Potential Surprise Theory as a theoretical foundation for scenario planning

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Abstract

Despite some recent progress, scenario planning's development as an academic discipline remains constrained by the perception it is solely a practical tool for thinking about the future, with limited theoretical foundations. The paper addresses this issue by showing that G. L. S. Shackle's 'Potential Surprise Theory' (PST) contains much that can lend theoretical support to scenario planning - especially its use of plausibility rather than probability, and its focus on potential extreme outcomes. Moreover, PST and scenario planning share the same ontology, viewing the future as constructed by the imagination of individuals. Yet, under PST, while the future is imagined and, therefore, subjective, individuals nevertheless seek to identify the 'best' option through a deductive process of elimination. PST therefore assists in overcoming the divide between the constructivist and deductivist perspectives in scenario planning as it employs both. Finally, the paper shows that theoretically underpinning scenario planning with PST would place it at the heart of contemporary debates on decision making under uncertainty taking place in economics and other fields, enhancing its status and profile as a discipline.

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1 Introduction

Scenario planning is a tool for considering the future that is widely used by business and government [1 p.215, 2 p.461, 3, 4 p.335, 5 p.79, 6]. Yet, despite this, scenario planning has not yet become a fully-developed academic discipline. One reason is argued to be the perception that, despite recent efforts to provide it with a

more solid theoretical underpinning, scenario planning remains a practical tool with limited theoretical foundations [7-8].

Chermack, some time ago, commented that 'the status of theory development in the area of scenario planning is dismal' [9 p.25] and that there is insufficient development of theory to support the 'fast growing' practice of scenario planning [10 p.60]. However, some progress has been made in addressing this issue in recent years - for example, by Phadnis et al. [11], who have recently set out an explicit set of theoretical axioms for scenario planning in this journal. Similarly, a number of augmentations to the 'standard' Intuitive Logics' (IL) approach to scenario planning have been set out in the recent literature, and the case for making these adaptations has drawn on theoretical discussions related to, for example, structuration theory [12], indeterminism [1, 13-14] and complexity theory [15], thereby adding more theoretical flesh to the practical scenario-planning process. Yet, despite this, it is still widely held, including by those having carried out what theoretical work does exist, that scenario planning remains underdeveloped theoretically. For example, Phadnis et al. [11] state that there remains a 'lack of theoretical grounding' for scenario planning, and Bowman [5 p.79], writing very recently, implies the same.

Bradfield [16] suggests that this 'lack of theoretical grounding' has come about because the growth in popularity of scenarios has happened for practical rather than theoretical reasons. Godet [17 p.88] similarly states that 'theoretical research and sophisticated tools have been neglected in favour of multiple applications' and Bowman [5 p.79] notes that 'an absence of theoretical belonging has left scenario-based approaches drifting between a multitude of frameworks'. The implication in each instance is that scenario planning requires more solid theoretical foundations to rectify this issue. Indeed, Kuhn [18], in his work on the evolution of scientific paradigms, showed that a lack of commonality in terms of practical approaches, as is evident in relation to scenario planning [5], is an indicator of a discipline that remains in theoretical flux and is yet to coalesce around a commonly-agreed theoretical standpoint. When the latter finally occurs, the discipline stabilises and proliferation of practical methods is reduced, for a time at least. Scenario planning has not yet reached this stage and the expectation is that a clearer theoretical underpinning is needed for it to do so [7]. Rather than a set of rigid axioms, this theory would likely consist of a set of generally agreed-upon over-arching principles that guide the implementation of scenario planning as it is tailored to suit the particular context in which it is applied. While a number of different approaches would remain, reflecting the manifold

contexts in which scenario planning is applied, these over-arching principles would be the common thread that joins them together.

Yet, theoretical frameworks that could potentially fulfil this role have already, from time-to-time, been identified, only to remain undeveloped and, eventually, forgotten. For example, Loasby [19] has recently noted that as long ago as the 1980s scenario planners working at Royal Dutch Shell recognised the similarity between the non-orthodox economist G. L. S. Shackle's theory of 'potential surprise' [20-42] and scenario planning. Shackle himself also recognised the similarity, as evidenced by private correspondence to Shell's then Chief Economist, Michael Jefferson [43 p.210], in which Shackle refers to the 'essential unity' between his ideas and scenario planning as then practiced at Shell. However, subsequent to highlighting this fact, Jefferson goes on to note [43 p.214] that 'as I look [today] at the 30 or so books on my shelves focussed on scenarios…not one refers to George Shackle'. Shackle's extensive corpus of work, then, is a prime example of a potential theoretical framework for scenario planning which has gone undeveloped and largely overlooked by scenario planning scholars. Those researching within the field continue to bemoan scenario planning's limited theoretical foundations, not realising that a theoretical framework capable of lending strong support to scenario planning has been existence for many decades already.

As this paper will show, the failure to develop the link between Shackle and scenario planning is a significant oversight. The connections between Shackle's theoretical ideas and the practical tool that is scenario planning are, if not one of 'essential unity' as Shackle put it, then at least one of considerable consilience. It is sufficient, at least, for Shackle's theorising to contribute significantly to the creation of a theory of scenario planning, and, potentially, it is adequate to form the central plank of such a theory. In short, Shackle's PST can potentially provide a significant part of the theoretical backbone needed to frame discussion on scenario planning, facilitating its stabilisation and development as an academic discipline, and assisting in reducing the current proliferation of practical approaches. This potential, however, requires consideration and discussion among scenario planning scholars, which this paper aims to stimulate.

In this vein, Shackle's ideas are particularly salient to recent (and long-running) debates on the use of plausibility compared to probability in scenario planning [44-45]. As practiced at Shell, scenario planning exclusively employed plausibility [46] and this was a primary reason for the 'essential unity' Shackle identified

between PST and scenario planning. PST provides a detailed theoretical justification for the use of plausibility; it also provides a theoretical bolster to justify scenario planning's focus on extreme outcomes. PST and scenario planning share the same ontology, viewing the future as constructed by the imaginings of individuals - implying a strong indeterminism - rather than existing objectively as a fully-specifiable choice set. Yet, under PST individuals constructing the future through imagination nevertheless seek to deductively identify the best (subjectively conceived) option; PST therefore assists in overcoming the divide between the constructivist and deductivist perspectives on scenario planning, which currently acts as a constraint on its development as a discipline [8, 45].

To summarise, the paper therefore has the following objectives:

1) To show that theoretical considerations are not divorced from practical ones when it comes to scenario planning; the two affect, and are affected by, each other. We argue that, despite some progress made in recent years, scenario planning remains theoretically underdeveloped, and that the lack of agreement in relation to scenario planning's theoretical underpinning has led to a proliferation of methods and approaches. This can only be reduced by detailed empirical work to identify those techniques that have the most efficacy. Yet, empiricism of this type firstly requires a certain level of theoretical development. Scenario planning may therefore be stuck in something of a cleft stick in which a reduction in the proliferation of techniques and a more theoretically-settled discipline requires greater empiricism; yet, for this to occur, there has to be at least some initial agreement on what should be empirically tested, which in turn requires a certain amount of initial theoretical common ground. The paper shows that PST contains much of use in establishing this theoretical common ground.

2) To provide a brief outline of PST and the aspects of it that led Shackle and those working at Shell in the 1970s and 1980s to consider it the theoretical manifestation of the practical technique of scenario planning. Central among these aspects is PST's rejection of probability as a means for considering the future, the reasons for which are explained in detail through a discussion of what Shackle referred to as 'crucial decisions', which are *not* amenable to probabilistic methods, in contrast to what he called 'divisible, seriable experiments', which *are* amenable to probabilistic approaches to decision making. The former is the realm of fundamental uncertainty with which scenario planning is concerned, the latter is instead the realm of risk, in which conventional forecasting techniques are more applicable. The paper

shows that ever since the advent of subjective expected utility theory - the foundations for which were laid by Savage [47-48] at approximately the same time that Shackle was setting out PST in the 1950s [49-51] - mainstream economists, and those in other disciplines that seek to mimic their approach, have made no distinction between fundamental uncertainty and risk, assuming that both can be dealt with in the same way using probabilistic (albeit, subjective probabilistic) techniques. However, the view that risk and fundamental uncertainty are essentially the same and do not require different treatment is increasingly questioned, thus bringing Shackle's ideas back to contemporary prominence [49]. For this reason, building scenario planning's theoretical foundations on PST situates scenario planning at the heart of contemporary discussions on uncertainty and how it can be dealt with, taking place in fields such as decision making and economics. Becoming part of this broader discussion can enhance scenario planning's status and profile, assisting in its development as a disciple.

3) To show how PST is able to lend theoretical support to other (i.e. not only the use of plausibility) important aspects of the Intuitive Logics approach to scenario planning, such as its focus on potential extreme outcomes, and to show that PST and scenario planning share the same ontology, viewing the future as constructed by the imaginings of individuals, rather than existing objectively as a fully-specifiable choice set. As such, both PST and scenario planning place indeterminism stemming from free will and choice at the centre of consideration of the future; however, both also envisage this indeterminism as bounded, rendering anticipation of the future possible.

4) To show how scenario planning theoretically underpinned by PST accommodates both a constructivist and deductivist perspective, resulting in an abductive scenario planning, as advocated in the recent scenario planning literature. And to evidence a link between PST and the antifragile approach to dealing with uncertainty [52-54], which has recently been transformed into a novel approach to scenario planning [1].

It should be emphasised that, in exploring the potential for Shackle's ideas to provide a theoretical foundation for scenario planning, the paper does *not* downplay the importance of scenario planning's practicality. In accordance with Shackle's own view [43], the view adopted here is that scenario planning's 'real world' practicality is its main strength. However, as described in the next section, this practicality would be enhanced rather than diminished through application of an explicit theoretical underpinning.

2 Scenario planning's practical origins and limited theoretical foundations

2.1 Scenario planning's practical origins

As described by Bradfield et al. [6 p.797], after WWII the US Department of Defense needed a means to consider which new weapons systems should be developed. At the height of the Cold War, they faced uncertainty from multiple sources. Firstly, from the perennial problem of military procurement that new weapons require long lead times to develop, resulting in uncertainty about the strategic environment at the time they become ready to deploy. Secondly, this was compounded by the lowering of the iron curtain, which greatly increased uncertainty about the context in which potential new weapons might be deployed. Thirdly, the effectiveness of the developed weapons depended on the effectiveness of those developed in response by potential enemies – in particular, the USSR. The uncertainty stemming from these three combined aspects provided the initial stimulus for the early development of scenario planning as a discipline [6].

It is subsequently shown that uncertainties such as these result in the requirement for what Shackle calls a 'crucial decision', or, alternatively, 'crucial experiment' [30, 34, 50 p.1136]. Crucial decisions change the very circumstances in which the decision is made, so that no future decision can ever be made in similar circumstances again. The development of a particular weapons system instead of one of its alternatives is just such a 'crucial decision'; the invoked response from enemies who then develop their own weapons systems will forever change the strategic circumstances in which the decision was originally made. While scenario planning emerged for the very practical purpose of mitigating the uncertainty associated with such decisions during the Cold War, it was not long before scenario techniques migrated to the world of business via RAND Corporation and Royal Dutch Shell [6]. Crucial decisions are also a source of fundamental uncertainty in this domain. Shell had found their conventional forecasting and modelling approaches to consideration of the future of limited value under circumstances in which there was a discontinuity in prevailing trends. Discontinuities lead to a 'fork in the road', which in turn render the decision as to which fork to take a crucial one. The initial scenarios developed by Shell proved successful beyond all anticipation, allowing them to identify the plausibility of a scenario describing impending oil crises in the 1970s and to prepare mitigation plans accordingly [55]. As a result, when these crises transpired, Shell were able to make the crucial decision to reduce production capacity [43], providing them with a competitive advantage over rivals whose production

capacities were no longer appropriate to the changed circumstances. This crucial decision was aided by the so-called 'producer miscalculation case' Shell developed through several scenario planning iterations [46].

This evidences scenario planning's usefulness for dealing with the type of decision Shackle labelled 'crucial' because it changes the very circumstances in which the decision is made in the first place. We later show how Shackle distinguished such decisions from more mundane sorts more amenable to probabilistic and computational approaches to consideration of the future, and how this distinction is perhaps his most major contribution to theory and a central part of the usefulness of PST as a theoretical framework for scenario planning.

2.2 The need for theory in scenario planning

Chermack [9-10, 56] has written widely on the need for theory in scenario planning, making reference [9 p.25] to Lewin's [57] famous phrase: 'Nothing is quite as practical as a good theory'. Chermack stated that theory development in the field of scenario planning, and futures studies more broadly, is dismal [9 p.25], implying that there is a tendency to think of method and theory as the same. However, these comments were made more than a decade ago, and some progress has undoubtedly been made since then to fill in this theoretical void. A number of augmentations to the standard IL approach to scenario planning have been suggested based on theoretical discussions encompassing, for example, indeterminism [1, 13-14], structuration theory [12] and Aristotle's philosophy of phronēsis [58]. Furthermore, a useful theoretical discussion relating scenario planning to complexity theory has also been initiated [15, 59].

It is inaccurate to say, then, that no progress at all has been made in theoretically underpinning the practical tool that is scenario planning. Yet, despite this progress, it is still commonly asserted in the current literature that scenario planning lacks adequate theoretical development. For example, Bowman [5 p.79] has recently implied that the continued limited theoretical development of scenario planning has led to a disparateness within the discipline, resulting in scenario planning 'drifting between a multitude of frameworks'. And also recently, Phadnis et al. [11 p.122] make a similar point, stating that as many as twenty-three techniques for developing scenarios now exist, as-well-as at least ten approaches to using scenarios, and linking this

proliferation directly to the failure to develop more comprehensive theoretical foundations for scenario planning.

Kuhn [18], in his research on scientific paradigms, shows the evolution of disciplines to follow similar cycles. In the pre-paradigmatic phase there is no theoretical agreement. The first phase of evolution following this is that in which a number - perhaps even a large number - of theoretical standpoints exists, leading to a proliferation of practical approaches. Eventually, those researching within the field gravitate towards a particular, common theoretical standpoint, leading to a reduction in the proliferation of practical approaches, and the emergence of agreement in relation to common theoretical principles and practical techniques. It is clear from the comments of Phadnis et al. [11] and those of Bowman [5], both of whom were writing very recently, that scenario planning remains in the early stages of this evolutionary process, with little common agreement in relation to theory and practical approaches yet evident. While the IL approach to scenario planning is considered the closest approximation to a 'standard' approach in existence, it continues to be revised, augmented and questioned - thereby evidencing this continued lack of agreement.

A problem in terms of moving from this stage to one in which there is greater stability and agreement on approaches is that scenario planning may be stuck in something of a cleft-stick. On the one hand, to develop greater theoretical common ground there is a need for empirical research to identify the practical approaches that work best; yet, at least if the approach to this is to be deductive and theory-led rather than the reverse, there needs to be a certain level of theoretical agreement before such empirical testing can take place, so as to identify what specifically to test. Establishing scenario planning as a fully-theorised academic discipline can therefore assist in galvanising the resources and attention needed for additional empirical research into the efficacy of scenario planning in its many guises, allowing for the identification of a core set of proven approaches. As the rest of this paper goes on to show, PST can form a significant part of the theoretical framework required to achieve this. In the next section we provide a brief outline of PST to assist the reader in understanding the subsequent discussion of its usefulness as a theoretical framework for scenario planning.

3 Potential Surprise Theory

3.1 A brief outline

In Potential Surprise Theory a decision-maker considering the future chooses among rival strategies based on two elements: expected potential gains and losses resulting from each alternative course of action, and the degree of *disbelief* or implausibility of a particular outcome [50 p.1137]. Plausibility is therefore measured through a consideration of its opposite: implausibility or disbelief [50], which allows Shackle to overcome the problem of additivity associated with probability, as we describe in detail subsequently. Unlike belief in a particular outcome, one's disbelief in several currently-considered future outcomes is not necessarily affected in any way by consideration of, and disbelief in, a newly-considered future outcome. This reverse perspective - which undoubtedly appears odd to those raised on probabilistic thinking with its basis in belief and what is known about a fully-specified set of choices - accommodates surprise and what is currently unknown. It provides room for the addition of new possibilities that do not currently occur to the decision-maker as she feels her way into an opaque and emerging future.

The 'surprise' element in the theory's name stems from this somewhat unusual means to consider plausibility based on implausibility, or belief in terms of disbelief. Shackle viewed the 'degree of *belief*' in a particular future outcome as simply corresponding to 'the degree of surprise to which this belief exposes us and will subject us in case the hypothesis proves false' [50 p.1138, 23 p.9]. To arrive at a measure of 'disbelief' or 'implausibility', PST envisages individuals as being able to assign degrees of surprise ranging from zero for outcomes that seem perfectly possible, to a maximum representing complete astonishment for outcomes that, under current conditions, seem completely impossible. To arrive at values on this 'surprise scale', Shackle envisages individuals asking themselves 'How surprised would I be if this outcome actually occurred, if, at the time it occurred, I were still looking at the world in the way I look at it right now?' [42 p.88]. One answer could be 'Not at all surprised, this seems perfectly possible', or it could instead be 'Very surprised indeed, there is just so much standing in its way' [42 p.88]. This measure of plausibility (via implausibility) is combined with the stimulus provided by the decision-maker's imagined potential gain or loss from the particular endeavour under consideration. By combining these two elements - potential gains and losses and plausibility - the decision-maker is able to rank particular actions on the basis of the 'potential surprise' associated with their imagined outcomes. For each action the focus is on two extreme values (called 'focus outcomes'), which are determined formally as resulting from the maximisation of a continuous stimulation function (for potential gains and losses) subject to a continuous potential surprise function (for plausibility) [50

p.1139]. It therefore becomes possible to compare and order actions based on how imaginable and arresting the potential gains and losses are, as modified by the plausibility of their occurrence.

This process can be summarised as follows:

1) For the particular aspect of the future under consideration (e.g. whether to start a business of one type or another; to innovate a particular new product or to improve an existing product; to build a submarine-based or land-based nuclear deterrent etc. etc., depending on the field of interest), imagine a set of rival strategies and their outcomes.

2) For each outcome to each strategy, consider its plausibility (e.g. whether its transpiring is perfectly possible, or its outcome would be somewhat surprising, or completely implausible etc. under current conditions), resulting in a measure on the 'surprise scale' for that outcome.

3) For each outcome to each strategy, imagine the impact (e.g. the gains or the losses that might be accrued) should it transpire.

4) For each strategy, identify the single outcome which is most arresting because of the combination of its plausibility (as in 2) and its potential positive impact (as in 3), and the single outcome that is most arresting because of its plausibility (as in 2) and its potential negative impact (as in 3). For each particular strategy, this results in the creation of two 'focus outcomes' (one representing gains and the other losses) determined formally as the maximisation of a continuous stimulation function (for potential gains and losses) subject to a continuous potential surprise function (for plausibility) [50 p.1139].

5) For all strategies, compare the respective pairs of focus outcomes in light of the respective (and subjective to the individual decision-maker) attitude towards the trade-off between losses and gains [42 p.98].

6) Select the strategy for which this trade-off is maximised (i.e. potential gains are largest in comparison to potential losses) in relation to the subjective appetite for uncertainty.

The use of focus outcomes to direct attention is an aspect of this procedure which is particularly congruent with scenario planning. Both PST and scenario planning view the natural means by which experts deliberate about the future as being one in which they focus on plausible extreme outcomes. Wright et al. [13 p.634]

show that in stage 4 of the standard IL approach to scenario planning 'two extreme, but yet highly plausible' outcomes are defined. In stage 5 of the process key scenario factors are identified as 'those which have both the most impact on the issue of concern and also the highest degree of uncertainty as to their resolution as outcomes' [13 p.634]. These then form the basis of the 2 x 2 matrix from which, in turn, four scenarios are derived – one for each quadrant of this matrix. This focus on extreme, but yet highly plausible outcomes, in combination with a focus on their impact, is an aspect of the IL scenario planning process that is in 'essential unity' with PST, as Shackle suggested in the 1980s in his private correspondence with Shell's then Chief Economist Michael Jefferson [43 p.210]. Another is PST's use of plausibility rather than probability, with PST essentially being a means by which to think about the future explicitly design to avoid using probability. As described below in detail, the reasoning behind Shackle's rejection of probability provides strong theoretical support for scenario planning.

3.2 The inadequacy of probability as a means for considering the future

3.2.1 Probability and the problem of 'crucial decisions'

A central part of the commonality - or the 'essentially unity', as Shackle put it [43 p.210] - between Potential Surprise Theory, as set out above, and scenario planning, is that both employ plausibility instead of probability. Indeed, Shackle's most enduring contribution to the literature was to show in detail why probability is a highly problematic means for considering certain aspects of the future – those characteristic of fundamental uncertainty, which are also the domain of scenario planning. Shackle shows that frequency-based probability amounts, essentially, to the outcome from a series of 'trials' of the same type – a 'reference class' in the parlance of probability theory. For example, tossing a fair coin many times represents a 'series of trials', each constituent trial of which would likely be conducted with the same coin, tossed by the same person, probably in the same environment. Even where some of these conditions vary to some extent [30 p.22], there is still knowledge to be gained from such a series of trials, but to gain this knowledge the series must be treated as a whole, allowing for the creation of a frequency ratio. In this case, this represents the ratio by which the coin lands with heads facing upwards compared to tails. Over a sufficiently long series, of course, the ratio will approximate 50/50 and, in this simple example, this is the knowledge which the 'series of trials' provides. This

knowledge is useful for decision-making about the future because a future series of trials of the same type will yield the same ratio.

The important point to note is that this useful knowledge can only be accrued through a process of aggregating together individual trials to form an overall 'experiment'. Such aggregation can only occur because each individual trial (toss of the coin) is sufficiently similar to every other. For this reason, Shackle refers to this type of aggregated experiment as 'divisible', because the useful knowledge accrued from it is achieved by dividing the problem into a series of replicable trials of the same type. By clearly establishing the simple concept of a seriable, divisible experiment leading to a frequency-ratio Shackle can more easily outline an accurate conceptualisation of the opposite: a non-seriable, non-divisible experiment, which is not amenable to probabilistic reasoning. This is a single act which cannot be 'broken down into a number of more elementary performances' [30 p.23], all of which resemble each other and which, when taken together, allow the observer to accrue useful knowledge in the form of a frequency-ratio. This is the nature of what Shackle calls a 'crucial experiment/decision' [30 p.6]. Crucial decisions are incapable of absorption into a reference class by any means, even by pooling their occurrence across the many different individuals or organisations to which they occur; and, for this reason, probabilistic reasoning is of no use for dealing with crucial decisions.

Wright et al. [13] show that scenario planning is carried out with three common objectives in mind, one of which is to improve decision-making. The types of decision for which scenario planning is conducted are those that are strategic in nature [13], representing crucial decisions. For example, Shell's decision to reduce capacity in light of an anticipated reduced supply of oil prior to the 'oil crises' of the 1970s [43, 46, 55] was a crucial strategic decision that was not amenable to a divisible, seriable experiment. Shell could not run a series of trials to test their decision to reduce capacity; oil-refining capacity cannot be ramped up and down easily, so a decision to reduce capacity has serious strategic implications if incorrect. In other words, Shell's decision changed the very circumstances in which it was made, so that future decisions would never again be made in the same circumstances - which is the essence of a crucial decision. For this reason they used scenario planning rather than the computer-based, probabilistic means to consider the future they had previously relied on [43, 46, 55]. As this example shows, Shackle's concept of a crucial decision is therefore highly useful as a theoretical justification for the use of scenario planning instead of probabilistic and projection-based modelling approaches. It is crucial decisions that make scenario planning necessary.

3.2.2 Probability and the problem of 'additivity'

At the time Shackle was setting out his ideas in the 1940s and 1950s, Savage was laying the foundations of what would become the subjective expected utility approach to decision making [50, 47-48]. Proponents of this approach could – and, indeed, did [50] – respond to Shackle's discussion of the crucial-decision problem by agreeing that it applied to a frequency-based approach to probability, but stating that it does *not* apply to a subjective probability approach. The use of subjective probability could accommodate crucial decisions, it is argued, because even where an objective probability distribution cannot be created based on frequency, a subjective one can anyway be elicited from individuals' decision-making behaviour [50 p.1134]. Yet, even if this is so, there remains a fundamental problem with probability, as shown by Shackle [30 p.68-74]: the problem of 'additivity'.

The 'additivity' that the problem's name refers to is the adding together of the probabilities of rival hypotheses about the future. If we imagine there to be three possible outcomes ('hypotheses', as Shackle refers to them [30 p.8]) in relation to a particular aspect of the future, under probability theory the sum of their rival probabilities must amount to unity (i.e. to 1). Therefore, if a new hypothesis emerges as to a fourth possible outcome, it can only be accommodated by reducing the probabilities associated with the current hypotheses, by adjusting one or more of them downwards. It stands to reason, then, that for probabilistic reasoning to be useful, and in order to avoid this problem, the entire set of possible outcomes must be known in advance – the 'choice set' must be complete from the start. This is a fundamental assumption at the heart of the Kolmogorov axioms that underpin probability theory [60]. These axioms assume that all possible outcomes are incorporated within a currently considered event space, such that the probability that one out of all the events comprising the event space will occur is equal to unity. Whereas, from the PST perspective, where there is an abundance of uncertainty and complexity about the future, as there is in relation to crucial decisions, this assumption will not hold, and an outcome that is not currently considered, and which is therefore not part of the current event space, could be the actual outcome. Under the Kolmogorov axioms, if the event space cannot be fully and precisely defined in advance, then the probability of any one outcome, or even of any subset of outcomes, cannot be defined.

For most - or even all - crucial aspects of the future, a full set of possible outcomes is not known, and can never be known, in advance. We cannot know the full set of possible outcomes so as to reduce the problem of the future to one of probability [41 p.75]. When closure cannot occur, additional possible outcomes must be added as we feel our way into an opaque future. We must add to currently considered possible outcomes new possible outcomes, but this cannot be done within a probabilistic approach without diluting the importance attributed to currently considered outcomes. This problem of 'additivity' applies whether probability is frequency-based, as in a seriable, divisible experiment, or conceived of in subjective terms, as in subjective expected utility theory.

In relation to this Earl and Littleboy [42 p.115] discuss how Shackle viewed games in which innovations in strategy occur over time to be problematic for probabilistic reasoning. In most environments in which scenario planning is employed, just such innovation occurs. The development of a particular weapon system by one power invokes a response which may negate it by another. Individuals alter their behaviour in light of changed circumstances and their observations of the behaviour of others. This reflexivity is at the heart of fundamental uncertainty and it acts against the possibility of ever having a closed choice set. Under these circumstances, the problem of additivity becomes acute. The use of subjective probabilities does not assist with this as they must still amount to unity, meaning there is still a requirement to adjust down existing hypotheses about the future to accommodate a further one. Shackle objected to the adjusting downwards of existing conjectures as new ones are added [30]. In his view, the emergence of a new hypothesis does not affect, in the decision-makers' mind, the possibility of the occurrence of existing hypotheses, as a probabilistic approach implies it must. It is for this reason that Shackle bases his measurement of potential surprise on *disbelief* in a particular outcome, rather than *belief* [30 p.30]. Disbelief in a newly occurring hypothesis does not affect disbelief in existing hypotheses, removing the problem of additivity[1].

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[1] However, it can be countered in response to the problem of additivity that a 'residual hypothesis' can be used as a catch-all category for future outcomes that do not currently occur to the decision-maker and which must, therefore, subsequently be added as their possibility emerges and is recognised. Shackle discussed this issue in several places in his work [30 p.59-62] and considered the idea that a residual hypothesis can overcome the problem of additivity in relation to a frequency-based approach to probability - as in a seriable, divisible experiment - to be an 'insidious fallacy' [34 p.111]. Yet, even within a subjective probability approach, in which probabilities are *not* assigned on the basis of objective frequencies, there remains the same problem of having to adjust the probabilities previously attached to those outcomes already considered and known, so as to accommodate a new possibility that emerges from the residual to become part of the known and considered outcomes over time. Shackle therefore maintained that the use a residual hypothesis is simply an acknowledgement by the decision-maker 'that he has no basis for considering his existing list of particularized hypotheses to be comprehensive' [49 p.251-252]. Shackle therefore considered the subjective probability approach to be unable to accommodate the use of a residual hypothesis in the same way a frequency-based probabilistic approach is unable to [49 p.262]. See Basili and Zappia [49] for a discussion of this issue, as-well-

3.3 The debate regarding the use of probability or plausibility in scenario planning

Ramirez and Selin [44] state that the debate about probability and plausibility in scenario planning is a long-running one that has never been adequately resolved, leading to confusion. They evidence this by reference to Godet [61] who situates the possible as a constituent part of the probable, whereas elsewhere the reverse view is taken [44]. It is also evidenced by Millet [45] who suggests using plausibility but then attaching subjective probabilities to scenarios. However, Jefferson [43, 46, 55] states that, during the 1970s period in which Shell successfully used scenario planning to anticipate the forthcoming oil crises, they explicitly chose *not* to attach probabilities because this undermined the scenario process. It focused too much attention on the probabilities themselves, thereby demotivating participants to examine in detail futures perceived as having low probabilities, but which could be highly damaging.

According to Ramirez and Selin [44], the debate about probability and plausibility manifests itself in three distinct 'cultural clashes'. Each of these is associated with a preference for one or the other of probability or plausibility. Firstly, there is the qualitative versus quantitative 'cultural' divide in scenario work. Secondly, there is that between those wishing to approximate prediction and those who think that fundamental uncertainty implies the impossibility of prediction. Thirdly, there is the divide between those who see scenario planning as an art and those who see it as a science. Which side of these 'cultural clashes' one belongs to determines one's view with regards to probability and plausibility. As Ramirez and Selin [44] go on to suggest, one group privileges a deductive, positivist and reductionist approach, leading to claims about 'truth' in relation to future reality, and an advocating of the quantitative, predictive and 'scientific' approach to scenario planning. A second group is on the side of qualitative, non-predictive scenario planning as an 'art'. For this group the future is constructed. Wilkinson [8] makes a similar distinction when referring to the former group as 'Homo-Deductivist' and the latter as 'Homo-Constructivist', and Millet [45] identifies two similar groups.

The theoretical insight of the crucial nature of some aspects of the future, taken alongside Shackle's discussion of the problem of additivity and the impossibility of a fully-specified choice set - both problems PST was designed to overcome - provide the means to settle the debate about probability and plausibility in scenario

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as recent developments in relation to 'non-additive probability theory' which seek to deal with the problem of uncertainty by retaining the use of probability but avoiding its additive nature.

planning. A probabilistic approach is of no use for dealing with crucial decisions and the requirement for additivity renders probability an impractical means for consideration of the future; because of the inability to 'close' choice sets, it is necessary to add conjectures over time, as the future unfolds, without diminishing the possibility of currently considered outcomes. Shackle's detailed distinction between the crucial aspects of the future, and the more mundane divisible and seriable – and, therefore, probabilistic – aspects, provides a compelling theoretical justification for the use of plausibility in scenario planning, the theoretical justification for which is sometimes left implicit currently.

4 Using PST to situate scenario planning within the broader contemporary debate on fundamental uncertainty

4.1 The initial rise and then decline of PST

Knight, writing in the 1920s [62], was among the first to set out a distinction between risk and uncertainty. Knight explicitly stated that 'Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated' [62 p.19]. Keynes, writing in the 1930s [63-64], made a similar distinction, describing his view on uncertainty thus:

> "By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known
> for certain from what is only probable…The sense in which I am using the term is that in which
> the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty
> years hence. . . . *About these matters there is no scientific basis on which to form any calculable*
> *probability whatever*" [emphasis added, 64, p.113-114].

It is clear, then, that Shackle was not the first economist of note to distinguish between decisions that are crucial, and therefore subject to fundamental uncertainty for which probability is no aid, and other types of decision that are more akin to risk, which are more amenable to probabilistic reasoning. Indeed, Shackle would have been more aware of the provenance of his ideas on uncertainty than anyone else since his second major contribution to economics after PST was his many writings on Keynes [42]; Shackle was one of the 20th century's most prominent experts on Keynes [42].

However, at approximately the same time that Keynes published his 'General Theory' in 1936 [63], two other economists, Ramsey [65] and de Finetti [66-67], published work that laid the foundations for a wholly different (from that of Knight, Keynes and Shackle) perspective on uncertainty - one which remains dominant to this day. This now dominant alternative makes no distinction between risk and uncertainty, implying both can be treated in the same way using a subjective probabilistic approach. It assumes that those making decisions under circumstances of uncertainty, as under circumstances of risk, behave according to a set of decision-making rules such that they maximise their subjective expected utility by using probability assumptions that are continually updated through the use of Bayes theorem [68, 69 p.271, 49-50].

This perspective on uncertainty was further elaborated by Savage in 1950 and 1954 [47-48]. Essentially, it implies that even in situations in which an 'objective' probability distribution, based on frequency of past occurrences, cannot be created, a subjective probability distribution can anyway be inferred from individual decision-making behaviour; and this subjective distribution is perfectly valid as a decision-making device even under circumstances characteristic of uncertainty, as long as the decision-maker's internal beliefs are consistent with each other. The upshot is that individuals are assumed to behave in the same way when facing either risk or uncertainty in decision making; and probability, in contrast to the view of Knight, Keynes and Shackle, is a useful means for dealing with uncertainty as well as risk.

During this period (the early 1950s), in which Savage laid the foundations for the subjective expected utility approach, Shackle's prominence within economics was at its height and, for a time, his alternative, non-probabilistic approach (PST) vied with subjective expected utility for acceptance as the 'standard' approach to decision-making under uncertainty [50]. However, Shackle's approach gradually fell out of favour, leaving the centre ground to subjective expected utility theory. The reason for this, according to Zappia [50], is in no small measure due to Shackle's personality - his unwillingness to engage with opponents, even those who were sympathetic to the importance of a behavioural distinction between the treatment of risk and uncertainty.

In fact, as Earl and Littleboy [42] describe, Shackle made no attempt whatsoever to take on the emerging early subjective probability approach, such that looking back at his work during that period in conjunction with his private correspondence, it appears that Shackle simply did not even notice that the subjective probability

approach had arisen while he had been setting out PST. However, this lack of engagement may have been because Shackle considered himself to be embarked on a wholly different journey to that of the subjective probability theorists. Subjective expected utility theory does not have reference points distinguishing potential outcomes in terms of gains and losses, or a focussing on extreme outcomes. Shackle's primary concern, then, is on how the individual may make important decisions, not on how insurance companies and others make decisions using aggregated data. Therefore, his lack of engagement may have stemmed from a consideration that his primary concern was a decision of a different type to that which is the domain of subjective expected utility theory.

Shackle's ideas gradually moved from a position of vying for the centre ground in economics in the 1940s and 1950s, to a peripheral position in subsequent decades, where they have remained until recently [50]. Ever since, a considerable amount of research in mainstream economics, as-well-as in other disciplines such as decision-making, has been devoted to an attempt to reduce decision problems under uncertainty to decision problems under risk. However, this may now be changing, bringing Shackle back to prominence [49].

4.2 The return to prominence

Shackle's PST is returning to prominence because there is increasing recognition that failing to distinguish between risk and uncertainty is untenable [49]. We now live in a world in which the distinctiveness of uncertainty - as well as its ubiquity - is perhaps more undeniable than ever before. Events such as the credit crunch, 9/11, and wars such as that in Syria, render the nature of uncertainty and its intractability tangible. Greater interconnectedness provides us with large amounts of data to analyse, implying the greater possibility of a probabilistic, computational approach to uncertainty; yet, this mass of data arguably increases opacity and uncertainty, rather than reducing it [52-53].

The increasing recognition of a qualitative difference between risk and uncertainty is reflected in the growing literature on the subject of 'deep uncertainty' [70]. Deep uncertainty is gaining increasing attention in the climate-change field in particular. Prominent authors in this field, such as Kwakkel et al. [71], refer to the 'confluence' of uncertainties we now face - including in relation to climate change - the interactions between which compound their 'wickedness', rendering them irreducible to risk. Similarly, Maier et al. [70 p.155], also

writing within this field, explicitly refer to a distinction between 'Knightian' uncertainty and probabilistic risk in their discussion of deep uncertainty. The growing recognition of this distinction in this field is leading to increasing emphasis on scenario-based approaches used in conjunction with formal modelling, since scenario techniques are considered more capable of dealing with uncertainty than are formal-modelling approaches used in isolation [72 p.248, 73-77].

Moreover, even in mainstream economics, the view that there is a fundamental distinction between risk and uncertainty is gaining ground. Basili and Zappia [49] state that in mainstream economics the view that risk and uncertainty are equivalent is no longer treated as an unquestionable dogma. This is propelling Shackle and PST to the forefront of contemporary debates in these fields [49]. Shackle's PST was ahead of its time [50] and is only now receiving the attention and prominence it arguably should always have done. By underpinning scenario planning with PST, scenario planning can ride the crest of the same wave that is propelling Shackle's ideas back to prominence. In the 1950s, the economist Kenneth Arrow [78] singled out PST as distinct from other contemporary approaches that made a distinction between risk and uncertainty because it is the only one to be fully formalised [50 p.1134]. While Knight and Keynes made a similar distinction between risk and uncertainty, only Shackle set out a complete, non-probabilistic approach to dealing with uncertainty. If any existing theory, then, can provide a theoretical underpinning for scenario planning - which also emphasises the fundamental distinctiveness of uncertainty and how to deal with it - it must therefore be PST.

Shackle showed that once time is taken into consideration, accurate foreknowledge becomes a logical impossibility [36, 39], because the effect of human reflexivity, creativity and imagination on the adaptation of actions ('sequels'), taken in light of present occurrences, means a complete choice set (leading to a fully-specified event space) can never be known in advance. As noted by Basili and Zappia [49 p.250], the problem of an incomplete choice set, so emphasised by Shackle, 'bears close resemblance' to the perspective adopted by modern day critics of the mainstream subjective expected utility approach to decision-making. This is one of the primary reasons that PST is now gaining traction having lain, if not dormant, then peripheral for decades.

A central aspect of this contemporary criticism of the mainstream perspective is the view that it only applies in a 'closed universe' [49 p.250, 79] in which all possibilities can be enumerated in advance. In contrast to this,

the futures of most systems of interest - such as the economy, the environment, or the strategy of individual organisations - are open and undetermined, acting against the possibility of ever fully-specifying all possible outcomes in advance. Shackle's PST, in emphasising the role of individual imagination in shaping the future, acknowledges that the future is constructed, open and impossible to close in the way mainstream decision-making theory implies; scenario planning acknowledges the same. In sum, scenario planning underpinned by Potential Surprise Theory can relegate the subjective expected utility approach to its rightful place as a means for dealing with circumstances characteristic of risk; scenario planning can then become *the* standard approach to dealing with uncertainty as distinct from risk.

5 Potential Surprise Theory as a theoretical framework for scenario planning

5.1 The shared ontology of Potential Surprise Theory and scenario planning

Reading Shackle's many works, his emphasis on the freedom to choose, and its implications for thinking about the future, can strike the reader almost as an obsession. That freedom to choose implies that the future is highly indeterminate is self-evident. The outcome of any choice made by an individual decision-maker depends not only on that choice, but the choice made by many others in response to it. This reflexivity implies a strong indeterminism. As Loasby puts it [80 p.81], since in Shackle's view the decision-maker is not even certain of his/her own future conjectures and contingent choice sets, it is certainly beyond capability to know those of others in response. According to Loasby, Shackle is therefore implying that a lack of foreknowledge about the future is irremediable [80]. Because of this seeming irremediableness, Shackle's theorising has been interpreted as highly nihilistic and self-defeating, negating any possibility of anticipating the future before it arrives [81].

However, in order to emphasise the indeterminism stemming from the freedom to choose and, related to this, our responsibility for the future, Shackle sometimes took to unrealistic extremes. This is evident in Shackle's tendency to characterise Potential Surprise Theory as a means for decision-making that is entirely independent of antecedent conditions, stemming instead from the 'autonomous, absolute origination' of the imagination of the decision-maker [41 p.73], implying an absolute form of subjectivity and, therefore, absolute indeterminism because of this absolute subjectivity. The irremediable lack of foreknowledge about the future Loasby speaks

of is reflective of this tendency to take an extreme view so as to emphasise indeterminism, choice and responsibility for the future. However, in reality, PST, like scenario planning, recognises that antecedent conditions affect future outcomes.

The tendency to mischaracterise his own theory so as to emphasise responsibility for the future was recognised by Shackle himself, as captured in private correspondence written by Shackle to John Spiers, Chairman of Wheatsheef Books, in which Shackle writes:

> 'In my book Imagination and the Nature of Choice, *I went to the extreme* of following out the consequences of supposing that thoughts can be in some respects exempt from governance by antecedents or current perceptions. This supposition will enable us to claim some responsibility for the course of things, releasing us from determinism and would require us to renounce any power of single-track prediction' [emphasis added, 82].

In acknowledging the extremity of this position, Shackle is acknowledging that choices do *not* occur in a vacuum. Individuals, or organisations such as governments or businesses, do not have a boundless range of options leading to an ability to conjure into existence any desirable future, exempt from the influence of antecedents. If this were true, it would not be necessary to consider the future at all, but simply bring the most desirable vision of it into being. Rather, the past, and perceptions of the present, impinge upon perceptions as to present options, which in turn bound the future. Individuals make 'history-to-come', as Shackle called it [41], but not in circumstances of their own choosing. While emphasising the indeterminism resulting from subjectivity, choice and reflexivity, so as to affirm our responsibility for the future, Shackle recognised this. In PST, future possibilities are, therefore, *not* considered boundless; decision-makers are able to dismiss future possibilities on the basis of 'fatal flaws' (i.e. immovable obstacles) to their realisation [41 p.70], bounding the range of possible outcomes.

Furthermore, Shackle, in Imagination and the Nature of Choice [38 p.2], makes reference to the importance of 'constant elements', which can be characterised as the prevailing trends within the particular 'field' in which a decision is to be made, and the impingement of these upon the decision. Herein we see further crossover with scenario planning, which incorporates the identification of 'pre-determined elements' [13], which are akin to

Shackle's 'constant elements'. Antecedent conditions and current perceptions (of what may transpire as important for shaping the future) feature strongly in the early stages of the IL scenario process through the identification, often through use of a PESTEL framework, of the 'driving forces' (i.e. causes) expected to bring about change in the future [13 p.634]. PST and scenario planning both envisage the future as made up of what Shackle referred to as 'the plurality of sequels' to emphasise indeterminism; under both, this plurality is bounded by current perceptions as to salient features of the future in the minds of the individuals considering it, and by their perception of antecedent conditions, which act to narrow the range of possibilities.

5.2 A shared philosophy of vigilance and scepticism in the face of uncertainty

How the process of imagination, leading to the formation of expectations, is visualised as occurring by Shackle is a particularly important aspect of PST in terms of a shared philosophical approach, based on scepticism in the face of uncertainty, as also adopted in empirical examples of successful scenario planning. This philosophical stance towards uncertainty is a further, important aspect of the shared ontology of PST and scenario planning.

Shackle envisages individuals asking themselves 'How surprised would I be if this outcome actually occurred, if, at the time it occurred, I were still looking at the world in the way I look at it right now?' [42 p.88]. One answer could be 'Very surprised indeed, there is just so much standing in its way' [42 p.88]; another answer might be 'Not surprised at all, since there is so little standing in its way'. In other words, the decision-maker considers barriers and enablers of a particular future's realisation, leading to the formation of a view on plausibility. However, Earl and Littleboy [42] highlight the possibility for this process to become mired in an infinite regress since the full process, as outlined by Shackle, involves iterative consideration of barriers and enablers. There is consideration, then, of the barriers and enablers of a particular future, and then the barriers and enablers of the barriers and enablers of this future, and then the barriers and enabling factors of those barriers and enablers, and so on, ad infinitum. The process of consideration of the future could easily become stymied then, with the mass of conflicting future possibilities and counter possibilities leading to a fog of complexity [42]. Furthermore, it is always possible that when operating within such a fog of complexity our imaginations overlook an important factor, whether an enabler or preventer of a particular future, which, had we considered it, would have caused that particular outcome to gain in prominence in our considerations.

Shackle was aware of these problems and so, ultimately, the underlying normative philosophy towards uncertainty that runs as a thread through PST is one which constantly emphasises the importance of remaining vigilant in the face of uncertainty, by never accepting that our expectations are definitive and complete. To avoid being taken by surprise it is necessary to look for barriers to outcomes that we might not previously have considered, or enablers which may promote in importance a previously-downgraded outcome. PST, then, promotes an attitude of scepticism leading to a constant questioning of conventional wisdom and widely-held assumptions. Jefferson shows [55] that it was exactly such a vigilant attitude of scepticism towards received wisdom, and the constant questioning and updating of considered barriers and enablers of particular future outcomes, that allowed those working on scenario planning at Shell in the 1970s to successfully anticipate the forthcoming oil crises. PST and scenario planning therefore both promote a philosophy of vigilance and scepticism as a means to deal with uncertainty.

5.3 Similarities to the anti-fragile approach to uncertainty and scenario planning

This philosophy of scepticism and vigilance also has much in common with N. N. Taleb's anti-fragile method for dealing with uncertainty [52-54], which has recently been transformed into a novel scenario-planning approach [1]. Taleb [52-54] also places strong emphasis on remaining sceptical and, in light of the aforementioned fallibility of the human imagination, and the potential to overlook or to be unable to identify important enabling or disenabling factors (i.e. causes), suggests focusing instead on potential outcomes without necessarily considering the cause of those outcomes [1, 54]. Indeed, Taleb makes reference to Knight, Keynes and Shackle [52 p.188] and their distinction between risk and uncertainty in his three-volume treatise on uncertainty which ends with the setting out of the anti-fragile approach to dealing with it [1].

The similarity between anti-fragility and PST is evident in that under PST the ascendency function, representing combined expectations in relation to plausibility and pay-off, leads to the creation of focus gains and losses for each possible future outcome, leading in turn to the selection of that option in which potential losses are smallest relative to the size of potential expected gains, and depending on the decision-maker's subjective appetite for uncertainty. Under anti-fragility's convex distribution of pay-offs [1 p.219] there is similarly a focus *loss* in the form of a cut-off point beyond which losses cannot occur. Furthermore, while there is *not* a fixed level of expected gain as in PST, constituting a 'focal' gain, under anti-fragility decisions are nevertheless made in a

similar spirit in that the option with the largest potential for exponential gains, but a clear focal cut-off point for losses, is that which should be selected.

5.4 Potential Surprise Theory: Normative or descriptive?

One aspect of PST's normative nature as a decision-making theory has already been touched upon above. It promotes a normative philosophy of vigilance and scepticism in the face of uncertainty such that we should never assume that identified barriers and enablers of particular considered futures are definitive. We must constantly seek to update our view of these based on new, emerging information, and we should constantly question received wisdom. Beyond this normative, general attitude towards uncertainty, the actual mechanics of the PST decision-making process are also normative in the sense that it represents a description of how decision-making *should* be conducted in order to avoid being caught out by surprises. Yet, it is clear from Shackle's theoretical discussions setting out PST that he also considered it to describe the way that crucial decisions are made empirically. While Shackle did not himself engage in any empirical research to provide evidence that might support PST as descriptive of real-world decision-making, others have conducted research that lends PST some support in this regard.

Earl and Littleboy [42 p.168] consider the extent to which Kahneman and Tversky's empirical work on 'Prospect theory' [83-87] provides empirical validation for PST. While prospect theory is a subjective expected utility approach based firmly on probabilistic-reasoning, which Shackle spent a lifetime rejecting, it lends weight to Shackle's thinking in that it views individuals as thinking about outcomes in terms of prospective gains and losses. As such, under prospect theory [83], as in PST, large losses weigh more heavily on the mind of the decision-maker, explaining the empirical phenomenon in which individuals are willing to take large risks in order to avoid making a loss, and the so-called 'endowment effect', whereby individuals' willingness to pay for something they do not yet have is less than they would be willing to accept for that same thing upon possessing it [42 p.168]. However, the empirical work conducted in relation to prospect theory did not ask individuals about major, circumstances-changing decisions [42 p.171] - those which Shackle characterised as 'crucial'. While one can easily ask individuals to decide upon different small sums of money to empirically test prospect theory, the crucial nature of crucial decisions renders them somewhat more difficult to conceive in the mind of the individual for testing purposes.

Kahneman and Tversky elsewhere make reference to the so-called 'Linda effect' [84 p.158-159, 86-87] on individuals who are asked to write descriptive narratives, as they are in scenario planning. They tend to assume that the sequence of details and events written into the story combine so as to *increase* the probability of the scenario story transpiring [84 p.158-159]. This is known in the scenario planning literature as the 'conjunction fallacy' [1 p.217], as associated with the 'simulation heuristic' [13 p.634]. The conjunction fallacy, as evidenced through the Linda effect, can be viewed as empirically validating Shackle's assertion that it is plausibility which governs individual decision-making, rather than probability. The additional details added to the scenario story increase its *plausibility* in the minds of decision-makers, even though in reality they reduce its *probability*.

Smithson and Ben-Haim [88 p.1912] note the chronic human tendency to underestimate the likelihood (i.e. probability) of surprises and show that one reason for this is the so-called 'Catch-All Underestimation Bias' (CAUB), as evidenced by Tversky and Koehler [89]. CAUB suggests that if event categories are combined under a single super-set then the probability assigned to the super-set (i.e. the probability of any member of it transpiring) is typically less than the sum of the probabilities assigned to its constituent categories of event. An example is someone asked to estimate the probability of being delayed tomorrow, who then assigns a lower overall probability to this than the sum of the probabilities they would individually assign to being late to rise, delayed by traffic, distracted by meeting someone on the way etc. [88]. The lack of detail associated with the probability assigned to the super-set leads to an overall underestimation, which is the opposite problem to that in the Linda effect in which detail causes an overestimation. In CAUB and the Linda Effect we therefore have empirical validation of the difficulty of using probabilities for thinking about future outcomes, which Shackle went to great lengths to emphasise.

5.5 Combining construction and deduction for a scenario planning based on abduction

Under abductive reasoning, as originally set out by Peirce [90], decision-making is based on conjectural leaps of the imagination. PST provides a formalised means for attributing values to plausibility and impact by eschewing probability and providing a quantitative scale for plausibility. Yet, at the same time, it fully recognises the subjective and constructed nature of any consideration of the future, which must inevitably be

based on imagination. Yet, it also recognises that the individuals doing the imagining nevertheless seek to arrive at the best strategy through a process of deduction, albeit one which is subjective rather than based on a fully-specified choice set. A scenario planning underpinned by PST therefore has the potential to assist in overcoming the divide between constructionists and deductivists in scenario-planning research by incorporating imagination and subjectivity, but also deduction - thereby rendering scenario planning an abductive means for considering the future, as advocated by Wilkinson [8].

6 Summary

In this paper we have shown that scenario planning's limited theoretical underpinning is perceived to affect its use in practice. Setting out a detailed set of theoretical foundations for scenario planning can assist in the development of scenario planning as a practical tool by rendering it more credible and by galvanising the resources and attention required to empirically test its efficacy, identifying the approaches which work best in different contexts. This is a pressing need since recent decades have seen a proliferation of different methods and approaches, and few, if any, have been empirically tested.

This paper has shown how G. L. S. Shackle's PST is highly congruent with scenario planning. The two contain many similarities, including the use of plausibility rather than probability, and the focus on extreme outcomes. The ontologies of the two are in unison in envisaging the future as constructed through the imaginings of individuals with the power to choose between different imagined options. This contrasts with more mainstream decision theory which views individuals, even under circumstances characterised by fundamental uncertainty, as choosing from a fully-specified choice set representing all possible outcomes, which are known in advance and therefore amenable to probabilistic optimisation. Because of the emphasis on freedom of choice and construction through imagination, PST places strong emphasis on indeterminism, as does scenario planning. Both see individuals as grappling with fundamental uncertainties which arise as a result of what Shackle termed 'crucial decisions', as well as stemming from the reflexivity associated with human imagination. Under both, the choice-set of the future is seen as open and impossible to close. Furthermore, because of its emphasis on subjectivity and choice and its view of individuals as constructing the future through imagination, yet selecting a best strategy through a deductive process of comparison and elimination of imagined options, a

scenario planning underpinned by PST can provide the means to overcome the current divide between constructivist and deductivist approaches in scenario planning practice and scholarship.

The correspondence between PST and scenario planning was recognised by those working at Shell in the 1970s and 1980s, and by Shackle himself, who considered them to be in 'essential unity'. That this correspondence has remained relatively unexplored is evidence of the generally atheoretical approach to scenario planning highlighted in this paper as damaging to its development, and which continues today, despite some recent progress. It is a considerable oversight since, as this paper has shown, PST has much to offer as a theoretical framework for scenario planning. The aim of this paper has been to begin a debate on the usefulness of PST as an underpinning theoretical framework, on the foundations of which scenario planning can be further developed as an academic discipline, lending support to its use as a practical tool.

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