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ABSTRACT
This article compares and contrasts the various perspectives on rationality and bounded rationality, and in doing so, advances two claims. The central one is that the definition of rationality depends on bounded rationality. This is reminiscent of debates in philosophy concerning the definition of concepts in terms of their opposites, which has led to efforts to destabilise dichotomies. In addition, as argued in this article, there is a related connection between the (bounded) rationality of economists and the agents they study.

KEYWORDS Rationality; bounded rationality; economists; agents

JEL CLASSIFICATION CODES B1; B2; D01

1. Introduction
In the decades following World War II, the economics discipline was characterised by the dominance of one research programme: neoclassical economics (e.g., Davis 2003; Colander, Holt, and Rosser 2004; Sent 2006). At the core of this programme stood the rational, self-interested individual who maximised the satisfaction of her preferences, given her budget and given the prices of all the commodities. Since the individuals in the economy were on an average rational in satisfying their preferences, the economy as a whole, i.e., the sum total of the individuals in the economy, would be in equilibrium.

Staring around 1980, the dominance of neoclassical economics gradually faded and a pluralism of new economic research programmes emerged (Davis 2010). One of the most prominent new economic research programmes has been behavioural economics (Heukelom 2010). After a number of years on the margin of
economics, this “new” programme of behavioural economics (Sent 2004a) became influential in the 1990s and developed into one of the key contenders for replacing the no longer dominant neoclassical economic theory in the 2000s. A central feature of behavioural economics has been its — to economists — new use of the terms “normative” and “descriptive”, namely: “normative” as the rubric under which to discuss how one ought to behave if one wants to behave rationally and “descriptive” as the deviation of the actual decision made by the individual from the full rationality decision.

This article compares and contrasts the various perspectives on rationality and bounded rationality, and in doing so advances two claims. The central one is that the definition of rationality depends on bounded rationality. This is reminiscent of debates in philosophy concerning the definition of concepts in terms of their opposites, which has led to efforts to destabilise dichotomies (e.g., Culler 2014; Derrida 1981). In addition, as argued in this article, there is a related connection between the (bounded) rationality of economists and the agents they study.

In order to advance the two central claims, the stage needs to be set. Only once it has been established that there are many interpretations of rationality and many versions of bounded rationality does it become clear why the definitions of the two are connected and what challenges economists face. The sense in which the definitions are connected and the efforts to overcome these challenges are next elaborated. The organisation of the article is, therefore, as follows. Sections 2 and three give a short overview of the different interpretations of rationality and bounded rationality. Section 4 develops the two claims in two subsections and the final section offers some closing comments.

2. On rationality

Economics has always relied on some notion of rationality. In the eighteenth century, economics was integrated into the great scheme of the natural law and a rationalistic worldview (Daston 1987; Weber 1999[1904]). During this time, the moral sciences aimed to reveal the rational grounds for action and belief. During the nineteenth century, a transition took place from a psychological framework to a sociological one. At the same time, the search for inexorable social laws
replaced the computation of rational self-interest. However, economics continued to cling to rationality. Throughout much of the twentieth century, many economists would separate economics from sociology upon the basis of rational or irrational behaviour (Samuelson 1947).

What has changed over time is the interpretation of rationality (Sent 2008). While it was initially associated with self-interest (Elster 1989), in later readings, such as rational choice and expected utility, it became linked with ideas such as consistency and indifference (Sen 1977). The most recent appeals to it include strategic aspects of behaviour. Within macroeconomics, rational expectations economists have taken rationality to its extreme, extending it to the formation of expectations. Overall, interpretations of rationality cover a wide range that includes it having the status of the axiom, \textit{a priori} truth, self-evident proposition, useful fiction, utopia, ideal type, analytical construct, heuristic construct, indisputable fact of experience and typical behavioural pattern under capitalism.

Rationality may be interpreted as either a positive or a descriptive notion. Efforts to test rationality interpret the notion in a descriptive manner. In short, rationality is presumed to characterise how people actually go about the business of reasoning. By contrast, a normative interpretation of rationality is concerned not so much with how people actually reason as to how they should reason (Suppes 1961). Others have interpreted rationality as a tautology or as pragmatic. It is a tautology in the sense that any and all behaviour can be described as rational. It is pragmatic in the sense that it is a useful organising category.

With rationality being such a central notion within economics, a brief historical overview reveals the richness of the status of rationality in economics. In the early nineteenth century, John Stuart Mill (1984[1836]) argued that economics is an abstract science because it reasons from assumed premises, such as rationality. In a similar vein, in the early twentieth century, John Robbins (1984[1935]) argued that the basic postulates of economics, such as rationality, are simple and indisputable facts of experience. These insights came under serious attack by Terence Hutchison (1984[1956]), who concluded that the rationality postulate was treated as analytic by economists, meaning that it is \textit{a priori} true yet with empirical content. Instead, he claimed that it must be synthetic, meaning that it must be stated in a testable form (see Kant 1998[1781]).
Hutchison’s arguments about the status of the rationality assumption found a serious critic in Fritz Machlup (1984[1956]), who argued that rationality is a theoretical construct. A contrasting perspective on the status of the rationality assumption in economics came from Milton Friedman (1984[1953]), who argued that assumptions are largely irrelevant to the validation of theories. In his opinion, the role of assumptions such as rationality is limited. They specify the conditions of validity but do not determine these. They offer an economical mode of describing or presenting a theory. An indirect evidence may follow if assumptions are the implications of related hypotheses. In a similar vein, Armen Alchian (1950) had argued that individuals who act in a rational fashion will be successful and “selected” for survival by the economic system. Karl Popper accorded a special status to the rationality principle within his situational logic as “zero principle” (Caldwell 1991).

Herbert Simon (1984[1963]) endeavoured to rescue interest in the rationality assumption in economics by criticising Friedman’s so-called principle of unreality. Simon argued that the unreality of premises is not a virtue but a necessary evil — a concession to the finite computing agency of the scientist that is made tolerable by the principle of continuity of approximation.

Having elaborated the sense in which rationality means different things to different people in the present section, with Simon, we make the transition to the next one, which illustrates that bounded rationality also means different things to different people. Subsequently, we turn to the sense on which economists have found their own heuristic for cutting through the complexity in the notions of rationality and bounded rationality in Section 4.

3. On bounded rationality

Starting with the occurrence of limited intelligence in 1840 and that of finite intelligence in 1880 and through the appearance of incomplete, limited, and approximate rationality during the first half of the previous century, we witness the eventual appearance of bounded rationality (Klaes and Sent 2005). Both finite intelligence and approximate rationality suffered through a process of conceptual fading, in which the expressions gradually ceased to be used. Limited intelligence exhibited a conceptual renaissance when the hitherto marginal
expression acquired a specific interpretation. Finally, we witness conceptual switching from “intelligence” to “rationality” from the nineteenth to the twentieth century, during which the use of one concept discontinued in favour of another.

Herbert Simon himself first appealed to “limited rationality” and “approximate rationality”, which had both earlier occurred in political discourse, before settling on bounded rationality. While refining and replacing the original expressions, Simon tentatively connected “boundary” and “rationality” into the concept that is the focus of the present section. While Simon’s endeavours were strengthened by his appeals to bounded rationality as a principle, subsequent authors entertained different interpretations of this presume principle.

The boundedness is sometimes defined as a deviation from the standard model (Sent 2004a; Harstad and Selten 2013). First, under bounded rationality conditions, humans are faced with limited cognitive abilities that constrain their problem-solving abilities. Second, bounded willpower illustrates that people sometimes make choices that are not in their long-run interest. Finally, bounded self-interest shows that humans are often willing to sacrifice their own interests to help others.

The size of the deviation determines the extent to which economics’ conception of human choice needs to be modified (Rabin 1998; Rabin 2013). First, there is evidence requiring relatively small modifications of the utility functions economists employ. This includes data illustrating that preferences are determined by changes in outcomes relative to a certain reference level. That is, decision-makers’ dislike for losses outweighs their desire for gains. Also, evidence that people pursue “other-regarding” goals such as fairness, reciprocal altruism and revenge might not require a complete overhaul of the mainstream model. The next set of insights focuses on biases in the judgment under uncertainty and calls for a more radical overhaul of the standard model. These show that humans often infer too much from too little evidence and misread evidence as conforming their hypotheses. Finally, the most radical critique includes support for the insight that people have difficulties evaluating their own preferences. There is also confirmation of framing effects, preference reversals, and related phenomena. There is evidence of self-control problems and a focus on short-run gratification inconsistent with long-run preferences.

Despite bounded rationality meaning different things to different people, or perhaps because of this, it is a central concept within
behavioural economics. In turn, this field in and of itself also means different things to different people. In particular, a distinction can be made between so-called old and new behavioural economists (Sent 2004a).

Old behavioural economists such as Herbert Simon and George Katona share a dissatisfaction with mainstream economics and a desire to develop an alternative. Since mainstream economics started from a given utility function, old behavioural economics focussed on discovering the empirical laws that describe behaviour correctly and as accurately as possible. While the neoclassical approach established a close connection between rationality and utility or profit maximisation, old behavioural economics scrutinised the implications of departures of actual behaviour from the neoclassical assumptions. Since mainstream economics starts from given alternatives and known consequences, old behavioural approaches begin with empirical evidence about the shape and content of the utility function.

The roots of new behavioural economics may be traced to the 1970s and the work of Amos Tversky, Daniel Kahneman, Baruch Fischoff, Paul Slovic, and others. Starting from the perspective of expected utility-maximisation and Bayesian probability judgments, Kahneman, Tversky and their followers evaluated the cognitive character of conformity or deviation from these benchmarks. New behavioural economists started from the rationality assumption that has characterised mainstream economics and next analysed departures from this yardstick, as opposed to developing an alternative one.

A central feature of behavioural economics has been its – to economists – new use of the term “normative” and “descriptive” (or “positive”) (Heukelom 2014). Normative has been defined ethically in economics at least since the publication of John Neville Keynes’ Scope and Method of Political Economy (1890). In the normative domain, one discussed what was good, fair, just or ethical in other ways (Hands 2001, 30). Positive first of all meant not value-based and secondly referred in a general sense to the empirical basis of a value-free science of economics. Behavioural economists, by contrast, introduced to economics the definition of normative as used by behavioural decision researchers, mathematical psychologists, mathematicians, philosophers and others, namely: normative as the rubric under which to discuss how one ought to behave if one wants to behave rationally. In addition, behavioural economists have claimed to be more empirically
oriented than neoclassical economists with their focus on rationality (e.g., Camerer and Loewenstein 2004). This returns us to the relation between rationality and bounded rationality.

Following up on this short overview of the richness of the concept of bounded rationality in the present section and the short synopsis of the various interpretations of rationality in the previous one, the article proceeds by arguing for its two central claims in the next section.

4. You cannot have one without the other

Having now established the various definitions of rationality and bounded rationality, the next step involves reading rationality and bounded rationality through the lens of continental debates about dichotomies to help stabilise the definitions of both. For that purpose, the present section will substantiate the article’s two claims in two subsections. First, the definition of rationality is argued to depend on bounded rationality. Second, the related connection between the (bounded) rationality of economists and the agents they study is elaborated.

4.1. Definition

There are many instances of mutual dependence between rationality and bounded rationality. These include game theory, rational expectations economics, zero-intelligence traders, ecological rationality, and rational inattention, as illustrated in this subsection.

Consider game theory first. Herbert Simon (1957) was a staunch critic of game theory, as marked by the quote: “the approach taken in the theory of games … is fundamentally wrongheaded … in ignoring the principle of bounded rationality” (202). Yet, surveying the recent bounded rationality literature, John Conlisk (1996) observed: “Game theorists have recently turned to bounded rationality with enthusiasm” (681). What happened is that game theorist encountered difficulties in defining rationality and turned to bounded rationality in an effort to address these.

What were these difficulties (Rizvi 1994)? First, the folk theorem illustrates the (very real) possibility of encountering multiple equilibria in repeated games. Second, intuitively unreasonable equilibria may be selected in the finitely repeated prisoner’s dilemma game, the chain
store paradox and the centipede game. Finally, Nash equilibria call for requirements such as common knowledge that are so stringent that they have resulted in theorems concerning the non-existence of trade and the impossibility of “agreeing to disagree” about an event.

Subsequently, game theorists have looked towards bounded rationality in their efforts to save the rationality of the Nash equilibrium (Aumann 1997; Sent 2004b). First, bounded rationality functioned as a dynamic for selection among multiple equilibria by promising to “refine” equilibria. Moreover, the evolutionarily stable strategy concept of evolutionary game theory may be viewed as a further refinement of perfect equilibrium, one of the most common notions used to refine the Nash equilibrium. Second, bounded rationality has been used to rule out unintuitive equilibria in the prisoner’s dilemma game, the chain store paradox and the centipede game. Third, the absence of a fully rational treatment of knowledge may circumvent the no-trade theorems by allowing speculative trade.

These attempts to strengthen Nash then lead to the apparently paradoxical situation, according to Robert Aumann and Sylvain Sorin, that “rationality in games depends critically on irrationality” (Aumann and Sorin 1989, 37). A similar appeal to bounded rationality to define rationality is found in rational expectations economics, to which we turn in our next illustration.

As with game theory, Herbert Simon was no great supporter of rational expectations economics, and vice versa. In Simon’s words: “Jack Muth, in his announcement of rational expectations in 1961, explicitly labelled his theory a reply to my doctrine of bounded rationality” (Simon 1991, 270–271). Yet, addressing the problems subsequently encountered within rational expectations economics, Thomas Sargent later noted: “Bounded rationality is a movement to make model agents behave more like econometricians” (Sargent 1993, 167). What happened is that rational expectations economists encountered difficulties in defining rationality and turned to bounded rationality in an effort to address these.

These problems arose because rational expectations economists sought to not only establish symmetry among economic agents but also put agents, economists, and governments on an equal footing (Sent 1997). These efforts led to a string of hurdles for rational expectations economists. First, how can there be trade among economic agents who are alike in the relevant dimensions? One
suggestion, following a line of research started by Robert Lucas (1972, 1977) is that equilibrium probability beliefs differ and that agents actually trade on the basis of different information. However, a whole series of no-trade theorems overrule this common-sense intuition. The second obstacle encountered by rational expectations economists involved error term justification. In particular, close scrutiny of the justification of error terms revealed that the econometrician needed to be outwitted by the agents. As Lucas and Sargent (1981, xxii) explained: “Errors in the estimated equation crop up perhaps because the econometrician has less information than the agents, in some sense, or else because the model is misspecified in some way.” Finally, how can policy recommendations be made when agents, economists, and governments are put on an equal footing based on rational expectations? When policy recommendations are possible, symmetry is impossible. The reason is that making recommendations for improving policy amounts to assuming that in the historical period, the system was not really in a rational equilibrium. When symmetry is possible, policy recommendations are impossible. The reason is that making the assumption that in the historical period, the system was in a rational equilibrium raises the question of why we study a system that we cannot influence.

Rational expectations economists have sought to invoke bounded rationality to support rationality and tackle the hurdles described above. In particular, incorporating bounded rationality opens up the possibility of a trade, offers a justification of error terms and allows policy recommendations (Sent 1997). Moreover, rational expectations economists use bounded rationality to reinforce the rational expectations hypothesis by focussing on convergence to this equilibrium through boundedly rational “learning”. They have also used bounded rationality to deal with some of the additional problems associated with rational expectations such as multiple equilibria and the computation of equilibria. While this article will return to the relationship between economists and agents in the next subsection, it will first offer a few additional, brief illustrations of its central claim concerning the relationship between rationality and bounded rationality.

Consider the concept of the zero-intelligence agent, a widely-employed characterisation in agent-based modelling, which had a remarkable impact in both economics and finance. The supposed simplicity of this kind of agent stems from the lack of strategy and the
random behaviour. Gode and Sunder (1993), and many since then have employed this device to illustrate the irrelevance of a high level of sophistication in strategies and learning at the individual level in achieving market level efficiency. In other words, it is rational to be boundedly rational.

Likewise, ecological rationality claims that the rationality of a particular decision depends upon the circumstances in which it takes place (Gigerenzer, Rodd, and Abc Research Group 1999). What is considered rational under the rational choice account thus might not be considered rational under the “ecological rationality” account, and vice versa? In particular, Gerd Gigerenzer argues that some observed behaviour, although violating rationality principles, might be rational in environments with specific characteristics. However, one ought to violate the principles of rationality, in a boundedly rational fashion, in order to act rationally in these environments.

A final, brief illustration of the rationality of bounded rationality involves the theory of rational inattention (Sims 2003). This theory analyses the effects of the cost of information acquisition on decision making. As rational expectations economist Christopher Sims explains, decision makers may rationally take decisions based on incomplete information, rather than incurring the cost to get complete information. Hence, yet again, it is rational to be boundedly rational.

As the various illustrations show, then the definition of rationality depends on bounded rationality. In the closing section of this article, we will relate this to debates in philosophy concerning the definition of concepts in terms of their opposites, as well as to efforts to destabilise dichotomies. However, first, the article addresses a related connection between the (bounded) rationality of economists and the agents they study in the next subsection.

4.2. Economists and agents

It could be argued that the focus on rationality on the part of economists is an illustration of their own bounded rationality. For rational agents are easier to study for boundedly rational economists. However, the assumption of rationality is a kind of heuristic for economists who are too boundedly rational to navigate the complexity of their agents. This subsection will offer various illustrations of this
intricate link between the rationality and bounded rationality of agents and economists.

A first example concerns Herbert Simon’s collaboration with George Holt, John Muth, and Franco Modigliani (Holt et al. 1960). Only with strong assumptions was the team able to solve the problems at hand. According to Simon (1991), the team “satisficed by finding the optimal policy for a gross approximation to the real world” (167). Moreover, Simon further observed that John Muth imaginatively saw this special case as a paradigm for rational behaviour under uncertainty. What to most in the Holt-Modigliani-Muth-Simon research team was an approximating, satisficing simplification, served for Muth as a major line of defence for perfect rationality. For, as a result of his participation in the project, Muth found that it was fairly easy to define and estimate the optimal forecast, which he did. He called the resulting forecast, which was unbiased and had the smallest standard errors, a “rational expectation”.

In total, Muth illustrated the rationality implicit in theories of bounded rationality. With respect to bounded rationality, Muth exposed the rationality hidden in the contributions of Grunberg, Holt, Modigliani, and Simon. Whereas Simon saw the strong assumptions made by the team as an instance of satisficing on the part of the team, Muth used these as the starting point for his rational expectations hypothesis.

At the same time, (Muth 1961) further illustrated the bounded rationality implicit in the existing formulations of expectations revisions. Whereas economists had long understood that expectations played a central role in driving the economy and that even the simplest economic theory should say something about how people viewed the future, they lacked a plausible theory of how expectations were formed. The first attempt to model systematic expectations revision in the light of new information was the hypothesis of adaptive expectations, which was based on the principle that expectations of the future are formed by the experience of the past.

However, even though people with adaptive expectations were thought to use their own forecasting errors to derive their next forecasts, no widely-accepted economic theory was offered to explain the magnitude of the adjustment parameter. Moreover, relying on mechanistic backward-looking extrapolative rules, adaptive expectations was criticised for overlooking the capacity of people to learn from
experience. Finally, adaptive expectations economists fit models that forecast better than agents because they allowed individuals to make systematic forecasting errors period after period.

For Muth, the suboptimal use of available information in adaptive expectations was hard to reconcile with the idea of optimisation that was the foundation of most economic analysis (Sent 2002). In addition, his rational expectations hypothesis got rid of asymmetry among economists, econometricians, and agents, by starting with the idea that individuals were inspecting and altering their own forecasting records in ways to eliminate systematic forecasting errors. This approach possessed the defining property that the forecasts made by the agents within the model were no worse than the forecasts by the economist or econometrician who has the proposed model. As a result, it eliminated the remaining bounded rationality in theories of rationality.

In short, within the adaptive expectations framework, economists were boundedly rational in using mechanistic backward-looking extrapolative rules. At the same time, economic agents were even more boundedly rational because economists fit models that forecast better than agents. Within the rational expectations framework, agents were presumed to be just as rational as economists. They were modelled as using the same general equilibrium models as theorists and these models resulted in vector autoregressions that could be tested by econometricians. However, error term justification requires bounded rationality on the part of economists.

The reason for this is as follows (Sent 1998). Despite the explicit stochastic nature of theorising and uncertainty, agents’ decision rules are exact functions of the information they possess. That is, agents know the equilibrium probability distribution. At the same time, the econometrician has to convert the exact equations into inexact ones. In the process, the econometrician faces estimation and inference problems.

While rational expectations economists and econometricians had challenged adaptive expectations advocates for fitting models that forecast better than agents, we now observe a reversal of the contested asymmetry. When implemented numerically or econometrically, rational expectations models impute more knowledge to the agents within the model (who use the equilibrium probability distributions in evaluating their Euler equations) that is possessed by an
econometrician, who faces estimation and inference problems that the agents in the model have somehow solved.

In an effort to address this asymmetry reversal, Thomas Sargent (1993) sought to restore the balance by picturing agents, economists and econometricians alike as being boundedly rational but converging to rational expectations. Ironically, however, this left him with a new asymmetry that emerged between him and the agents in his models. Specifically, Sargent had to be smarter when he made the agents more bounded in their rationality because his models became larger and more demanding econometrically. Furthermore, the proliferation of free parameters in the bounded rationality programme left him with an asymmetry between economists and econometricians: “Despite the compliment thereby made to their kind, macroeconometricians have shown very little interest in applying models of bounded rationality to data. Within the economics profession, the impulse to build models populated by econometricians has come primarily from theorists with different things on their minds than most econometricians” (Sargent 1993, 167–168).

As this subsection has elaborated, the (bounded) rationality of economists and agents is complexly connected. It could be due to their own bounded rationality that economists typically modelled agents as being rational. Under adaptive expectations, economists were boundedly rational, but agents even more so. The subsequent move to rational expectations economics was inspired by a desire to place economists and agents on an equal footing, with both being rational. Yet, error term justification requires bounded rationality on the part of economists, inspiring a move (back) to bounded rationality. Subsequently, economists had to become smarter, because modelling boundedly rational agents are highly demanding.

To a philosophical reflection on the historical connections between rationality and bounded rationality elaborated in these two subsections, we now turn in the final section.

5. Closing comments

Binary dichotomies or dialectical oppositions such as the one between rationality and bounded rationality inhabit Western metaphysical thought. Philosopher Jacques Derrida (1981) criticises these binary oppositions for exhibiting “a violent hierarchy” in which “one of the
two terms governs the other” (41). Indeed, these binary dichotomies or dialectical oppositions typically implicitly privilege one term over the other.

Economists have typically privileged rationality over bounded rationality. As this article has illustrated in support of its central claim, bounded rationality has been invoked to address concerns arising in relation to rationality. The next step would be to destabilise the rationality-bounded rationality dichotomy and thereby disprivilege rationality. In this vein, some have called for a new so-called holy trinity in economics instead of the persistent focus on rationality, greed, and equilibrium. For instance, David Colander, Richard Holt, and Barkley Rosser (Colander, Holt, and Rosser 2004) support a move to the broader trinity of purposeful behaviour, enlightened self-interest, and sustainability. Similarly, John Davis (2007) argues for a focus on social embeddedness, evolutionary processes, and mutually influencing individuals and structures.

Instead of viewing rationality and bounded rationality in terms of a binary dichotomy, then these calls make it clear that they form integral parts of an entwinement. As this article has illustrated in support of its second claim, the rationality and bounded rationality of agents is entwined with that of economists. That is, when economists are boundedly rational, then agents need to be rational. When agents are boundedly rational, then economists need to be rational. Yet, such a claim also trades on the dichotomy that is in need of destabilisation.

The entwinement of which rationality and bounded rationality of both agents and economists form integral parts cannot be grasped fully by setting up oppositions. Indeed, perhaps such oppositions are mostly an illustration of the bounded rationality of the author of the present article. Hence, subsequent authors are encouraged to think of rationality and bounded rationality in terms of constellations of thought. The next step would then be to create new notions or concepts.

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