The Master's idea: Revitalising uncertainty

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Abstract

John Maynard Keynes can be credited not only with being the most influential economist of the 20th century, but also with having put forth the most intriguing concept of uncertainty. The "Master's" understanding of uncertainty is indeed so radical that not even his avowed disciples dared facing all its consequences. As the recent financial crises have proven, however, the prevailing concepts of uncertainty require a refurbishment. This note highlights the key features of Keynesian uncertainty and the role uncertainty plays in his thinking. These ideas will then be put in the context of recent challenges to economists and econometricians. The paper concludes with a discussion of contemporary research trends which take Keynesian uncertainty into account.

Contents

1 Introduction

When back in the mid-1990s I bought my first reflex camera this decision was guided by maximising my utility over my entire remaining life span. I did, for example, take into consideration the fact that twenty years later I would call this camera analog and had the option to prop-up my digital life with a Nikon D80, the last digital reflex camera which did not yet come with a video recorder.

Figure 1: Analog camera: Utility maximisation subject to digital photography invention

Admittedly, I did, of course, not care at all the Nikn but used a friend's advise and a little common sense for buying the analog camera. The example, however, shows in a very stylised manner the wide gap between modern economic decision making theory and actual human behaviour. To carry the

point a little further just think of the spectacular failures of the Long-Term Capital Management fund in 1998, the collapse of the Russian Rouble in the same and the Asian financial crisis in the preceding year and last but not least the bankruptcy of Lehman Brothers in 2007 and the enduring crisis that followed.

According to economic textbooks pretty much none of these events should either not have happened at all or not in this fashion, or at least not so many crises should have occurred in this short period of time.[1] Therefore, after listening to presentation on the mechanics of the financial the Queen of England is said to have asked the simple question "Why did nobody notice it?"[2]. I think, for economists this question remains the major legacy and challenge of the crisis until today.

In the following I would like to expand a little on one particular approach to address the royal concern. It centres on the notion of uncertainty which definitely plays an important role in understanding my purchasing decision and in the creation of the crisis. Moving uncertainty to centre stage is what John Maynard Keynes called for in his two great works, the "Treatise on Probability" and "The General Theory of Employment, Interest, and Money".

[1] "If we knew what tomorrow would bring – there would never [...] be a financial crisis." (Skidelsky, 2011b, p. 2)

[2] 2008-11-05 The Telegraph

And this is also why I gave my talk its title: Revitalising the Master's idea.[3]

I will first attempt to define uncertainty, then sketch the treatment of uncertainty in modern economics and econometrics and finally list some research paths which I consider promising in terms of accounting for uncertainty in a more appropriate, crisis-proof economics. Throughout, I will make a few references to my own work which I have presented in support of my habilitation and also some newer research which has been published since or is currently in the process of publication.

2 Definitions of uncertainty

Let me now first try to offer a definition of uncertainty. In very general terms, "uncertainty" is supposed to characterize events or set of events. In

[3]The term "Master" is borrowed from Skidelsky (2011a).

Figure 2: The Queen of England (Source: The Telegraph)

statistics and econometrics, uncertainty can be understood as the ratio of the number of favourable events to the number of all possible events. For example, we might say that in one out of six cases a fair dice rolls a one, or the expansion of the gross domestic product in Germany will fall between minus one percent and plus two percent with a 95 percent probability.

However, using "uncertainty" in this manner is largely owed to the desire for accuracy in describing possible events rather than owed to the desire to accurately describe possible events. There are, in fact, many more ways to characterise the set of possible events; a probabilistic approach is only one of them and it is by no means obvious that assuming a one-to-one equivalence between "uncertainty" and probability is appropriate. Instead, the term "uncertainty" deserves a thorough investigation before applying it.

Having to define a precise meaning of "uncertainty" results not the least from its linguistic origin as the opposite of the Latin "certus" which means "sure" or "fixed", "settled", or just "certain". To get a handle on the definition of this opposite we might therefore start with the original which is an easier concept.

The origin of "uncertainty" is "certainty" which describes an event, or a set of events that occurs no matter what. In economics and econometrics these kinds of events can be pretty handy as they may serve as an anchor for identifying causalities. We may regard Christmas or Eastern as certain

events and conclude that Bazaars pop up because of Christmas and Easter Bunnies due to Eastern and not the other way round although the timing of the events would imply otherwise. To some extend, fixed effects in panel data regressions serve the same purpose. In reference to the probabilistic approach and to custom in econometrics we may also label the certain event as the result of a deterministic process. In short, the certain event derives its importance from the fact that it does occur and nothing can be done about it.

Events which are not certain, therefore, may occur, or they may not occur. The challenge now is to usefully categorise the typical features of these uncertain events in order to get a handle on a large variety, if not all economically relevant human decisions.

There are two principle ways to categorise "uncertain" events. We either focus on the mechanisms by which events are generated in a non-deterministic way, or we focus on the properties of these events or sets of events. The first option directly targets potential economic decisions or behaviour in general. The so-called model uncertainty which tries to capture the possibility of facing several plausible explanations for one and the same observable phenomenon, say, inflation, is a good example.

I prefer the second option, however, and suggest to define "uncertainty" according to the degree of knowledge we have about this occurrence or not-

occurrence. This definition strategy is in line with Keynes in his Treatise[4], and has the clear advantage that the mechanisms denying or providing us with the desired knowledge can be categorised rather than running the risk of finding numerous mechanisms with each creating its own type of uncertainty. It also affords as a hierarchical ordering of uncertainty in which the respective rank is determined by the available knowledge.

A natural basic category is provided by the mathematical probabilistic approach which we now commonly and for simplicity refer to as a probability distribution function for a set of events. In his Treatise on Probability, Keynes considered the mathematical probabilistic approach as the status quo and contrasted it with four alternatives:

> Either in some cases there is no probability at all; or probabilities do not all belong to a single set of magnitudes measurable in terms of a common unit; or these measures always exist, but in many cases are, and must remain, unknown; or probabilities do belong to such a set and their measures are capable of being determined by us, although we are not always able so to determine them in practice. Treatise (1921), chapter III, §10

The first two of these four alternatives are certainly the most interesting

[4]chapters. III and XXIV

ones but before I turn to them, let us have a look at a contemporaneous definition owed to Frank Knight. Knight focussed in his research mainly on the behaviour and the role of entrepreneurs in the economy. Obviously, entrepreneurs very often have to decide in uncertain conditions which demands a definition of uncertainty. In his version, he also drew a distinction between mathematical probabilities and higher order uncertainties:

> The practical difference between the two categories, risk and uncertainty, is that in the former the distribution of the outcome in a group of instances is known (either through calculation *a priori* or from statistics of past experience), while in the case of uncertainty this is not true, the reason being in general that it is impossible to form a group of instances, because the situation dealt with is in a high degree unique. Knight (1921, p. 233)

In other words, Knight assigned mathematical probabilities the term "risk" and considered those events uncertain for which a probability exists but cannot be given. Careful reading of Knight's definitions and comparison to Keynes' four alternatives shows that they only partly overlap. Keynes further differentiated Knight's "risk" into probabilities which can be learned and those which are known *a priori*. The latter, according to Keynes, is covered by the standard, mathematical definition of probability.

Let us now take up Keynes' first two alternatives. Number one arises when "there is no probability at all", Keynes says and the second when "probabilities do not all belong to a single set of magnitudes measurable in terms of a common unit". A few lines down this list Keynes explains that "Which of the two we favour is ... partly a matter of definition" (Treatise, chap. III, §13). In other words, what really matters is its meaning and this meaning Keynes makes clear beyond doubt in his 1937 Quarterly Journal of Economics article in defence of his General Theory.

> By "uncertain" knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. 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, or the obsolescence of a new invention, or the position of private wealth-owners in the social system in 1970. About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not

know. Keynes (1937, pp. 213f)

This clarification finally lets us sum up the categories of uncertainty by degree of knowledge. Ordered from complete ignorance to perfect knowledge we should distinguish between events for which[5]

- a probability distribution does not exist (Keynesian, or radical uncertainty),
- a probability distribution exists but its parameters cannot be determined (Knightian uncertainty, or ambiguity),
- a probability distribution exists, its parameters are unknown but they can be learned (common risk),
- a probability distribution exists and its parameters are known (simple risk),
- occurrence or not-occurrence is not a matter of judgement (deterministic events).

The following examples shall illustrate these various categories of uncertainty. We owe Keynes the first example which is the rate of interest twenty years hence, or, for that matter, the next generation electronic gadget replacing my digital reflex camera.

[5]Alternative categories are due to (Dequech, 2011), or Dow (2015).

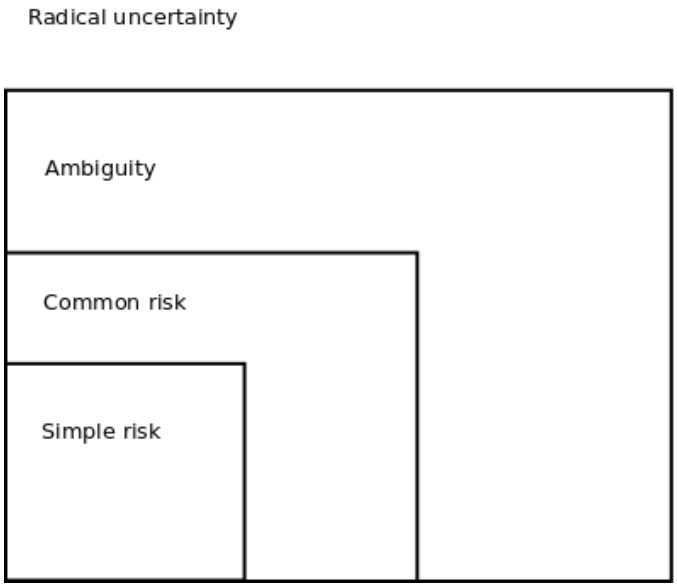

Figure 3: A taxonomy of uncertainty

We face Knightian uncertainty, or ambiguity, whenever we know that a probability distribution function exists but we are not able to determine its parameters. Such a situation is best be described by Ellsberg's urn experiment in which the participants are asked to draw a single red or black ball only once and the only information provided is that the urn contains red or black balls only. In that case, the probability of fetching a, say, red ball follows a binomial distribution but its parameter is unknown and not learnable "because the situation dealt with is in a high degree unique" as Knight has put it.

In economics and econometrics the most frequent situation is what I label "common risk". It is an event, or a set of events for which a probability distri-

bution exists and we are able to determine its parameters through "learning". Learning in this sense means to be able to estimate or to obtain the parameters in any other form by observation. We may, for example, estimate the probability of rainfall tomorrow morning.

Finally, the category "simple risk" describes a situation in which the odds are known for sure. This is the case if logical, mathematical derivation suffices to determine the parameters of the probability distribution function. Maybe strikingly, it is not easy at all to offer good examples for this category. The best example that comes to my mind is the wave/particle duality for which we know that there is a 50 percent chance of observing either a wave or a particle. Basically all probabilities in social sciences must first be learned in one way or another. Therefore, it is matter of convenience to summarise those two categories as "risk" quite as Knight suggested. We will maintain this differentiation, however, as it allows us to relate econometric practices to the categories we have just suggested.

We next turn to the role the respective categories of uncertainty play in Keynes', in neo-classical-neo-Keynesian and in institutional economics.

3 The roles of uncertainties in economics

3.1 Uncertainty in Keynes' works

The notion of uncertainty is key to two important aspects of Keynes' work. First, it is the main driver of investments and hence employment, money and the business cycle. Second, it limits, in his view, our ability to gain insights in the sense that it raises methodological barriers to knowledge which we are a hardly able to overcome.

Keynes assumes that fundamental uncertainty dominates in the economy. People are faced with decisions under uncertainty more than under more favourable circumstances. He shares, by the way, this conviction with Alois Schumpeter who approvingly looks at uncertainty as a main leverage for economic progress. Without uncertainty visionary entrepreneurs would not engage in the recurring cycle of creative destruction. Keynes, however, focussed stronger on uncertainty as a powerful investment deterrent. He argues that elevated levels of uncertainty depress the marginal efficiency of capital. This marginal efficiency reflects the ratio of *expected* returns over costs. In other words, the value of the marginal efficiency of capital must be uncertain because it is determined by an event in the future and the best we can formulate is an expectation about the future value.

Keynes' main point – as we have already seen – now is that the applicable

category of uncertainty is radical uncertainty. Keynes holds the view that "Economics has to start from the assumption of [radical] uncertainty, not from perfect information" (Skidelsky in Spectator.org[6]). The implications of this starting point are far reaching and can hardly be underestimated. First, any attempt to overcome the lack of knowledge must fail, because "we simply do not know". Business cycles are therefore, in principle, unavoidable and cannot be corrected by market forces alone. Financial markets will have a natural tendency towards fragility because nowhere else do expectations matter more. Moreover, if fundamental uncertainty is mistaken for risk then the best guess we make will only be "precisely wrong" whereas we preferably should be "roughly right" as Keynes is said to have quipped.

The policy implications are also pretty strong. Due to the dependency of the rate of marginal efficiency of capital on investments, any attempt to control the economy by means of interest rate policy will show only limited effect. Interest rates can be lowered even below zero as we just learn and Japan has already learnt the hard way but that below zero may still be insufficient to compensate for low levels of the marginal efficiency of capital. It is only through addressing the root cause directly, which is uncertainty, that this rate can be pushed up.

Keynes maintained that it is the government's role to re-assure investors

[6] `http://spectator.org/articles/40770/keynes-uncertainty-principle`

by, for example, acting as an investor itself when everyone else feels too uncertain to do so. Economic policy thus is about managing uncertainty in the first place. I am sure that Ben Bernanke's study of the Federal Reserve Policy during the Great Depression led him to the conclusion that the US central bank's best policy response to the financial crisis would be to reassure investors and thus lower the level of uncertainty. He did so by offering unprecedented and unlimited liquidity to the banking sector. The European Central Bank copied this policy but with a considerable time lag. As a consequence the US is now in a position to discuss a return to normal monetary policy conduct with a rise in the interest rates while the ECB still fights the spectre of recession and deflation.

Starting from the assumption of radical uncertainty has also an effect on the epistemology of economics. Strictly speaking, under radical uncertainty statistical inference and induction is invalid. Keynes has in his 1921 Treatise hence very forcefully argued against the use of inductive statistics and reenforced his position in the General Theory and most prominently in an attack on Tinbergen's report to the League of Nations.[7]. Keynes even went as far as liking econometrics to "alchemy" while demanding a scientific approach instead.

Keynes levelled two different kinds of criticism against the emerging field

[7]Tinbergen (1939)

of econometrics.[8] On the one hand he doubted that what we today call simultaneous equation bias, omitted variable bias, structural breaks and non-stationarity could be properly dealt with in econometrics. On the other hand he argued that under uncertainty ergodic processes do not exist.

The replies to Keynes' reservations against econometrics have fuelled the research engines of many decades to come. Starting with Tinbergen's reply[9] to Keynes, Don Patinkin's presidential address[10] and David Hendry's 1993[11] justification of econometrics being a science rather than alchemy, many refinements and improvements of econometric methods can be read as solving the problems Keynes had spotted early on.

There remains one important detail, however. While it is reasonable to side with David Hendry when it comes to the first kind of criticism the issue of ergodicity has not been resolved entirely. Under radical uncertainty there is also little hope as yet that it ever will be. The reason for this pessimism is pretty easy to see. Ergodicity means that we can infer from past experience about the future. For example, hundred years of observations of interest rates would provide us with a good expected value of the future mean interest rate under ergodicity. Keynes has, however made clear that this possibility

[8] See e.g. Giovanna and Roberto (2007) for details of the criticism.

[9] Tinbergen (1940)

[10] Patinkin (1976)

[11] Hendry (1993)

must be ruled out because fundamental uncertainty prevails and "the rate of interest twenty years hence" "We simply don't know."

I have to add word of caution at this point because it would be a misrepresentation of Keynes' view if we would conclude that Keynes rejected statistical analysis outright. Quite to the contrary, in his "Treatise on Money" Keynes, states that "Statistics are of fundamental importance to suggest theories, to test them and make them convincing [...] and to eliminate impressionism" (Keynes 1930, vol.2).[12] Keynes thus acknowledged the central role statistics plays for advancing knowledge but maintained his reservations. In fact, his criticism is not free from contradiction and in part – irony.

For example, while Keynes was highly critical towards the inductive statistical method by which model parameters can be estimated, he also made attempts to estimate the propensity to consume himself. This parameter determines the effect of government stimulus and it was therefore essential to know it.

Moreover, due to the impossibility to quantify expectations for radically uncertain events, Keynes suggested that people resort to intuition, experience or the famous animal spirit instead for forming expectations. Therefore, the use of statistics and econometrics is conveniently justified as a means of expectation formation even though it might be ultimately flawed quantita-

[12]Keynes (1930)

tively.

A way to reconcile the criticism and the Keynes' own practice might be to respect the limits of econometrics for predictions and to accept econometrics for ex-post analyses and theory testing.

Let me wrap up the discussion of uncertainty in Keynes work by noting that Keynes considers radical uncertainty to be the norm rather than the exception. From this presumption it follows that economic fluctuations must be viewed as a result of radical uncertainty and the government's economic policy should be directed at containing the level of uncertainty in the economy. Radical uncertainty also implies a general absence of ergodicity which necessarily renders econometric predictions "precisely wrong" while we should prefer methods that provide us answers which are "generally right".

3.2 Uncertainties in the neo-classical and neo-Keynesian literature

Let me now move on to uncertainty in neoclassical, neo-Keynesian and monetarist thinking. Uncertainty enters these schools in several distinct ways. It is most convenient to link these ways to two of the three basic assumptions which are usually considered the cornerstones of the neoclassical school. Let me briefly recall these cornerstones.

First off, individuals are assumed to take decisions based on rational

choice. Second, individuals are considered utility maximisers and third, they act independently using all relevant information.

Uncertainty affects the rational choice assumption twice. On the one hand, choices have to be evaluated and this evaluation very often involves uncertain matters. Therefore, neoclassical economists must have an idea of how individuals cope with uncertain events. On the other hand, in order to conclude that a choice is indeed rational, the economist must also be able to judge whether or not a specific choice is rational. In other words, the economist has to possess at least the knowledge and capacities every individual has. Otherwise, any choice would qualify as being rational which would render the rationality assumption superfluous or unscientific.

To the extent individuals maximise utility and firm profit, they both must form expectations about uncertain factors that impact on utility and profit. In the case of the memory stick, I could have spared the expenses for the computer in order save the money for buying more or better sticks in the future. The price and also the specifications of the memory stick was uncertain, however at the time of buying the computer. Similar arguments hold for profit maximisation where firms have to make investment decision before the market price of their output is known, for example. Again, the market price is subject to one kind of uncertainty or another.

The main difference between neo-Keynesian and neoclassical economist

amounts to arguments about sluggish price adjustments. There is no noticeable difference with the previously discussed assumptions and their relations to uncertainty. The same holds true for monetarist approaches. We therefore continue without further drawing a distinction but refer to all three by the term neoclassical synthesis.

Since it is impossible to cover the whole area of this dominant field, I'd like to confine myself to those part to which I have also contributed, or at least tried to contribute to. This is the field of business cycle analysis and particularly, financial market analysis.

I have mentioned before that Keynes but not Keynes alone stressed the role of expectations for investment decisions, for example. Savage Savage published a very influential book on how those expectations might be formed at the individual level. His method of subjective expected utility maximisation remains the landmark contribution to which newer research still is compared to. Among other things Savage devised a tool for gauging individual expectations from observations of actual behaviour. Based on his axioms, it is possible to even determine moments such as expected values.

It turned out, however, that the method does only work for what we called before common risk because Ellsberg could show by means of experiments that identical situations and decision processes result in contradictory conclusions about the underlying probability distributions simply due to swapping

the colors of balls, literally.[13] The critical element in the experiment was an event under Knightian uncertainty, or ambiguity. The notion of ambiguity aversion now is a well-known concept in decision theory. To the best of my knowledge it took more than thirty years before Gilboa, Schmeidler and Bewley took up the matter again and augmented the approach to also cover decision making under Knightian uncertainty.[14]

A second, although unintended blow, to the subjective probability approach in neoclassical thinking was dealt by John Muth in 1961. He came up with the idea that if there is an objective probability distribution function for an event, all subjective probability distribution function must converge towards the objective one under rationality.[15] It follows that rational expectations all have to be formed by using the objective probability distribution function.

Over time, economists adopted this approach and more or less all econometric analyses of macroeconomic time series and financial data is based on Muth's (1961) arguments. The objective, rational expectation method has, however, finally and completely removed anything beyond common risk from the neoclassical agenda. This effect is easy see because the existence and the knowability of the objective probability towards which individual expec-

[13]Ellsberg (1961)

[14]Bewley (1988), Gilboa and Schmeidler (1989), Bewley (2002)

[15]Muth (1961)

tations converge is the backbone of rational expectations. If, by contrast, a probability did not exist, that is, we have Keynesian uncertainty, or the probability could not determined, which would be Knightian uncertainty, no convergence could take place or arbitrary results would follow. So again, with Knightian or Keynesian uncertainty this part of neoclassical theory would be either void of meaning or unscientific.

The most important contribution of radical uncertainty, or rather its absence to neoclassical and neo-Keynesian thinking has in, my opinion, been achieved by Robert Lucas with his famous Lucas critique.[16] Lucas demanded that policy advisers include the predictions of their macroeconomic models to be fed back into their models. These economic models should then operate on the basis of those expectations they generate themselves. We call these expectations model consistent expectations.

Let me remind us that Keynes argued for government intervention in order to fight the effects of elevated levels of uncertainty. These interventions are therefore, meant to cure the negative impact of uncertainty. Ironically, however, if these interventions are systematic and successful, then uncertainty is defeated and vanishes from the equation.

Of course, this, in some sense self-defeating Keynesianism, or better self-defeating uncertainty sneaks into economics through adding Muth's (1961)

[16]Lucas (1976)

the objectivity approach which only works in the absence of ambiguity and foremost in the absence of radical uncertainty. This is the case because only under the assumption that there is one objective truth does it make sense to look for the one true model which tells us how to steer the economy and how to form expectations. In other words, assuming away radical uncertainty conveniently proves that the world is ruled by common risk in the worst thinkable case.

Unfortunately, the enduring financial crisis seems to indicate that this risk-based method does not answer all the questions. For example, central banks have sent and still send, as we have seen last Thursday, a strong message to the markets when they promise to buy troubled assets or even government bonds essentially without limit. Monetarist, neo-classical and neo-Keynesians economist first of all understand this message only as a signal for future inflation. Having in mind Keynes's dictum that radical uncertainty rules the economy, it must, however, be understood as a means of re-assurance, or a way to calm markets and instil trust in the economy to overcome the general feeling of uncertainty which still hampers investment.

Therefore, I think that going back to the drawing board and include radical uncertainty may indeed help to understand how to stay clear of the crises we have seen in the recent past.

3.3 Uncertainty in institutional economics

Let me now and very briefly only turn to the last school of thinking I'd like to include in this survey. This school looks at understanding and managing the economy from a different angle. Let me talk about institutional economics and the role uncertainty plays there.

Institutional economics, as the name suggests, considers the economy to be determined by institutions meaning man-made set of rules. Uncertainty of any kind nicely fits into this framework by noticing that man-made rules can either promote or tame uncertainty. Governments after all, also are institutions. The major worry in this context, however is, to strike a wise balance between regulating, or taming uncertainty and giving way to it.

The discussion about the right dose goes back to Schumpeter at least. Schumpeter was fascinated by innovations as the engine of progress. Tight rules might stabilise an economy and weaken destructive forces but too tight rules would of course choke off innovation and development because outdated technology and market structures are not destroyed and replaced. Having spent some time in Egypt I can tell from first hand experience how destructive the absence of uncertainty eventually becomes.

An institutional economist's policy advise for the banking sector might be for example, not to try by all means to understand and control manage-

ment decisions such that the market outcome is efficient subject to having a resilient banking sector. Trying to do so is maybe hopeless because human ingenuity would always find ways around management controls and no financial crisis has been a copy of any earlier one except for its consequences. Instead, institutions, that is rules should be designed such that the financial sector still works even when large banks fail, for example.

Figure 4: An institutional response to uncertainty

Figure 4 an example of this kind of policy conduct. We see on this picture the remains of the Icelandic ring road after the eruption of the Gjalp in 1996. Iceland decided to re-build its ring road not in a way to withstand future expected eruptions because they considered it too hard to figure out the maximum possible impact. They voted instead for a cheaper layout that would get destroyed more easily but was also easier to re-build after future destruction by the volcano.

4 New approaches to uncertainty in economics

Up until this point I have concerned myself primarily with the principal importance of uncertainty and the alleged, unfortunate absence of it in the most influential school of economic thoughts and in econometrics. I'd now like to offer a list of ongoing and I think promising research that might eventually lead to the revival of Keynesian uncertainty in economics.

The first item on this list is the research into the origins of radical uncertainty. There are two major research questions and one methodological curiosity. Let me start with the last one. The typology of uncertainty we defined before ranks radical uncertainty highest because it is the least restrictive. If we work with methods tailored for anything more restrictive, one should expect a careful reasoning why one is supposed to accept the restriction. As it stands, the opposite is the case, however. The first research question therefore is, can we proof that radical uncertainty truly prevails.

Figure 5 shows one such attempt of mine in a recent publication where I argue that well-behaved processes, which means processes for which we could potentially find a probability distribution should behave like depicted here.[17] The empirical reality looks quite different though which is visible from the alternative graph in figure 6.

[17] Müller (2015)

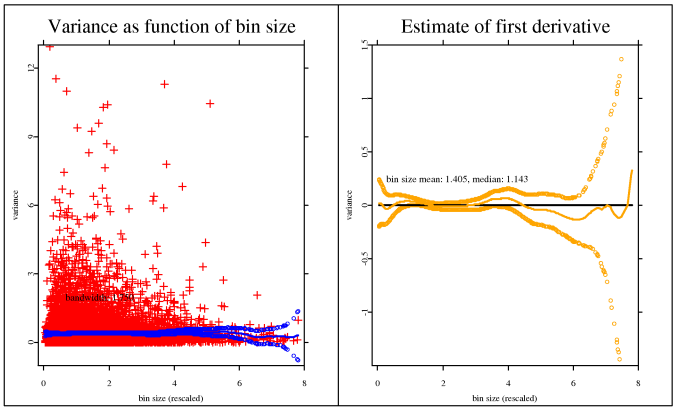

Figure 5: Data properties under common risk (Source: Müller (2015))

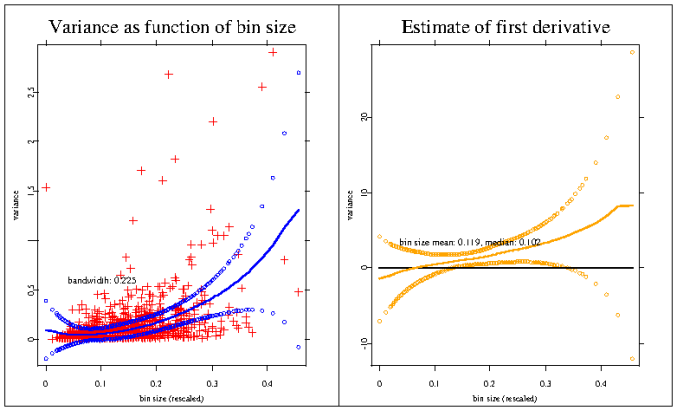

Figure 6: Data properties under radical uncertainty (Source: Müller (2015))

It is, by the way, another curiosity that data analyses with this kind of results are in fact very widespread.[18] Just think of the literature on all sorts of puzzles. In this literature essential theories are either rejected or don't find empirical support. As a consequence, however, the evidence is

[18]Meese and Rogoff (1983), Cheung, Chinn and Pascual (2005)

reconciled with theory by augmenting the theory instead of acknowledging the principal failure of it. In my opinion, unless radical uncertainty is safely ruled out, radical uncertainty must always be considered one, if not the solution to these puzzles.[19]

This consideration leads me to the second research question which is what theories can explain the existence of radical uncertainty or ambiguity? Or, to put it differently, what mechanisms generate radical uncertainty? Fortunately, this seems to be an area where progress is highly visible. Among the ideas brought forward are complexity, reflexivity and subjectivity.[20] Subjectivity is my preferred explanation because it derives radical uncertainty from irreducible individualism. If humans were drawn from a probability distribution function all human wit and genius could likewise be replaced by computers. I don't think that this is a fair reflection of the state of the world. If however, humans were truly unique, subjective expectations cannot be aggregated to a representative expectations and all we have said about model consistent expectations and the vanishing of uncertainty from our equations evaporates.

Let us now assume for a moment that radical uncertainty has been accepted as the rule rather than the exception. The second item on the list

[19]Müller-Kademann (2009), Müller (2011)

[20]Ormerod (2015), Soros (2013), Hommes (2013)

now obviously is about how to deal with it in economics. Admittedly, this is the harder of the two items and therefore also the prime candidate for understanding why it has not yet been accepted. However, things change in that respect as well. For instance, Knightian uncertainty, or ambiguity shows up significantly more often on paper titles than it did before the crisis. Not all labels are used for the right content but one publication I would like to mention in particular. It is Ilut and Schneider's business cycle theory in which cycles are driven by ambiguity.[21] I am currently trying to understand the model with the help of some mathematicians because I am not yet fully convinced that they do not use common risk in disguise. The undeniable achievement of Ilut and Schneider, however, is to have put the topic on the agenda of the most important economics journal.

At the micro level the question of how to deal with radical uncertainty and ambiguity has also been addressed at least partly. I have already mentioned before the decision theory under ambiguity due to Bewley.[22] To the best of my knowledge it has not yet found widespread application. I might be mistaken or it will hopefully find many applications in the future. In both these cases, I am confident we will see very interesting results.

When it comes to radical uncertainty, the gap probably is the largest. My

[21] Ilut and Schneider (2014)

[22] Bewley (2002)

best guess for timely progress is to borrow from Managerial control. This area of research is not exactly economics but better described as management sciences. Nevertheless, there is no reason to assume, however, that it is bound to be uninformative for economists. My optimism with respect to Managerial control derives from the fact that management decisions are much more often assumed to be made under radical uncertainty than we are used from standard practice in the neoclassical and neo-Keynesian literature.

Finally, institutional economics might also become a source of deep insight into both the origins and the management of radical uncertainty. I have already explained the quasi-natural link between radical uncertainty and institutions. What is left though, is to also establish a link to the big macroeconomic question of determining employment, interest and money.

5 Conclusion

My ride at full speed through the economic universe has certainly left out many important aspects and did not do full justice to all or any of the discussed schools of thoughts and the notion of uncertainty. But this potential deficit notwithstanding, I think it is safe to say that the concept of uncertainty deserves a more thorough treatment in economics. This treatment starts with achieving a commonly agreed definition of the various types of uncertainty and does not stop with its acknowledgement as a key factor in the economy.

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