A New Theory of Expectations

Richard T. Curtin¹

Received: 8 November 2021 / Accepted: 18 August 2022 / Published online: 5 September 2022
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2022

Abstract
Expectations are essential for understanding the economic choices of individuals as well as cyclical developments in an economy over time. The initial theory of how people form their expectations was first introduced by Aristotle more than two millennia ago. The core elements he advanced were that forward-looking decisions must be based on expectations and those expectations must be formed by reason, free from the corrupting influence of passion. These guidelines have been formalized in theories of rational expectations. There has been no consensus among social scientists, however, about whether rationality should be defined by how expectations are formed (favored in psychology) or by the outcomes of the formation process (favored in economics). Data collected by the University of Michigan over the past half-century appear to support both views: the psychological thesis of bounded rationality in the formation of expectations by individuals as well as the unbounded rationality thesis of economics when applied to the expectations observed across the entire economy. The goal of this paper is to correct empirical misspecifications, and to incorporate recent advances in neuroscience, including the dominance of nonconscious processes over conscious deliberation, the critical role of affective evaluations, and the formation of expectations by a Bayesian updating procedure. The new theory highlights the importance of contextual factors, and provides a more accurate assessment of costs and benefits. Although these innovations represent a radical departure from orthodox theories, they are justified by the increase in explanatory power provided by this new theory of expectations.

Keywords Expectation theory · Measurement of expectations · Non-conscious cognitive expectations · Cyclical indicators

¹ University of Michigan, Ann Arbor, USA
1 Introduction

Expectations play a prominent role in the collective research programs of CIRET members as a determinant of macroeconomic cycles. Aristotle wrote more than 2000 years ago that forward-looking decisions must be based on expectations, and that the accuracy of those expectations depend on human reasoning alone, stripped of the corrupting influence of passion. Decisions about nearly every aspect of contemporary life are now based on judgements about the expected likelihood of a given outcome. No contemporary of Aristotle, nor for that matter of Adam Smith, or even Maynard Keynes, would recognize the remarkable developments in our empirical arsenal of expectations. Everyone, from Aristotle to present day analysts, have recognized that the basic foundation of economic forecasting depends on expectations formed by rational calculations. Although theories of rational expectations have become more exacting and sophisticated over time, they still mirror Aristotles basic insights that he advanced more than two millennia ago.

Despite the widespread agreement on the importance of rationality in economic decisions, there has been no consensus among social scientists about how rationality should be defined. Economics has avoided the details of the formation process, opting to judge rationality based solely on the accuracy of the formed expectation. Psychologists have taken the opposite approach, defining rationality by whether agents use a rational procedure to form their expectations, shifting the accuracy tests from the outcomes to the inputs. Given these fundamental differences in how rationality is conceptualized, empirical tests based on either theory cannot reject the other. This has meant that there has been disjointed theoretical guidance for the practitioners who measure and use expectations for predicting economic cycles.

My research program at the University of Michigan has focused for the past half-century on understanding how consumers form expectations, the accuracy of their expectations, and their impact on shaping macroeconomic trends. Many scholars are skeptical about the ability of consumers to form rational economic expectations, based on either concept of rationality. Perhaps skepticism is too generous an assessment since many believe that the average consumer is simply incapable of gathering the necessary information and interpreting its meaning to form a rational expectation. Most believe that the expectations of consumers are simply uninformed guesses. I must admit that I was initially drawn to that view, partly based on hearing respondent mention that the formation process was tedious, the data too costly to obtain, too difficult to interpret, and the calculations were too hard to perform.

Herbert Simon (1955) introduced the notion of bounded rationality, which recognized these difficulties, and Kahneman et al. (1985), along with many other scholars, produced the heuristics and bias approach to describing the formation of expectations that recognized the importance of these limitations. Although bounded rationality is now the dominant alternative to John Muths (1961) rational expectations hypothesis, I have always found the bounded rationality alternative
unsatisfactory as it gave theoretical credence to the notion that people never learn from their repeated mistakes. The persistence of such maladaptive behavior goes against the overwhelming evidence of human evolutionary progress. After years of research, the data convinced me that a third alternative was needed to replace the simplistic choice between bounded and unbounded rationality.

The first hint of the necessity of a new theory came from survey data that appeared to support both bounded and unbounded rationality. The result depended on whether the analysis was conducted at the micro or macro levels. At the micro level, focusing on the behavior of individual consumers, the data provided a clear rejection of the rational expectations hypothesis and showed greater consistency with the bounded rationality approach. At the macro level, focusing on aggregate economic trends, the analysis came to an opposite conclusion. The macro analysis found that the way expectations changed over time were consistent with the rational expectations hypothesis.

This mixture of micro failures and macro successes was first noticed in the 1950s based on analysis of the University of Michigan’s Sentiment Index as a predictor of consumption. Given the limited number of time-series observations, the analysis focused on the micro data to determine the relationship between the Sentiment Index and consumption expenditures of individual households. James Tobin (1959) interpreted the evidence as a clear rejection of the predictive power of consumers’ economic expectations. Many agreed with his argument that the prediction failures among individuals could not be sensibly aggregated into positive results at the macro level. These empirical results led economists to eventually reject the positive findings at the macro level as illusory. But given its predictive performance at the macro level, survey data on expectations became an indispensable component of systems of leading economic indicators now conducted by nearly every country in the world (Baghestani & Fatima, 2021; Campelo et al., 2020; Cesaroni & Iezzi, 2017; Curtin, 2007; Lahiri & Zhao, 2016).

The initial goal of this paper is to resolve this micro/macro duality by advancing a more robust and comprehensive explanation of the empirical results. A good deal of my critique is based on correcting erroneous interpretations of how expectation theories have been conceptualized in empirical tests. The more significant elements of my critique, however, involve our failure to incorporate the scientific advances made by other disciplines, especially neuroscience. Importantly, the theoretical shortcomings that I will highlight are not simply a matter of degree, but represent radical departures from orthodox theory. As such, they constitute a disruptive change. The most important changes include a more comprehensive definition of cognitive deliberation, the inseparability of reason from passion, the critical importance of contextual factors, revised standards for judging accuracy, the recognition of innate mental processes that guide revisions, and a more accurate assessment of costs and benefits. Each of these fundamental challenges to orthodox theory are justified by an increase in the explanatory power of the revised theory.

This is an ambitious agenda. The most complete account of these changes is book length, which I entitled Consumer Expectations: Micro Foundations and Macro Impacts (Cambridge University Press, 2019). I will not repeat the supporting empirical data and analyses in this brief paper. My goal is to simply convince you that
such a disruptive overhaul of the theory of expectations is necessary and the changes suggested are appropriate. Importantly, these suggested revisions apply equally to expectations measured in firm surveys as well as household surveys. I will begin with the least controversial departures from current conventions, and end with the most significant departures which will entail the greatest reformulation of empirical research designs.

1.1 Conventional Economic Theory

It is useful to start this discussion by summarizing the common elements of the conventional theories of expectations. The orthodox approach holds that firm and household agents form expectations about economic factors that could potentially influence their economic decisions. Economic agents are hypothesized to depend on the resources and expertise of federal statistical agencies to collect the data. The latest information from these statistical agencies are widely available, immediately disseminated in the mass media, and are used by households and firms to update their expectations. This process is repeated across a range of statistics so that a wide variety of expectations are formed and ready for immediate use when needed for making economic decision. An important property of the process is that the resulting expectations are formed to be independent of any contextual factors and thus thought to be appropriate for any subsequent use. The costs of forming expectations are considered to be lower than the average benefit derived from their use, so no cost–benefit calculations are usually necessary. Finally, the accuracy of any formed expectation is based on a comparison with the data collected by the federal statistical agency.

1.2 Expectation: National Versus Personalized

One of the most important of the conventional assumptions, and the least challenged, is that economic agents use the data published by federal statistical agencies as the standard to form their own expectations, and to subsequently assess the accuracy of the formed expectations. A careful reading of conventional theory, however, makes it clear that the relevant expectations are defined by the economic conditions consumers or firms actually face in the marketplace. Who could arrive at an optimal decision if they based their expectations on economic conditions that they did not actually face? The differences are often substantial. For example, the data on unemployment collected by the U.S. Labor Department over the past several decades indicate that the mean rates of unemployment were three times as high among those with the least education as among college graduates. Why would those substantial differences be ignored when people form their own expectations? A more plausible expectation is that people would judge their job opportunities as comparable to other people with similar skills and abilities, and would usually restrict their focus on their own local areas. The same is true for inflation and income expectations and many other economic series.

The use of national data has often been indirectly justified by the common use of representative agent models: with just one agent, the national data becomes the
appropriate standard. Alternatively, this shortcut is sometimes justified by the high costs and impossible task of any one household or firm collecting the required personalized data. Nonetheless, the impact of these assumptions are often ignored when interpreting the results, with some analysts incorrectly concluding that the heterogeneity of expectations across agents constitutes robust evidence of irrational expectations (Mankiw et al., 2004). Under a more appropriate analytic assumption based on the personalization of expectations, the heterogeneity of expectations would be seen as the normal outcome for rational expectations.

Just this one correction has an enormous impact on the interpretation of the micro–macro split in the empirical results mentioned earlier. It was simply incorrect to assert that the macro relationship must be illusory given the lack of evidence at the micro level. What was illusory was the presumption that all expectations would be identical with the national figures. This finding was simply due to the empirical misspecification of the theory. That is not to imply that every respondent provided accurate data on the economic conditions that they actually faced. That would be a highly improbable claim. Even the rational expectations hypothesis does not require the absolute accuracy of every formed expectation; rather it requires unbiased expectations, meaning prediction errors are random and tend to balance out over the longer run.

The proper analysis of the accuracy of expectations would require much more specific data collected within local areas and for various demographic subgroups. Federal agencies in the U.S. are now moving in this direction and it may become routine in a future era of big data.

1.3 Media Dissemination of Official Statistics

Another common assumption is that the national media provide extensive coverage of the economic releases of the statistical agencies. The coverage is so extensive, it is argued, that most people could not avoid hearing about the latest quantitative numbers for unemployment, inflation, GDP, and so forth. That assumption has been shown to be empirically false (Curtin, 2008; Curtin, 2010).

I tested the assumption by searching twenty-two newspapers with the largest U.S. circulations, and five major TV and cable news stations. This task was easier than it sounds given that digital records were available for both print and video news sources. Each source was checked for coverage of the official releases that specifically cited the quantitative data for the rates of unemployment, inflation, and GDP. The time periods covered were two sixteen month periods, from January 2006 to April 2007, during an expansion, and from January 2008 to April 2009, during a recession. It was anticipated that economic news would draw much greater attention during downturns than during upturns. Surprisingly, only one media source cited quantitative information on all three statistics for every data release the Washington Post, a newspaper which had a daily circulation of less than one million at that time. Of the five TV networks, none included a quantitative figure for all releases. The average newspaper and TV network included quantitative figures for about half of the releases. The official websites of the statistical agencies were accessed much less
frequently than the print and video media included, and had a much higher concentration of users from non-U.S. locations.

Rather than citing numerical figures, the media most commonly described the data using subjective adjectives, such as surging inflation, strong job growth, soaring interest rates, or a sinking economy. These verbal descriptions were invariably supplemented with either a photograph or video of a person who either suffered or benefitted from the changing performance of the economy. This communication strategy was based on research on how the media could communicate their message as effectively as possible. Neuroscience has confirmed that people have an innate ability to understand another person’s facial expressions and body language. Mirror neurons are activated that simulate those same emotions as though they themselves had those same feelings (Rizzolatti & Craighero, 2004). The important role played by emotions in how economic information is consciously perceived will be discussed in more detail in a later section.

1.4 Knowledge of Official Economic Statistics

Many studies have found that consumers have a surprising lack of knowledge about official economic statistics (Blinder & Krueger, 2004). In a survey conducted at the University of Michigan, one-third of the population reported that they had never heard of the Consumer Price Index (CPI) or Gross National Product (GDP), and half as many reported that they had never heard of the official unemployment rate in 2007 and 2009 (Curtin, 2019). Another four-in-ten reported hearing of those statistics, but did not know the current rate. This data was first collected in 2007 near a cyclical peak, so it was thought that low inflation and high GDP didn’t attract much attention. The questions were repeated in 2009, with the hypothesis that the deepening financial crisis would greatly heightened peoples awareness of these statistics. This hypothesis was rejected as knowledge of the latest data on unemployment, the CPI or GDP was not significantly changed from 2007. Perhaps even more surprising, among those who reported that they had recently heard the official announcements, the errors in the unemployment, inflation and GDP rates were twice as large in 2009 than in 2007 despite excessive media attention to these economic statistics during the Great Recession.

This lack of knowledge was for the official statistics. Needless to say, people become aware of changes in unemployment, inflation, and economic growth in many ways other than based on the official releases. I will discuss in more detail how, where, and why people acquire their information about the economy, but for now I will just indicate the results of alternative questions about prospects for inflation. When asked about the expected inflation rate during the year ahead, virtually every respondent gave a percentage figure. As many of you already know, the University of Michigans measures of inflation expectations are quite accurate at the macro level, rivaling forecasts by professional economists (Curtin, 2010; Mehra, 2002; Thomas, 1999). This implies that the lack of knowledge applies only to the official statistics and not to the underlying economic concept, a surprisingly positive result for economic theory. How consumers accomplish this feat represents the most
challenging reinterpretation about how people process information and form their economic expectations. Prior to that discussion, I need to finish my discussion of the conventional means to assess the accuracy of expectations.

1.5 Criteria for Accuracy

Tests on the accuracy of expectations have suffered from the presumption that accuracy should be based on the official statistics. I have already noted that the national results are a poor proxy for the economic conditions that people actually face. Accuracy, however, is an even more demanding concept. Expectations are formed to improve decision making. Expectations have no intrinsic value, their value is derived from use. A more appropriate gauge for cost–benefit analysis is how the degree of accuracy improved the outcome of the decision. Economics has instead shifted the primary focus to the accuracy of expectations themselves, independent of any use.

In sharp contrast to the implications of the contextual independence assumption, the degree of accuracy required varies depending on the actual decision. Some decisions need only a ballpark estimate, while other decisions need to be based on highly accurate expectations. The cost of forming expectations varies depending on its intended accuracy, whereas conventional theory assumes the costs associated with complete accuracy. Those costs of forming fully accurate expectations, however, are typically assumed to be negligible as the media provides the data at a near zero marginal cost and mental calculations were incorrectly assumed to be costless. The best interpretation of standard theory is that the costs of forming fully accurate expectations could be considered a form of insurance to guard against higher costs and lower accuracy when an economic expectation had to be estimated immediately for a pending decision.

The same argument applies to the maintenance of a wide range of economic expectations. As a result, households and firms are assumed to maintain a mental or physical file containing a large number of expectations, with regular updates based on the latest data released by federal statistical agencies. Although the mental costs of maintaining all expectations are often consider negligible, the opportunity costs of using mental resources for maintaining a full range of expectations are substantial. One could easily imagine that opportunity costs are high enough to place rather severe limits on the number of expectations people consciously maintain based on the repeated data releases from federal statistical agencies.

The new theory holds that expectations are context sensitive, not context independent. Elicited expectations are naturally subject to priming, framing, and anchoring effects. This sensitivity has been extensively documented by Kahneman, (2011) as well as by many others. These contextual factors have invariably been interpreted as a source of bias. This interpretation is misleading. Expectations are intentionally designed to be context sensitive. Adaptive behavior requires that expectations be tailored to specific situations. This contextualization of expectations is consistent with how the human brain processes and stores information. Who could deny that context counts in many situations, for example the price of identical products, identical
homes, or wages for identical work all depend on where the product is purchased, where a home is located, and where the work is performed. Context independent expectations are only correct on average, and generally not optimal for any specific decision. Overall, the undue simplification of the theory of expectations has again resulted in self-inflicted errors in their interpretations of empirical analyses.

1.6 Cognitive Limitations

Peoples cognitive abilities have played a dominant role in assessing an agent’s capability to form economic expectations. Cognitive abilities are involved in all phases of the formation process, from gathering the relevant information, interpreting the data, and performing the necessary calculations. The usual presumption is that the conscious mind has the most advanced cognitive abilities. Differences in cognitive abilities are difficult and expensive to measure in population surveys. The typical proxy to determine differences in cognitive abilities has been the level of formal education. Each analysis I undertook using education as a proxy, rejected the hypothesis that conscious cognitive differences were important for forming inflation and unemployment expectations (Curtin, 2019).

The most surprising results were based on empirical tests of the rational expectation hypothesis (Curtin, 2010). This analysis was based on time series models of inflation expectation fitted separately for those who differed in educational attainment. From those who did not finish high school to those who completed post-college graduate studies, the estimated equations were not able to significantly dismiss the rational expectations hypotheses for any education subgroup the average errors across the entire period were insignificantly different from zero, and the expectations of every educational subgroup were insignificantly different from the actual inflation rate over a period of twenty-five years.

Similar tests were performed for unemployment expectations for the U.S. plus 14 EU countries, and arrived at the same conclusions: the level of education was not associated with differences in the accuracy of expectations (Curtin, 2019). Needless to say, many psychologists as well as economists were surprised by these empirical outcomes. Even with an imperfect proxy for cognitive differences, most would not have anticipated that conscious cognitive abilities would have no differential impact on forming economic expectations.

These results depend on a distinction that many may not have considered. Most have assumed that cognition required conscious deliberation, but cognition can be undertaken by the nonconscious mind as well. Cognition is defined as the ability to acquire information, interpret information, and make decisions (Neisser, 1967). Developments in neuroscience have shown that all cognitive processes can be conducted either consciously or nonconsciously (Kihlstrom, 1987). Nonconscious cognition occurs without any awareness by the conscious mind. Indeed, these nonconscious cognitive processes represent the vast majority of cognitive activity, with the conscious mind fully controlling only about 10% of all behavioral decisions (Lindsay, 2020).
The dominance of nonconscious cognitive processes resulted from millions of years of evolutionary development, whereas the prefrontal cortex, responsible for conscious deliberation, is a relatively late mental addition, added only about 250,000 years ago (Massey, 2002). An important implication is that the much longer evolutionary development of nonconscious cognitive abilities has resulted in more evenly distributed nonconscious cognitive abilities across the population. In contrast, the recent addition of conscious cognitive abilities varies considerably more across the population. Importantly, it is this longer and more equal development of the nonconscious that is hypothesized for its dominance in forming expectations.

1.7 Theoretical Inclusions and Exclusions

All current theories of expectations are restricted to conscious cognitive reasoning for gathering data, interpreting data, and calculating the resulting expectation. There have been two reasons advanced for these limitations, although neither reason can withstand scientific scrutiny. The primary reason is that the details of nonconscious reasoning are unknown, either to the person directly involved or to an impartial observer. The telltale difference, it is alleged, is whether people can provide cogent rationales for forming their expectations, such as the data and the assumptions used to generate their expectations. In contrast, it has been held that people who describe their expectation as merely a guess or a hunch are unlikely to have formed that expectation by rational deliberation. Unfortunately, all such inferences are unreliable since no person is knowledgeable of even their own nonconscious processes. More importantly, people have been known to favor deductive logic and causal models when asked to justify their expectations; they have learned and prefer those scientific explanations even when the expectation was formed nonconsciously (Nisbett & Wilson, 1977). This implies even among those who offer cogent justifications for their expectations, those responses may not indicate that conscious rational deliberation was involved.

Aside from this natural preference for causal reasoning, there is another reason to doubt that people base their expectations on conscious rational deliberation. Conscious reasoning requires a degree of effort that people find difficult to sustain over long periods of time (Kahneman, 2010). Moreover, even relatively short periods of conscious deliberation cannot be completed without interruptions from other sensory inputs. The interruption of conscious deliberation typically means that the cognitive task are transferred to the nonconscious for additional processing; and then, at some future time, the issue may be returned for additional conscious processing. Indeed, the process of forming rational expectations, from gathering data, interpretation, and calculating expectations is likely to be a rather long process, with many interruptions in conscious processing. No person can accurately judge the relative influence of conscious versus nonconscious processes had in shaping the final result.

The second reason for the reliance on conscious reasoning is the notion that what cannot be objectively observed, cannot be part of a scientific theory. That justification is simply incorrect. The true principle is that conjectures that are not falsifiable cannot be part of a scientific theory (Popper, 1935). Economics has long used
scientific methods to empirically test the structure and impact on behavior of many black boxes, whose contents were not directly observable. Perhaps the most famous recent example has been the Higgs boson which was finally observed a half-century after its critical role in advancing particle physics was theorized. Continued progress in neuroscience is also likely to render features of black box of the nonconscious mind observable in the future.

### 1.8 Evolutionary Purpose of Expectations

The evolutionary purpose of expectations is to provide a means for people to efficiently and effectively use their mental faculties to adapt to a changing environment. Innate mental processes automatically form expectations among the youngest of babies, even before they can walk or talk, and by the oldest of adults (Reber, 2002; Bargh & Chartrand, 1999). There are three distinct uses of expectations. First, expectations determine which mental faculties are used to process incoming information. Second, expectations are automatically updated by innate mental processes to maintain their accuracy. Finally, expectations are formed and organized in memory by contextual factors to achieve an optimal impact on behavioral choice. Before detailing these evolutionary purposes of expectations, some more general points need to be mentioned.

Perhaps the most important is that all expectations are formed and revised by the same mental processes, even though they may be based on very different sources of information. The number and range of expectations is enormous, with economic expectations forming only a very tiny portion of the total. If the mental process for forming expectations was different for every type of expectation, it would easily overwhelm the resources of the human mind. Similar to modern computer algorithms, standard subroutines provide consistency in the formation and revisions of all expectations.

The first function of expectations is to automatically sort information. The sorting criterion depends on whether the information represents events that were expected or unexpected. Fully expected events provide no new information about the environment. Fully expected events are still processed by the nonconscious and used for Bayesian updating of existing expectations. This sorting function of expectations is predicated on the fact that conscious information processing is severely limited, so much so that nearly all information is processed by peoples nonconscious cognitive resources. There is wide agreement among neuroscientists that the capacity for nonconscious information processing is orders of magnitude larger than for the conscious mind. It has been estimated that the advantage of the nonconscious information processing compared with conscious processing is as high as 11.2 million to 40 bits per second (Dijksterhuis, 2004; Lewicki et al., 1992; Wilson, 2002).

The severe limitations on consciousness means that the sorting process cannot be accomplished by the conscious mind. Such a task would represent a needless waste of a very limited and valuable resource. This sorting function is done at a pre-conscious stage of awareness. This function is controlled by an area of the brain called the limbic system, which evolved millions of years prior to the prefrontal
cortex which is responsible for conscious reasoning (Massey, 2002). The limbic system processes information a few milliseconds prior to peoples conscious awareness, and can alternatively route the information to conscious or nonconscious processing. The limbic system, sometimes called the emotional brain, also attaches an evaluation to the information it processes, which will be discussed in a subsequent section on the impact of affect on expectations. The outcome of the sorting process, as well as the attached evaluation, are not irreversible, but they are not random as they are based on the acquired experiences and learning of the individual (Zajonc, 1980).

The second innate mental process tests the accuracy of current expectations and revises them when needed. The neurotransmitter dopamine automatically responds to the prediction error or gap between what was expected and what was experienced. Expectations are then updated based on this information by Bayesian procedures (Lindsay, 2020; Solms, 2012). Expectations are continually and automatically updated with each bit of additional information that is acquired based on the gap between expected versus realized outcomes (Friston, 2009). The acquisition of new information does not simply replace prior information, but it is modified based on the probability characteristics of the new and old information. These revisions are automatic, part of the natural functioning of the brain, with the evolutionary purpose of maximizing human adaptation to a changing environment.

The third evolutionary function of expectations is to maximize the probability of a rational decision. Learning how to optimally respond to complex changes in peoples personal, social, or physical environments can be accomplished either consciously or nonconsciously. For the most difficult and complex decisions, shifting between modes is as common as it is automatic, even a repeated series of back-and-forth shifts. A sense of confidence or uncertainty about a pending decision is often reflected by the degree of consistency people feel between conscious and nonconscious assessments; commonly described by people as differences between my head and my heart. People recognize the advantages of sleeping on it before making their final decision; sleep has been shown to integrate both forms of learning (Fischer, et al., 2006). Moreover, nonconscious processes have some advantages over conscious processes: conscious deliberation is effortful, nonconscious is effortless, conscious deliberations is subject to interruptions by other events, nonconscious deliberation can remain focused on decisions over extended periods of time (Kahneman, 2011).

1.9 Critical versus Trivial Decisions

Many observers may admit that nonconscious cognitive process may dominate when trivial or noncritical decisions are made. Conscious deliberation, it is argued, would dominate when decisions involve large dollar amounts and for decisions whose consequences involve life-or-death. A moment of introspection would indicate that such a simplistic view is faulty. People hold far more nuanced views about the appropriate integration of their conscious and nonconscious cognitive resources (Hogarth, 2001).
Imagine you are driving to work along a familiar route. When arriving at the office, most people cannot recall whether they stopped at some traffic light or what traffic conditions existed when making turns, but simply assume they made appropriate decisions since they arrived safely at their destination. Such driving is controlled by nonconscious processes, while you were listening to the news, enjoying music, or conversing with a fellow passenger. If something out of the ordinary happened, conscious attention would occur; it could be a dog darting into the road or that you recognize a friend or colleague at an intersection. If an accident threatens, your nonconscious mind immediately caused your foot to move toward the brake even before you became consciously aware of the impending accident. People implicitly trust their nonconscious to control their driving decisions, and if necessary, to alert their conscious mind to take control if an unexpected event occurred. These automatic processes must be learned over time, with new drivers paying greater conscious attention to avoid mishaps.

1.10 Conscious Versus Nonconscious Learning

Most examples of learning about the economy typically assumes the conscious use of deductive methods and casual models. The standard drill for school children is that correlation does not mean causation. The long accepted wisdom is that no causal relationships can be based on associations. Since nonconscious learning is driven by associations, it is met with considerable resistance. Nonetheless, recent innovations in econometrics as well as the increased availability of big data has begun to change these opinions. This shift has been due to both the failures of conventional econometric models as well as by the advantages of analytic methodologies based on associations.

The rapid development and use of large econometric models during the past half century has led to the recognition that the underlying estimates are subject to serious errors due to model misspecification and coefficient instability. Hendry & Krolzig, (2005) and Sims, (1980) have advanced the notion that the models should be conceptualized as relationships among unobserved variables. These unobserved variables are poorly approximated by official statistics, but can be estimated by factor models based on their observed inter-correlations. These models are judged by predictive accuracy, just like traditional models. Importantly, these newer factor models follow the same methods used by nonconscious learning.

Studies of nonconscious learning, such as artificial grammar (Reber, 1967) or studies of operating sugar factories (Berry & Broadbent, 1984), have confirmed Milton Friedmans oft cited example of the accurate billiards player: people can learn the outcomes of complicated problems by experience, and then play the game expertly, without ever knowing any of the underlying principles. This same prowess of nonconscious learning based on associations was confirmed when people could correctly recognize grammatical errors after some practice with artificially devised grammar rules but nonetheless could not verbally state the underlying rules. When subjects learned to maximize profits at a sugar factory, they could not specify the rules for profit maximization. When pressed to explain how they could perform
so well and yet not know the underlying rules, subject were likely to cite explanations that relied on guesses, hunches, or intuitions. The same type of responses were given by respondents when asked to explain their economic expectations that were presumably formed nonconsciously. Even more surprising was when subjects were told the underlying rules of the artificial grammar or how to maximize sugar factory profits, that knowledge did not help them to perform any better than those who were not told the underlying rules.

Associative learning has been shown to approximate optimal solutions. Some observers have seen this as a positive result and others as a shortcoming. The greater precision of standard econometric models is due to their ability to estimate an absolute maximum, if one exits. For analyses based on associations, the approximate solution excludes any claims of point accuracy. It could be argued that innate updating of expectations by nonconscious Bayesian methods could be improved by conscious deliberations, but the associated opportunity costs would usually be too large to incur. Rather than approaching the problem in a piecemeal fashion, people would maximize the accuracy of the total number of expectations formed by relying on the less costly mental procedures that are innate and automatic.

### 1.11 Reason and Passion are Inseparable

The elimination of passion from reason has long been held as a critical element of rational decisions. The separation of reason from passion is not only unwarranted, it is impossible. The insistence of the separation is usually motivated by examples where the influence of emotions caused disastrous outcomes for a household or firm. There is no denying these extreme miscalculations are present, and many believe even common. Incorrect choices due to emotional influences are often grouped with losses from decisions which were rational at the time they were made but nonetheless caused disastrous losses. Although the stock market is the premier example of the intrusion of emotional responses, other examples include the extreme political partisanship that has influenced economic expectations as well as the influence of the covid-19 pandemic.

Economic theory has tried to avoid these complications by the assumption of fixed preferences. This assumption has the dual benefit of isolating economic analysis from the influence of emotional responses and the impact of subjective preferences on behavioral goals. The static nature of orthodox economic theory also precludes how changing economic circumstances influence shifts in economic preferences and goals. These exclusions by assumption, however, do not change the fact that even simple behavioral choices have been found to be impossible without the influence of passion (Damasio, 1994).

The separation of passion from reason is impossible since every bit of information that is processed, automatically comes with an attached evaluation. The limbic system, as mentioned earlier, initially sorts information to conscious awareness or to nonconscious processing. When the information is sorted, the limbic system also adds an evaluation of that same information (Zajonc, 1980). The conscious mind can reject the evaluation, but this is rare since those automatic evaluations are based on
past experiences and learning in similar contexts. A comparable procedure is used in computational models to speed the convergence of its estimates: the model is initialized with estimates of the coefficients based on past experience or learning. The same is true for mental reasoning: it is made more efficient and effective to update revised expectations based on priors under similar contexts. This is the essence feature of Bayesian updating.

1.12 Types of Affective Influences

The overall impact of affect on economic behavior is much larger than the simple impact of evaluations on perceptions. The range of affective influences on an individual's behavior is quite large, although most of those expectations are irrelevant to the functioning of the macro economy. A macro impact requires an emotion to have a similar influence on the behavior of a vast number of people at the same time. Three different types of affective influences that are germane to cyclical economic activities: evaluations, moods, and emotions.

Evaluations are judgements about specific issues or events. They are brief generalized summaries, such as the information has good or bad implications, or signals a better or worse outcome. Survey questions often mimic these natural evaluations when asking about finances, jobs, GDP, and many other economic and noneconomic topics. Their use enables respondents to easily answer the questions and yields reliable and robust measures of expectations. Since the response scales are not very detailed, the responses are often seen to limit cross-section or micro analysis of the data. Nonetheless, they have been shown to have substantial predictive power in macro analyses. In contrast, economists favor more detailed response scales, with expectations elicited in terms of probability distributions. In macro tests of prediction errors of qualitative versus probability scales, the qualitative responses had far smaller prediction errors and were far less costly to administer in population surveys (Curtin, 2019).

The second type of affect is mood. Moods are general affective states that have multiple causes and persist over time. Consumer Sentiment is often called the mood of the consumer. The importance of moods lies in how it influences information processing in the different phases of economic cycles. Upswings in economic activity not only support optimistic moods but also cause people to mainly use nonconscious processes to monitor information on the economy. In downswings, rising pessimism encourages people to mainly use conscious information processes. This difference has an important implication. The most significant is that shifts from nonconscious to conscious information processing can occur almost instantly across the entire population, but shifts from conscious to nonconscious information processing occurs very slowly. Even aside from sudden catastrophic changes, downturns in economic sentiment occur much more rapidly than upturns. The speed of sentiment downturns is due to how emotions increase the likelihood of conscious information processing. The resulting shift also acts to give greater weight to potentially negative information. These differences means that sentiment declines are much faster, usually enabling greater lead time for warnings of a potential recession. It also implies
that sentiment recovers much more slowly and provides later signals about the start of a potential recovery.

It should be noted that the shift to conscious information processing does not mean that people are more likely to seek out or devote greater attention to the economic statistics published by state agencies. It was already shown that consumers gave less accurate responses about GDP, inflation, and the unemployment rates in the midst of the 2009 recession than during the 2007 expansion. The increased conscious attention is for subjective evaluations of economic trends, not the underlying official statistics.

Emotions represent the final type of affect that has a bearing on economic behavior (Elster, 1998). Emotions have a known referent and are intense. They can cause immediate and discontinuous shifts in the behavior of households or firms. Emotions are much more likely to be negative than positive, suggesting that the evolutionary purpose is to signal potential threats rather than potential benefits (Ekman, 1992). Like evaluations and moods, to influence the course of the macro economy, emotions must be widely shared by a significant portion of the population. A few decades ago I used the examples of military conflict and terrorist attacks as examples, recently adding the covid-19 pandemic as a generator of emotional reactions. These events typically generate extreme and rapid economic dislocations as well as social discontent. Indeed, the emotions surrounding the pandemic has transformed the behavior of households, firms, and economic policies in ways that would have been unthinkable in prior years. As one example, federal and state stimulus and relief payments have soared to levels that have far exceeded any past recession, with citizens likely expecting the great expansion in payments to be repeated in response to not only future recessions but to become part of a sustained government welfare program.

1.13 Knightian Uncertainty: When Affect Replaces Reason

I have argued that the advantage of sentiment variables is primarily due to the added benefit that passion provides to reason, especially around cyclical turning points. Specifically, affect can substitute for reason in making decisions where risks are ambiguous or unquantifiable. Such situations are commonly called Knightian uncertainty. In these situations orthodox theory holds that no rational decision is possible. Economists have believed that such situations are extraordinarily rare, and found the most appropriate reaction was to simply postpone making any decision until the ambiguity is resolved. However, Keynes indicated long ago that rationality was effectively replaced by affect (animal spirits) for making decisions in these circumstances. For most consumers, the assessment of risks at turning points is often viewed as unquantifiable, but not making a consumption decision is usually not an option. It is precisely in those situations that affect substitutes for reason. It should be remembered that the content of these affective influences is based on Bayesian processes that update priors based on newly available information. Presumably, those are the same methods were envisioned by Keynes when he anticipated the actions of entrepreneurs when faced with Knightian uncertainty.
Secular as well as cyclical economic trends can be influenced by emotions. I had for years dismissed the impact of emotions on cyclical developments in the U.S. economy. The dismissal was based on the notion that emotions were short-lived responses. To influence economic cycles, a sizable portion of households and firms must have the same emotional response over an extended period of time. The classic example is war, along with pandemics and economic inequality. While most U.S. presidents have had both fans and foes, Donald Trump converted those political differences into intense and lasting emotions. I documented at the last CIRET conference in Brazil, how those emotions had a significant impact on differences in optimism across political parties. Under the Biden presidency, those same intense emotional responses have continue, although optimism and pessimism have simply switched sides on the political aisle.

The extreme partisan divide in the U.S. can be tied to differences in preferred economic policies with regard to the distribution of income and wealth. These policy differences are solely based on economic values not rational calculations, and are likely to have a strong impact on secular growth rates. Strong emotions have maintained and heightened these pronounced differences in economic policy preferences. The covid pandemic has heightened partisan calls for substantial changes, and already produced a number of policies unmoored to conventional economic principles. The implementation of these monetary and fiscal policies will serve as a political test of their effectiveness. Whatever the eventual outcome, economic policies directly reflect the importance of affective influences on the macro economy.

2 Summary

Many of you are likely to have a split opinion on the new and more comprehensive theory of economic expectations. The split is likely to be located at the point when my presentation shifted from the misinterpretation of empirical results to the implications based on recent developments in neuroscience. The theories of expectations that now dominate economics were developed long before advances in neuroscience revolutionized our understanding of the brains structures and functions. Neuroscience has found that expectations play a pivotal role in determining the optimal and efficient use of peoples overall mental resources. While the contributions of neuroscience to our understanding of economic expectations is a new innovation, its contributions to other areas of economic behavior have been long recognized (Camerer et al., 2005).

Forming and revising expectations is an innate and automatic process for all types of expectations, including economic expectations. Accuracy is innately and automatically judged within decision contexts, and those contextual factors are used to update expectations based on Bayesian methods. People routinely encounter a vast amount of information in their daily lives as well as through their social interactions. Most information is nonconsciously processed and categorized by its associations with prior information and used for nonconscious pattern recognition and learning. Each bit of additional information is used to update expectations based on a Bayesian like process. The efficiency of these mental processes is enhanced by seeding
cognitive reasoning, whether conscious or nonconscious, with affective as well as other pre-existing information. While information on past expectations represent a critical element in this process, so does affective evaluations of that information. These evaluations are not seen as a form of irrationality, but represent a more efficient means to make optimal decisions. The designs of artificial intelligence systems mimic these same considerations, with associations and pattern recognition driving a continual process of revisions as new data are processed. These systems are also seeded with affective criteria that govern appropriate actions and responses so as to achieve preferred goals.

The critical element of this new theory is the recognition that nonconscious cognitive activity plays a dominant role in forming expectations. That is the real dividing line between those who cling to the orthodox theories, and those who recognize that the prominent role of the nonconscious in forming and revising economic expectations.

I will end by repeating an old joke in economics: A man is searching on a dark night under a street light for an item he lost somewhere along the road. An economist asks: why are your searching here? He answers because this is where the light is. For far too long, consciousness is the light economists have huddled under for explanations of human behavior.

2.1 Epilogue

I am not an armchair theorist. My new theory of the formation of economic expectations has been developed based on a half-century of empirical research at the University of Michigan. I have always preferred the power and elegance of a good theory, and I have always known that theoretical advances are built on good data. I will briefly review in this postscript the practical implications of the new theory for the design and interpretation of robust measures of expectations. Importantly, the application of the new principles go well beyond economics to cover the measurements of expectations across all social sciences.

Perhaps the most important element of the new theory is that survey measures of expectations cannot solely focus on rational factors but also must include an affective dimension. Long before rational expectations dominated economics, George Katona as well as many other pioneers in Europe, created survey questions that included a joint emphasis on reason and passion. The verbal likelihood questions simply asked whether the economy would be good or bad, or some other similar wording that simultaneously combined rational and evaluative factors. Those questions turned out to be powerful predictors of emerging trends in the macroeconomy. Their predictive accuracy withstood the repeated criticisms and calls for more rational measures that excluded subjective criteria. Undeniably, defenders of these questions were uneasy about justifying the question wording based solely on its predictive performance; I was certainly uneasy with this defense. Indeed, I believe that empirical success based on accurate predictions can only achieve scientific acclaim when supported by theory. The new theory provides the scientific evidence on people’s mental faculties underlying this longstanding measurement strategy.
The second distinctive element of the new theory is the dominant role of the nonconscious rather than conscious mental deliberations in forming expectations. Expectations are largely formed by nonconscious mental faculties that use a Bayesian-like updating process. The updating procedure uses the attached affective evaluation as a means to weight the impact of the new information for revising existing expectations. Psychologists have long used the term valence to describe gradations of evaluations as more or less positive or negative. Indeed, the affective tags on information and their valences play a crucial role in all phases of the formation of expectations; they are hardly superfluous nor do they create a non-adaptive bias. The range of valences associated with differences in affect justifies whether a seven-point, a five-point, or a three point scale is used for the measurement.

The characteristics of the new theory have several implications for the measurement of expectations. First, questions should be phrased in terms of change, not levels. It is change data that is most relevant for updating expectations. Second, the expectation should focus on the economic conditions that households actually face in the marketplace. No economic theory holds that people should maintain expectations about conditions they would never face. Third, questionnaire descriptions of the affective evaluation is as critical as the definition of the expectation. The affective description should be designed to represent meaningful distinctions in affective evaluations for a given expectation. Fourth, the number of response codes should match critical differences in the valences of the subjective evaluations, and mirror the desired weights for updating purposes. This criteria may justify extreme codes for some questions that only a few people would normally choose, but if they did, the response would indicate an extreme change and an extremely large weight in the updating calculation. Finally, no useful data can be obtained by asking people how they formed their economic expectations. Most expectations are formed by nonconscious processes, and the aim of these nonconscious mental faculties is to produce rational assessments that are adapted for specific decisions and contexts.

The above comments apply to the current survey and statistical methodologies used to estimate economic expectations. I will end this postscript with how the new theory of expectations will support radically different measurement methods based on advances in artificial intelligence.

The need for a new methodology stems from the growing problems that have beset population surveys. Robust and reliable statistical results depend on using probability sampling, obtaining high response rates, and insuring adequate sample and subgroups sizes for statistical inferences. Rising costs have accelerated the move to self-administered internet surveys from telephone surveys, and before that, from in-home personal surveys. None of these transitions reversed trends in declining response rates or limited the falloff in the representativeness of the results. Moreover, the usual tools of statistical inference hardly apply for the extraordinary low response rates that are now common, with many in the single digits, and conventional statistical inferences are inappropriate when nonprobability samples are used.

The ongoing declines in data quality at ever higher costs constitute a low barrier for alternative methods to successfully compete with traditional survey methodology. The leading candidate now being developed is based on digital data that is automatically collected and widely available from various sources. These techniques
will require new analogs for response rates and population coverage that need to be developed for reliable statistical analysis. Just as new sampling and statistical methods were developed nearly a century ago to facilitate the scientific assessments of population surveys, the growing utilization of “big data” must be supported by new advances to insure its robust scientific analysis.

While detailing the required innovations in methodology is outside the scope of this postscript, my new theory is ideally suited to using artificial intelligence and digital data to estimate the expectations of consumers and firms. Unlike the old theory which requires the frequent and complete recreation of expectations, including compiling data, interpreting trends, and calculating expectations, the new theory requires only the updating of existing expectations. The new theory holds that expectations are constantly updated using Bayesian techniques based on an ongoing assessment of the relevant data. This task is now manageable by advances in artificial intelligence that simulate the Bayesian updating processes. The Bayesian updating will also require new estimates of the affective valences attached to the information as weights, a task that artificial intelligence can also handle by associating affective connotations with the changing economic information. While some may think basing estimates of economic expectations represent a potential but distant development, many advances have already occurred, with many potential sources of digital data already in use. This is especially true for recent research conducted within developing countries is already based on available digital data. Moreover, economic expectations estimated by artificial intelligence may soon be available in real time. While the cost advantages will be attractive, it will be the predictive accuracy of expectations based on the newly devised methodology that will ultimately win adherents.

**Funding** The author did not receive support from any organization for the submitted work.

**Availability of Data and Materials** As a review article, all materials referenced in this paper represent secondary analyses of previously published materials in academic journals, books, and data files in the public domain.

**Declarations**

**Conflict of interest** The author have no relevant financial or non-financial interests to disclose.

**Human or Animal Rights** Research involving Human Participants.

**Informed Consent** No informed consent was required as no human subjects were contacted as part of this review article.

**References**

Baghestani, H., & Fatima, S. (2021). Growth in US durables spending: Assessing the Impact of consumer ability and willingness to buy. *Journal of Bus Cycle Research*, 17, 55–69.
Simon, H. A. (1955). A behavioral model of rational choice. *The Quarterly Journal of Economics, 69*(1), 99–118.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica, 48*(1), 1–48.

Solms, M. (2012). *The hidden spring: A Journey to the source of consciousness.* W. W. Norton & Company.

Thomas, L. B., Jr. (1999). Survey measures of expected US inflation. *Journal of Economic Perspectives, 13*(4), 124–144.

Tobin, J. (1959). On the Predictive value of consumer intentions and attitudes. *The Review of Economics and Statistics, 41*(1), 1–11.

Wilson, T. (2002). *Strangers to ourselves: Discovering the adaptive unconscious.* The Belknap Press of Harvard University Press.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*(2), 151.

**Publisher’s Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.