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Article

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Uncertainty: A Diagrammatic Treatment

Sheila Dow

Abstract

The purpose of this paper is to clarify the difference between the mainstream and Keynesian understandings of uncertainty which persists in spite of superficial similarities. It is argued that the difference stems from the mainstream habit of thinking in terms of a full-information benchmark, where uncertainty arises from incomplete information. Degrees of uncertainty (or ambiguity) refer to the quantifiable extent of incompleteness. In contrast, Keynesian uncertainty cannot, even in principle, be eliminated. By treating uncertain knowledge as the norm, Keynesian uncertainty theory analyses differing degrees of uncertainty in relation to grounds for belief and thus considers the cognitive role of institutions and conventions in influencing the degree of uncertainty. The paper offers a simple diagrammatic representation of these differences, and illustrates its use with different depictions of the crisis, its aftermath and the policy response appropriate to each understanding.

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1 Introduction

Uncertainty rose sharply with the financial crisis, causing a rush for liquidity and a collapse in spending plans; recovery from the ensuing economic crisis required a restoration of confidence in expectations and some positive animal spirits.

This statement would probably be supported by a large swathe of economic commentators. It sounds like a very Keynesian analysis – so is it the case again that ‘we are all Keynesians now’? But the above statement has to be understood in terms of what is assumed about expectations more generally (including outside of a crisis situation), and ultimately about the nature of the subject matter. When we explore this further below we will see that uncertainty in mainstream economics is treated as an aberration from the certainty benchmark, with greatest incidence in times of crisis. We will explore the very different Keynesian analysis of expectations which applies in and out of crisis, without a certainty benchmark, and where uncertainty is endogenous to social conventions and institutional developments (see further Dow 2013, 2015). Since each approach understands uncertainty differently, they each hold different implications, not only for theorising, but also for policy addressed to reducing uncertainty.

The term ‘uncertainty’ itself is used in the literature with a range of meanings which in turn reflect different frameworks.¹ In traditional mainstream economic and finance theory, uncertainty is conflated with risk, which is in turn measured by low (objective or subjective) probability. But here we treat known quantifiable risk (including higher-order stochastic structures) as falling within the category of certain knowledge and use the term ‘uncertainty’ to apply only to any circumstances where quantifiable probabilities are not known, whether knowable or not. It will be argued that it is that proviso about knowability which will prove to be crucial. Uncertainty about quantitative probabilities, or ambiguity, has been an increasing focus of the mainstream analysis of uncertainty in the wake of the crisis. But since ambiguity presumes that quantified probabilities are in principle knowable, it is a special case of uncertainty. *Fundamental* uncertainty (or ‘radical’ uncertainty) is the outcome of the absence of quantifiable cardinal probabilities, which Keynes argued to be the more general case.

¹ See Dequech (2011) for a typology of different meanings of uncertainty. Sometimes different terms have common meaning. This too can be confusing, but our focus here is on different meanings of the term ‘uncertainty’.

There is a substantial literature on this subject, but it is dense and complex. Other notable figures than Keynes, such as von Mises, Hayek and Shackle, have also explored uncertainty that in a range of ways differ from the standard mainstream account. We focus here on Keynes's views on fundamental uncertainty as providing a theory of decision-making which is arguably the most philosophically-grounded and the most developed, as a counterpoint to the mainstream. Further the account here of Keynes's ideas is itself a simplification, since a full account requires a more complex typology (as offered for example by Carabelli 1995). But given that the purpose here is to clarify the most important differences between fundamental uncertainty and ambiguity (both distinguished from risk), some simplification is necessary.²

The aim is clarification rather than advocacy of any one approach. We attempt to communicate the material in a simple, visual, way in a series of diagrams set out below. These diagrams refer to the 'universe of expectations' in an economy, i.e. the emphasis is on a (simplified) notion of the state of expectations in the economy. Where relevant to the analysis we will consider compositional issues; in the mainstream approach these refer to the scope for different groupings of representative agents with different information sets, and in the Keynesian approach primarily to the role of social conventional knowledge within different groupings.

First we consider how uncertainty is understood according to the dualistic identification of fundamental uncertainty with ignorance. We then proceed to consider non-dualistic ideas on degrees of uncertainty. The differences of approach are illustrated further by diagrammatic representations of the run-up to the crisis and the situation following the onset of crisis. The paper concludes with a discussion of the implications for theory and policy of these different understandings.

² Dequech (2000) provides an excellent account of the distinction between these two approaches to uncertainty, going into many of the theoretical issues addressed here in greater depth.

2 A traditional dualistic understanding of uncertainty

In the absence of a theory of fundamental uncertainty, traditional mainstream analysis generally conflates uncertainty with risk by our definition. While the scope for establishing objective measures of risk may be problematic, Savage's (1954) subjective expected utility (SEU) device allows for the general establishment of subjective quantitative measurement of probabilities of events occurring.³ In the traditional Bayesian framework, these probabilities apply to a (subjectively or objectively) known range of states of the world and expected events arising within that range. The universe of expectations is therefore a closed system (Chick and Dow 2005) and so fundamental uncertainty has no place in such models. In dualistic terms, either knowledge (as information) is certain in that it is subject to quantifiable probabilities, i.e. risk, or else it is not, i.e. it is the dual of risk. Uncertainty can then only be understood as ignorance.⁴ This approach is captured in the strong version of rational expectations hypothesis (REH) which became embedded in mainstream macroeconomic models, whereby there is shared knowledge of the correct model by which to calculate probabilities.

Nevertheless, in traditional mainstream macroeconomic models, there is still scope for uncertainty as an exogenous variable, a source of shock.⁵ We can show this view of knowledge in simplified form in Figure 1, which classifies the universe of expectations about events according to whether or not they are subject to (quantifiable) risk or uncertainty. Most knowledge is viewed as known (or known to be stochastic in some form), shaded white, with a solid boundary to indicate presumed knowledge about the range of possible outcomes within the known state space. There is in addition scope in non-Bayesian theory for a component of the universe of expectations, shaded black, which is outside economic theory and therefore falls within the category of uncertainty in the sense

³ Lucas (1980) justifies such an approach on the grounds that it renders Keynes's ideas on expectations operational and thus more 'fruitful', in the process eliminating a role for uncertainty.

⁴ See further Dow (1990) on dualism.

⁵ This includes models which address the unknown future by devices such as assuming prices to be established on the basis of contingent claims (Lucas 1980: 707). Earlier, Coddington (1982) had discussed Keynes's uncertainty analysis in terms of his need to find an exogenous variable to explain instability.

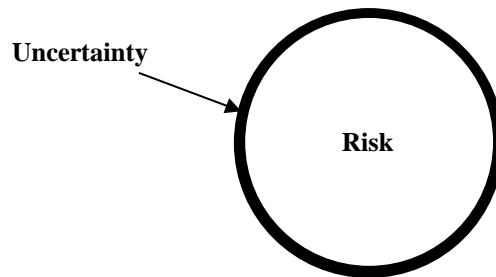


Figure 1: Expectations in mainstream economics: dualistic version

of a shock. But the scope for such uncertainty is very limited, something which is reflected in the inattention to uncertainty (as defined here) in the traditional mainstream literature. The small black outer area in Figure 1, representing uncertainty, is also bounded by a solid line to reflect the heavily circumscribed scope for shocks (which are often themselves depicted as emanating from a random distribution). The general case is knowledge to which quantitative probabilities apply, leaving the absence (if any) of such probabilities as the special case, independent of the specified range of states of the world.

This dualistic view has also been applied to Keynesian uncertainty, but with the opposite view as to which is the special case for the universe of expectations: risk or uncertainty. Keynes (1921) opened his *Treatise on Probability* with a statement about the generality of uncertainty, whereby knowledge could be treated as certain only in very special circumstances (direct knowledge and logically necessary propositions). This followed from his understanding of the subject matter, particularly of social systems, as being open and organic, limiting the scope for demonstrative logic. Subjective probability measurement did not provide the same escape from uncertainty as in the mainstream literature. Keynes (1921: 4) understood probability in its logical sense as something objective, given evidence to which reason is applied. It is also subjective in the sense that each agent draws on her own understandings in order to establish grounds for belief, but this by no means precludes uncertainty given that these grounds may be weak. Further, Keynesian expectations apply to propositions about the possible states of the world which generate events, i.e. more widely than the quantified event predictions of mainstream theory.

It was understandable how the Keynesian literature could be read in a dualistic way from a mainstream perspective, with its focus on certainty and in the absence of a theory of uncertainty. Indeed this dualism also characterised much of the earlier literature on Keynesian uncertainty (see Dequech 2000: 53). Until the re-issue of *A Treatise on Probability* in 1973, the understanding of Keynesian uncertainty was heavily influenced by Keynes's restatement of the argument of *The General Theory* in his 1937 article, where he said with respect to long-term expectations: 'About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know' (Keynes 1937: 114).⁶ For a long time the dualistic reading dominated.

This dualistic understanding of Keynesian uncertainty can be represented by Figure 2, where uncertainty/ignorance is the general case and certain knowledge, or risk, only pertains to very particular circumstances. The universe of expectations has a dashed outline to reflect the openness of the subject matter to the evolution of structure and the effects of creativity. Since these prevent the enumeration of all possible events, they account for the general absence of quantified probabilities.

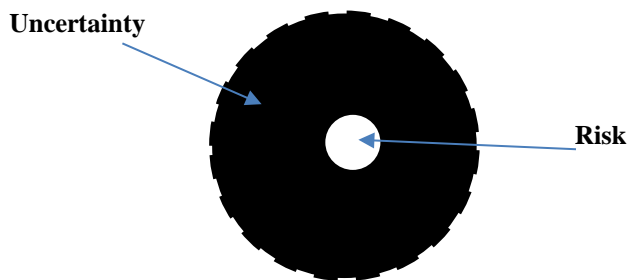


Figure 2: Expectations in Keynes: dualistic version

⁶ Knight's (1921) uncertainty is commonly discussed in similar dualistic terms. As with Keynes, Knight's discussion of uncertainty and how to deal with it is more complex than this depiction allows; however arguably Knightian uncertainty could fall within what we will discuss below as ambiguity.

Understood in these terms, it is not surprising that Coddington (1982) should warn of nihilism.⁷ From a mainstream perspective, whatever is unexplained within the formal equilibrium framework represented by the small white area is exogenous and thus beyond the scope for economic analysis. To argue that most knowledge falls outside that framework, the black area of uncertainty thus dominating the white area, is seen as giving up on scientific knowledge. This is where the issue of framework is crucial, since a Keynesian framework does in fact provide analysis of uncertain knowledge. Uncertainty may be classified as ignorance of certain knowledge, but there is much more to be said about it. In what follows we consider such possibilities within a non-dualistic framework. Further, while it is well-established now that Keynesian uncertainty is a matter of degree, are there degrees of uncertainty in the mainstream literature which do not collapse into quantifiable stochastic structures?

3 A non-dualistic understanding of uncertainty

The dualistic representation of understandings of uncertainty is at odds with the modern Keynesian literature, which we will explore below. But it may also be regarded as being at odds with the weak form of the REH, whereby there is a diversity of views as to which is the (knowable) correct model on which to base expectations because of differing, limited information sets. Concerns with uncertainty were raised early on in terms of the consequence of missing information (see e.g. Jones and Ostroy 1984) and of uncertainty about the true structure of the economy, or model uncertainty (see e.g. Hansen and Sargent 2001).

But the experience of the crisis itself provided a significant impetus to developments in mainstream thinking on uncertainty, in that it posed particular challenges to the SEU approach. The freezing of markets during the crisis was evidence that there are times when agents are not willing to place bets, i.e. unwilling or unable to estimate probabilities.⁸ Other phenomena such as

⁷ Postmodernists have also applied this term (in an approving way) to the implications of Keynesian uncertainty. See for example Amariglio and Ruccio (1995).

⁸ See Runde's (1995) critique of the SEU approach along these lines.

unexplained rises in credit risk spreads also encouraged attention to the possibility of uncertainty (Boyarchenko 2012). More generally the crisis encouraged the further development of the information-theoretic approach. The source of the crisis was seen in institutional impediments to information access (asymmetric information) with respect to risk assessment of particular products.

The effect of the crisis was seen as an exogenous shock to uncertainty itself, with consequences driven by uncertainty aversion (which may differ as between different cohorts of representative agents). These factors made it more difficult for agents to access and process information and then to learn in such a way as to converge on correct equilibrium expectations (including learning about each other's behavioural reactions). Indeed the limitations on full information, on the capacity to process information and on knowledge of the true structure of the economy may even be endemic (see e.g. Stiglitz 2009). Within this increasingly influential approach, missing information, and thus less-than-complete confidence in expectations, have come to be regarded as the norm. But uncertainty is still treated as ignorance of information which can in principle be acquired (see Morgan and Sheehan 2014). The assumption is that all possible outcomes can be listed; the real economy is such as to yield stochastic structures and these are, in principle, knowable. In other words, the subject matter is still understood as a closed system.

Uncertainty has been considered lately in mainstream economics in terms of the emergence of 'unknown unknowns' in the sense of unimaginable events. Feduzi and Runde (2014) question the coherence of such 'unknowable unknowns' in a Bayesian framework, which requires a known state space.⁹ They can only make sense as 'knowable unknowns', i.e. events which could have been imagined, but had been unimagined. Within a mainstream framework, the explanation must lie in missing information or cognitive limitations.

A related discussion of degrees of uncertainty has arisen in the financial risk literature, building on Taleb's (2007) reference to black swans as a metaphor for (supposedly) unimagined events with serious consequences like the financial crisis. The 'black swan' term is a reference to the standard example of unknown possibilities used to explain the (statistical) problem of induction as an inability to

⁹ Where an unknown unknown is understood as a low-probability event it falls within the category of risk.

enumerate all instances within a given range of possibilities.¹⁰ In unpacking Taleb's use of this metaphor, Runde (2009) pinpoints some ambiguities in the way that it has been used. For our purposes what is significant is the interpretation that the crisis is seen as a black swan event in the sense of a low probability event but also an unimagined event, i.e. as falling within the category of uncertainty as represented in Figure 1. A grey swan event is only a low-probability event, and so falls into our category of risk. However in the financial risk literature a grey swan event is sometimes also classified as an event which is less difficult to predict than a black swan event, and thus corresponds more closely to a lesser degree of uncertainty than a black swan event (see e.g. Mathijs 2012).

The possibility of degrees of uncertainty has been pursued in the mainstream literature, using instead the term 'ambiguity', in a way which accords well with information theory and which allows scope for discussing a modification of the dualistic representation of the mainstream account depicted above. Camerer and Weber (1992: 330, emphasis added) define ambiguity as '*uncertainty about probability, created by missing information which is relevant and could be known*'.¹¹ They distinguish between expectations which can be subject to higher-order probabilities from those which cannot. Higher-order quantifiable probabilities fall inside our category of risk, while ambiguity which cannot be so captured falls into the category of uncertainty. Uncertainty about (even higher-order) probability distributions is greater the more information is missing. As new information emerges, agents may change their probability estimates. But more evidence would always be expected to reduce the degree of ambiguity, other things being equal. So, even within the mainstream framework where there is one correct model (although agents are uncertain as to what it is) and therefore one notion of relevance of evidence, and where all possible outcomes have been identified, the inability to establish a quantifiable probability (i.e. uncertainty) is subject to a quantifiable scale.

While ambiguity means that there is a lack of confidence in any estimate of a single probability or stochastic structure, this can be a matter of degree which can

¹⁰ This is a more restricted notion of the problem of induction than the Humean notion we discuss below as applied by Keynes.

¹¹ Arguably this corresponds also to Knight's (1921) understanding of uncertainty. Some of the ambiguity literature also refers to cognitive limitations to the absorption of information.

be measured. Thus for example Kozeniauskas et al. (2014: 1) are typical in identifying different types of uncertainty in quantifiable terms: ‘Macro uncertainty is the second moment of the distribution of a macro quantity (here, GDP growth) conditional on what an agent knows. Micro and higher-order uncertainty are cross-sectional variances that measure differences in firms’ earnings or forecasts’. Higher-order uncertainty corresponds to model uncertainty, with the range of forecasts reflecting the extent to which agents are uncertain as to which is the correct model: confidence in expectations is thought to be inversely related to the degree of dispersion of opinion. Bloom (2009) also considers dispersion of economic forecasts as an indicator of model uncertainty, but uses second-order stock market volatility in his formal analysis. Boyarchenko (2012) identifies missing information (ambiguity about the quality of signals) and model uncertainty (ambiguity about the underlying dynamics) by means of different error structures.

But in modelling practice, these indicators of uncertainty can come to represent uncertainty itself, endogenising it within a closed system where probabilities are quantified by the analyst (Dow 2004). It is therefore important to distinguish between uncertainty about quantifying probabilities on the one hand and measures of this inability on the other. Within a mainstream rational expectations framework, which depicts agents forming expectations in the same way as an econometrician, the two become conflated; ambiguity in the model is the same as the stochastic indicator of ambiguity, and thus risk. Orlick and Veldkamp (2014: Abstract) put it as follows: ‘This paper argues that people do not know the true distribution of macroeconomic outcomes. Like Bayesian econometricians, they estimate a distribution. Using real-time GDP data, we measure uncertainty as the conditional standard deviation of GDP growth, which captures uncertainty about the distributions [of] estimated parameters’.

Much of what is termed ambiguity is therefore in fact covered by risk, the white area in Figure 3, while the small black area representing the scope for exogenous uncertainty shocks remains. We classify this as ‘fundamental’ uncertainty (rather than fundamental uncertainty) because, unlike Keynesian fundamental uncertainty, it is known to have a(n unknown) stochastic structure. Only outside an REH framework, if agents are *not* represented as econometricians, is there scope for ambiguity which cannot be converted into risk. But the degree of

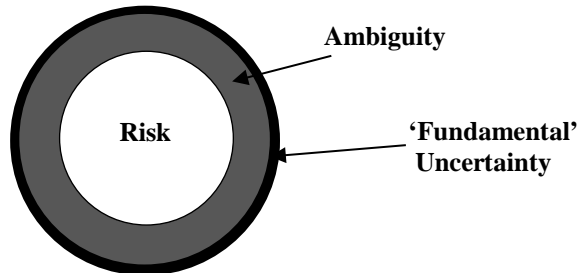


Figure 3: Expectations in mainstream economics: non-dualistic version

this core element of ambiguity which corresponds to uncertainty can be measured definitively by the extent of missing information and model uncertainty. We show this as a grey area whose boundary is solid, representing the definitive way in which the incidence of this type of uncertainty can be measured in the ambiguity approach.

While degrees of uncertainty only gradually emerged in mainstream theory, Keynes was clear from the start that he understood uncertainty as a matter of degree. He began his *Treatise on Probability* as follows:

In most branches of academic logic, such as the theory of the syllogism or the geometry of ideal space, all the arguments aim at demonstrative certainty. They claim to be conclusive. But many other arguments are rational and claim some weight without pretending to be certain. In *Metaphysics*, in *Science*, and in *Conduct*, *most of the arguments*, upon which we habitually base our rational beliefs, *are admitted to be inconclusive in a greater or less degree*. Thus for a philosophical treatment of these branches of knowledge, the study of probability is required (Keynes 1921: 2, emphasis added).

Keynes argued further that the reason for this general inconclusiveness was the organic nature of the subject matter, where at any one time the future is yet to evolve or be created. For Keynes the subject matter and therefore our knowledge about it are open systems, in contrast to the closed system implied by mainstream theory (Chick and Dow 2005). While ambiguity theory rests on the assumption that full information with respect to one correct model is in principle available

(even if in practice access is limited), for Keynes this was inconceivable except under very special circumstances. Indeed, within an open system of knowledge, the concept of ‘information’ can only refer to a subset of knowledge, such that *information* can never be full enough to justify action. Even fundamentally uncertain *knowledge* can provide justification for action, even if that justification proves to have been misguided.

For Keynes, the problem of induction was the Humean one which referred to the impossibility of knowing causal structures, far less the enumeration of all instances. At best we can normally only form provisional partial theories by applying logic to past experience. Given that we cannot establish universal demonstrably-true axioms, classical deductive logic cannot apply and we need to rely instead on ‘human’ logic to address the uncertainty surrounding any premises. Unlike for ambiguity theory, the norm for Keynes is not quantifiable probability but rather, at best, ordinal probability (Carabelli 1995).

Since there are limited grounds on which to be certain about anything, and yet generally we are able to justify action, it is unhelpful to lump all other knowledge into the category of ignorance. Indeed Keynes used the term ‘ignorance’ to refer to lack of evidence relative to availability of evidence, i.e. it is a matter of degree. This discussion arose in the course of his introduction of the term ‘weight of evidence’. An expectation and the probability attached to it were more reliable the more available was relevant evidence relative to absence of relevant evidence. This was independent of whether the probability was high or low. We have noted that there is a parallel with the ambiguity literature in that confidence is lower (uncertainty and ambiguity higher) the less relevant evidence can be brought to bear. Uncertainty is a matter of degree.

But there are important differences. First, since there is in general no possibility of accessing complete evidence, far less conceiving of what full evidence might be, Keynesian weight cannot be measured in cardinal terms, but is rather an ordinal concept (Dequech 2000: 52). Second, while uncertainty inevitably falls with new information in the ambiguity literature, it may rise in the Keynesian framework. What is relevant depends on the understanding of how the economy works, and new evidence might reveal unrecognised realms of ignorance (Runde 1990). Third, there is no benchmark true model or measure of complete information, given the openness of the economic system and therefore the unknowability of the range of possible outcomes. So judgements as to weight of

evidence must be provisional and incomplete, and open to shifts for reasons which reflect the interface between emotion and cognition (Dow 1995). There is therefore no basis for a cardinal measure of weight of evidence and therefore for degree of uncertainty. Even the measure of disparity of expectations cannot be used as an indicator of uncertainty, as is the case in the mainstream literature. Each set of expectations may be confidently held, while even if all are agreed on an expectation there may also be agreement that this expectation is not confidently held, i.e. it is subject to a high degree of uncertainty (see Dow et al. 2009).

The scope for reliable knowledge varies according to circumstances. For example, even although cardinal comparisons between probabilities are not in general possible, ordinal comparisons may be possible, as a guide to action. Thus for example, insurance companies can use actuarial tables as an imperfect, but serviceable, guide to quoting premiums, since the structure of actuarial risk tends to be quite stable. (The wealth of historical data means that weight of evidence is relatively high.) Even for one-off risks, reasonable ranges of risk can be estimated, as in the ambiguity literature, near the top of which a premium may fall. As Keynes (1921: 176) put it: 'Many probabilities, which are incapable of numerical measurement, can be placed nevertheless between numerical limits. And by taking particular non-numerical probabilities as standards a great number of comparisons or approximate measurements become possible.' But, while in ambiguity theory one of the range of possible non-additive probability distributions is correct, for Keynes the general case is that there is no reliable numerical probability distribution to be discovered.¹²

But in most circumstances there is less scope for reliable knowledge. Human logic employs strands of reasoning which are not necessarily commensurate (allowing collapse into a probability calculation), such that different pieces of evidence and different reasons may conflict. Even more challenging are circumstances where reason and evidence are lacking. Where there is thus no basis for decision-making, the sensible option is inaction, as in the exercise of liquidity preference. The difficulty of making judgements about probability apply particularly to the long term. It was the scantiness of knowledge about the very

¹² Keynes's (1921) early analysis of uncertainty included analysis of what came to be termed ambiguity as a special case.

long term which prompted Keynes's (1937: 114) statement 'We simply do not know', a case where (even partial) reasons and evidence are lacking.

From a mainstream perspective such an epistemology may seem to verge on nihilism. But the fact is that decisions are generally taken, in spite of pervasive uncertainty, demonstrating the prevalence of practical rules which are used to guide decisions, as explained for example in Keynes (1937).¹³ Keynes argued that it is conventional to give more credence to extrapolation from past trends than we know is reliable. It may therefore be conventional, under fundamental uncertainty, to act as if there was a preferred model and a relevant set of information (and thus the scope to measure risk), with uncertainty relevant only in the sense of ambiguity. But since the underlying subject matter does not yield correct models or notions of completeness of information, this convention is vulnerable to being confounded by actual developments. What supports such conventions in the face of contrary evidence, and what then accounts for new evidence prompting a recognition of low weight of evidence is substantially a matter of psychology which for Keynes was integral to epistemology (Dow 2011). Social psychology is particularly relevant, given that judgements as to the uncertainty of knowledge will reflect conventional judgements among peers; different groups in society will apply different judgements.

The scope for instability implied by this epistemology is moderated, not only by conventions, but also by institutions which perform a cognitive role (Dequech 2000). Indeed, considered over the evolution of society, some institutions have evolved precisely to provide a grounding for decision-making under uncertainty. Uncertainty is thus endogenous (Dow 2014). The kind of institutional arrangements which are identified as the source of missing information in the mainstream approach (such as administered prices, or central bank support for banks facing liquidity problems) can provide a stable environment which reduces uncertainty (just as Coase, 1937, analysed institutional structure at the firm level as a mechanism for dealing with uncertainty).¹⁴

¹³ A subsequent large literature has developed, particularly in the management field, on conventions to support decision-making under uncertainty (Feduzi and Runde 2014).

¹⁴ See also McKenna and Zannoni (2001), who pursue this tack in direct response to Coddington's, 1982, charge of nihilism and Dow and Dow (2011), who explore the way in which animal spirits can be molded by institutions and conventions.

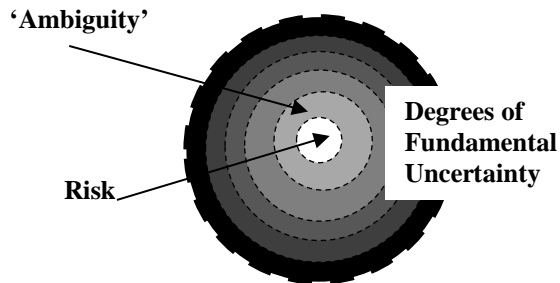


Figure 4: Expectations in Keynes: non-dualistic version

Figure 4 is an attempt at depicting this non-dualistic version of Keynesian uncertainty. Again only a very small proportion of expectations can be based on anything approaching certainty, shaded white. Now we also include an area where it is conventional to treat the subject matter *as if* arising from a closed system, such that uncertainty is regarded as ambiguity, even though it is in fact subject to fundamental uncertainty (so it is labelled ‘ambiguity’ rather than ambiguity). But, otherwise, uncertain expectations are shown as varying in degree of reliability, where there is no expectation of arriving at a ‘correct’ model or a complete set of information. But, while weight of evidence plays a part in determining the degree of uncertainty, it is conditional on notions of relevance with respect to an understanding of the economy for which there is no benchmark in the form of a correct model. At any one time there will simultaneously be more or less confidence in different types of decisions, represented by the different shading. This contrasts with the layer of ambiguity in Figure 3 whose quantifiability renders it homogeneous.

In fact uncertainty in a Keynesian framework is multidimensional, so that Figure 4 can only be indicative of a much more complex and evolving structure of expectations. Each band has a hatched outline to represent the openness of judgement and the scope for discrete shifts, given the absence of any benchmark for ‘complete information’; it also reflects the fact that fundamental uncertainty applies to (at best) ordinal rather than cardinal probabilities and reflects ordinal rather than cardinal notions of weight. Among the incommensurate contributors to weight are conventional judgements.

4 Risk, uncertainty and the crisis

We can use the crisis as a case study by which to understand the significance of the difference between these two non-dualistic approaches to uncertainty. We consider how we might represent the two approaches in the run-up to the crisis, and then as the crisis hits.

The general case within an ambiguity framework is a stable incidence of missing information, the outcome often of institutional constraints. But the run-up to the financial crisis poses a problem in determining whether ambiguity due to missing information rose or fell. The explanation for the crisis from an information-theoretic point of view is that information was concealed, leading to the mis-pricing of risk. This was due to the institutional structure, including such factors as opaque structured products and active concealment of information by credit-rating agencies. But while this would imply increasing levels of ambiguity as the crisis approached, that is not what is picked up by the measurement of ambiguity by second-order volatility. Rather what is shown is that uncertainty was relatively stable before the crisis, but then spiked at the onset of crisis, acting as a shock to confidence in expectations. The appreciation that information was missing only occurred *ex post*.¹⁵ So we must represent ambiguity with this source as being low.

This would be consistent with the view that model uncertainty was judged to be low in this period. It was the last stage of the Great Moderation, a period of stable rising asset prices and confidence in financial markets to manage risk. Macroeconomic policy (including its key component, monetary policy) was consensual. Given the prior position that there is one best macroeconomic model, combined with the advances in robust control theory, there was confidence that the tools were available to settle any differences on which was the best model. We represent this position in Figure 5 by a smaller component of ambiguity than the general case in Figure 3.

¹⁵ It is in fact hard to sustain this argument within a rational choice model; agents freely bought structured products whose risk-profile was unknowable.

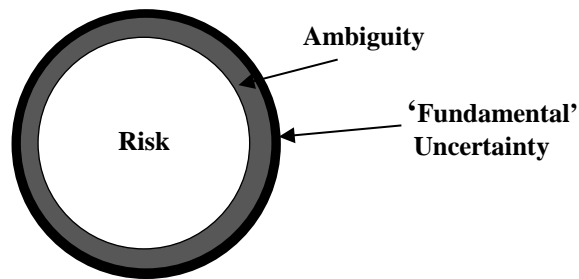


Figure 5: Expectations in the run-up to the crisis: mainstream economics

But with the onset of crisis, awareness of uncertainty escalated, something which has been documented in the econometric studies of ambiguity (see e.g. Bloom 2009 and Boyarchenko 2012). First there was the event of the crisis itself being treated as an exogenous shock from within the black area of uncertainty – an ‘unknowable unknown’. This shock increased awareness of the potential extent of ignorance, shown by an enlarged grey area: a higher degree of ambiguity (Figure 6).

There was increased awareness of the flimsy information basis for the valuation of many assets; it is at times of crisis that agents are most likely to feel the absence of correct information. Further the evident shortcomings of macroeconomic models in the face of the crisis spawned activity in formulating new macroeconomic models to capture the new environment, the assumption continuing to be that there would be one best model (Lawson 2009). In the meantime, model uncertainty could be said to have increased. But the increase in uncertainty has been identified empirically as a spike in volatility which was short-lived. As time passed after the crisis, institutional adjustments designed to increase transparency and an improved understanding of the structure of the economy are both expected to reduce the area of ambiguity to the norm depicted in Figure 3. The implication is that, if attention to transparency of information is sustained (alongside reduction in state-led distortions to incentives), crises are avoidable.

The Keynesian analysis of the run-up to the crisis, drawing on Minsky (1986), has emphasised the euphoric state of expectations encouraged by the stable rise in asset prices. The expanded capacity to increase leverage in order to make further capital gains was facilitated by the deregulation of the financial sector. Because

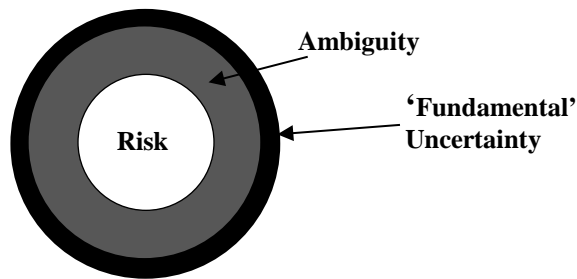


Figure 6: Expectations at the onset of crisis: mainstream economics

this process in fact increased the fragility of the financial sector, increasing the risk of a crisis, the weight attached to the evidence of continuing gains was not reasonable. But, as Minsky had argued, stability breeds instability by encouraging an unreasonable increase in confidence in expectations. There was a presumption that markets were pricing risk effectively with the aid of mathematical models while in fact assets were being priced according to a dominant market convention which seriously understated the underlying fragility. There was a general inattention to uncertainty.

This is represented in Figure 7 by an enlarged white area of expectations for which it was thought that most risk was quantifiable, and an enlarged area of ambiguity reflecting the widely-held conventional view that the information and modelling capacity were within reach for making judgements on quantification of other risks. There was uncertainty of differing degrees, reflecting different degrees of reliability of expectations in different circumstances, particularly outside financial markets, but of very limited extent compared to the areas of presumed certainty and ambiguity.

But the emergence of subprime mortgage defaults and the knock-on falls in wider classes of assets from 2007 forced a reassessment of asset pricing as the extent of investor ignorance was revealed (a lower weight of argument than had been thought). The possibility of default by financial institutions in particular challenged conventional trust in bank liabilities and thus in the payment system, something which had provided an institutional defense against fundamental uncertainty. The crisis was not seen as an exogenous shock, but rather in Minskyan terms as the inevitable outcome of the ever-increasing fragility of the

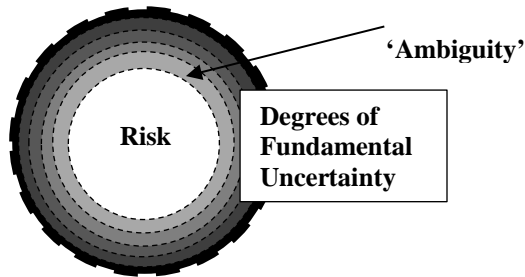


Figure 7: Keynesian expectations in the run-up to the crisis

financial system in the preceding period of apparent stability. As Runde (2009) points out, the crisis was not an ‘unknown unknown’ for Keynesian scholars, or indeed for Taleb himself, but rather the logical consequence of increased leveraging which had been spurred on by inattention to uncertainty, but without any countervailing efforts from the authorities. Nevertheless the timing of the crisis and the particular event which would reveal the extent to which pricing had been based on over-confidence were both subject to fundamental uncertainty. The resulting marked rise in fundamental uncertainty, illustrated in Figure 8, prompted the freezing of markets and a general unwillingness to commit to lending and spending plans.

But, while the mainstream approach presumes a return to the normal configuration of Figure 3, the Keynesian approach cannot presume a return to Figure 4. Expectations and the confidence held in them are founded on conven-

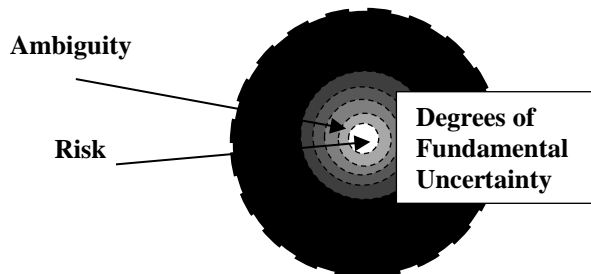


Figure 8: Keynesian expectations at the onset of crisis

tional judgement and institutional arrangements alongside reason, evidence and sentiment. But the crisis itself has had an irreversible effect on both conventions and institutions. Market players have returned to earlier levels of activity, adapting conventions to the new environment, and mainstream economists express confidence in models refined to allow for the crisis, implying a return to former patterns. But in the real economy governments continue to adjust the regulatory framework for financial institutions in a not-altogether-convincing attempt to reduce public anxiety about the reliability of a range of assets, particularly the formerly-safe assets of government debt and bank deposits. Banks continue to display a high degree of liquidity preference, at the cost of limited availability of credit, particularly for small and medium-sized business. Fundamental uncertainty remains relatively high.

5 Implications

So what can we take from these different perspectives on expectations and the crisis? If we return to the opening statement, both approaches highlight the marked increase in uncertainty with the crisis and its real economic consequences. Thus for example, from an ambiguity perspective, Faigelbaum et al. (2014) argue that higher uncertainty can discourage investment and that uncertainty shocks cause real instability. This seems to echo the Keynesian (1987) argument that financial instability causes increased liquidity preference and reduced expenditure plans when the crisis hits.

But because these stances arise from very different perspectives, the policy implications are also very different. From a mainstream perspective, the key is to limit the extent of missing information by promoting greater transparency. This is to be achieved by altering incentives to acquire information, e.g. by reducing moral hazard through replacing bailing-out with bailing-in. The emphasis has in fact been on increased transparency on the part of the state, in terms of monetary policy analysis and the treatment of vulnerable financial institutions for example. A major focus of uncertainty (identified for example in Boyarchenko's, 2012, analysis) was whether or not too-big-to-fail would apply. As Morgan and Sheehan (2014) argue, the outcome has been 'thin' institutional solutions to deal with future crises. The absence of more radical solutions follows from the mainstream

understanding of stability as the norm ensured by freely operating markets and the identification of increased uncertainty with shocks.

But from a Keynesian perspective transparency and the removal of state support for the monetary system may in fact be highly damaging. This has been discussed particularly with respect to the conduct of monetary policy (see Dow et al. 2007). Further, in terms of central bank relations with banks, there was a notable difference between the experience of the 1980s debt crisis and the crisis which began in 2007. In the former case, the liquidity problems of UK banks were dealt with in private while the very public airing of the banks' problems from 2007 seriously worsened their positions (eroding confidence) and increased the need for bail-outs. A change in regulation is required to allow practices which sustain confidence in expectations.

From a Keynes/Minsky perspective, instability is the norm and the incidence of crisis cannot be prevented, because of the nature of financial markets. Given fundamental uncertainty, there are no true prices to act as benchmarks, to which markets can return after a crisis. Yet conventional judgements build up, often in defiance of reason and evidence, which fuel instability. The first focus of policy from this perspective therefore has to be vigilance in monitoring financial markets for signs both of unreasonable confidence in expectations and increasing fragility (Dow 2012). The focus of policy addressed to moderating any tendency for increasing uncertainty would involve promoting stability through appropriate design of practices, conventions and institutions.

It is urgent that policy address the potential for uncertainty to aggravate continuing instability. But it is important for policy-makers to understand how differently such a statement is understood from different perspectives. Until the different ways of analysing uncertainty are acknowledged and understood, the policy discourse will continue to be mired in confusion.

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