Prediction in Economics: a Case Study of Economists' Views on the 2008 Financial Crisis

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Abstract

Prediction in economics is the focal point of debate for the future of economics, ever since economists were burdened with the failure to "predict" the 2008 Financial Crisis. This paper discusses positions held by philosophers and economic methodologists regarding what kinds of predictions there are and creates a taxonomy of prediction. Through evaluation of those positions, this paper presents different senses of prediction that can be expected of economics, and assess economists' reflections according to those senses.

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I. Prediction: Center Stage in the Future of Economics

The 2008 Financial Crisis triggered a debate about economists' alleged failure to "predict" the crisis. Alan Greenspan, the former chairman of the Federal Reserve, claimed that no one could have predicted the crisis (Burry, 2010). While Michael Burry, the founder of hedge fund Scion Capital, says that he "saw the crisis coming" (Burry, 2010). In academia, people questioned the approach of economics and its future. For example, Paul Krugman (2009) thinks economists, in failing to predict the Financial Crisis, were mistaking beauty for truth. In his column, "How Did Economics Get it So Wrong?", Krugman argued for a more Keynesian approach as opposed to the currently dominant neoclassical economics. He claimed that "Keynesian economics remains the best framework we have for making sense of recessions and depressions" (Krugman, 2009). To illustrate this, he discusses several of the absurd conclusions the "freshwater economists" have drawn[1]. Among the conclusions that he regarded as absurd were explaining the Great Depression as the "Great Vacation" and denying the possibility of the existence of bubbles. Great Vacation is a term Krugman uses to encapsulate Edward Prescott's explanation of recessions, which states that workers "voluntarily work more when the environment is favorable and less when it's unfavorable" (Krugman, 2009). In his view, economists were too quick to take rationality as a given and imagined the financial market to be perfect and frictionless. Krugman (2009) thinks that economists should 1) admit that the financial market is subject to "extraordinary delusions and the madness of crowds," 2) admit that

[1] Freshwater economists generally refers to economists from schools close to the Great Lakes (such as the University of Chicago), who leaned towards the view that the market could correct itself and thus favor a laissez-faire approach to government policy. In opposition are saltwater economists who are from schools on the coasts (such as University of California, Berkeley, Harvard University, MIT, Stanford) , who are more critical of rational expectations and advocate a greater role for government policy.

Keynesian economics remains the best framework to understand recessions and depressions, and 3) incorporate realities of finance into macroeconomics[2].

Krugman's position is rejected by many economists. One of his opponents, John Cochrane (2011), argued in his article "How Did Krugman Get It So Wrong?" that it was Keynesian economics that took a wrong turn instead of the economists Krugman criticized. In Krugman's article, he claims Cochrane declared that high employment is good, specifically quoting Cochrane as saying: "We should have a recession. People who spend their lives pounding nails in Nevada need something else to do[3]" (Krugman, 2009). Cochrane debunks Krugman's attack on him, stating that this quotation Krugman used to make Cochrane seem absurd is taken out of context. First, he argues that efficient market hypothesis precisely states that "nobody can tell where markets are going," therefore he thinks Krugman illogically attacks the followers of the efficient market hypothesis for not predicting the financial crisis, which their theory precisely states to be unpredictable (Cochrane, 2011, p. 36). Second, Cochrane thinks that the "beauty" economists pursue is simply logical consistency, pointing out many inconsistencies in Keynesian economics that Krugman advocates. Finally, he points out what he regards as Krugman's empty view on the crash (Cochrane, 2011, p. 38). Here Cochrane is referring to Krugman's belief that fiscal stimulus is the answer to the "depression-type economic situation" of the 2008 Financial Crisis (Krugman, 2009). Cochrane (2011) believes the future Krugman argues for, which according to Cochrane are merely political debate points, is "nonsensical" because it "disdains quantification and comparison to data" while appealing to "the authority of ancient books while advocating that we spend a trillion dollars" (Cochrane, 2011, p. 40). In

[2] Krugman here uses the title of Charles Mackay's 1841 book, "Extraordinary Popular Delusions and the Madness of Crowds". In the book, Mackay describes a few economic bubbles in history such as the Dutch tulip mania of the early seventeenth century.

3 Krugman is referring to Cochrane's claim in his keynote address to the 2008 CRSP Forum.

contrast, Cochrane's view is that economics is: "a discipline that ought to result in quantitative matches to data; a discipline that requires crystal-clear logical connections between the 'if ' and the 'then'" (Cochrane, 2011, p. 40). He thinks that Krugman wrongly prefers "literary style of exposition" to comparing theories quantitatively to data because he attacks economists for mistaking mathematical beauty for truth (Cochrane, 2011, p. 39). Furthermore, Cochrane (2011, p. 37) thinks Krugman's Keynesian economics requires people to make logically inconsistent plans to "consume more, invest more, pay more taxes with the same income." It also presumes that people do not think about the future in making decisions today so governments can systematically fool people again and again (Cochrane, 2011, p. 38). Therefore, he thinks that Krugman's view is not logical.

These methodological views on economics rest on what is to be concluded from the failure to "predict" the financial crisis. Therefore, it is important to get a clearer idea of what we mean by prediction, and what kind of prediction should economics be held accountable for. Agreeing with what prediction is would be essential to making progress in the debate about the future of macroeconomics.

Once we analyze what economists mean by prediction, the conclusions of how economics should proceed as a field can vary greatly. Furthermore, it is evident that prediction plays a big role in what is to be concluded from the financial crisis. For example, Steve Keen represents a heterodox view based on an implicit view on prediction. His article, "Predicting the 'Global Financial Crisis': Post-Keynesian Macroeconomics," compares predictions of empirical indicators based on mathematical models among neoclassical and other economists (Keen, 2013). According to Keen (2013) and D.J. Bezemer whom he quoted, to count as a successful prediction of the 2007-2009 financial crisis requires that the prediction (1) offered an account on

how the conclusions were arrived at; (2) predicted beyond a real estate crisis and provided an analytical account of linkage to real economy; (3) made the predictions themselves in public; and (4) had timing attached (p. 228). Prediction is used in the sense that if the indicator reaches some level, the high likelihood for a severe economic crisis could be deduced. In Keen's (2013) article, indicators are not only used to predict the potential of an event, but also the course of events such as "the crisis will continue until private debt levels are substantially reduced - by of the order of 150 per cent of GDP in the case of USA" (p. 249).

Keen (2013) points to mathematical models of post-Keynesian macroeconomics to be successful where the neoclassical models failed. He thinks "the OECD's observation that 'the current economic situation is in many ways better than what we have experienced in years'" is typical of official forecasts (Keen, 2013, p. 228). While this may not seem like a forecast but rather a description of current state of economics, I believe what Keen is trying to refer to is OECD's explicit forecasts after this statement. The OECD (2007, p. 7) stated that their "forecast remains indeed quite benign: a soft landing in the United States, a strong and sustained recovery in Europe, a solid trajectory in Japan and buoyant activity in China and India." Keen claims that while behavior of the crisis could emerge in neoclassical models the crisis if some level of shocks could be injected into the dynamic stochastic general equilibrium (DSGE) models, he does not think the shocks could have been anticipated prior to the crisis. By comparing empirical indicators between neoclassical and post-Keynesian models, he claims victory for post-Keynesian models for predicting the Global Financial Crisis.

David Colander, in "The economics profession, the financial crisis, and method," defends economics by arguing the financial crisis was not predictable (Colander, 2013). He thinks models cannot respond quickly enough to be relevant for policymaking because models are far

removed from actual real-world events, so there could be many explanations for why something happens and the model failed to predict its happening. I interpret him to mean that the economy is taken to be a complex system so that no model could capture its entirety to generate accurate predictions. However, he states that his position is that economic models should have allowed for the possibility of the crisis, while the DSGE models assumed away the complexity that could have allowed for that possibility (Colander, 2013, p. 419). He advocates for more complex systems models which he thinks could tell us that such a crisis would be impossible to predict, thus diverting criticism away from the failure of specific event prediction[4].

Keen and Colander have diverging views on prediction. While Keen argues that the crisis was predicted by post-Keynesian models, Colander thinks that the nature of the crisis made it unpredictable. Keen's sense of prediction is that the fulfilment of conditions in the form of indicators reaching some level implying high likelihood for a crisis to happen. While Colander does reject the same sense of prediction discussed by Keen, he also rejects the possibility of predictions of real-world events in ways that are useful for policymaking. In the "Policy Implications" section, Keen (2013, p. 250) lists some ways the outcome of models could be useful, such as "rapid acceleration of private debt" warning of an "approaching financial crisis." This implies that Keen thinks that prediction could be useful for policymaking. Thus, they have different concepts of prediction and reach different conclusions regarding whether the crisis could have been predicted.

4 Complex systems are systems where the collective behavior of their parts entails emergence of properties that can hardly, if not at all, be inferred from properties of the parts. Examples of complex systems include ant-hills, ants themselves, human economies, climate, nervous systems, cells and living things, including human beings, as well as modern energy or telecommunication infrastructures. (Complex Systems Society, 2018)

In this thesis, I will draw upon long-standing debate in philosophy about scientific prediction to create a taxonomy of prediction. In the following sections, I will present what I find is the best way to separate the different kinds of prediction and argue for the kind which is suitable for economics. Then, I will re-evaluate the economists' views, explaining how their meaning of prediction leads to different conclusions about the future of economics.

II. Taxonomy of Prediction

Among different sense of prediction that can be conceived, I want to focus on those that come up most often as points of disagreement or confusion by philosophers and economists. Senses of prediction can be sorted according to six dimensions. A prediction is either:

1) conditional, apparently unconditional, or unconditional;
2) probabilistic or deterministic;
3) something that refers to new kinds of events or to events of kinds which are known;
4) qualitative or quantitative;
5) general or specific;
6) about an event, a relationship across time, or a concurrent relationship;

These dimensions are independent of one another. The positions taken with regard to prediction may mention only a few dimensions and take no position on the others. These dimensions are chosen because 1) economists often differ upon them without explicitly stating them, 2) philosophers disagree on whether some are scientific and should be used in economics,

and 3) they lead to different conclusions on whether the crisis was predicted and what it means for economics.

Dimension 1: Conditional, apparently unconditional, or unconditional

Prediction can be conditional, apparently unconditional or unconditional. *Conditional predictions* are in the form "if event A occurs, then event B will occur." The prediction made by Law of Supply in economics is an example of a conditional prediction: if the price of a good increases, the quantity supplied for that good will increase (ceteris paribus). *Unconditional predictions* are in the form "event B will occur," without an antecedent. *Apparently unconditional predictions* are in the same form as conditional predictions, but they assume the fulfillment of the condition "if event A occurs" so that event A has occurred. An economist who predicts "the housing bubble will burst" is most likely an example of an apparently unconditional prediction instead of an unconditional prediction. The unstated but understood conditions, such as interest rate hikes and higher unemployment, are typically supposed to be already fulfilled. In a financial crisis, the public seems to always be demanding unconditional predictions such as "we will face the worst financial crisis since the Great Depression in 2007 to 2008" whereas economists rarely provide them. In the next section, I will also show that the sciences generally do not offer unconditional predictions either, contrary to apparent perception.

Dimension 2: Probabilistic or deterministic

Predictions can also be *probabilistic* or *deterministic*. A probabilistic prediction would include "... with x% chance," similar to the way in which weather forecasters say "tomorrow will have a 30% chance of rain." An example of a probabilistic prediction in economics is the prediction by the Federal Reserve Bank of New York that there is a 10.8366% probability of a

U.S. recession in March of 2019 (Federal Reserve Bank of New York, 2018). A deterministic prediction would not have probabilities stated or implied. A specific, deterministic prediction, for example, could be when an economist predicts that U.S. consumer spending will increase in 2018. If this is taken to be a deterministic prediction, then the prediction could be proven false if actual U.S. consumer spending does not increase in 2018.

This dimension is independent of others, thus having combinations of different dimensions beyond the example previously mentioned. A deterministic prediction can also be general, such as prices increase when supply decreases, ceteris paribus. Probabilistic predictions can also be qualitative instead of quantitative when replacing the quantified probabilities with "likely" or "unlikely".

Dimension 3: Refers to new kinds of events or events of kinds which are known

Predictions of *new kinds of events* are statements made about things that have not happened in the past but instead are about things of a kind that are actually observed for the first time only after making the prediction. For example, Dmitri Mendeleev's prediction of new elements would be predictions of new kinds of events. Predictions of *events of kinds which are known* are also statements made about things that occur after making the statement but can be about things that have happened. A prediction of events of kinds which are known is the prediction of an earthquake tomorrow.

Here, "kind" is understood loosely as similar to a large degree, and what is the same kind may be based on convention. For example, a newly discovered element is a different kind because it has not been observed before, whereas the next recession and the previous one are of the same kind because the nature of recessions enables us to say that the recession has been

observed before. While new kinds of events may not seem to be relevant in economics, there are however still economic events that can be understood as of a new kind, especially for the purposes of the debate at hand. When an economist says the financial crisis is unprecedented, what he means that its nature is of a kind that has not been observed before, thus he is taking the financial crisis to be new kinds of events. The emergence of bitcoins could also be a new kind of event due to being the first decentralized digital currency without a central bank or single administrator (Brito and Castillo, 2013).

Dimension 4: Qualitative or quantitative

Qualitative predictions are statements made about measures of quality while *quantitative* predictions are statements made about measures of quantity. For example, the law of demand makes a qualitative prediction that if price declines, consumers will purchase more of that good. A prediction that GDP will rise 2% next year would be a quantitative prediction.

Dimension 5: General or specific

General predictions are made regarding multiple occurrences, or a type, while *specific* predictions are made about a point instance, or a token. A general prediction could be "whenever price goes up, quantity demanded goes down" whereas a specific prediction could be "if the price of steel goes up in the U.S. next month, the quantity of steel demanded next month will go down."

It is important to distinguish between quantitative vs. qualitative and general vs. specific. Economists and philosophers as well often talk about quantitative as equivalent to specific, and qualitative as equivalent to general. However, there is no reason to assume such equivalence upon closer inspection. A prediction such as "if a government increases spending by $1bn and

the country's marginal propensity to consume is 0.8, then the national income would increase $5bn" is quantitative but not specific. It says that whenever the government spends $1bn more, the national income would increase $5bn, not just a specific instance such as next year.

Therefore, quantitative predictions do not have to be specific. Qualitative predictions also do not have to be general. A prediction that the housing bubble will burst next year is qualitative but also specifically about the event that the bubble will burst next year. Therefore, quantitative vs. qualitative and general vs. specific are independent of each other.

Dimension 6: About an event or a relationship;

A prediction *about an event* predicts the existence of a new kind of event or the occurrence of an event of kinds which are known. For example, the prediction of the emergence of time travel could be a prediction about the existence of a new kind of event, while the prediction of an earthquake is a prediction about the occurrence of an event of kinds which are known. A prediction *about a relationship* predicts that A stands in some relation to B. An example of this is the prediction by Engel's Law, that higher-income families have a lower percentage of income spent on food.

III. Methodological Arguments about Prediction

Before we dive into differentiating these senses of prediction, it is necessary to first determine the scope of use for the prediction we discuss here. While there are questions about whether economics is a science, whether there is unity of the sciences, and whether all the sciences should be held to the same standards observed in the natural sciences, I will refrain from getting into that debate. Instead, I will stipulate that we are addressing scientific prediction and I will draw parallels between economics and the natural sciences.

By scientific, I am referring to predictions characterized by methods and principles of science. This should be viewed as distinct from other senses of prediction outside the domain, such as fortune-telling. If the implied view of prediction requires economics to be able to conduct fortune-telling, which means to make claims about things in the future without scientific explanation, then the view of prediction would not be taken seriously.

In the next pages, I will first offer five statements regarding prediction that I believe to be true, and detail my arguments in following paragraphs. At the end of this section, I hope to have shown why different senses of prediction are used and argued for.

Statement 1: Prediction should be conditional predictions and apparently unconditional predictions but not unconditional predictions, with the conditions able to be used for test of theories.

Prediction can be conditional only because formulations of scientific predictions are conditional. Karl Popper (1962, p. 339) distinguishes scientific predictions from unconditional historic prophecies (or unconditional predictions). Popper refers to the tendency of using historical methods in sociology as historicism[5] (Popper, 1962, p. 333). He draws comparisons between the natural sciences and social sciences to conclude on what types of predictions are possible. In his arguments against historicism, Popper observes that ordinary scientific predictions are conditional. His sense of prediction is that "certain changes will be accompanied by other changes" (Popper, 1962, p. 339). Popper (1962) uses economics as an example and argues the economist can predict that "under certain social conditions, such as shortage of commodities, controlled prices, and say, the absence of an effective punitive system, a black

[5] Popper uses sociology loosely to refer to social sciences throughout the book.

market will develop" (p. 339). This means a prediction such as "a black market will develop" would not be scientific. The initial conditions, "such as shortage of commodities, controlled prices, and say, the absence of an effective punitive system," are necessary as part of the prediction.

One may argue that some predictions in science do not have conditions, which would make some predictions unconditional. However, apparently unconditional predictions, upon closer inspection, are in fact conditional predictions with the implied fulfilment of conditions. Popper finds apparently unconditional predictions in science to be conditional predictions that have omitted the conditions due to the conditions being fulfilled or unstated (Popper, 1962, p.338). For example, if astronomers accurately predict when the next eclipse is, it is because the conditions for an eclipse to happen in that specific time frame can be ascertained at the time of the prediction. The conditions such as the planetary relations will stay the same, or the physical laws will hold, are implied in the prediction and we are confident that they will hold.

The only constraint on the conditions is that they can be used for test of a theory. This means that they can be realized and ascertained in reality to be fulfilled, and transformed into apparently unconditional predictions that can be compared against observations to test a theory. Popper, however, thinks such transformations are impossible for economics due to human history being mainly not repetitive (Popper, 1962, p. 340). If we ask whether Popper thinks financial crises can be predicted the way eclipses can be predicted, he would answer no. He finds eclipses to represent the type of historical prophecies that are derivable only from conditional scientific predictions because they are applied to systems that are "well-isolated, stationary, and recurrent" (Popper, 1962, p. 339). He thinks societies are subject to ever-changing conditions and emergent situations such as the consequence of new scientific discoveries (Popper, 1962, p.

340). Thus, Popper would not think that social sciences can make such predictions due to societies not being these types of systems.

While I agree with Popper's argument against unconditional predictions, his argument against apparent unconditional predictions is not clear. I agree that complexity of the social systems may make the resulting predictions not as accurate with the same level of precision. For example, if we were to predict when a crisis could hit hundreds of years from now, with the precision of what time of day it would hit, then it is can seem impossible to be as accurate as the astronomers predicting eclipses. However, we should also question the relationship between precision and possibility in apparently unconditional predictions. Predicting a crisis to happen sometime over the next hundreds of years may not be a goal of economics in the first place. Thus, even though it may not seem practically possible to make apparently unconditional predictions to the degree of precision of astronomers predicting eclipses, it should not be confused with the possibility of making apparently unconditional predictions in general.

Logically, it would be impossible to allow only conditional predictions and not apparently unconditional predictions. Carl Hempel (1965) thinks explanation, prediction, and postdiction are alike in their logical structure but differ in certain other respects. He argues that the three of them all show that "fact under consideration can be inferred from certain other facts by means of specified general laws" (Hempel, 1965, p. 174). He explains it further in his argument for the symmetry thesis. It states that for any adequate explanation, had its premises—its initial conditions and covering laws—been taken into account at a suitable prior time, then a deductive prediction of the occurrence of the explanandum event would have been possible, and conversely. Explanation is just prediction written backwards. Therefore, he would agree with Popper that predictions are conditional, and can only be apparently unconditional had the

preceding conditions been fulfilled. If an argument is presented before the occurrence of the event explained, then it is a prediction.

On testability, the economist Fritz Machlup disagrees with Hempel regarding its compatibility with conditionality and its practicality. Machlup (1978) agrees with Hempel that prediction is deduction from theory (p. 154). He argues that because of non-reproducibility of the "experiments" or observed situations and courses of events in the economy, it is impossible to test whether predictions based on a theory come true. He then claims that only if he were "prepared to make unconditional predictions" using his theories, could those theories be tested by comparing such predictions with "actual outcomes" (Machlup, 1978, p. 154). To be able to test theories, these predictions would also have to be "without hedging about probability and confidence limits" (Machlup, 1978, p. 154). Thus, these predictions he refers to are unconditional and deterministic. For a financial crisis, he would think that only if he predicted an event of such and such magnitude to happen at such time, could such a prediction be testable. Both conditional and apparently unconditional predictions are thus fundamentally in conflict with testability in Machlup's view. Later Machlup still suggests empirical testing to be useful especially in economics, which may imply that he is arguing against relying too much on the accuracy of a specific, conditional prediction.

However, if a prediction involves conditions that are so specific and many that the conditions are not repeated, then the explanation also is not general enough. If I predict the financial crisis will occur if account holders withdrew $1.55bn from IndyMac in Southern California, the condition would be too specific to be reproduced. This prediction would be a test of the theory that explains the cause of the financial crisis to be account holders withdrawing $1.55bn from IndyMac in Southern California. Because the condition will not repeat in the

future, this theory cannot be tested and falsified by comparing the prediction with observed outcomes.

To Machlup, a more general prediction such as if demand goes up, price goes up also cannot be tested and falsified. Here, the conditions are ceteris paribus, or holding all other conditions constant. Machlup's view indicates that this prediction cannot be testable, since many other factors could explain why price does not go up even if demand goes up. Indeed, the complete conditions can never be recreated, but this is true for the natural sciences also. As long as we can agree that there is regularity in the economy and in the physical world, then there must be few enough conditions to enable repeatability within certain limits of precision. If I predict a recession will occur within three months if the fertility rate drops 5%, the condition is only that the fertility rate drops 5%.[6] This condition is finite and repeatable enough so as to be testable. Therefore, testability is not incompatible with conditional and apparently unconditional predictions.

Machlup (1978, p. 155) then argues that, realistically, these predictions would still not be used to test theories because it is in principle impossible to verify every part of the predictions and diagnosis behind them. He thinks that lucky coincidences make it impossible in reality to verify whether a prediction was right. The prediction could have gotten the magnitude right by accident yet described the reasons and process of how the crisis occurred in a completely wrong way. Because events and changes rarely occur under the same conditions, he thinks each event is a "single occurrence." Conditional predictions (and apparently unconditional ones as well) are impossible to disconfirm. However, this view assumes that test of prediction is to deduce the

[6] In the NBER working paper "Is Fertility a Leading Economic Indicator?" by Kasey Buckles, Daniel Hungerman, Steven Lugauer, conception rate is found to drop several months before other signs of a recession become visible. (Buckles, Hungerman, & Lugauer, 2018)

correctness of a theory or an explanation by finding the prediction correct based on observation. However, even if the prediction of one instance proved to be correct, it would not make the explanation or the theory correct. Otherwise, it would be committing the fallacy of affirming the consequent[7]. Testability of prediction can be the test of whether the prediction is wrong, so as to provide a reason to reject a theory or explanation the prediction is based on.

One could argue that even if the prediction was wrong in one instance, it could have failed to predict the crisis while having described the correct reasons and process. However, this would take us away from the argument between conditional (and apparently unconditional) and unconditional, since unconditional predictions could also be subject to such criticisms. When does a false prediction lead to rejection of a theory is another separate discussion for economists.

Statement 2: Predictions can be probabilistic.

Machlup (1978, p. 155) thinks that apparently unconditional predictions cannot be made without hedging about probability and confidence limits. He thinks that any prediction made with less than 100% probability value cannot be disconfirmed, because "any kind of outcome is consistent with the prediction" (Machlup, 1978, p. 155). Although he concedes in the footnotes that this statement about prediction does not refer to strictly empirical hypotheses obtained by statistical inference, its implications on general theories still show that Machlup thinks probabilities in principle are problematic. While strictly empirical hypotheses may seem to be what we observe as economic prediction, to Machlup they are in fact too specific to enable repeatability, thus making them irrelevant to the present discussion of scientific prediction which can be general. His argument is that only if the same case occurs a hundred times or more can we

[7] Fallacy of affirming the consequent is the fallacious form of if p then q; q is true; therefore p is true. For example, "if we are in 1993, Popper would be alive"; "Popper is alive"; "therefore, we are in 1993".

"verify the stated probability by the frequency of 'hits' and misses'" (Machlup, 1978, p. 155). However, this not only assumes that economic phenomena repeat rarely, but also more importantly the precision of any prediction in economics is limited in ways that cannot make predictions useful for testing theories. I could predict that recessions happen four out of five times after a dramatic decline in pregnancy rates, with a margin of error of one time. Thus, if the dramatic decline in pregnancy rates happened 10 times, anywhere from 7 to 9 times a recession followed would be consistent with my prediction. Therefore it is a matter of precision and convention whether probabilistic predictions can be used to test theories, but this does not rule out the testability of probabilistic predictions in principle. Furthermore, if the prediction is about a relationship, the test may not be only based on one event, but necessarily based on what that relationship is describing.

Statement 3: The tradeoff between accuracy and precision is one to be decided based on practicality, and not on principle.

If the prediction is true compared with observed outcomes, then it is accurate. Precision in prediction is the range of observations that would make a prediction true. For example, a prediction of GDP rising 3% with a margin of error of 1% would be accurate if the actual GDP growth is between 2% and 4%. Precision in this case is the margin of error, and we can make the prediction more precise by decreasing the margin of error to 0.5%, making the prediction accurate only when actual GDP between 2.5% and 3.5%. The increase in precision increases the scenarios which make the prediction false, thus making it harder to be accurate.

Machlup (1978, p. 155) believes that predictions of economists should not be tested on their accuracy, but on the reasonableness of their predictions. Here I do not think he is arguing

against the value of empirical testing for all sciences, but trying to refocus on what makes economics distinct from other sciences - it agents are humans instead of particles, molecules or other animals. Prediction, in his sense, would not be an attempt to foresee single occurrences like the financial crisis. His view rests on his claim that the social sciences are distinct from natural sciences in that "man is both observer and subject of observation" (Machlup, 1978, p. 152). Therefore, he thinks that the observations are themselves results of human actions interpreted by human agents. A good prediction should make sense to other humans rather than fit the realized outcomes in whatever degree of precision. "Reasonableness" thus replaces "accuracy" as what should be achieved in economics.

This view is problematic because of ambiguity in "reasonableness" and a rejection in principle of accuracy. Economics studies the actions of humans, but those actions occur as objective facts that can be compared with predictions. If we take "reasonableness" to mean "fitting of our intuitions," Machlup's view would in principle allow predictions that deviate greatly from realities but seem right by intuition to fellow humans.

The pursuit of accuracy should also be balanced with precision according to the needs in practice. A prediction such as "if I throw a paper airplane in this seat, it will land in the state of North Carolina" is accurate, but not very useful to test the law of aerodynamics. Similarly, a prediction such as the housing bubble will burst may be accurate, but not very useful for testing the existence of a housing bubble in the present day. If housing prices collapse 50 years from now, the prediction would be consistent with the observed outcome, but it would not provide current policymakers with confidence to regulate the housing market or prove that currently there exists a housing bubble. Thus, the degree of precision is decided by what makes the prediction a useful test of theories in practice.

Statement 4: Theories should enable prediction of events of kinds which are known, and progress of science requires the discipline to develop theories that enable prediction of new kinds of events.

If one believes progress, or the accumulation of knowledge, to be the essence of science, then economics should aim towards developing theories that predict new kinds of events. Progress of science requires the discipline to develop theories that enable prediction of new kinds of events[8]. Because progress in the natural sciences have been enabled by predictions of "new kinds of events," Popper (1962, p. 117) thinks scientific theory requires prediction of new kinds of events beyond prediction of events of a kind which are known. In his arguments against instrumentalism, Popper refers to discovery of wireless waves, zeropoint energy, artificial building up of new elements not previously found in nature as examples of prediction of new kinds of events. For prediction of events of kinds which are known, he refers to eclipses or thunderstorms (Popper, 1962, p. 117). Therefore, scientific prediction should allow for predicting recurring events as well as unprecedented events. In the case of economics, Popper would think economics should aim towards prediction financial crises whether or not financial crises are considered events of a kind which are known or new kinds of events due to the unique characteristics of each one.

Hempel agrees with Popper on the prediction of new kinds of events. He argues that science can forecast what has never before been encountered, such as the existence of viruses by Dmitri Ivanovsky (Hempel, 1965, p. 262). Thus, even if we have never experienced a crisis before, economics should aim towards predicting crises. He does not think there are intrinsically

[8] "Events" is a loose term used by Popper that refers to phenomena, events with time and place, etc. It can be understood as existence or occurrence of anything, whether they are relationships, material objects, or properties.

mysterious unexplainable things. If something seems unexplainable, it only indicates the current scope of knowledge (Hempel, 1965, p. 263).

An economist, arguing against the prediction of new kinds of events, could object that some theories may indicate that our scope of knowledge is limited, such as the Efficient Market Hypothesis. The Efficient Market Hypothesis states that when new information becomes available, it is incorporated into the price of the asset immediately, thus making it impossible to predict the future prices of assets. The impossibility of predicting the future prices of assets is a deterministic prediction about a relationship, while the "prediction" it refers to in "predicting the future prices of assets" is about events. This seems to pose an objection to Hempel and Popper's belief that nothing should be in principle unpredictable, but these views may be reconciled by understanding their reasons. Furthermore, the Efficient Market Hypothesis has a prediction in one sense and not the other, even though one may take for granted that the event prediction should be possible. I will leave this for now and come back to it when discussing Robert Lucas's specific view on unpredictability.

One could also argue against the prediction of both new kinds events and events of kinds which are known, due to the system of society being able to react to the prediction. The reaction could make the prediction self-fulfilling or self-defeating. A prediction of a bank's failure can be self-fulfilling, since it may cause people to withdraw their deposits, resulting in a bank run when otherwise there may not have been a bank run. A prediction that there would be a lot of traffic on a particular highway may be self-defeating, since drivers then steer clear of that highway so the congestion does not happen. Furthermore, economic predictions are used in policy to take actions that prevent certain predictions from being realized. Therefore, policy actions may lead

to the predictions being self-defeating. Thus, predicting a crisis would not be like predicting a hurricane, since the hurricane cannot hear my prediction and shift its course.

In the case of self-defeating prophecies, because we have established that unconditional predictions are unscientific, the prediction can be used as test of theory. The traffic expert's prediction of congestion is conditional on people driving as planned. However, the condition can be changed by people who know of the prediction. Thus, if people react to the prediction to change its condition and avoid the realization of the prediction, the prediction is practically useful, even though people may then incorrectly think the prediction had no basis. A comparison with when people do not know of the prediction can test whether the theory is not disconfirmed. In the case of self-fulfilling prophecies, it would be difficult to imagine a case where the birth of the prediction instantly makes it self-fulfilling. For example, in the bank run case the self-fulfilling reaction is caused by unfiltered information provided to the general public without regard for consequences. Furthermore, the prediction of a bank run being self-fulfilling can be exactly what a theory predicts, thus a theory can give us insight on what makes the prediction self-fulfilling, and let us avoid the result. Because the prediction is provided to policymakers instead, deposit insurance, public guarantees, and capital support can be among things that help prevent the prediction from fulfilling itself. When a prediction is averted by policy, the test is whether the subsequent prediction - the policy will negate the result - is realized, and not the initial prediction we wanted to avert.

Statement 5: Whether predictions should be quantitative or qualitative is a matter of practice, while in principle theory should allow for both general and specific predictions.

Specific predictions follow from general predictions. Generality means in every instance, such prediction would apply, thus a general prediction which applies to many instances would necessarily apply to one specific instance. One may argue that that social events are unique and unrepeatable, thus inaccessible to causal explanation. Therefore, single events cannot be explained by a general explanation. Hempel (1965, p. 253) disagrees and thinks that only repetitions of certain antecedent characteristics are needed for explanation instead of their individual instances. For example, heat accompanies friction is a prediction that states certain antecedent characteristics but not specific instances such as where the friction happens or what surface it happens on. In social sciences such as economics, Hempel's argument could be interpreted to mean that if crises share certain characteristics, then certain preceding characteristics could predict such crises.

Machlup (1978, p. 156) thinks that "specific hypothesis," or specific predictions, are limited to time and space, and are thus "historical propositions." He thinks that if "the relationships measured or estimated in our empirical research are not universal but historical propositions, the problem of verification is altogether different - so different that according to intentions expressed in the introduction we should not be concerned with it" (Machlup, 1978, p. 156). The intentions Machlup refers to are that of discussing scientific prediction which should be universal propositions instead of historical propositions (unconditional predictions), which Popper also argued to be unscientific. Machlup seems to find it impossible for specific predictions to provide a test of general theories on the sole basis that they are historical propositions. Therefore, it is likely that he is using "historical propositions" in the same way Popper uses "historical prophecies." Historical prophecies were rejected by Popper because they are unconditional predictions which are impossible in sciences in general, as discussed in the

conditional, apparently unconditional and unconditional section. However, here Machlup is confusing unconditional predictions with specific predictions. The reason that historical propositions are not scientific is not that they are limited in time and space, but that they are unconditional. Since we have rejected unconditional predictions, historical propositions are indeed not what we want in economics. But propositions limited in time and space do not have to be unconditional. A prediction involving time and space could predict that a recession will happen in the U.S. next year given current interest rates. This specific prediction can also be used as one of the instances in testing theories regarding recessions and interest rates. Thus, just because specific predictions may be limited in time and space, does not mean that they cannot be scientific.

Machlup also thinks his argument against specificity extends to numerical relationships, or quantitative prediction, which he describes to be statistical data covering a particular period compared with the data of another period (Machlup, 1978, p. 156). He begins the argument by pointing out that "successive estimates on the basis of new data have usually been seriously divergent" (Machlup, 1978, p. 156). His explanation of this outcome is that because numerical relationships in economics are subject to unpredictable change, so the test of new data fitting hypothesis is just a comparison between two historical situations, "an attempt to find out whether particular relationships were stable or changing" (Machlup, 1978, p. 157). I read this statement as suggesting that even if the relationships were found to match, the only conclusion to be drawn is that they are stable, and not that the theory describing the relationships is true. If I predict that a 5% decrease in pregnancy rates is correlated with a 5% decrease in GDP, Machlup would think that this relationship would be subject to unpredictable change across time and space, so that the ratio may be different in U.S. and Japan, or different in 2008 and 2018.

Because this conclusion seems to make general predictions impossible to be verified as well, Machlup (1978, p. 157) then states that in practice there are probably limits to the variations of numerical relationships. Therefore, he thinks data from different periods or geographies can be used to test general theories "according to which certain parameters or coefficients must fall within definite limits" (Machlup, 1978, p. 157). An example of this according to him is generalizing that "the marginal propensity to consume cannot in the long run be greater than unity" (Machlup, 1978, p. 157). However, what limits of variations can be used as test for theories is a matter of precision and convention.

Machlup responds to the diverging data against both specific and quantitative predictions, but then confusingly concedes that they may be used to test general theories. He is in fact claiming that specific predictions can test general theories, but general theories cannot be applied to generate specific predictions because no relationship holds across time and space. However, a prediction being general necessarily means it holds across time and space. We can imagine a theory that explains change in GDP by change in pregnancy rates. This theory would generate a general prediction that if pregnancy rate changes, GDP changes. If the relationship between GDP and pregnancy rate does not hold across time and space, then it would mean that the prediction implies conditions of a specific time and space. The theory would only be able to explain the relationship in that specific time and space, which is only one instance. Such a theory would not be scientific at all because scientific theories need to be general. Thus, it does not make sense for a theory to both not apply to different time and space and still be general. While a theory can be used to make a prediction across all countries over a specific year, it is the prediction that is general, but in a conventional sense, while the theory itself may be general in a broader sense.

Whether a prediction should be qualitative or quantitative should depend on practice, specifically what is being explained and what kind of prediction can be useful. What is being explained can decide whether the prediction is qualitative or quantitative. If the prediction is whether or not there will be a recession next year, then the prediction is either there is or there is not, with some limitations of precision attached. In prediction the occurrence of a recession, one is not looking for numbers of recessions or amount of recessions, but a qualitative prediction about whether there will be an event with the essential features of what we identify as a recession. However, if the prediction is what the inflation rate will be next year, it will have to be quantitative, without the possibility of judging what the quality of that inflation rate is. Usefulness in practice also decides whether a prediction is qualitative or quantitative. For investing in a business, a quantitative prediction of economic growth would be useful to compare with the business's projected growth.

In conclusion, whether predictions are quantitative or qualitative is a matter of practice, while in principle theory should allow for both general and specific predictions.

IV. Re-evaluating Economists' Views

While economists offered differing reflections on what the 2008 Financial Crisis meant for the discipline, they may not have been talking about the same thing when they talk about prediction. In this section I discuss their views of prediction and how it fits into their conclusion about the lessons learned, then determine whether they have confusing positions.

Ricardo J. Caballero (2010), in "Macroeconomics after the Crisis: Time to Deal with the Pretense-of-Knowledge Syndrome," distinguishes his conceptual view of prediction from the public's. The view he rejects is what the public places on economics, which is predicting specific

crises before their occurrence. This view of prediction is apparently unconditional, specific prediction about an event. Caballero rejects this view by claiming severe crises to be "essentially unpredictable" (p. 85).

Caballero acknowledges that certain indicators can mean an increase in the fragility of a financial system to warrant action, but thinks this is very different from what he understands as prediction. He quotes mathematician Benoit Mandelbrot to say that crises are like storms, and can only be predicted after they form (Caballero, 2010, p. 94). This can be understood as stemming from their understanding that financial crises are complex and evolving events similar to storms. What he means by the storm analogy is not actually predicting the existence of the storm/crisis, but the path it would take. For example, he would agree that predicting crises is similar to predicting storms in that we can see the initial signs of it happening already, and then predict what will it become in later days. This view is prediction about relationship across time, with the relationship being between the event of a crisis occurring and what happens next. He also provides an example that confusion triggers panic in a crisis, and suggests that a government can provide insurance against extreme events. This suggests that a crisis having such magnitude and severity as the most recent one is conditional on panic taking its course, thus policymakers can change the conditions to mitigate a crisis. Thus, Caballero is essentially claiming conditional, specific, and probabilistic prediction about relationship across time, in parallel with weather forecasts. What he rejects is the specific, unconditional and deterministic prediction of an event.

Charis Christofides, Theo S. Eicher, and Chris Papageorgiou (2016), in "Did established Early Warning Signals predict the 2008 crises?", did not find a single Early Warning Signal (EWS) that alerts to all dimensions of the 2008 crisis. They state that "the magnitude of the crisis should evoke strong predictive power for any valid Early Warning Signal" (Christofides et. al,

2016, p. 104). While they concluded that the sets of EWSs prior to 2008 could not have predicted the 2008 crisis, their main takeaway is that the nature of the crisis should be specified before EWSs are examined. For example, which dimensions out of banking, balance of payments, exchange rate pressure, and recession are identified in the crisis. This suggests that they believe the crisis to be predictable. Thus, they use Bayesian Model Averaging (BMA) approach to examine how well the 2008 crisis could have been predicted by consensus Early Warning Signals. For linear regression models, the BMA finds the best model (subset of regressors) given a dependent variable, a number of observations, and a set of candidate regressors. Dimensions of crises are captured by a narrow set of dependent variables. For example, whether an International Monetary Fund (IMF) facility was accessed is an indicator for balance of payment crises. They used a sample of 95 countries and 57 annual macroeconomic and financial independent variables (potential EWSs) and four dependent variables (crisis indicators). All independent variables predate 2008 to minimize endogeneity issues (Christofides et al., 2016, p. 106). They concluded that no single set of EWSs could have predicted all dimensions of the crisis. Their conclusion is not that the crisis is not predictable, but that given the models available, we could not have predicted the crisis due to lack of clarity on what is the nature of the crisis we are trying to predict. This suggests that economics should aim to understand the nature of crises, and then develop models that can predict crises in the future.

They used postdiction to test the models, but implies that prediction should be possible in the same way as well[9]. Therefore, their sense of prediction is conditional, quantitative, specific, probabilistic, and about an event. Their view that prediction is about an event is in conflict with

[9] Postdiction is defined as prediction after the fact, and can be used in testing theories as long as the fact was not known prior. For example, retroactively tracing the location of an archeological site would be a postdiction, since the site existed prior to making the prediction, but was not known to the maker of the prediction.

Caballero's view that crisis prediction is about relationships. Thus, their disagreement with Caballero on whether the crisis could be predicted concerns the same view of prediction, since Caballero thinks prediction of an event is impossible while they think prediction of an event is possible. However, Caballero's remark about indicators signalling fragility in the financial system not being prediction may imply that he would not think what Christofides et al. think of as prediction of an event is really prediction.

Robert Lucas (2009), in "In defense of the dismal science," argued for a different view of what the public can reasonably expect from economics and whether economics fulfilled that expectation. Based on the Efficient Market Hypothesis, he thinks it is impossible to have a set of models to forecast "sudden falls in the value of financial assets." In other words, predicting the crisis is impossible, in that "if an economist had a formula that could reliably forecast crises a week in advance, say, then that formula would become part of generally available information and prices would fall a week earlier" (Lucas, 2009). Thus, Lucas defends the policymakers who were criticized during and after the financial crisis. Frederic Mishkin, then a governor of the Federal Reserve, and Ben Bernanke, chairman of the Federal Reserve were among those defended by Lucas. Rejecting that Frederic Mishkin's "reassuring" simulations were a failure by macroeconomics, Lucas points out that the simulations were not presented as an assurance that no crisis would occur in the first place. He states that the Federal Reserve's FRB/US forecasting model predicted what could be expected conditional on the crisis not occurring. What he means by this statement is that the forecasting model has some fundamental assumptions that rely on the economy being at normal states, instead of having been affected by sudden shocks of the crisis. He further argues that after the Lehman bankruptcy, similar models that combined new information produced very accurate predictions for the next two quarters. Thus, Lucas is against

the view of prediction about an event, but thinks prediction is about relationship across time. The relationship across time would be between an event such as the Lehman bankruptcy and what would happen after. What he rejects is prediction about an event such as the Lehman bankruptcy.

He then goes on to defend Frederic Mishkin and Ben Bernanke by stating that they recognized the potential for a crisis, but "recommending pre-emptive monetary policies on the scale of the policies that were applied later on would have been like turning abruptly off the road because of the potential for someone suddenly to swerve head-on into your lane" (Lucas, 2009). In reality, he thinks the best policy is to "keep your eyes open and hope for the best" (Lucas, 2009). This shows that he thinks probabilistic prediction of the crisis is possible and was made, yet in practice one should be cautious and not overreact on a prediction with low probability.

Lucas's view on prediction is thus specific, probabilistic and about relationships across time. However, he also thinks that the prediction of a theory or explanation could be that some things cannot be predicted. In the case of predicting sudden fall of asset prices, Efficient Market Hypothesis (EMH) states that market prices fully reflect all available information and only react to new information which, if known ahead, would create room for arbitrage that eventually adjusts the prices. Thus, in the case of crisis, EMH predicts a concurrent relationship between the price and its reaction to information. While on the surface this may conflict with our previous conclusion that unpredictable things indicate only limitations on the current scope of knowledge, the two views are in fact discussing different senses of prediction. As mentioned in the previous section there are two senses of prediction in EMH: the first sense of prediction is the "prediction" referred to in "predicting the future prices of assets", which is about events; the second sense of prediction is a relationship prediction that such events are not predictable from any information

prior to the events occurring. Therefore, EMH does make a prediction, but in a different sense than the sense we normally attribute to it.

Lucas's defenses of the FRB/US model and policymakers are matters of practice. The model conditioning on a crisis not occurring would be a terrible model to rely on to predict a crisis, and the fault would not lie with the model maker but on those who used the model for the wrong reasons. The policymakers are then defended not against the criticism of "not seeing it coming," but rather "not doing something about it" (Lucas, 2009). It can be interpreted that Lucas thinks the policymakers saw the possibility of a low probability event, but rightly did not take actions because in most cases, taking action would have been inappropriate.

Thomas Sargent (2010) agrees that the models criticised "describe aggregate economic fluctuations during normal times when markets can bring borrowers and lenders together in orderly ways, not during financial crises and market breakdowns." This position implies that events are unpredictable, and thus rejects the view of prediction about events. He disagrees that the crisis caught the economists by surprise (Sargent, 2010). He says that economics has already constructed models of causes of financial crises and what government action can do to "arrest them or ignite them" (Sargent, 2010). The implied view here is that conditional, specific prediction about relationships across time.

With the taxonomy, we can better interpret the disagreement between Keen and Colander. Keen's sense of prediction is apparently unconditional, specific, quantitative, probabilistic and about an event. Colander rejects this sense of prediction, due to concluding that economic models will likely tell us the crisis is unpredictable. First, because he thinks models are far removed from the real world, Colander would find that this sense of prediction cannot be

done in principle. Second, Colander would find that the new Keynesians whom Keen said did predict the crisis did not really predict the crisis. Colander concluded that "it did not take a rocket economist to recognize problems in the financial sector as the burgeoning sub-prime mortgage market was bringing in less and less creditworthy buyers" (Colander, 2013, p. 420). Therefore, Colander thinks the potential of a crisis was predicted, but that is not the sense of prediction at debate here. The new Keynesian models only saw the potential of a crisis occurring, but did not predict the crisis in the apparently unconditional, specific, quantitative, probabilistic, about an event sense that Keen endorses. Thus, they are disagreeing on the same sense of prediction due to differing requirements on precision and usefulness.

Colander's own sense of prediction is relationship prediction: while certain events are unpredictable, a prediction could be made that these events are unpredictable given available information. Therefore, even though explicitly Colander thinks prediction is impossible, he is referring to the sense of prediction held by the likes of Keen, and not his own. Colander's sense of prediction is relationship prediction, which is the same view held by Lucas.

In conclusion, further clearing up of economists' views of prediction shows that they may or may not caricature the criticisms given to economics and have varying positions on what prediction is. The discussion that should be continued, however, is how economics is different from weather forecasting. Two problems are evident and discussed by economists: 1) economic systems can react to predictions and 2) epistemic uncertainty may make certain things essentially unpredictable. To address the first problem, how predictions of crises influence realization of the predictions should be extensively studied, which may involve what is the best way to minimize the public's ability to react and what policymakers should do with regard to predictions by economists. To address the second problem, all tools and capabilities should be exhausted before

coming to the conclusion that there is epistemic uncertainty in economics, and the conclusion should always be subject to test in the future.

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