

## RESEARCH PAPER

### Can behavioural biases in choice under novelty explain innovation failures?

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*This paper proposes a new framework of 'behavioural innovation economics' as a synthesis of behavioural economics and innovation economics in the context of choice under novelty. The standard heuristics and biases framework of behavioural economics is applied to map and analyze systematic choice failures in the innovation process by distinguishing between choice under uncertainty and choice under novelty. Behavioural biases that affect choice under novelty are then elaborated. The paper then suggests 10 ways in which choice under novelty is behaviourally hard, rendering innovation subject to characteristic failure along these behavioural dimensions.*

#### Introduction

Since its emergence as a field of economic study in the 1960s, behavioural economics has transformed core fields of economic analysis: notably choice theory (Simon, 1955, 1978; Earl, 1990, 2005; Conlisk, 1996, Rabin, 1998; Thaler, 2000), the theory of the consumer (Earl, 1986), the behavioural theory of the firm (Cyert and March, 1963; Nelson and Winter, 1982; Dew *et al.*, 2008), the theory of investment (behavioural finance) (Shleifer, 1999), and even behavioural policy (Thaler and Sunstein, 2008). Boundedly rational entrepreneurs, managers, investors and consumers regularly populate models of the innovation process (Earl, 2003; Dosi *et al.*, 2005). It should therefore seem uncontentious to advance a *behavioural innovation economics* as an application of behavioural economics of 'heuristics and biases' in the context of innovation processes and systems, particularly that of innovation difficulties and failures (Vromen, 2001; Dopfer, 2004; Earl and Potts, 2004a; Shiller, 2005; Beckenbach and Daskalakis, 2008).

Several analytic principles are proposed here, along with a research programme to examine the behavioural causes of characteristic points of difficulty and failure in innovation. This is not a new idea; much innovation theory implicitly runs on behavioural economics assumptions. What is new is the endeavour to make this foundation explicit and to extract a systematic analytic framework to investigate how behavioural effects (i.e. heuristics and biases) affect innovation processes (i.e. choice under novelty). What does an analytic framework of behavioural innovation economics offer? First, by identifying the specific points of contact, clearer pathways for the

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import of ideas from neuroscience and cognitive, behavioural and social psychology are suggested for the study of innovation. Second, by identifying which agents are affected and how, a better understanding of behavioural effects at different phases of the innovation process may be obtained. Third, practical implications for innovation strategy and policy may result from a better understanding of how behavioural choice and action affects the innovation process.

The analytic foundation suggested here for behavioural innovation economics builds on a much overlooked but critically important distinction between choice under uncertainty and choice under novelty. For many analytic purposes, the behavioural approach is sufficiently defined by a context of imperfect information or uncertainty that results in bounded rationality, or the use of satisficing choice heuristics. But the innovation context is more demanding still, because while missing information or insufficient cognitive resources are certainly factors affecting choice, a further problem also exists in the context of novelty in knowing how to make a choice, or even whether to make a choice at all. Choice under novelty differs from choice under uncertainty because current decision rules may simply not apply. In choice under novelty, past framings of the choice context may not only be weakened by the missing information, but actually wrong or misleading. Genuine novelty invariably requires not just new decisions within extant frameworks, but new decision frameworks. This is a major reason why behavioural biases, which for the most part reassert past framings, can cause innovation failure.

In choice under novelty, new rules for choice need to be acquired, constructed, adapted or imagined. For choice under uncertainty, this is often unnecessary (Earl, 1999). Choice under uncertainty involves going deeper into an existing rule; for example, simpler versions of the choice heuristic that require less or different information, but it does not necessarily require developing new rules, as choice under novelty does. Uncertainty is a harder choice environment than risk because of missing information for choice (hence bounded rationality), but novelty is a harder choice environment than uncertainty because of missing rules for choice. Choice under novelty requires an entrepreneurial mindset to explore, imagine and adopt new choice frameworks in a way that choice under uncertainty does not. When these difficulties and behavioural traps are analytically organized, they offer a map of the research programme of behavioural innovation economics.

The next three sections address this analytic objective, arriving at three core biases that affect choice under novelty and the classes of innovation failure they cause. We then consider empirical innovation literature to map 10 preliminary dimensions of innovation difficulties and failures to the behavioural biases that may explain them. Conclusions follow.

### **Behavioural assumptions in innovation economics**

The efficient markets hypothesis, the logical extension of rational choice over perfectly competitive markets, holds a prominent place in economic theory. While the predictions of this theory have been severely tested of late, the underlying idea remains analytically useful in defining the various theoretical points of departure. A similar exercise can be performed for innovation economics to identify points of departure for behavioural innovation economics from an analogous 'efficient innovation hypothesis'. It is curiously difficult to state an explicit model of innovation in a perfectly rational and competitive context (see Dosi, 1988; Makowski and Ostroy,

2001; Boldrin and Levine, 2002), but allowing this thought experiment, consider the concept of an ‘efficient innovation hypothesis’ based on a ‘rational innovation theory’ under perfect competition. Obviously, it is incorrect to talk of perfectly competitive innovation because such novelty and innovation creates new markets (i.e. the first stage of novelty and innovation is by definition a monopoly, as Schumpeter explained). Still, the rational choice implications of an efficient innovation hypothesis can mark the main points of departure for a behavioural innovation economics.

The central implication is that an innovation would not be path dependent. It would not be a trajectory, but rather a choice situation where something that was once an imagined prospect or uncertainty (e.g. a new technology) became revealed simultaneously to all. If someone (it matters not who or where) arrives upon a new idea (about anything), the value of the novelty is immediately apparent to everyone, inducing a global ‘reaction’. Entrepreneurs would be an ‘operator mechanism’ in this model (see Metcalfe, 2004). All technologies and preferences are immediately updated. All firms reconfigure production, shifting demand for inputs and supply of output. Consumers make a similar calculation, reconfiguring their demands. There is no coordination problem. And because information and transaction costs are presumed to be nil, there is no change to the structure of competition itself as the novelty is integrated into the economic order.

Observe what does not occur in the efficient innovation hypothesis. Agents do not overlook ideas, or suffer from being unaware of new ideas, nor do they misconstrue new ideas. They see and understand each new idea *in toto* and without bias. Agents suffer no ambiguity about the value or opportunities of an idea, the connections it makes, or the competitive threats it poses. They respond strategically, promptly and efficiently. In the efficient innovation hypothesis, all agents know what to do next, suffering no barriers to action. Individual agents may or may not choose to adopt the new idea because of their current endowments, preferences and opportunity costs. Yet even when the choice is complicated, it is never complex. Mistakes will not occur, regret will not be experienced, and expected utility will be an unbiased estimate of actual utility. In the efficient innovation hypothesis, even the smallest amount of new true information ultimately prevails and thus all behavioural effects are transitory.

Behavioural innovation economics turns away from the efficient innovation hypothesis by seeking to account for departures from ‘perfect innovation’ in terms of characteristic failures associated with choice and knowledge that do leave lasting structural affects (see Loewenstein, 1990; Dopfer, 2004). To unpack this, we must distinguish between rational and behavioural choice over novelty.

### **Choice under novelty**

Human choice (cf. *homo oeconomicus*) does not optimize but satisfices using rules for choice, or decision heuristics. Such behavioural choice is widely studied in the context of characteristic heuristics and biases that arise from evolved human instincts (Findlay and Lumsden, 1988; Dissanayake, 1992; Cosmides and Tooby, 1994; Pinker, 1997), as well as from the situational, social, cultural and contextual framing of events. Behavioural economics is the study of systematic departures from theoretically optimal choice outcomes caused by behavioural heuristics and biases (see Earl, 1990, 2005). Behavioural innovation economics is the study of these systematic failures in the specific context of choice under novelty. This requires us to distinguish between behavioural choice in: (1) a known environment; (2) uncertainty; and (3) novelty.

Rational choice is possible in a known environment. But the behavioural model still holds because of the cognitive costs of finding and processing information. Agents will economize on information by relying on ‘rules of thumb’ or choice heuristics that satisfice. They can still make systematic mistakes if information is wrongly framed, inducing application of the wrong choice heuristic; or if the right heuristic is applied on the wrong subset of information; or if a simple heuristic is applied to a complex situation, and so on (Kahneman *et al.*, 1991; Gilovich *et al.*, 2002). Behavioural choice theory emphasizes that even in a known decision environment, scarcities of time and attention will still induce agents to use choice heuristics that result in systematic mistakes with characteristic biases (Brocas and Carrillo, 2008).

But with choice over uncertainty, a rational choice suffers a critical information deficit. This may be due to unknowable actions of others, uncertain payoffs, or the uncertain space of possible events (Shackle, 1972). Rational choice under uncertainty is defined as an unbiased choice given preferences over a distributional outcome. In theory, mistakes will happen, but they will not be systematic. Yet common empirical biases, such as loss or risk aversion and myopia, do lead to choices with systematic error (Kahneman and Tversky, 1979; Kahneman *et al.*, 1997). Uncertainty is a universal feature of the innovation context, so these factors will also be manifest (Cohen and Levinthal, 1989). Attention and thinking are scarce resources, thus sub-optimal choice under uncertainty may simply reflect a higher-level choice about the costs of addressing such concerns. If so, behavioural choice outcomes under uncertainty should converge on rational choice outcomes under competitive selection. Yet this is not necessarily so with choice under novelty.

Novelty does not refer to new information where uncertainty may be reduced by this information, but rather to a new idea, new knowledge, or a new connection (see Potts, 2000; Earl and Wakeley, 2010). Several paths explore this domain. Evolutionary and Austrian economists, such as Schumpeter, Mises, Shackle, Kirzner, Bianchi and Witt, all examine the interaction among novelty, discovery, choice and action (see Bianchi, 1990). There exists a sizable literature on learning and adaptation in the choice context of novelty (Gigerinzer, 2000). This examines the experimental and creative process and how the value of novelty is ascertained (Winter, 1971; Dosi *et al.*, 2005; Becker *et al.*, 2006; Nelson, 2008). Choice under novelty differs from choice under uncertainty because in the initial instance there is no information, only awareness of something new that might be consequential. Thus choice under novelty requires a process of discovery and learning to elicit information. Experimental play, for example, is a common approach (Hermann-Pillath, 1994; Thomke, 2003; Dodgson *et al.*, 2005). Another is use of induction and deduction in combination with analogical reasoning (see Popper, 1972; Magee, 2005). These creative responses, probes, experimental conjectures and tests are commonly coupled with observation of others’ responses, possibly adopting their preferences or choices (Offerman and Sonnemans, 1998; Earl and Potts, 2004b; Potts *et al.*, 2008). These various strategies decompose the novelty into something familiar to connect it to current choice rules and understandings. Unlike choice under uncertainty that can occur within known options (because of satisficing), choice under novelty by definition involves contemplation of novel options and the unknown consequences of new ideas, and thus the necessity of new rules for choice. Choice under novelty requires choice about whether to make a choice at all, such as whether to engage in experimental learning or to commit to the uncertainty of a new path (Kay, 1979).

### Three specific biases affecting choice under novelty

The set of cognitive biases affecting choice is sizable (*Wikipedia*, for example, lists over 100) and is subject to ongoing revisions and additions; yet we may isolate a subset of particular salience to economic choice, as in Table 1 below (Gilovich *et al.*, 2002). Rather than addressing these individually, it will be instructive to focus on a superset of three that have been extensively studied in economics and plainly affect choice under novelty: namely, inertia, loss and risk aversion, and myopia (see Potts and Morrison, 2008).

Inertia covers the various heuristics and biases that affect a reluctance to change. These are manifest in *status quo* biases – preferring the current situation (however arbitrary or dysfunctional) and imposing high standards of proof on the benefits of change. This can be caused by sunk cost effects, where decisions erroneously factor the cost of choices already made. Inertia is also caused by strategic and organizational conservatism bias, where firms maintain existing strategies, business models and resource configurations in the face of evidence that sources of competitive advantage in their markets have changed. Incumbents may fail to notice disruptive innovations from new market entrants. Similar effects occur on the consumer side when novel consumption possibilities are not noticed due to the inertia of a broader consumption system and the perceived costs of changing the *status quo* (Earl, 1986). Systematic overestimation of costs of change and underestimation of benefits is a common bias that leaves consumers reluctant to try new products or services, and firms reluctant to invest in new markets or technologies. Inertia creates and reinforces path dependence that inhibits structural improvements.

Risk and loss aversion are a common aspect of human and organizational behaviour (Paquet, 1998). Excessive risk aversion means choices over uncertain outcomes are biased toward certainty. Loss aversion means equivalent losses and gains are experienced asymmetrically with losses overvalued. Risk and loss aversion combine to make the rational benefits and strategic advantages of adopting, for example, ‘open innovation’ processes difficult because of instinctive framing of such in terms of down-side risks rather than up-side benefits. Risk and loss aversion also affect consumer and user adoption of novelty, impeding the adoption of new products and services (Gourville, 2005).

**Table 1.** Common heuristics and biases affecting economic choice

Bias	Definition
Risk aversion	Choice over uncertain outcomes is biased toward certainty
Loss aversion	Equivalent losses and gains are experienced unequally
Myopia/hyperbolic discounting	Overweight the near future and underweight the distant future
<i>Status quo</i> bias	Overly strong preferences for current states
Sunk cost effects	Treating sunk costs as significant
Endowment effects	Overvaluing assets you have, undervaluing assets you do not have
Availability biases	Treating recent or high-profile information as excessively salient
Framing biases	Organizing information on inappropriate templates
Optimism bias	Systematic overestimation of one’s own abilities
Confirmation bias	Tendency to ignore evidence not supporting existing hypotheses

Myopia tends to overweight the near future and underweight the distant future (Frederick *et al.*, 2002). Myopia interacts with endowment effects and availability biases, making it difficult to conceive and value future outcomes that depart, as they will with novelty, from the current context of assets, strategies, competencies and markets. Myopic bias tends to overvalue tactics and undervalue strategy. Myopic bias thus has inhibitory effects in developing the connections, partnerships and capabilities to create new knowledge and economic possibilities (Earl and Wakeley, 2007). This can induce reluctance to enter into, for example, knowledge sharing networks, or to adopt new business models that may take time to adapt and perfect. On the consumer side, myopic biases inhibit adoption of new products and services or new ways of consuming that may take time for benefits to accrue.

### **Ten reasons why innovation can fail because choice under novelty is behaviourally hard**

Mapping innovation difficulties onto behavioural heuristics and biases enables us to outline the dimensions of a behavioural innovation economics research programme. Drawing on empirical literature in innovation studies, R&D management and evolutionary economics, we may assemble a rudimentary catalogue of ways in which choice under novelty (the analytic context of innovation) is naturally difficult for *homo sapiens* although not for *homo economicus*. Choices and actions that are behaviourally hard – even after accounting for technological, organizational and institutional prostheses – suggest salient characteristic points of behavioural failure in the innovation process and system. Mapping these points and examining their mechanisms thus offers a research programme for behavioural innovation economics.

#### **1. Awareness of novelty is hard**

Novelty may be ubiquitous, but it is not always noticed at the threshold of conscious attention (Lanham, 2006). The human brain has evolved to develop to maturity through a process of adaptively learning to subconsciously filter most novelty. In a stable knowledge environment where few new things occur, this cognitive instinct is an effective adaptation. Only children are really good at noticing novelty (Konner, 2010). This is not because they are naturally more creative and open, but because they have not yet fully developed filters to block out the incessant noise of low-value novelty. Human perceptual and cognitive apparatus involve significant filtering mechanisms (Hekeeren *et al.*, 2004), yet in the adult brain this often works too well, causing novelty to be overlooked. Noticing novelty requires cognitive effort (Schweizer, 2006). The human mind is not adapted to a world of rapid and continual change; it requires effort to notice and register their actual pace and effect. In a modern economy, this is difficult to achieve in more than a few specialized domains.

Novelty is often easier to notice when it has a relatively small cognitive distance from something familiar (Wuyts *et al.*, 2005). Larger distances require greater effort because the agent will have only limited appreciation heuristics, the effect of filters will be stronger, or cognitive dissonance effects will reject discordant information (Earl, 2010). Radical novelty can thus often hide in plain sight, leading to the familiar notion in innovation studies of firms being ‘blind-sided’ by what Christensen (1997) called ‘disruptive innovations’.

Systematic underestimation of change in a technological, market or socio-cultural environment is for evolved behavioural bias reasons a common experience in a market economy. This can constrain the development of novel ideas into innovations by failure even to recognize the novelty proposed. Such failure to notice novelty leads to poor strategic response, such as when businesses fail to notice the extent of the new idea or under-estimate the competitive threat, leading to an inappropriately low innovative response. Failure of awareness of novelty, due to evolved cognitive filtering adaptations, is the first station of a behavioural innovation economics research programme.

## **2. *Knowing how novelty affects you is hard***

Even when noticed, a new idea may fail to be appropriately assessed and prioritized for action. Some new ideas are *sui generis*, category creating or change the extant categories or mental models used to partition markets, niches or technologies. Such category dynamics leads to competition blindness through failure to see how a novel idea changes the substitution possibilities of producers or consumers, or how the new connections that the novel idea makes affect which market a firm is actually in (Witt, 2000; Nooteboom, 2000). This can cause poor strategic response; not because novelty went unrecognized, but from failure to appreciate its consequences. The rational firm will anticipate such possibilities by developing external connections with multiple sources of knowledge (Damanpour, 1991); yet this mechanism can easily fall to the confirmation bias, where like-minded competitors reinforce each other's filtering of the novelty as inconsequential, or frame a response in which a political fight through lobbying is viewed as superior from a *status quo* perspective to a competitive fight through innovation.

Cognizance of effect may be revealed only through market selection as consumers adopt the novel idea and substitute away from extant goods and services, revealing which specific markets are affected (Metcalf, 1998). Businesses may fail to recognize this in real time. If so, a strategic response will require catch-up through imitation or withdrawal from market segments. This will cause lasting first-mover advantage. Market selection dynamics involving considerable Schumpeterian creative destruction may possibly be required to resolve this behavioural bias, but only after significant path dependency has resulted. The behavioural mechanism by which novelty affects an agent – endogenously by dynamic recognition (awareness of consequence) or exogenously by dynamic implication (market selection) – thus suggests a further dimension of behavioural innovation economics.

## **3. *Selecting among new ideas is hard***

The innovation process within a firm typically has three stages: (1) search for opportunities; (2) refinement of ideas for selection; and (3) development and exploitation (Koen *et al.*, 2001). Of these three stages, selection is widely reported to be the most difficult (Kay, 1979). It is also here that behavioural heuristics and biases loom largest. The search phase (phase 1) can be contingent and open to fortuitous connections and environmental circumstances: indeed, the standard economic model of optimal search is the treasure hunt (Weitzman, 1979; see also Schweizer, 2006). The exploitation phase (phase 3) often runs on standardized operating procedures, and so can be managed (Burns and Stalker, 1961; Nelson and Winter, 1982). Selection is often the most difficult phase because choice about the adoption of a new idea or between

multiple new ideas can never be an entirely deductive procedure. Selection requires inference and analogical reasoning. It is here that choice over novelty runs into a raft of behavioural biases, including loss aversion, sunk cost effects and availability or representativeness biases that constrain innovation (Magee, 2005; see also Starbuck, 1983; Van Pelt, 2008). Consumers also experience this effect when seeking new consumption possibilities.

Furthermore, selection within an organization invariably requires champions: some person or coalition must support and promote an idea for it to succeed (Howell and Sheab, 2003; Howell and Boies, 2004). New ideas compete most not with other new ideas but with extant organizational priorities. Thus champions matter; yet selection then becomes functionally dependent upon who that is and why. Strategic selection of ideas may occur for reasons less to do with the idea *per se* and more with the persons championing it. This bias forms a basic category error: selection among new ideas is hard, whereas selection among people championing new ideas is often behaviourally easier. Behavioural mechanisms engaged in selecting people function *de facto* to select new ideas. Compared with the vast literatures on optimal selection of personnel or of new ideas in organizations, there is little research on the co-selection of individual champions as proxies for new ideas, suggesting a further research dimension for behavioural innovation economics.

#### **4. *Open innovation and learning from outsiders is hard***

Kin selection models in evolutionary biology emphasize that human nature operates with instinctive atavistic distinctions between insiders and outsiders of a social group (Bergstrom, 1996). Firms and organizations harness this mechanism in lowered transaction costs of coordination, and in lowered barriers to sharing information and ideas. Novel ideas occurring within a group are often treated differently from novel ideas issuing from outside the group. This asymmetry tends to overvalue endogenous novelty and undervalue or discount exogenous novelty. This bias is homologous to the endowment effect, where people overvalue assets they already have and undervalue assets they do not (Kahneman *et al.*, 1990).

Eliciting cooperation in experimenting with new ideas and sharing knowledge is easier within an organization and more difficult across such organizational boundaries with outsiders. This explains why participating in 'knowledge networks' is often difficult and challenging. It is why 'open innovation' can seem unnatural (cf. Chesbrough, 2003). Learning new ideas from others is easier when they are inside a social organization or network, but more difficult when it requires cooperation with outsiders. History teaches that human civilization progresses by ever expanding domains of cooperation with strangers (Seabright, 2005); but behavioural psychology teaches that new ideas from outsiders commonly trigger atavistic instincts that raise barriers to adoption and require sometimes significant mental effort to overcome. This effort is not always made, potentially inducing behavioural innovation failure. Behavioural barriers to 'open innovation' thus suggest a further research line for behavioural innovation economics.

#### **5. *Being rational about innovation is hard***

Rational choice over novelty should extend only to objective desiderata. The problem is that it often continues to subjective dimensions of, for example, identity and social



leadership. Choice under novelty may turn on the person or organization making the choice over substantive aspects of the new idea (Potts *et al.*, 2008). Attitudes to new ideas are key personality and identity markers, thus overlaying social identity effects that are often difficult to decompose (Akerlof and Kranton, 2000). New ideas also present opportunities for displays or signalling of leadership, dominance, submission or cooperation, all of which have values and functions far removed from the rational undertaking of innovation (Sarasthathy, 2008). In essence, choice over novelty has social strategic signalling aspects that can override or distort objective criteria for choice under novelty.

Innovation is a social process. By definition, a new idea becomes an innovation only when systematically adopted by others. This will involve adaptation and reconstruction of identities of participants, affording many opportunities for social learning, discovery and leadership (Hermann-Pillath, 2008). The psychological depth of affect in choice over novelty means that socially constructed behavioural factors will influence choice under novelty. This may further explain why largely ceremonial factors (for example, those that create or reinforce an illusion of control) are common in innovation processes. One example is revenue forecasts made in the context of 'start-up pitches'. These have been shown to be no better than random, but they do function as a ritualistic signal of willingness to cooperate (see Douglas and Shepherd, 2002). Innovation failure may thus occur for reasons less to do with objective considerations of the novel idea than with improper observance of the socio-cultural norms associated with introducing novelty.

### **6. *Incentivizing novelty creation is hard***

Encouraging the creation and development of new ideas in organizations is difficult. The market institution is an effective innovation incentive mechanism operating *on* organizations, yet *within* organizations incentives can be difficult to create and maintain. The behavioural theory of the firm is of institutionally organized habits and routines into which employees slot by adopting and normalizing prevailing local habits and procedures (Cyert and March, 1963; Nelson and Winter, 1982). The capabilities of an employee will thus depend on their adoption and effective execution of these routines. This militates against deviation and introducing new ideas (Raines and Leathers, 2000). Thus an innovating firm will need to create exceptions to this organizationally normalizing behavioural force.

Yet even when formally sanctioned, exceptions may remain behaviourally unpalatable. The high levels of anxiety experienced when behaviours differ significantly from those of the 'tribe' are well documented in social psychology. The power of this conformity bias makes it difficult to stimulate innovative thinking because the incentive must compensate for the risk of social rejection (Milgram, 1974). Incentives to innovation must not only cover the opportunity cost of new actions, but also overcome risk aversion and loss aversion over multiple dimensions, including compensating for sunk cost effects of investment in reputation as a 'team player'. Yet even when income and material risks are carried by the organization or financiers, there still remains the prospect of loss in status, loss of identity or loss of other people's trust and confidence if a new idea that is observably championed subsequently fails. This bias also works on the consumer side in terms of peer group references and the risks of novel consumption (Earl, 1986).

### **7. Thinking about innovation portfolios is hard**

Another difference between rational and behavioural choice under novelty accrues to the value of ‘portfolio thinking’ and the difficulties the human mind experiences in conceptualizing novelty other than in isolation. This is a prime behavioural effect in innovation in which humans find it hard to think of innovation as a parallel flow and instinctively constrain mental models to sequences of isolated events. The human mind can easily conceive how one novelty leads to another, as in the construction of a story (Boyd, 2009), but finds it harder to conceive many novelties simultaneously, as is the market context of most competitive reality.

It is difficult to think about novelty and innovation from a portfolio perspective (Barnes, 1984). It is more natural to think about a new idea as a particular consequence. This may be explained by an asymmetry between evolutionary and economic rationality (Bianchi, 1990; Arthur, 1994; Smith, 2005). Portfolio approaches to risk are economically rational because the sum of a bundle of uncorrelated risks has lower variance than each. They partially cancel out, lowering down-side variance. Serial entrepreneurship is thus an effective strategy, as is the gathering of multiple innovation directions under one organization (Florice and Ibanescu, 2008). Many new ideas pursued simultaneously can potentially be a lower long-term risk strategy than a single new idea pursued intensively if these many ideas are uncorrelated. Human minds, however, evolved under conditions of social payoff to being right about risks one at a time. This draws upon instinctive capabilities to lead a journey, to organize a project, to champion an idea, to become a hero, and so on, all under sexual selection pressure (Miller, 2001). Single ideas or projects thus seem a natural unit for choice under novelty; but strictly speaking they are not. They are a behavioural bias.

Portfolio thinking is different. Innovation projects are led, but portfolios are managed. Portfolios are about being statistically right, not dramatically right. Portfolios are rational, but not instinctive. It is difficult enough to deal with one novelty at a time, let alone a portfolio of novelties because of the cost of developing new rules of choice in each case; yet the contrast with choice under uncertainty is stark, as these are often effortlessly bundled into contexts executed with a single behavioural routine.

*Portfolio aversion* (to coin a bias) may thus explain why innovation capabilities are often hard to develop in an organization unless explicitly connected to particular projects that might be heroically led in a socially observable way. This makes them subject to subsequent confirmation and overconfidence biases (Lovello and Camerer, 1999; Brocas and Carrillo, 2004). General purpose innovation resources and capabilities will thus be expected to arise in organizations already organized about a portfolio-based business model. This behavioural bias should have a disproportionate effect on the innovation efficacy of smaller businesses (with smaller portfolios of innovation), suggesting a further dimension of behavioural innovation economics.

### **8. Investing in innovation is hard**

A stylized fact of innovation studies is that investing in innovation is hard. People and firms systematically under-invest in developing innovation competences, capabilities, projects and portfolios. Further, when investment does occur, there is a marked tendency to underestimate the complexities and difficulties of projects with significant novelty (Flybjerg *et al.*, 2009). Optimism bias can cause difficulties to be overlooked and expected positive outcomes to be overweighted. Models of how the new idea may change things may be constructed from false similarities to past innovations. Risk and

loss aversion further inhibit investment in innovation, as does myopia (Kahneman *et al.*, 1997; Rabin and Thaler, 2001).

Investing in innovation also requires persuading others to cooperate (Tether, 2002). This can fail when others do not see the value of the innovation, or when inertia and *status quo* biases are strong and difficult to displace. The experimental costs of the innovation may loom large, while the potential gains may be perceived as distant or difficult to quantify. Loss aversion and hyperbolic discounting may reinforce diminishing individual willingness to invest in experimental endeavours, thus unravelling cooperation and commitment. In network, collaborative or open innovation projects, failure to secure early cooperation can mean failure of sufficient buy-in of organizational resources or support for experimental phases of development in getting to market. Innovation teams are often hard to assemble because support and cooperation require commitment, but the prospect of commitment highlights the implications of loss in closing other possible uses of the commissioned resources and capabilities. The opportunity cost of these real options is often difficult to evaluate, especially when others have not signalled commitment. Risk aversion may thus manifest itself as ‘early cooperation aversion’ (to coin another bias) in the emergence of coalitions about novelty. Investing in innovation is hard because it requires cooperation, suggesting a further research dimension of behavioural innovation economics.

### **9. *Creating space for innovation is hard***

Successful innovation requires an appropriate space for experimentation. This may be a physical space with suitable resources (i.e. a ‘skunkworks’), or an institutional space such as a market (Potts, 2001), but an equally important innovation space is mental. Creating a mental space to experiment with novelty may disconnect from past decisions and knowledge, which is behaviourally hard. Endowment effects and sunk cost biases affect evaluation of novelty through past knowledge, contractual positions or asset holdings. It is hard to create an objective physical and mental space where only information pertaining to the new idea is relevant.

A common behavioural bias is the tendency to form mental accounts, violating the rational principle of fungibility (see Kahneman and Tversky, 2000), yet experiments with novelty often explicitly require a separate mental account and possibly a separate material and organizational account with greater tolerance of failure and heightened attention to feedback. Failure to create and isolate such an account can result in the application of inappropriate innovation behaviour, suggesting a further dimension of behavioural innovation economics research.

### **10. *Coping with innovation failure is hard***

A robust finding in the innovation literature is that failure is hard and actively avoided. This violates a rational (Popperian) model of the growth of knowledge, where failure of a hypothesis test works to eliminate error systematically. The problem is that this mechanism runs against the grain of human behaviour, which instinctively tends toward confirmation bias and loss aversion. Innovation failure is commonly over-weighted. New ideas require experimental learning to ascertain their value and reveal the opportunities they harbour. Experimental learning (i.e. the scientific method) by definition involves the prospect of failure (Potts, 2009). Failure provides crucial information by revealing what does not work, thus creating knowledge to eliminate error.

Human behaviour is often construed as if people were acting as scientists, continually engaged in conjecture and refutation (Kelly, 1963), yet it is easier to think of new ideas as conjectures than to test them. It is harder still to recognize and absorb the implications of failure resulting from such tests.

This leads to two related behavioural failures in the context of experimental learning: (1) failure to recognize failure when it occurs (ignoring it or reconstructing narratives, e.g. cognitive dissonance); and (2) failure to learn from failure, by not absorbing feedback and reconstructing conjectures with new information. Failure has value only when it supplies feedback for further learning. This extends to social learning and the common focus on the success stories of others, ignoring the learning opportunities associated with failure that such stories otherwise provide. Still, models of 'fast failure' from market feedback are difficult to learn. Holding on too long before product release (fear of realizing failure), or staying too long in a declining market (fear of admitting failure) are behavioural biases that slow the innovation process (Lovello *et al.*, 2008). The impacts of risk and loss aversion are thus conditioned by a firm's dynamic status. A small start-up with an aggressive growth strategy will likely perceive loss in not building networks or experimenting with new technologies and markets, but a small company in a protected or mature market might perceive the opposite, seeing the risks of innovation as considerable. Thus how behavioural biases affect an organization will depend upon both the size of an organization and its growth profile, suggesting yet another dimension of research for behavioural innovation economics.

## Conclusion

The hypothesis of this paper is that behavioural biases cause characteristic forms of innovation failure. The study of these biases and their effect on innovation processes is thus suggested as the subject domain of a behavioural innovation economics. These can be analytically gathered as problems of *choice under novelty* in the form of a research programme for a behavioural innovation economics (Table 2 overleaf).

With choice under novelty, systematic behavioural error is expected to be prevalent and consequential. Behavioural failures in maladaptive heuristics and characteristic biases cause the innovation process to undershoot the efficient innovation hypothesis model of optimized behaviours over new ideas. Innovation failure may occur for reasons extending beyond standard technology failure, market failure, management failure, or even policy failure arguments, but through a further class of behavioural innovation failure. If so, innovation systems analysis can re-gather under the various behavioural biases that make choice under novelty fraught with behavioural traps. The positive research programme of a behavioural innovation economics thus seeks to map the difficulties in innovation to the behavioural biases that might explain them as a construction of mechanisms that affect choice under novelty. Normative applications would then follow, as in the 'nudge' framework of Thaler and Sunstein (2008).

Moreover, a behavioural innovation economics need not be exclusively economic. It may similarly apply to cultural and socio-political evolutionary dynamics also shaped by human choices under novelty. A generalized behavioural innovation economics research programme thus recognizes that behavioural heuristics and biases affecting innovation apply wherever individual choice under novelty manifests itself as the social coordination problem of new ideas.

**Table 2.** Ten ways that choice under novelty is hard, leading to innovation failure

Dimension of difficulty	Mechanism	Example
Awareness of novelty	Human brain routinely filters novelty	Novelty with a smaller 'cognitive distance' is easier to notice
How novelty affects you	Some ideas <i>sui generis</i> : no existing routines process them	Novelty that creates new categories is hard to process
Selecting new ideas	Selection over novelty difficult to allocate	Criteria to select people <i>de facto</i> mechanism for selecting new ideas
Open innovation	Overvalue endogenous and undervaluing exogenous novelty	'Not invented here' ideas routinely overlooked
Rational innovation	Identity constructs displace rational choice	Personal, social, political factors enter into choice over novelty
Incentivizing innovation	<i>Status quo</i> bias, conformity bias, loss aversion	Behaviour over novelty must overcome costs to any action at all
Innovation portfolios	Portfolios not a natural cognitive category	Difficulty thinking about multiple novelties simultaneously
Investing in innovation	Myopia, imagination failures	Underinvestment in new ideas & undervaluation of cooperation
Space for innovation	Mental accounts	Tendency to infect novelty with extant context
Innovation failure	Accounting for experimental failure	Failure difficult to rationalize, causing avoidance of experiments

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