the assumed costs of implementing RI, even if RI produces long-term benefits and/or cost reductions. As an instance of the 'growth paradox' (Edwards 2012), this phenomenon can be explained by the concept of information asymmetry, which prevents consumers with a preference for RI from paying more for RI-oriented products and services (McGoldrick and Freestone 2008; Iyer and Soberman 2016). We then demonstrate how a certification scheme can act as a proxy signal to resolve the asymmetric information problem present in the case of RI, by considering how such a signal could make an RI model more compelling than traditional innovation models. Finally, we discuss some of the central considerations that would need to be addressed in establishing a certification scheme. The paper ends with concluding remarks about how to further facilitate RI uptake in the business sector.

An overview of RI and its current state of implementation within the business sector

The concept of RI is generally centered around the question of which substantive norms should guide innovation in a responsible manner. However, RI substantive values are not fixed by the values anchored in a policy agenda (Owen, Macnaghten, and Stilgoe 2012; Sutcliffe 2013; Buzás and Lukovics 2015) and hence its interpretation is rather broad. In defining the concept, von Schomberg (2013, 60) argues that Responsible Research and Innovation (RRI) is a

transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).

Although Von Schomberg's definition of RRI is broad, it aligns with the European Union (EU) policy agenda and values in which it suggests that considering social, environmental, and ethical aspects during the innovation processes can be valuable to all

actors in an innovation ecosystem. More broadly, Stilgoe, Owen, and Macnaghten (2013, 1570) define RI as: 'taking care of the future through collective stewardship of science and innovation in the present.' Both of these definitions suggest that RI/RRI requires conscious decisions to be made in research and innovation (R&I) processes in order to both foresee and address non-obvious risks and consequences; thereby providing preventive measures against the environmental, social, and ethical risks and consequences that are normally extraneous to business decision making.

Several RI methods and frameworks have been developed in an attempt to enable the implementation of RI in business contexts (Fisher, Mahajan, and Mitcham 2006; Felt, Fochler, and Sigl 2018; Pavie and Carthy 2015; Tyl et al. 2011). Furthermore, attempts to implement or install RI in business settings tend to fall into one of the following three categories.

Primarily, in the first category, at the level of individual interactions, RI concepts and tools have been deployed and in some cases successfully integrated into day-to-day R&I work (Bergvall-Kareborn, Hoist, and Stahlbrost 2009; Schuurman et al. 2011; Pavie and Carthy 2015; Fisher and Schuurbiers 2013). Whereas many individuals are open to embedding RI methods and frameworks (Yaghmaei and Van De Poel 2021), RI has limited conscious strategies and methods for bringing RI into practice (Flipse, Van Der Sanden, and Osseweijer 2014; Gurzawska 2021). In the second category, at the organization level, a number of RI tools, actions, and strategies have been developed for private sector settings including, among others, KPIs (Lehoux et al. 2020; Lubberink et al. 2017; Yaghmaei and Van De Poel 2021). Finally, in the third category, at the governance level, the European Committee for Standardization (CEN) and the UK National Standards body BSI have published the management standards 'CWA 17796 Responsibility-by-design' ('CWA 17796 Responsibility-by-design' 2021) and 'PAS 440 Responsible Innovation' ('PAS 440 Responsible' 2020), respectively, to deliver actionable strategies for RI in the business sector.

Despite this rising interest in using the RI construct in business settings, efforts to bridge the gap between RI principles and business practices have remained limited (Lehoux et al. 2020). This lack of scholarly attention and business uptake can be partly explained by both the presence of barriers and the lack of potential incentives for the inclusion of RI in private industry. For instance, Brand and Blok (2019) identify a tension between the RI ideal of deliberative engagement and 'the way in which the competitive market operates' (4). By far, the most commonly mentioned source of tension for businesses to implement RI is the challenge of how to balance the need to achieve financial profit with the resources needed to conduct their activities in a responsible manner. In this respect, a recent study by Kwee, Yaghmaei, and Flipse (2021) argues and demonstrates that there is a potential alignment between KPIs of RI/RRI activities with those of organizational R&D activities. This seems to be a promising premise for stimulating businesses to engage in RI.

Operationally, however, the primary challenges to implementation of RI focus on the additional costs and time that would be involved in engaging in RI. To a large extent, RI activities might slow innovation and development processes which can be a significant concern for people working in competitive environments (Ko, Yoon, and Kim 2020; Steen 2021). The high extra costs of implementing RI and an increase in bureaucratic burden bring the need of supplying more documentation to extra management work, and it means more resources need to be made available (Porcari et al. 2020).

In contrast to the previous arguments of speed and costs associated with RI implementation, a counterproposition is that implementing RI in the business sector requires right incentives (Gurzawska, Mäkinen, and Brey 2017). In this respect, one of the most frequently discussed incentives for the RI uptake in industry is the potential for an improved corporate image/profile or reputation (Porcari, Borsella, and Mantovani 2016; Yaghmaei et al. 2019). This, in turn, is also associated with increased profits as good corporate reputation may provide a competitive edge (Flatt and Kowalczyk 2008).

Additionally, since it is often unclear about the measurable benefits (e.g. in terms of revenue) of embedding RI principles and the results are attained mostly over a longer period (Steen 2021), business innovation actors show limited interest in implementing RI in their R&I initiatives (Nádas et al. 2017). Over time, although the corporate innovation environment is increasingly more open to the idea of RI (Flipse et al. 2015; Flipse and Yaghmaei 2018; Martinuzzi et al. 2018), the tension between the profit motive and the social contribution remains evident (Ko and Kim 2020). This causes difficulties for integrating RI into existing organizational processes, especially, in industrial contexts (Ceicyte et al. 2020).

Whereas the discourse of RI has been emerging for about a decade, there are only a few innovators and practitioners who have been successfully reached to embed the idea of RI in their innovation initiatives (Owen et al. 2020; Van De Poel et al. 2020). Widespread adoption of RI requires RI to be present not only at the level of a small number of individuals within industrial organizations, but also to spread as widely as possible throughout the business sector. It is therefore intriguing to identify RI performance criteria in the business and industrial contexts that emphasize the interconnectedness of the organizational and individual contexts (Greenwood et al. 2017). To embed RI in the business sector, the connections between businesses and their norms, external stakeholders, and wider society ought to be considered to be able to authorize and legitimize the logics, behaviors, and practices of RI in their business organizations (Greenwood et al. 2017; Scott 1995). In the next section, we will further argue that a signal in a form of RI certification scheme can be an application of such interconnectedness. Such a scheme could both empower businesses that already want to be more responsible, as well as encourage other players in the industry, who are currently indifferent or opposed to be more responsible.

An economic perspective on the business rationality of RI implementation

Our approach targets business managers rather than researchers. While many existing RI approaches focus on the moral engagement of the researchers themselves, in a business environment they are bound to have limited power and authority to implement the principles of RI. For instance, important decisions about what to research, how much resources to spend on research and in what way, and when to bring a product to the market are made at the managers' level (Jarmai, Tharani, and Nwafor 2020). Furthermore, in the classical agency theory, managers tend to represent the interests of the shareholders (Jensen and Meckling 2019). Shareholders, in turn, may or may not be interested in how socially responsible the innovation process is, but they are assumed to be interested in the long-run profitability of the business. This is an important assumption made by mainstream neoclassical economics (Mas-Colell, Whinston, and Green 1995; Pindyck

and Rubinfeld 2009; Varian 2014), even if it is admittedly a simplification of a more complex, but less tractable reality.¹ Building on this thought, RI may provide businesses with an emerging opportunity to produce a more valuable² product for their consumers. The profit-maximizing decision makers of the business will ask whether the implementation of RI is also offering more (or at least, not less) profit.

Von Schomberg's definition of RI (2013, 60) states that an innovation process or innovative output needs the characteristic of 'societal desirability' to be responsible. Drawing on Von Schomberg's definition of RI, RI appears to have a policy emphasis rather than concrete business impacts which may contribute to the reason why businesses are reluctant to embrace the idea of RI. The new welfare economics addresses the distribution efficiency aspect of societal desirability, i.e. a notion of economic reallocation of resources in such a way that it creates more additional benefits than additional costs to all stakeholders concerned (this is known in economics as the Kaldor-Hicks criterion (see e.g. Zerbe 2001, 5)). Even though RI can mean much more than this economic impact, successfully incorporating at least this part of social responsibility into business innovation processes may already be a significant step towards RI adoption in businesses.

An important issue with RI uptake is that it may result in additional costs to the innovative business, for example, in terms of longer innovation process, conducting additional tests, managing stakeholder involvement (Steen 2021). These costs need not all be monetary costs: they can include switching costs, the additional time, effort and training to conduct innovation differently than before.

On the demand side of the market, there can be a group of consumers who actually care about and value innovation done responsibly, just like there are environmentally conscious or ethically concerned consumers. This group of consumers may have a higher willingness-to-pay for products resulting from RI. Rode, Hogarth, and Le Menestrel (2008) is one example of a study that sets out to elicit increased willingness-to-pay for ethically produced goods. They do find, that consumers seem to have a 'demand for ethics' (278) i.e. they are willing to pay a premium if they know that the producer incorporates ethical guidelines.

In fact, if a consumer can choose between similar products/services, one of the key drivers for the consumer's choice could be the evidence of the products/services compliance with environmental and/or societal requirements (Dragusanu, Giovannucci, and Nunn 2014; Goff 2018; Gutsche and Zwergel 2020; Johannessen and Wilhite 2010). For such products/services, consumers may be willing to pay ethical product premiums (McGoldrick and Freestone 2008) and vice versa, they will not pay these premiums for RI nonconformity products/services.

Moreover, many of the additional benefits from RI will only appear at a later time (e.g. in the form of lower repair and servicing costs, increased safety of use), and will accrue to people who might not even be their consumers (benefits from increased safety can also spill over to non-users) (Lukovics, Nagy, and Buzás 2019). If the consumers are not conscious about these additional benefits which are in fact benefits to society, they will not have the willingness to pay for RI-oriented products/services. This type of 'externality' problem is studied in economics under the heading of market imperfections, when free and competitive markets cannot create an outcome that is socially desirable.³

To illustrate the externality problem connected to responsible innovation, we will take the basic profit maximization model from any mainstream economics textbooks, because

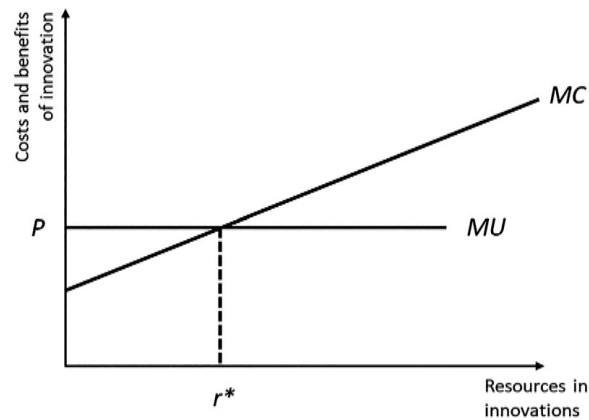


Figure 1. Optimal resource usage in innovation: the baseline case. Source: Authors' own illustration based on Pindyck and Rubinfeld (2009).

it is simple enough to show the main problem to be solved without the added complexity that might misdirect our attention. It is a general habit of economists to start out from the simplest model to explore the basic logic of the problem, that later allows them to add more complexity.⁴ Figure 1 shows how the innovator company sees the market, and what they will base their innovation decision on.

The increasing MC curve is the business's marginal cost curve showing that using additional resources in innovation means an increasingly higher cost to them. The horizontal MU curve is the consumers' marginal utility curve showing their additional benefit which is also their willingness-to-pay from additional resources used in innovation.⁵ Where the two curves meet, at r^* , is the point up to which a competitive profit-maximizing business will use resources in innovation. Using more resources than this would be socially wasteful, as it means using resources that are less valuable than they cost. Similarly, using less resources than this would also be socially wasteful, as it means not using some resources the usage of which would be more useful than they are costly. This intersection point also marks the price of the innovation output: eventually it is the consumers' valuation that determines how much resources should go into innovation. If we added imperfect competition to the picture (for example monopoly, which is another market imperfection just like externalities), our model would predict that market power associated with less than perfectly competitive business drives up the equilibrium price above marginal cost, and reduces the optimal resource usage. Resource usage would not be increased up to r^* , because even though it would create more value to society than it costs to the business(es), it would also reduce the innovators' profit.

Let us incorporate the unintended negative or positive side effects of innovation into the baseline model. In line with Von Schomberg's definition of RI, one should consider such side effects and encourage the generation of positive side effects, while reducing the generation of negative side effects. If RI is able to do just this, then it can be said to be creating positive externalities, or reducing negative externalities. This is shown in Figure 2.

The left-hand-side panel shows the case when RI is generating benefits not only to the consumers, but also to external parties. The MSB (marginal social benefit) curve is

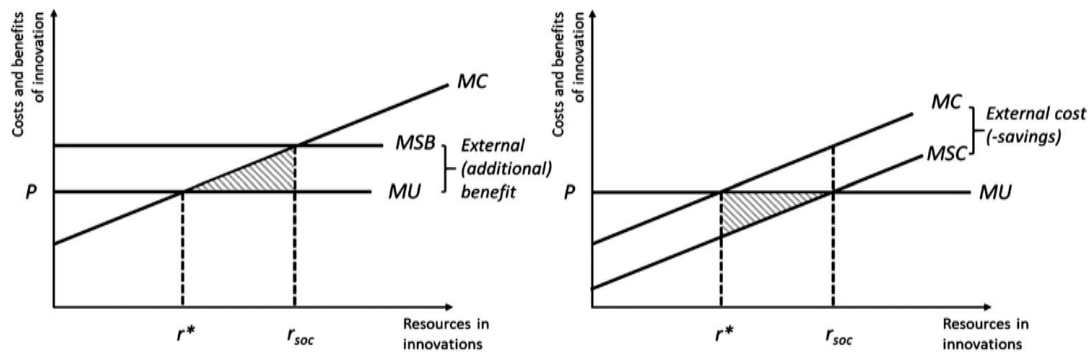


Figure 2. Positive external effects generated by the responsible innovation model. Source: Authors' own illustration based on Pindyck and Rubinfeld (2009).

representing the combined benefits that whole society can derive from a certain resource usage of resources in innovation. The right-hand-side panel is showing the case when the responsible innovation results in cost reduction to external parties. The MSC (marginal social cost) curve, in this case, represents the combined cost that whole society is bearing in connection with a certain usage of resources in innovation. Now it is socially advantageous to increase (or socially wasteful not to increase) resource usage up to r_{soc} : as resource usage between r^* and r_{soc} generates more benefits to society than it costs society overall. The problem with externalities is that these additional (external) benefits and costs are not manifesting at the consumers of the business or the innovative business itself; therefore they do not influence the decision of the profit maximizing business: They still use resources up to the point r^* . The result is underusage of resources.⁶ Increasing the resource usage would be beneficial to society but would also mean a lower profit to the innovator. The shaded area is the societal loss from the business's profit-maximizing decision that is not in line any more with society's welfare maximizing goal due to the positive external effect. If we expect innovative businesses to be responsible out of personal motivation and to disregard the profit motive, then those businesses that do RI will be less profitable compared to their non-responsible competitors, losing out in competition and possibly even going out of business eventually.

Making things worse: information asymmetry

Profit-maximizing innovative businesses would be willing to increase resource usage and innovate more responsibly, if all or part of this increased utility or reduced cost to society becomes evident to them in the form of higher revenues from their consumers. Their existing consumers who value responsible innovation can have an increased willingness-to-pay as they realize the advantages they have from the responsibly conducted innovation. On the one hand, it would be difficult for them to properly assess these benefits lacking counterfactual evidence. On the other hand, even if they did correctly assess these, it might not result in additional revenue for the responsible innovator. This is due to the phenomenon that economists call information asymmetry.

Information asymmetry refers to market transactions when one party has more information than the other. A famous example of this is George Akerlof's used car market (or 'market for lemons', 1970), in which the seller has accurate information about the quality

of the car they are selling, while this information is not available to the buyer. Michael Spence (1973) studied a similar phenomenon in the labor market, wherein a potential employer cannot make a proper distinction between employees with superior and inferior skills, while the employee knows which category they belong to. There is a similar problem found in the insurance market when a person intending to buy health insurance knows their own health status, but the insurance company does not.

In the context of RI, information asymmetry means that innovative businesses know whether they are responsible innovators, bearing the additional costs of innovating responsibly, but this is not known to the consumers. Only looking at the final innovative product, the consumers are not able to tell whether or not it was researched in a responsible way. In the above-mentioned cases of information asymmetry, the result is that the market breaks down and adverse selection happens, when the goods of inferior quality (i.e. a 'lemon' car or a less qualified employee) forces the goods of superior quality out of the market. Using this analogy, if consumers with a preference for responsible products cannot tell the difference between a product that is responsibly produced (consequently, represents a higher value to them) and a product that is not, they will only be willing to pay the value of the lower value (which is associated with the value they are willing to pay for non-responsible product) (Connelly et al. 2011).

To illustrate the problem posed by information asymmetry, let us take first an imaginary market that has producers with a homogenous product and consumers that have willingness to pay according to the perceived usefulness of the product. The meeting of the producer and the consumers will result in a price as in Figure 1, and there is no information asymmetry here (Figure 3).

Let us have now two types of consumers: consumers that value innovation and products made in a responsible way (call them 'responsible consumers') and consumers who do not find this important (call them 'ordinary consumers').⁷ Even though the responsible consumers might have a higher willingness-to-pay, since there are no responsible innovators/producers, the price of the product will not change and neither does resource usage in innovation.



Figure 3. The market of an innovative product with homogeneous innovators and customers. Source: Authors' own rendition.

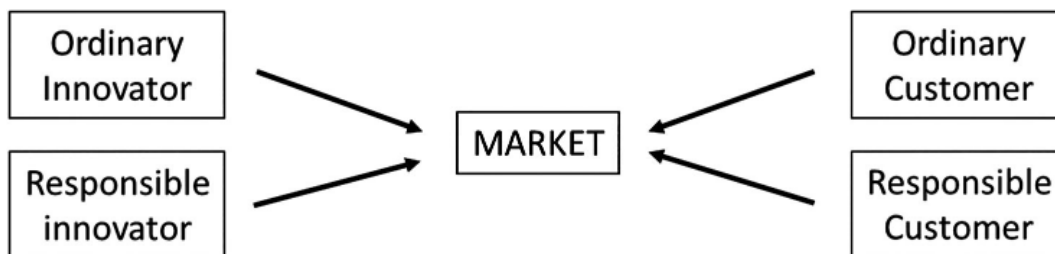


Figure 4. Heterogeneous innovators and customers in the market of an innovative product: a pooling equilibrium. Source: Authors' own rendition.

Next, let us divide the producer's side into two as well: 'responsible producers' who conduct research responsibly, and 'ordinary producers' who do not. Information asymmetry arises if the two kinds of producer's products look identical, that is the consumers cannot tell whether a certain product variant comes from a responsible or an ordinary producers. When the two types of consumers meet the two kinds of producers on the market, the models of asymmetric information predict an outcome that is called 'pooling equilibrium' (Rotschild and Stiglitz 1976) (Figure 4).

If the higher value responsible product and the lower value ordinary products are pooled together in the market and the consumers cannot be sure which one they are getting, they will not be willing to pay the higher price for the more valuable products in fear of eventually getting the lower value product (and thereby not only paying more for a less valuable product, but also patronizing a business that is not innovating according to their preferences). The consumers perceive the products to be homogenous. The average cost level increases (as there are higher cost and lower cost innovators), the average willingness-to-pay also increases (we have the responsible and the ordinary consumers), the ordinary innovators would earn higher profits on average while the responsible innovators' revenue would not cover their costs, thus the composition of businesses would change over the long run, shifting toward non-responsible innovators. Information asymmetry leads to adverse selection, like in the case of Akerlof's market for lemons, and ordinary innovators force responsible innovators out of the market, a phenomenon known as Gresham's law.

Standing out from the crowd: signaling RI

Responsible innovators produce outputs that are considered more valuable by consumers with responsible preferences. The cost of the innovation and the product resulting thereof is higher when RI guidelines are employed. However, due to information asymmetry when consumers cannot identify correctly the responsible innovators, they would likely not pay a higher price, even if they have a higher willingness-to-pay.

Information asymmetry is not an invention of economics, but of course economic theorists noting the existence and importance of this phenomenon set out to find possible remedies for the problems caused by it. In the presence of better and worse informed parties, one set of remedies concentrates on costly action on the part of the less informed party which is called 'screening' (Spence 1973; Riley 2001). Used car buyers bring a trained mechanic with them to determine the quality of the cars they plan to buy. In case of the job market, the potential employers conduct interviews to select more able candidates. In the case of insurances, the insurance companies design different insurance plans with various fees and coverages to make the potential customers self-reveal their health status.⁸

The second set of remedies involves costly action on the part of the better informed party and is called 'signaling' (Riley 2001; Spence 2002; Connelly et al. 2011). When the better informed seller is offering a product of higher quality, they have an incentive to signal this fact to the consumers. In the context of RI 'better quality' would mean a product that is researched according to the principles of RI. Such a product is seen as being of better quality, or just being more valuable by the responsible consumers.⁹ A good signal allows them to correctly identify responsible producers. If this is done successfully, then a 'separating equilibrium' (Rotschild and Stiglitz 1976) is reached, as demonstrated in Figure 5.



Figure 5. Separating equilibrium in the market of an innovative product. Source: Authors' own rendition.

The market is separated into two submarkets: one for the ordinary products, and one for the responsible products. The responsible consumers with a higher willingness-to-pay can be sure that they only pay a higher price for a product that in fact has a higher cost because the innovation is conducted in a way that better suits their preferences. In the signaling literature, it is important that the signal is costly, and that signaling cost is inversely proportional to the quality being signaled (Riley 2001). In the RI context, this would mean that signaling has to be less costly for those businesses that are more in line with RI principles. Costs also play a central role in avoiding false signals. Good signals give reliable information to consumers guiding their purchasing decision. It is important to note that even though it is certainly advantageous if the business's main decision makers are sympathetic to the idea of RI, they don't necessarily have to be. Behavioral economics argues that, in the presence of consumers who are interested in products researched in a responsible way and willing to pay premium for such products, a purely profit maximizing business is willing to provide these products and to pay the higher cost of RI and signaling, if these also result in higher profits to the business.

One way of creating such a signal would be advertising. Responsible innovators could make commercials and advertisements that inform the consumers about how they are implementing RI standards into their operation. Just as there exist dishonest or misleading advertising campaigns about a company producing green products or being engaged in Corporate Social Responsibility (CSR) (Pope and Waeraas 2016), the same could happen with RI advertising. Hence, we propose a different method: an RI certificate with which an objective and professional third party certifies that an innovative business meets certain RI standards. Such certifications already exist in the field of quality assurance, environmental friendliness, CSR, benefit corporations, and higher education. In case of these certifications, a professional third party, who has an advantage in information gathering and thus can do it at a lower cost, certifies that the business complies with certain standards (Terlaak and King 2006). If this third party is reliable and trustworthy, then the certificate they issue provides low cost information to the consumers – in our case about RI compliance of a business. The goal of such certification is to attract higher willingness-to-pay consumers and reach higher profits.

Setting up the signal for responsible innovation

Based on the arguments in the earlier sections, it appears that a well-designed RI certification targeted specifically at the business sector can complement existing methods in

spreading RI practices. During the certification process, a professional certifier investigates whether an innovative business conducts its R&I according to certain standards, and issues a certificate acknowledging the compliance. This certificate then allows the business to use an RI label on its innovative products. The label can function as a signal to inform consumers that the product was produced responsibly. Such a label can set responsible innovators apart from ordinary innovators that do not conduct their research and development according to specified principles and guidelines. Designing such a certification process and the criteria for obtaining a certification, in turn, raises several important considerations.

Certification considerations

In order to ensure the effectiveness of any RI certification scheme, including the idea of an RI label discussed here, the following considerations would need to be carefully addressed: cost of entry, criteria, and ability to address information asymmetry.

Cost of entry. An RI label should have a fee-based standard-type character. Businesses willing to pay the fee for a certificate indicates that they are seriously interested in the application of RI, and this is an important signal towards the consumers. Involving a third party to certify compliance to well-defined standards increases the credibility of the signal, as opposed to self-assessment. If the certificate is easily obtainable or can be forged, then it cannot fulfill its signaling role.

Criteria. In the spirit of doing the right thing while ensuring profitability, there should be clear RI-relevant criteria for certification, but business-focused indicators should also be included. It is very important that the certification criteria drive the effective adoption and implementation of RI principles. Furthermore, they should do so in a manner that supports the profit-maximizing behavior of businesses. Thus, certification criteria and indicators would need to be elaborated by a broad professional consensus among RI scholars, the business community, and others relevant actors and stakeholders. Whether such a broad consensus is indeed possible is a fair question although it is beyond the scope of the present investigation. Moreover, developing appropriate indicators would present a further possible challenge since existing studies tend to focus on indicators for RI in a general sense (Eden, Jirotko, and Stahl 2013; Owen et al. 2013). Furthermore, these are often based on six key RRI elements – public engagement, science education, ethics, governance, open access and gender equality – identified by the European Commission (EC 2013), which fail to incorporate the economic aspect of responsible innovation (Yaghmaei 2015). The precise formulation of RI criteria and indicators is essential, as without it businesses could claim to be responsible innovators as a result of testing, quality assurance measures, CSR reporting, or other common practices that do not necessarily involve the reflexivity, anticipation, and responsiveness process dimensions widely associated with RI.¹⁰ Thus, the certification criteria would likely need to incorporate business-focused indicators that depict the R&I cost and benefit measures of the company, as profit is an important objective in the life of businesses, and which would themselves help measure the economic impacts of the RI-related activities of the company.

Ability to reduce information asymmetry. An easily recognizable RI signal that fulfills the above can help to inform consumers about the responsible nature of the innovator

business. If the certification process is based on the right indicators and the certifying body is professional, trustworthy and credible, then the resulting RI label can help responsible consumers correctly identify responsibly produced innovations. Its job is to enable the separating equilibrium mentioned above with responsible consumers paying a higher price for the higher cost responsibly-produced products that they find more valuable and ordinary consumers, who get ordinary products less expensively. The two markets are separated in a non-transitional way (i.e. responsible innovators do not want to move to the ordinary market, and ordinary innovators cannot move to the responsible market) and prevents adverse selection that would happen in the pooling equilibrium as explained above. The easier it is for ordinary innovators to obtain or use the RI label, the less it succeeds in reducing information asymmetry, and the closer the market will get to the pooling equilibrium.

Responsible innovation as a rational choice

Following the assumption that economic rationality is a central factor influencing the decision making of businesses, we find that a well-designed RI signal can encourage businesses toward the adoption of RI principles in their R&I decisions without external government intervention and hence, complement the need for an individual RI engagement. Such a signal can help to make the choice of RI profitable by making it rational (profit maximizing) for both consumers and businesses.

Firstly, consumers may be encouraged by various motives to pay a higher price for a product marked with an RI signal. In this case, it may seem trivial that a person chooses the innovation output labeled as responsible because they consider themselves to be a responsible customer and are willing to pay more due to such preferences. The RI signal enables them to pay a higher price only for responsibly-produced products. However, there is a rational decision behind it: the responsible consumer realizes that they themselves can save future costs (i.e. repair, complaint, compensation, conscience, nervousness, uncertainty, etc.), or enjoy additional benefits (i.e. future security, predictability, security, etc.) if they buy a responsibly-produced product. Considering these possible future costs and benefits, the 'higher price' might not be higher if one takes into account the entire life cycle of the innovation output. Realizing these positive side effects of RI can increase the number of responsible consumers. Responsible businesses could thereby have both more consumers and higher willingness-to-pay consumers as a result of an RI label that functions as an effective signal of RI.

Similarly, RI can become a rational choice for businesses if they take into account the entire economy of innovating responsibly. As we have argued, RI can mean additional costs for companies. Currently, existing RI methods mostly can tell businesses how they can behave more responsibly, but not how they can collect returns from doing so. With an RI label, innovators can send a credible signal to their consumers that they are responsible. This signal, together with a higher willingness-to-pay on the part of these consumers can thus manifest in form of higher price for – and only for – responsible products. This achievable higher price can in turn be a market incentive for businesses who would voluntarily choose to innovate responsibly. The ideal case would be if the full extent of the positive external effects could appear as a higher price. In this case, the innovator's profit-maximizing choice of resource use would be exactly r_{soc} . It is possible, however, that the

higher price paid by responsible consumers does not incorporate all of the additional benefits gained or costs foregone (because, for example, a part of them is not realized by these exact customers). In this case, the result may only be a partial adjustment of the resource usage. The profit-maximizing choice of the innovators still comes closer to society's aim to maximize quality of life and more rational innovators will choose a responsible innovation model under these conditions, too.

Current individual RI methods aim to shape the innovator's thinking and to initiate a kind of learning process, usually involving a third party as a coach, provocateur, facilitator, etc. (Balmer et al. 2015). An RI label would also require a third party in the form of a professional certifying body. In this case, however, the focus would not only be on learning and installing RI process principles, but on more broadly, harmonizing the profit motive and the social objective of RI. In both cases, there are costs associated with implementing RI in business and industrial settings, whereas the latter case allows both of these costs to be offset and even converted into higher profits, as we have argued. Ultimately, the purpose of such an RI signal would be for company decision-makers who dispose over research and innovation funds (e.g. principal investigators, financial managers, corporate managers) to become interested in and adopt RI principles and practices, even if simply due to the possibility of the higher profits it can bring.

Conclusions

Most of the current methods for the practical application of RI focus on the personal motivations of researchers and is applied in the academic sector. Although there have been successful adaptations of these methods in business settings, the overall uptake of RI concepts and ideas in the business sector appears to be quite limited. In order to more widely disseminate RI frameworks and approaches on a broad scale, it is necessary to popularize the idea in the corporate sector.

In this paper, we used an economic approach that is under-emphasized in the RI literature, but that we believe is important to use in the business context, namely, the economic logic of profit maximization. According to conventional economic theory, most businesses make decisions based on a 'rational' motivation for profit; accordingly, profit-oriented businesses' decisions about the character of innovation processes also tend to follow profit-maximizing criteria. Thus, innovative businesses will not choose to innovate responsibly unless it is profitable. Using conventional economic tools, it was suggested that RI can generate positive external effects for society and that if these positive external effects do not generate additional revenues to offset higher cost of RI, the rational (profit-maximizing) innovator will not opt for RI.

An RI signal in the form of a label can allow for a reliable matching of responsible innovators and consumers with responsible preferences. This way, responsible consumers who are willing to pay a higher price for a product that is a result of RI can be sure that they get a product that suits their preferences, and RI-certified businesses can obtain a higher price rewarding their efforts. With the application of an RI label, the profit-maximizing aim of innovators and society's goal of maximizing welfare and quality of life are less or not likely to conflict. An RI label can directly influence the costs and benefits of companies, so it can also render the responsible innovators the profit-maximizing choice. The RI label proposed in this paper can successfully promote and spread the practical application

of RI on a broader scale in the business sector based on economic rationality complementing and strengthening current methods.

Calling attention to the economic aspect of the innovation process and choices associated with it, we aim to open new perspectives, discussion platforms, and research topics for RI scholars to facilitate RI uptake in the business sector. We call for new research to define the parameters of the certification of an effective RI signal and to scrutinize what mechanisms might be implemented and how resources and capabilities should be deployed to raise societal awareness of the benefits of RI.

Notes

1. Both quoted textbooks discuss the limitations of this assumption as well. Mas-Colell, Whinston, and Green (1995) writes that ‘whenever there is more than one owner [of a firm] [...] all owners would agree, *whatever their utility functions*, to instruct the manager of the firm to maximize profits’ (152–153., italics authors). Varian (2014) mentions that ‘It is difficult to assign a meaning to profit maximization when there is uncertainty present. However, in a world of uncertainty, maximizing stock market value still has meaning’ (366).
2. Value is a subjective term. Whenever we write ‘more valuable’ in this paper, we mean that the consumers who value innovation conducted in a responsible way find the output thus created more valuable. Other consumers might find these outputs even less valuable.
3. Another market imperfection is monopoly power. The effect of any type of less-than-perfect competition is of the same direction as the one we are going to explore here. Thus, imperfect competition would amplify and not dampen the effects we describe below.
4. They even like to add more complexity in an economic way, following the rule ‘increase complexity until the additional benefit exceeds the additional cost of doing so’. Increasing complexity generally makes the models more realistic at the cost of decreasing their predictive power.
5. The MU curve is often pictured as downward-sloping, representing the law of diminishing marginal utility. Allowing for this would not qualitatively change the predictions of the model we present here.
6. Here we looked at the competitive case. As mentioned above, imperfect competition itself results in underusage of resources and underproduction. Positive externalities coupled with market power thus results in an even heavier underusage of resources; the two types of market imperfections complement and amplify each other.
7. While we are aware that how important or valuable somebody considers the responsibility of an innovator can be a continuum, this simplification does not qualitatively change the results of our example.
8. In case of RI, screening would mean that the cost of identifying responsible innovators lies with the consumers. The main problem here is that this would be very costly to the consumers. The responsible aspect of the innovation process can even less be observed on the spot than the state of a used car or the abilities of a prospective employee.
9. Valuation is of course subjective, and the responsible product will only be more valuable to the consumers with responsible preferences. They will be willing to pay a higher price. The ordinary consumers will not, since they do not find this product more valuable, only more costly or expensive.
10. Jarmai, Tharani, and Nwafor (2020) show how some companies employ Corporate Social Responsibility (CSR) strategies without fulfilling any requirements for any indicators.

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Notes on contributors

Miklós Lukovics is an economist, he is an Associate Professor with habilitation at the University of Szeged (Hungary) Faculty of Economics and Business Administration. His main research fields are emerging technologies, responsible innovation, urban development. He has published 60 English and more than 100 Hungarian articles and book chapters in these fields.

Benedek Nagy is a theoretical economist, he is an Associate Professor with habilitation at the University of Szeged (Hungary), Faculty of Economics and Business Administration. His doctoral thesis was in the field of economics of intellectual property rights and especially patents, but in his research activities he tries to explore the economic aspect of phenomena like responsible behavior in innovation.

Zenlin Kwee is an Assistant Professor of Strategy and Innovation at the Faculty of Technology, Policy and Management in Delft University of Technology. Incorporating the interweaving of technology and society, her research interests and publications are in responsible innovation, blockchain and decentralized autonomous organizations, finance, economics and strategy.

Emad Yaghmaei is a Senior Researcher at Delft University of Technology and Managing Director of YAGHMA B.V.. His work covers governance of organisations and processes with focus on their ethical, social, and governmental impacts. He is specially interested in designing and developing necessary policies and methods for implementation, evaluation, and assessment of responsible innovation and non-financial values and risks within industrial context. His publications lie in the intersection of science, innovation, technology, and society. His current work takes the outset in UN Sustainable Development Goals (SDGs) and Responsible Research and Innovation (RRI) and its institutionalisation within stakeholders across innovation ecosystems.

ORCID

Miklós Lukovics  <http://orcid.org/0000-0003-1765-4660>

Benedek Nagy  <http://orcid.org/0000-0001-5472-0423>

Zenlin Kwee  <http://orcid.org/0000-0003-4146-033X>

Emad Yaghmaei  <http://orcid.org/0000-0003-4884-7801>

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