Toward behavioural innovation economics – Heuristics and biases in choice under novelty

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Abstract

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ABSTRACT. A framework for 'behavioural innovation economics' is proposed here as a synthesis of behavioural economics and innovation economics in the specific context of *choice under novelty*. We seek to apply the heuristics and biases framework of behavioural economics to the study of the innovation process in order to map and analyze systematic choice failures in the innovation process. We elaborate the distinction between choice under uncertainty and choice under novelty, as well as drawing out the 'efficient innovation hypothesis' implicit in most behavioural models of innovation. The subject domain of a research program for behavioural innovation economics is then briefly outlined in terms of a catalogue of characteristic ways in which choice under novelty renders innovation processes subject to failure.

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1 INTRODUCTION

Innovation studies have long drawn on behavioural economics foundations to model the innovation process by representing the implicit choice context in terms of *bounded rationality* and adaptive *decision heuristics* (Simon 1955; Loasby 1976). Boundedly rational entrepreneurs, managers, investors and consumers regularly populate models of the innovation process (Dosi 1988; Earl 1990; Dosi *et al* 2005). The behavioural theory of the firm (Cyert and March 1963; Nelson and Winter 1982; Kay 1984) occupies a central role in innovation studies by representing firms as carriers of knowledge – through the habits and routines that compose the firm's competences and capabilities, including abilities to originate, adopt and retain new ideas. Behavioural theories of entrepreneurs and consumers emphasise bounded rationality and the effect of choice heuristics and satisficing behaviour in shaping the process of novelty creation and the adoption of new ideas (Earl 1986, 2003). To a considerable extent, the study of the innovation process is built upon behavioural economics foundations.

Somewhat surprisingly, however, this has never been constructed from first principles as a distinct sub-field: i.e. as *behavioural innovation economics*. Instead, the study of innovation has drawn variously on aspects of behavioural economics, innovation economics, economics of entrepreneurship, economics of learning and adaptation, economics of information and technology, evolutionary economics, resource based theories of the firm, economics of strategy, economics of endogenous preferences and learning consumers, and so on. The result is a rich and complex analytic tapestry of the mechanisms and processes involved in the innovation process, all of which are shot-through with behavioural economic assumptions, insights and methods. So much so, in fact, that it is difficult to untangle the specific behavioural economics content of a general analysis of the innovation process.

Analysis of complex hybrid processes often requires complex hybrid theory, and innovation processes are certainly complex and hybrid. Yet three broad reasons suggest value in seeking to elucidate the *general role* of *specific behavioural assumptions* in analysis of the innovation process. First, this provides clear pathways for the importation of ideas from neuroscience, cognitive science, cognitive and behavioural psychology, and other experimental and theoretical domains of the study of human behaviour. Second, this may help to integrate the study of innovation with respect to overarching behavioural principles and analysis, enabling better understanding of behavioural effects at different parts of the innovation process and how they relate and interconnect. Characteristic behavioural signatures may thus be extracted from many different contexts toward a more general behavioural theory of innovation. Third, by seeking to generalise the behavioural context of innovation, clearer and more consistent normative implications may be drawn with respect to characteristic *failures* due to behavioural effects (Beckenbach and Daskalakis 2008). These may then be systematically developed with respect to innovation management, strategy and policy.

The field of *behavioural economics* emerged from the early work of Herbert Simon (1955, 1978), who introduced the notion of *bounded rationality* at the intersection of cognitive psychology and the economics of choice (Earl 1990, 2005; Conlisk 1996; Rabin 1998; Thaler 2000). The central idea in behavioural economics is that bounded rationality – which arises due to the cost of thinking – implies the use of *satisficing* choice heuristics. These sometimes approximate a rational choice (in which thinking is 'free' or without cost), but nevertheless often fail in characteristic ways. Behavioural economics is thus the study of the implications of bounded rationality. The field of behavioural economics has since developed in many directions – of consumer choice, of strategic choice, of the firm, of finance, of macroeconomics, and other domains. But it has principally focused about the mapping and analysis (both experimental and theoretical) of the various heuristic biases, anomalies and systematic errors, and relations between choice and knowledge as associated with the behavioural choice and social psychology characteristics of *Homo Sapiens* decision-making in contrast with the standard model of 'rational economic man' or *Homo Oeconomicus*.[1]

[1] The focus on anomalies and systematic biases (following the work of Kahnaman and Tversky) is arguably the 'mainstream' of modern behavioural economics. However, this is not the original or ongoing 'heterodox' interpretation of behavioural economics (following Herbert Simon), which emphasises the normality of all choice and action as 'behavioural' in the use of choice heuristics or 'rules' (Earl 2005; Earl and Potts 2004b; Dopfer 2004; Dopfer and Potts 2008). This paper attempts to re-connect both views in representing all choice under novelty as 'behavioural' in the use of rules, but also allowing that there are characteristic and systematic 'failures' involved.

This paper seeks to extract the particular content of behavioural economics that relates exclusively to the innovation process.[2] The innovation process has many dimensions as it unfolds though the actions of entrepreneurs, firms and consumers in the context of organization, markets, industries and institutions (Rogers 1995, Freeman and Soete 1997, Dopfer and Potts 2008). Furthermore, the economics of innovation extends well beyond behavioural considerations to include studies of entrepreneurship, organizations, strategy, technology, institutions and culture – all broadly within the domain of Schumpeterian/evolutionary economics (Metcalfe 1998, Loasby 1999). However, we seek to extract from this multi-faceted domain only the behavioural dimensions of choice. Thus *behavioural innovation economics* refers to the overlapping domains of both behavioural economics *and* innovation economics. This is centred about the behavioural heuristics and biases that affect choice in the context of the origination, adoption and retention of new ideas: that is, with respect to *choice under novelty*.

Behavioural innovation economics concerns analysis of the behavioural choice aspects of innovation in the context of systematic heuristics and biases that affect choice under novelty, which is the defining choice characteristic of the innovation process. We begin by distinguishing between *rational choice* and *behavioural choice* models in: (1) a known world; (2) a knowable, but complex world; and (3) a world in which there are new ideas. This third distinction forms the basis of behavioural innovation economics, a position that will be constructed in sections two and three. Section four then seeks to outline the main content of a heuristics and biases framework of choice under novelty. Section five discusses how a behavioural innovation economics might proceed empirically and theoretically, and to what application.

2 THE EFFICIENT INNOVATION HYPOTHESIS

The framework we shall present here seeks to represent the logic of a world in which behavioural choice heuristics and biases systematically affect the innovation process. Hence, it is important to clearly state the null case in which these have no affect whatsoever. The broad heterodox and evolutionary economic literatures are replete with stylized characterizations of rational choice and perfect competition models in terms of the myriad ways in which they depart from 'the real world'. A standard critique is that in perfectly competitive rational choice models, novelty, innovation, entrepreneurship and open systems are all ill-defined exogenous considerations (Loasby 1999, Potts 2000). In turn, innovation theory tends to depart immediately into an analytic world of bounded rationality, imperfect competition, costly information, complex learning, distributed knowledge, and organizational, technical and institutional dynamics.

Yet, in drawing such behavioural, evolutionary and institutional models into the fray, it routinely passes without comment that *ipso facto* there must logically exist some prior analytic notion of innovation under conditions of perfect rationality, perfect information, perfect markets, etc, from which the behavioural, evolutionary and institutional models then depart. Yet despite some effort, we have struggled to identify a single clear characterization of what innovation would specifically mean in such a context.[3] Thus it seems that a useful starting point is to first clearly state the otherwise implicit notion of

[2] Innovation is defined as the origination, adoption and retention of a novel idea into an economic system (Dopfer and Potts 2008).
[3] Although see Dosi (1988); Makowski and Ostroy (2001); Boldrin and Levine (2002); Mahdi (2003).

'*rational innovation theory*' or the '*efficient innovation hypothesis*'[4] that, by definition, must lurk behind any behavioural innovation theory departure.

Rational innovation theory (RIT) and the efficient innovation hypothesis (EIT) would imply that innovation occurs not as an unfolding experimental *process* or *trajectory*, but, rather, instantaneously upon receipt of a new idea *anywhere* into the economic system. In essence, someone (it doesn't matter who or where) stumbles upon a new idea (about anything), of which its value (however large or small) is immediately apparent to everyone. This then induces a global action. All technologies and preferences are immediately updated. A round of substitution then occurs as all firms reconfigure their production, shifting their demand for inputs and supply of output. Consumers make a simular calculation based on these new demands and supplies, thus reconfiguring their demand for outputs and supply of inputs. The matrix of all inputs, outputs and prices will change to reflect the new general equilibrium of the post-innovation world as a consequence of the new idea. Furthermore, it is assumed that information costs and transaction costs are zero, and that there is no change to the structure of competition itself. No new firms or markets are required and no existing firms or markets are destroyed as the new idea seamlessly and effortlessly integrates into the economic order.

While this model emphasises the familiar general equilibrium dimension of markets, quantities and prices, it is important to also extract the particular behavioural actions that are assumed to occur in the context of a 'perfect innovation'. The transmission of the idea is assumed immediate and costless in high fidelity – all agents have immediate access to the idea, all understand its implications and realise its value, and *then* decide what to do about it. The new idea is implicitly assumed to fit within existing preferences or to immediately update these so as to make choice possible. There is no ambiguity or uncertainty with respect to the value of the new idea, or with how it connects to other elements of the agent's objective function. Agents all know immediately what it is, what it is worth, and what to do next. Of course, individual agents may or may not choose to adopt the new idea, depending upon their current endowments, preferences and such like reflecting current opportunity costs; but the choice will be simple, transparent and immediate. Mistakes will not be made, regret will not be experienced and expected utility will be an unbiased estimate of actual utility. It will be irrelevant who has the idea, or what subjective thoughts they might have about it, because the idea will come, as it were, 'fully labelled'. They just 'pick it up and take it to market', where they are immediately paid some fraction (a bargaining outcome) of its total net present value to everyone.

RIT and EIH represent a stylised extreme of a contingent real-world innovation context. Still, it does nevertheless reflect a suitable model of the very long period: once all transaction, information and experimental costs have been absorbed; all false trails extinguished; all experimental possibilities examined in all possible contexts; all intellectual property expired and path dependencies shaken out; and of course once time and passage have been sufficient for 'everyone' to have become familiar with the idea and to have arrived at a collective (aggregated) agreement of its value and worth.

[4] *Cf*. rational expectations theory, or the efficient markets hypothesis, as the systematic applications of rational choice theory and perfect competition to expectations and markets respectively.

However, the context of innovation theory is rarely construed over this very long run, but instead examines the *innovation process* as it unfolds. This concerns how information is diffused, how organizations respond, how markets facilitate experimentation, and so on. The central focus thus falls on the effect of bounded rationality in the context of choice associated with creative and entrepreneurial behaviours, adoption and adaptation of novelty – including learning in people and organizations – and how value is discovered and realised. Behavioural economics thus carves away from the RIT and EIH world by seeking to account for departures from 'perfect innovation' in terms of characteristic failures associated with choice and knowledge. To unpack this, it is useful to distinguish carefully between *rational choice theory* – as the behaviour of *Homo Oeconomicus*, or what Richard Thaler (2000) calls 'Econs' – and *behavioural choice theory* – as the behaviour of *Homo Sapiens*,[5] or what Thaler edifying calls 'Humans' (Lowenstein 2000).

3 RATIONAL AND BEHAVIOURAL CHOICE THEORY

Rational choice theory is the study of choice outcomes made by rational agents.[6] This has a particular technical definition (Sen 1987) and is widely used in economic analysis as a foundation for analysis of market outcomes subject to incentives. Behavioural choice theory, however, derives its foundations from cognitive psychology and other domains that seek to account for the characteristic ways that the human mind frames and executes decisions (Earl 1990).

At the core of behavioural choice theory is the notion of the 'economics of thinking and choosing' in which all thought process incur *cognitive cost* which in turn gives rise to bounded rationality (Simon 1955). Within the general context of bounded rationality, the rational choice model thus pertains only in the special case when these costs are assumed to be zero. Because of the positive costs of framing and processing information, the human brain is assumed to 'economise' by developing sufficiently efficient and effective 'thinking technologies' in the form of decision heuristics that are good enough in most situations – that is they *satisfice* rather than optimize (Simon 1978). While some heuristics are a broad product of genetic endowment that is developmentally tuned, others are originated, learned and adapted though the course of experience and social interaction. Where rational choice theory fundamentally rests on the set of preferences and constraints, behavioural choice theory emphasises choice outcomes as a product of which decision-rules are used, and in what context.

While much of this focuses on aspects of real-time learning and adaptation, the 'economics of thinking and choosing' can be interpreted in a much broader evolutionary context in terms of the evolved nature of the human mind (Findlay and Lumsden 1988, Dissanayake 1992, Mithen 1996, Pinker 1997; *cf*. Gabora 2005). Rational choice theory models agent choice 'as if' it were the product of a 'universal choosing machine'. However, modern evolutionary theory emphasises that the human mind is itself a product of evolutionary forces and composed not of general purpose intelligence, but rather of many

[5] See Dopfer (2004) and Dopfer and Potts (2008) on *Homo Sapiens Oeconomicus*.
[6] A rational choice represents an optimizing choice subject to stable preference functions over known constraints.

specifically adapted 'modules'[7] adapted to characteristic choice situations. These modules supply the *instinctive* choice heuristics for many common actions (Cosmides and Tooby 1994). Regardless of origin, actually-used decision heuristics do not always correspond to what rational choice theory indicates as optimal (from the individual perspective) in any given context. In this sense, *behavioural choice theory* is the study of systematic failures in choice to deliver theoretically optimal outcomes. *Behavioural innovation economics*, in turn, is the study of these systematic failures in the specific context of *choice under novelty* or with respect to new ideas. To arrive at this, however, it will be useful to carefully distinguish between behavioural choice in the context of perfect information, imperfect information, and novelty.

3.1 Choice in a known world (perfect information)

The rational choice model, as described above, corresponds to this case. Because all information is available and costless to process *Homo Oeconomicus* is expected to make optimizing choices with respect to their known preferences and constraints. They will make no systematic mistakes, nor arrive at positions that could be improved with different choices or further exchange.

In the behavioural choice model, the agent (*Homo Sapiens Oeconomicus*) will not necessarily arrive at the rational choice optima, even where full information exists. This can occur for several reasons: information may be framed in such a way that induces the wrong choice heuristic to be applied; or the right heuristic is applied but on the wrong subset of information; or a simple heuristic is applied to an actually more complex situation, and so on. In some cases, this may not matter much – the choice will be 'good enough'. Or the feedback to utility may be weak or delayed, allowing the sub-optimal choice to persist. Thus even in a fully-known world, an agent may yet make systematic mistakes owing to the choice of choice-heuristics. This is the core focus of behavioural choice theory as associated with 'heuristics and biases' (Kahnaman *et al* 1991; Gilovich *et al* 2002). Yet this is not necessarily a serious problem; in some cases it may even represent a higher form of optimization in that choices are made that are 'good enough' for the context and appropriately reflect the allocation of scarce resources of attention and thinking (Brocas and Carrillo 2008).[8] Not every decision need be optimal, and the opportunity cost of more attention and thinking to one choice is, invariably, less to another. However, what is emphasized in behavioural choice theory is that this leads to *systematic mistakes* with *characteristic biases*. It is not so much the mistakes or sub-optimality that is of central interest, but the fact that they are systematic.

3.2 Choice in a knowable but uncertain world (imperfect information)

A broader context for choice theory occurs when we move from a known perfect information world to the context of choice over uncertainty. Here, a rational choice suffers from a deficit of information (as for example with respect to the unknown actions of others, payoffs, or the space of possible events). In

[7] This is the 'massive modularity hypothesis'. These many modules are argued to be adapted to recurrent selectively important features of the ancestral environment (Potts 2003).
[8] See Lanham (2006) for a classical-rhetoric based analysis of the economics of attention.

such cases, a rational choice is defined with respect to an unbiased choice, i.e. one that does not make systematic mistakes. This is variously defined as preferences over a distributional outcome in terms of expected utility, or with respect to a state-preference approach. An example is *rational expectations theory* in which agents use a (correct) model of the world and all currently available information to form a 'rational expectation' about the future state of a variable. While the agent does not have all information, they do know how to correctly apply the available information. Mistakes will be made, but they will not be systematic (i.e. errors will be stochastically distributed).

'Human choice' under uncertainty centres on a more complex problem. There is the same prospect of stochastic error, but also the further prospect of systematic error due to application of 'wrong models'. Human agents may fail to appreciate what information is missing, or may fail to appropriately recognise the context of the uncertainty (possibly even failing to recognise that there is uncertainty), leading to the selection and application of inappropriate choice heuristics. They may fail to allocate enough attention, time and resources to the choice, leading to an overly simplified choice (or indeed, the reverse). There are numerous well-known biases with respect to uncertainty – such as loss aversion, risk aversion and myopia (Kahneman and Tversky 1979; Kahneman *et al* 1997) – that lead to sub-optimal choices under uncertainty that are characterised by systematic (as well as stochastic) error. Again, uncertainty is a universal feature of the innovation context, and so these factors will also manifest.

The central issue here is the implicit cost of applying the correct models to the right information. Attention and thinking are scarce resources, thus sub-optimality or failure of decision-making under risk and uncertainty may also reflect a higher-level choice about the costs of addressing such concerns.[9] As such, the extent of choice-failure and departure from the rational choice outcome, in both perfect and imperfect information cases, will be a function of the marginal costs of making an improved decision, and the marginal incentive to do so. As incentives rise and costs fall, we should expect that behavioural choice outcomes will converge (or at least tend to converge) on rational choice outcomes. Yet this is not necessarily the case in choice over novelty.[10] This is why behavioural *choice under novelty* (not choice under risk or imperfect information, or choice under uncertainty) is the proper foundation for behavioural innovation economics.

3.3 Choice in a newly unknowable world (novelty)

Behavioural innovation economics is not premised on imperfect information or even uncertainty, for these are secondary aspects of a more fundamental dimension of choice: namely, choice under novelty. Novelty refers to a new idea – whether emerging from within, or entering from without – that changes the connectivity or dimensionality of 'the world'. Novelty does not refer to new information (in the same way that uncertainty may be reduced by new information) but rather to a new idea, new knowledge, or a new connection (Loasby 1999, Potts 2000). The effect of novelty is that the world becomes more open, conceptually larger, and immediately more complex.

[9] Leibenstein's (1966) notion of X-efficiency sought to capture this aspect in the dynamic value of organizational slack in a firm.

[10] In the sense that the only consistently rational position is not to make a choice at all, but wait until all others have made their choice, and then choose using the information generated by everyone else. But in doing so, all possible profit opportunities (broadly understood) are foregone, which thus also makes this option irrational. Call this the 'choice paradox of novelty'.

This domain has various lines of exploration in economics. Evolutionary and Austrian economists such as Joseph Schumpeter, Ludwig Mises, George Shackle, Israel Kirzner and others have long been interested in the interaction between novelty, discovery, choice and action. There is also a sizable literature on learning and adaptation in contexts involving substantiative novelty (e.g. Winter 1971; Dosi *et al* 2005; Becker *et al* 2006; Nelson 2008). Both literatures emphasise the experimental and creative process of discovery that gives rise to novelty in the first instance as well as in respect of the process by which its value is ascertained. Choice and action with respect to novelty differs fundamentally from modes of rational choice under perfect or imperfect information in that, in the initial instance, *there is no information* – only an awareness of something new. It is impossible to be rational about choice under novelty, only with respect to the process by which novelty-focused action proceeds. This, in essence, involves a process of discovery and learning in order to *elicit information*.

This can proceed in several ways. Experimental play is a common approach (Thomke 2003; Dodgson *et al* 2005). Another is the use of systematic induction and deduction (Popper 1972), or proceeding in combination with the use of analogical reasoning (Magee 2005). These will likely also be coupled with observation of other's responses (Offerman and Sonnemans 1998), possibly adopting their preferences (Earl and Potts 2004) and/or their choices (Potts *et al* 2008). All are methods to decompose the novelty into something familiar (Gennaioli and Shleifer 2008) to connect it to current understanding, as well as to understand its substantiative newness in order to modify current understanding (Loasby 1999).

A characteristic, defining aspect of choice under novelty is that it requires a choice about whether to make a choice at all. Rationality is impossible, or at least undefined in this context, and so choice about choice (the allocation of attention) turns purely on behavioural considerations via instinctual attention-allocating 'rules', or learned rules and experience, or both. Knowing when to make a choice, and the development of capabilities to make choices under novelty, is a crucial and determining aspect of human behaviour that is logically prior to all rational and behavioural choice contexts, as above. Yet there is no general economic analysis of choice under novelty. Instead, the closest relevant domain is broadly that of 'evolutionary or adaptive rationality' that seeks to study adaptive quasi-experimental behaviour in complex environments (Bianchi 1990; Kirman 1993; Herrmann-Pillath 1994; Darley and Kauffman 1997; Gigerenzer 2000). Choice under novelty is by definition a domain of behavioural choice theory in that agents use decision heuristics. However, bounded rationality is not a necessary precondition in this context because there is no information imperfection *per se*. Rather, it is the opposite: information (and resources including time and attention) has to be *added to the context* (e.g. through experimental play, reasoning, trial and error, metaphorical transfer, observing others, etc) in order to elicit sufficient information just in order to make a choice about whether to make a choice.

Choice under novelty is thus conceptually distinct from choice under uncertainty. The purpose of such probing is to gather information about: (1) whether the novelty is significant or not (i.e. can it be ignored? Should it be prioritized?); (2) if further attention is to be paid, how much, i.e. of what value is the novelty?; (3) if it is significant and valuable, what then? And so on. This unfolding sequence of choice with respect to novelty thus continues down a path that may eventually lead to the adoption and retention of the new idea, and thus to change in the capabilities of the agent through the adoption of the new idea (or new knowledge), thus leading to new possible actions and opportunities.

Behavioural innovation economics is thus centred about *choice under novelty*. This begins with first apprehension of novelty (and the cognitive heuristics that lead to that awareness) and ends, potentially, with the adoption and retention of that novelty for ongoing use. It concerns the full gamut of choice behaviour over the *process* of an *innovation trajectory* that begins with a new idea, runs to the adoption and diffusion of that idea, and ends with the stabilization of that idea in the knowledge base of a carrier or population of carriers (Dopfer and Potts 2008). It thus refers to the behavioural foundations of the growth of knowledge in an open economic order. Within this, behavioural innovation economics seeks to identify the particular heuristics and biases that depart from 'perfect innovation' and thus lead to *innovation failures*.

4 TEN WAYS CHOICE UNDER NOVELTY IS HARD

The program of behavioural innovation economics seeks to address the various characteristic ways that innovation can fail in terms of heuristics and biases with respect to choice under novelty. However, rather than gathering the various innovation failures as the inverse of 'drivers of innovation', we suggest that it is more cogent, from a behavioural perspective, to catalogue the ways in which choice over novelty and innovation is naturally difficult for Humans, although not for Econs. Things that are behaviourally 'hard' – even after accounting for technological, organizational and institutional prostheses – are all likely points of failure in the innovation process, and thus in the innovation system.[11] These are summarised in Table 1 below.

Table 1. Ways that choice under novelty is difficult, leading to behavioural innovation failure

Dimension of difficulty	mechanism	example
Awareness of novelty is hard	Human brain routinely filters novelty	Novelty with a smaller 'cognitive distance' is easier to notice
Knowing how novelty affects you is hard	Some new ideas are *sui generis*: no existing 'routines' can process them	Novelty that creates 'new categories' is hard to process
Selecting among many new ideas is hard	Selection over novelty suffers 'halting problems': requires *ad hoc* criteria to resolve	Criteria used to select people become *de facto* mechanism for selecting new ideas
Open innovation and learning from outsiders is hard	over-valuing *endogenous novelty* and under-valuing *exogenous novelty*	'Not invented here' ideas routinely overlooked
Being rational about innovation is hard	Identity constructs displace rational choice	Personal, social, political factors entering into choice over novelty
Incentivizing novelty creation and innovation is hard	Status quo bias, conformity bias, loss aversion	Behaviour over novelty must overcome costs to any action at all

[11] Note that the list below can be further grouped over three high-level categories: (1) thinking about novelty; (2) interacting with respect to novelty; and (3) organizing and coordinating novelty (see Dopfer and Potts 2008 on the four classes of generic rule). Distinct heuristics and biases gather about each meta-category.

Thinking about innovation portfolios is hard	Portfolios are not a natural cognitive category	Difficulty in thinking about multiple novelties simultaneously
Investing in innovation is hard; getting cooperation for a new idea is hard	Myopia, imagination failures	Under-investment in new ideas
Creating space for innovation is hard	Mental accounts	Tendency to 'infect' novelty with extant context
Coping with innovation failure is hard	Accounting for experimental failure is difficult	Failure is difficult to rationalise, leading to avoidance of experimental action

4.1 Awareness of novelty is hard

Novelty and the effects of creativity may well be ubiquitous, but we do not always notice it. This is because the human brain has evolved to routinely filter most novelty out because most novelty is effectively 'noise'. Only infants and young children are really good at it – not because they are naturally more creative and open, but because they have not yet fully developed filters to block out the noise of low-value novelty. Human perceptual and cognitive apparatus are, to a considerable extent, filtering mechanisms. Yet this mechanism often works too well, causing novelty to be overlooked. Noticing novelty requires cognitive effort.

A common effect is that novelty is easier to notice when it has a small 'cognitive distance' (Wuyts *et al* 2005; Nooteboom *et al* 2006) from something familiar. The larger this cognitive distance grows, the more effort is required to see the novelty. The result is that radical novelty can become effectively invisible, leading to the familiar notion in innovation studies of firms being 'blind-sided' by what Christensen (1997) called 'disruptive innovations'. Because novelty requires effort – and the greater the novelty, the more effort required – this can lead to systematic underestimation of both the extent of change in an environment (whether a technological, market or socio-cultural environment), as well as underestimation of the speed of such change (Tidd and Bodley 2002). The human mind is not adapted to a world of rapid and continual change; it requires effort to notice such changes and register their actual pace (Paquet 1998). This is difficult to achieve in more than a few specialised domains. There is significant experimental evidence in cognitive psychology about the various cognitive filters and serial attention mechanisms that relates to novelty awareness and the conditions under which it is heightened and repressed (Anderson 2000: ch 3).

Failure to notice novelty affects innovation in several ways. First, it can constrain the development of raw ideas into entrepreneurial potential. Second, failure to notice or appreciate the extent of novelty can lead to limited adoption, for example when businesses or consumers overlook the value of a novel idea. Third, failure to notice novelty can lead to poor strategic response when businesses in similar or related markets fail to notice the extent of the new idea, systematically under-estimating the competitive threat and thus leading to inappropriately low innovative response.

4.2 Knowing how novelty affects you is hard

Even when noticed, a new idea may yet fail to be appropriately recognised, both with respect to what it is, and the effects it may have. This is consequence of some new ideas being *sui generis*, and thus in effect 'category creating' or changing the extant categories presently used to partition markets, niches, technologies, etc.[12]

Such category dynamics leads to a second class of failure – 'competition blindness' – through failure to see how a novel idea changes the substitution possibilities of producers or consumers, or how the new connections the novel idea makes affect which market a firm is actually in (Potts 2000, Witt 2000, Earl 2003). Often, this only becomes apparent through the effect of market processes and dynamics when consumers begin to adopt the novel idea and substitute away from extant goods services, thus revealing which markets are affected. Businesses may thus be 'the last to know'. Strategic response will consist of catching up through imitation or even withdrawal from some market segments, thus affording sometimes lasting first-mover advantage.

4.3 Selecting among many new ideas is hard

Within a firm, the innovation process can be generically characterised as beginning with the search for opportunities and discussion and refinement of ideas (the 'fuzzy front end', Koen *et al* 2001) followed by selection of ideas for further development and exploitation. Of these three stages, selection can be the most difficult. The first phase of 'gathering' can be highly contingent and open to fortuitous connections: it is effect 'casting a net' and often modelled as if it were a 'treasure hunt' – the prime criteria for success here is sufficient resources and connections. The third phase, in turn, often runs on well-defined and standardised operating procedures; it can often be effectively and rationally managed.

The difficult part is always the selection phase because it is never possible to be entirely rational (there always remain significant unknowns), yet nor is it ideal to just let selection percolate and self-organize, as this may result in drift. Within an organization, selection invariably requires champions: someone must get behind an idea for it to succeed. Because of this, the selection process becomes functionally dependent upon whom that is, and why. Selection of ideas to advance to development can occur for reasons that have little to do with the idea and much with the person or coalition championing them. Failures may thus occur when novel ideas are poorly selected due to 'the wrong champions' or the failure of potential backers to gather behind an idea. Mechanisms that select people will thus often function *de facto* to select among new ideas. Purely objective evaluation and selection is hard and systematic mistakes can be expected to occur.

4.4 Open innovation and learning from outsiders is hard

[12] Even in simple environments forecasting future utility is hard (Loewenstein *et al* 2003). Projecting the effects of a new idea makes such forecasts highly prone to systematic error. This occurs because initial assumptions can amplify in expected ways, and also because feedback and interaction effects are especially hard to intuitively model.

Kin selection models in evolutionary biology underscore the natural human sociality in terms of families and tribes with clear boundaries between insiders and outsiders (Bergstrom 1996). Firms and organisations harness that mechanism. A consequence is that novel ideas occurring within a group are often treated differently to novel ideas arising from outside. This asymmetry tends to over-value *endogenous novelty* and under-value or heavily discount *exogenous novelty*.

There is a strong innate tendency to 'hunt and gather' ideas only from within the territory defined by the organization's sense of what industry and markets it believes itself in. Cooperation in respect of experimenting with new ideas and sharing knowledge is easy within the boundaries of an organization, but often very difficult across such boundaries with 'outsiders'. This is why participating in 'knowledge networks' is so hard and why 'open innovation' can seem strange and 'unnatural' (Chesbrough 2003). The point is not that learning from others is hard, as it is certainly not when they are part of an insider group (family, friends, peers and colleagues within an organization), but that this is very different when cooperation is required with outsiders. The core of human civilization is of course ever expanding domains of cooperation with strangers (Seabright 2005) through institutions of trade, organization, coordination and so on. Yet the novelty of new ideas always, in some way, triggers an atavistic impulse of suspicion of outsiders and the risks associated with their different ideas. Effort is required to mentally overcome this instinct, effort that is not always made, leading to innovation failure.

4.5 Being rational about innovation is hard

Many of the difficulties with choice under novelty arise through the myriad consequences of the difficulties of being rational with respect to novelty and innovation. An important dimension arises because novelty and innovation involve more than just operational, material or financial consideration and risks, but also extend into identity construction and maintenance as well as leadership, learning and discovery in a social context (Carruthers 2002). Choice under novelty can be as much about the person or organization making the choice as about the substantiative material aspects of the new idea itself.

Attitudes with respect to new ideas can serve as important and distinct personality and identity markers, thus overlaying all manner of social identity effects into choice with respect to novelty that can be difficult to decompose. New ideas also present clear opportunities for displays of leadership, adventure and even aggression, or of submission and cooperation, all of which have values and functions that may have little to do with the rational undertaking of innovation (Veblen 1899, Schumpeter 1942, Baumol 2002, Sarasthvathy 2008).

Innovation is by definition a social process, as the value and use of new ideas is 'socially constructed' through continual feedback between users, producers and other parties. A new idea only becomes an innovation when it is systematically adopted by others and embedded into the knowledge base. This process involves sometimes marginal, sometimes radical adaptation and reconstruction of identities of all participants, involving opportunities for learning, discovery and leadership in this process – that is, innovation is not simply diffusion (Rogers 1992). Yet the net result of the psychological depth of effect

that novelty presents is that rational choice under novelty is hard. It is easy to allow social behavioural factors to dominate decision-making.

Evidence of the difficulties of rational choice can be seen in the extent to which largely 'ceremonial' factors regularly intrude into the innovation process. One example is revenue forecasts made in the context of start-up pitches. These have been shown (Douglas and Shepherd 2002) to be essentially random. Yet they do nevertheless function as a ritualistic signal of willingness to cooperate. Choice under novelty is a rich territory of often arbitrary rhetorical and symbolic conventions and institutions that yet serve important social functions in shepherding a new idea. Innovation failure can thus occur for reasons that may have nothing to do with the idea itself, but with respect to improper observance of the socio-cultural customs associated with the introduction of novelty.[13]

4.6 Incentivizing novelty creation and innovation is hard

A common problem in creating an 'innovation culture' that arises when a firm seeks to become 'more innovative' lies in finding appropriate and effective ways of incentivizing the creation and development of novel ideas. The market institution itself is an effective innovation incentive mechanism.[14] Yet within organizations, incentives toward novel behaviours are often difficult to create and maintain. The behavioural theory of the firm (Cyert and March 1963; Winter 1971; Nelson and Winter 1982) models a firm as a complex system of institutionally organized habits and routines, into which members of the firm then 'slot'. The individual 'fitness' of an employee thus depends on their ability to adopt and effectively execute these routines: this, by definition, militates against deviation and the introduction of new ideas (Raines and Leathers 2000). Thus exceptions need to be created, all of which involve cost and risk. Like all social animals, humans normalise fast to prevailing local habits and ways of behaving.

There is vast experimental evidence and literature on the extent of dissonance and anxiety experienced when behaviours and ideas are maintained or pursued that differ significantly from those of the 'tribe' or peer reference group. The power of conformity bias is what makes incentivizing innovative thinking hard, in that the incentive is not that of a marginal substitution, but must fully compensate for potential 'ex-communication' from the tribe. Few people have a high tolerance for this, and most require compensation to be considerable. Instead, effective novelty incentives need to work within the grain of an organizational structure or business model, making them difficult to 'bolt-on' to an existing organizational model.

Incentives to novelty and innovation have to be sufficient to overcome risk and loss aversion that may carry into multiple dimensions. Even when income and material risks are carried by the organization or by financiers, there still remains the prospect of loss in status, identity or confidence if a new idea fails. These expectations differ between people and in different contexts, thus no generic incentive system will work equally well in all contexts. The costs associated with discovery of what motivations are at

[13] This adds a new twist to Thorstein Veblen's critiques of the ceremonial nature of capitalist institutions by arguing that some ceremonies associated with novelty have highly functional value in legitimating novelty and in signalling cooperation and participation.

[14] The institutions of intellectual property for example are often presented as an incentivizing mechanism, yet much evidence points to it having the opposite effect (Boldrin and Levine 2008).

work and in what dimensions losses are salient makes design of incentives for novelty and innovation difficult.

4.7 Thinking about innovation portfolios is hard

A much overlooked aspect of the difference between rational and human thinking about novelty accrues to the rational value of 'portfolio thinking' and the innate difficulties humans experience in conceptualizing novelty in anything other than an isolated context. It is extremely hard to think about novelty and innovation from a portfolio perspective. It is far more 'natural' to think about a new idea in terms of a project (with *ad hoc* capabilities and considerations).

The reason for this may well be due to an asymmetry between evolutionary rationality and economic rationality. Portfolio approaches to risk are economically rational because the sum of a bundle of *uncorrelated risks* has lower variance than each individually (appropriately scaled). In essence, they partially cancel out, lowering down-side variance (Markowitz 1952). Serial entrepreneurship is thus an effective strategy, as is the gathering of multiple innovation directions under one 'organization'. Many new ideas pursued at once can be a lower risk strategy than just a single new idea if (and only if) those many ideas are uncorrelated. It is noteworthy that a portfolio is effectively a mechanism of *group selection*, with the group consisting of the multiple ideas gathered into a single portfolio. However, human evolution is not an outcome of group selection (Henrich 2004), but rather of individual selection. However, like all other social animals, human minds evolved under conditions of social payoffs 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. Single ideas – projects – seem a 'natural unit' for choice under novelty, but they are not: they are a behavioural bias.

Portfolio thinking is not like this. Innovation projects are led, but portfolios are managed. Portfolios are about being statistically right, not dramatically right. Portfolios are rational, but not instinctive. '*Portfolio aversion*' (as we shall call it) explains why systematic or generic innovation capabilities are often hard to develop in an organization unless explicitly connected to particular projects (that can be heroically led). General purpose innovation resources and capabilities (Dodgson *et al* 2005) only tend to arise in organizations that are already strongly organized about a portfolio-based business model.[15]

4.8 Investing in innovation is hard; getting cooperation for a new idea is hard

Perhaps the central stylised fact issuing from innovation studies – in conjunction with economic growth theory, business strategy, and so on – is that investing in innovation hard. Firms (and people) systematically under-invest in the development of innovation competences and capabilities, as well as under-invest in particular innovation projects and portfolios.[16] Investing in innovation is hard for two

[15] A further aspect of portfolio aversion is the asymmetric tendency, also observed in sports gambling (Thaler 1992), to overweight the prospects of 'long-shots' and to under-invest in 'favourites' when a series of projects fail in sequence. This can be thought of as a dysfunction of risk perception arising from attempting to force a portfolio approach onto the last in a sequence of serial decisions.

[16] Over-investing due to excessively optimistic entrepreneurial expectations can also occur (Brocas and Carrillo 2004).

distinct behavioural reasons. First, expectations are hard to form. Models of how things might change in consequence of the new idea may be inappropriately constructed from false similarities to past innovations (Magee 2005, Gennaioli and Shleifer 2008). The absence of objective information leads to over-emphasis on the reputations or characteristics of the person or group promoting the idea. Imagination is required and stories can be unduly effective, distorting, or misleading. Second, investment requires persuading others to cooperate. This can fail when others fail to see the need of value of the innovation (as above), or when inertial forces and status quo biases are strong and difficult to displace due to instinctive calculation of gains and losses with respect to the current situation. The experimental costs of the innovation may loom especially large, while the potential gains may be perceived as distant or difficult to quantify.

A related difficulty occurs in gathering support and inducing cooperation about a new idea. Innovation, by definition, requires cooperation to marshal and coordinate resources and induce experimental adoption and learning. Yet failure to secure early cooperation is perhaps the most common form of innovation failure. This can occur as failure to get sufficient buy-in or to gather sufficient resources, both organizational and material, early enough to support the experimental phases of development or of getting 'to market'. In start-up or spin-out enterprises this often manifests in failure to secure sufficient early stage funding or to lock-in suitable partners. In network, collaborative or open innovation projects failure commonly arises when cooperative connections fail to form. Innovation teams – whether within an organization or across several – are hard to put together. In the masses of literature in innovation studies and strategic management that attest to the many reasons for this, behavioural factors loom particularly large. In particular, support and cooperation require *commitment*, and commitment draws in the implications of loss with respect to closing other possible uses of the committed resources and capabilities. Yet the opportunity cost of the loss of 'real options' is often difficult to evaluate, especially if others have also not yet signalled their commitment (and thus offering a reference point for evaluating opportunity cost). Risk aversion may thus manifest in the form of '*early cooperation aversion*' in the often difficult and path-dependent emergence of coalitions about novelty.

4.9 Creating space for innovation is hard

Successful innovation requires creating an appropriate 'space' for experimentation. This may be a physical space (i.e. a place with appropriate resources), an organizational space (as in Lockheed's 'skunkworks' and other models of corporate venturing), or an institutional space (i.e. a market). But an equally important and widely overlooked innovation space is mental.

The creation of mental space for experimenting with novelty can be difficult because it requires letting go or disconnecting from past decisions and knowledge. Endowment effects and sunk cost biases both contribute to this difficulty. Evaluation of novelty is invariably influenced by past knowledge, contractual positions or asset holdings: memory and endowment. It is hard to create an objective space within which only information pertaining to the new idea is relevant. A common behavioural bias is the tendency of people to form *mental accounts*, violating the rational principle of fungibility (Thaler 1985). However, to experiment with novelty often explicitly requires a separate mental account (as well as

physical and organizational) within which much greater tolerance of failure and heightened attention to feedback occurs. The failure to effectively create such an 'account', and to isolate it from other operational behaviours and actions, can result in inappropriate behaviours and heuristics applied to the experimental situation.

4.10 Coping with innovation failure is hard

New ideas require experimental learning to ascertain their value and to reveal the opportunities they harbour. Yet experimental learning (i.e. the scientific method, Popper 1972) by definition involves failure. Failure is the most important source of information because it informs about what does not work, thus creating knowledge from which to eliminate error and continue experimental and conjectural learning. And while human behaviour can often be construed 'as if' people were acting as scientists, continually engaged in conjecture and refutation (Kelly 1963), it should also be recognised that one side of this is harder than the other. It is easy to think up new ideas in conjectural form; it is harder to test them, and even harder still to recognise and absorb the implications of failure resulting from such tests.

This can lead to two related behavioural failures in the context of experimental learning: (1) the failure to recognise failure when it occurs (either by outright ignoring it, or by reconstructing narratives in which it was not a failure, e.g. cognitive dissonance); and (2) the failure to learn from failure, in the sense of failing to absorb the feedback information it provided, and thus failing to go on to reconstruct hypothesis and conjectures with that new information. Failure is only of use and value when the information it supplies is then used for further learning; otherwise it's just waste (Potts, forthcoming). This second failure also extents to social learning and the pronounced tendency to focus on the success stories of others (which mostly contain little useful or novel information) but to ignore the failures and the learning opportunities they provide.

A further instance is the difficulties of developing models of 'fast failure' (Thomke 2003). Firms often find it difficult to develop a business and innovation model of going 'fast to market', or the release of success 'beta' models, even to trial markets, in order to learn from market feedback. There may be legitimate concerns about reputation and brand damage in some cases, but this must also be weighed against the benefits to learning and opportunities to cut losses quickly and move on if conjectured value is disproved by market feedback. Holding on too long before product release (fear of realising failure), and staying too long in failing market (fear of admitting failure, or holding to a belief that a corner will soon turn) are common behavioural biases that slow the innovation process.

5 CONCLUSION

Choice under novelty is hard. Systematic behavioural mistakes are easy to make and cause the innovation process to undershoot what 'rational innovation theory' and the 'efficient innovation hypothesis' would suggest as ideal behaviours with respect to new ideas. Innovation failures may thus be common in the economic system for reasons that go well beyond standard technology failure, market failure or even policy failure frameworks. This paper has sought to argue that an important, and

much under-examined, aspect of innovation failure can be gathered under the various behavioural heuristics and biases that make *choice under novelty* an often difficult process fraught with traps.

We began by seeking to distinguish between rational choice and behavioural (human) choice models under conditions of costless information, uncertainty and novelty. The key point was that there is a crucial distinction between choice under both certainty and uncertainty and choice under novelty. This distinction has been widely overlooked, yet serves to provide a rationale for why behavioural choice models are most relevant in choice under novelty. We then sought to outline some characteristic ways that behavioural heuristics and biases affect choice under novelty, which is of course the essential choice context of innovation. We proceeded not by seeking to elaborate innovation drivers or even systemic failures, but rather by a catalogue of aspects of innovation that are routinely and universally found to be difficult. The underlying premise is that these difficulties are inherently behavioural in origin and thus present common loci of failure that might usefully then be further studied in pursuit of possible choice-prosthetic improvements (Thaler and Sunstein 2008).

We dub this domain *behavioural innovation economics*, although this is far from a *de novo* development. There is a great deal of work in the experimental domains of neuroeconomics, cognitive science, experimental economics, behavioural choice theory, behavioural finance, and so on, that contributes already to behavioural innovation economics. Our main contribution has only been to seek to gather these many threads and seek to focus them about a singular choice problem – choice under novelty – in order to bring some order to the behavioural foundations of innovation studies.

The research programme of behavioural innovation economics thus proceeds on two levels. The first is to map the many difficulties in the innovation process (as revealed by innovation studies and strategic management) to the various behavioural heuristics and biases that may explain these (from cognitive science, behavioural and experimental economics). The second, parallel program is to take these descriptive and empirical conjectures and develop theoretical explanations of the particular mechanisms at work in *choice under novelty*. Normative applications in the sense of developing better innovation strategy, better innovation policy, etc, may then follow by seeking to exploit these findings and mechanisms. Furthermore, while the context of behavioural innovation economics is most obviously constructed about the process of innovation in firms, markets and industries (the natural domain of innovation studies and strategic management), the application domains of behavioural innovation economics need not be exclusively 'economic'. It may also usefully apply to the broad domains of anthropological, cultural, socio-political and institutional evolution (Boyd and Richerson 1993; Shiller 2005) which are of course equally driven by new ideas and innovations that are the outcome of human choices under novelty.

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