Conundrums of the Representative Agent*

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Where the hole of the doughnut is what is in question, one only obscures the issue by taking for an expository example a doughnut with a very small hole. (Samuelson, 1952, pp. 128-29)

0. Introduction

This paper will examine the increased role of the representative agent in contemporary economics. The introduction provides some background and section one explains the increased role that the representative agent has played in economic research during the last few decades. It will be argued that it has increased its appearance in both macroeconomics and microeconomics, although in very different ways. In macroeconomics the assumption of the representative agent is *explicit*, primarily a tool of *abstract theorizing*, and a *common feature* of the *core theoretical framework*. On the microeconomic side the representative agent is *implicit* in the theoretical framework, primarily a tool for *empirical research*, and at this point is restricted to *only a few subfields* within microeconomics. Rather than moving directly to the main argument, section two will discuss one explanation of the rise of the representative agent that does not hold up under very well under careful examination. Finally, section three discusses a few of the developments – some relatively internal to economic theorizing and some much broader – that have facilitated the rise of the representative agent.

There are two important points to make about the type of representative agent discussed here. First, although there are many different version of the representative agent in the history of economics – Marshall's concept of the representative firm; Jevons's "trading bodies;" the representative capitalist, landlord, and worker in classical economics; to name just a few – the discussion here will focus exclusively on the utility-maximizing representative agent: an agent maximizing well-ordered preferences subject to the relevant constraints. This is the "rational economic agent" of mainstream microeconomics – the agent who maximizes a well-behaved utility function subject to a budget constraint in demand theory and makes decisions based on maximization of expected utility in risky environments – as well as the rational individual agents in "decision theory" and "rational choice theory" in related fields. The representative agent that concerns us here is where this familiar utility-maximizing individual is used to model the demand, supply, or equilibrium of an entire market or characterize the equilibrium of an entire economy.[1]

[1] It should be noted that one could construct an average, or representative, agent on the basis of empirical data using various statistical procedures, and that versions of such (statistically) representative agents are used in various ways in empirical economics. Also note that a single

Second, the *aggregation* problem associated with a representative agent comes about because it is only under very restrictive conditions that it is possible to add-up the behavior of a number of individually rational agents, each with (potentially quite different) preferences and constraints, and get behavior that is *as if* it were generated by a single rational agent.[2] Although starting with individual agents and aggregating them into a representative agent raises questions (theoretical, empirical, and practical) about aggregation and the associated restrictions, not all representative agent models involve aggregation. Another option is to skip individual agents altogether and *simply assume a single representative agent* is the sole decision-maker in the model. Employing Kevin Hoover's terminology, starting with heterogeneous agents and imposing additional restrictions that allow aggregation is a *non-eliminative* approach to the representative agent – the individual agents are not eliminated, they are just restricted in such a way that their aggregate behavior is *as if* there were only one agent; on the other hand, simply assuming there exists a single representative agent is an *eliminative* approach – it eliminates individual agents from the model altogether (Hoover, 2012).

Finally, I will take it as given that the evidence from experimental psychology and behavioral economics has influenced the way that economists think about and model individual decision-making. The defining feature of this research has been to provide empirical evidence that human decision makers often behave in ways that are inconsistent with utility maximization. The result has been a vast number of empirical *anomalies* – including reference-dependence, loss-aversion, social preferences, preference reversals, framing effects, endowment effects, hyperbolic discounting, and many others – and these anomalies have now become a familiar aspect of contemporary economics.[3] Although it is not clear exactly what impact these anomalies will have – or should have – on standard economic practice, it is clear that the empirical and theoretical adequacy of individual choice theory has increasingly been a topic of debate. So why is this relevant to the rise of the representative agent discussed here? There are at least

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agent model need not involve utility-maximization. There exist economic models with representative agents whose behavior is characterized by bounded rationality, prospect theory, fast-and-frugal heuristics, or some other non-rational choice based characterization of choice behavior. Although both statistical- and non-rational choice based representative agents exist in contemporary economics, the discussion here will focus exclusively on traditional utility-maximizing representative agents.

[2] The most common assumption is that all agents have identical homothetic preferences (see Chipman 1974, Gorman 1953); a summary of these results is contained in the appendix of Hands (2016).

[3] This literature is too extensive to provide comprehensive references, but a few useful resources (from a variety of different perspectives) include: Angner and Loewenstein (2012), Camerer and Loewenstein (2004), Heukelom (2014), Kahneman (2003); Kahneman and Tversky (2000), Sent (2004) and Thaler (1980, 2000). See Lee (2011) for a discussion of how the heuristics and biases program differs from other programs in experimental economics.

two reasons. The first is that, as argued below, these anomalies may have played a role in the rise of the representative agent. The second is a timing question. It seem ironic that at a time when utility-maximization is being questioned in its original domain of individual choice, it would be extended to predict and or explain the behavior of entire markets and/or entire economies. But, as demonstrated in the next section, this is precisely what has happened over the last few decades.[4] I will discuss both aspects of this pattern, beginning with macroeconomic side.

1. The Rise of the Representative Agent

During the last decade of the twentieth century a new theoretical consensus emerged within mainstream macroeconomic theory. The program has been called the *new neoclassical synthesis* (Goodfriend and King, 1997), but the most common label is *dynamic stochastic general equilibrium* (DSGE) theory. DSGE has often been criticized in the aftermath of the 2008 financial crisis, but prior to the crisis DSGE it was considered by many to be a compromise approach: a new theoretical framework that incorporated "important elements of each of the apparently irreconcilable traditions of macroeconomic thought" (Woodford, 2009, p. 269). The conventional view was that while there would still be disagreement about policy and data, DSGE would provide a shared theoretical framework that would stabilize macroeconomic theory by being able to accommodate key elements of New Classical Macroeconomics (e.g. Lucas, 1972, 1981; Lucas and Sargent, 1981) and real business cycle theory (e.g. Kydland and Prescott 1982), as well as the sticky prices and imperfect competition of New Keynesian theory (e.g. Mankiw and Romer, 1991; Galí, 2008).

The DSGE literature is vast and relatively diverse, but there are a few common features of such models. These features include: 1) a commitment to *microfoundations*: all behavior is based on utility-maximization, and since the models are stochastic, it is expected utility-maximization, 2) a commitment to Walrasian general equilibrium, and since the models are dynamic, it is intertemporal general equilibrium, 3) expectations are model-consistent and take the Lucas critique into account (Lucas, 1976), and 4) they allow for the possibility

[4] A quick JStor search provides some fairly striking numbers about the increased use of the representative agent. Searching for articles containing the term *representative agent* in *articles* in all of the *economics* journals in JStor gives the following numbers by decade: 1950-59:0, 1960-69:1, 1970-79:1, 1980-89:166, 1990-99:627, and 2000-2009:629. This is of course just a very rough indication since the papers were not examined for how the term representative agent was being used, the number of journals in each year, and other details. Nonetheless these numbers seem striking and there are at least two reasons why they are probably understated: 1) the search was only for "representative agent" and not "representative consumer" or "Robinson Crusoe" or other terms that have been used, and 2) as noted above and discussed in detail below, most of these references are to macroeconomics since the term "representative agent" is almost never used in the microeconomic literature.

that both real parameters such as tastes and technology, as well as monetary parameters, can, depending on the model and time-frame, have an effect on equilibrium values (Duarte, 2012; Woodford 2003, 2009). All of these features are related, but understanding the role of the Lucas critique is probably the best place to start explaining how the various aspects of DSGE fit together and how the representative agent became involved.

The Lucas critique was an influential criticism of the policy analysis associated with the large-scale Keynesian macro-econometric models of the 1960s and 1970s. The argument was that since the parameters of these models are not structural and thus not policy-invariant, it was impossible to predict the effect of policy changes using such models. The structural parameters most likely to be invariant are the core givens of microeconomics – tastes (utility functions) and technology (production functions) – and thus it was argued that macroeconomic theory required microfoundations based on the standard characterization of competitive consumer and firm behavior.

Both DSGE and the new classical literature that preceded it, are committed to microfoundations, but they are also committed to Walrasian general equilibrium theory. However Walrasian models are notoriously difficult to solve, particularly in macroeconomics where the goal is the explanation of the behavior of aggregate, and policy relevant, variables like real output and employment. Employing the *representative agent* solves this problem. If the model has only one utility-maximizing agent then it has microfoundations, but with only one such agent representing the entire economy, it becomes practical to solve the model and engage in equilibrium analysis. In addition, the utility function of the representative agent "provides a natural objective in terms of which alternative policies should be evaluated" (Woodford, 2003, p. 12). With the representative agent it is possible to construct a dynamic, stochastic, Walrasian general equilibrium model with utility-maximizing microfoundations and a built-in social welfare function.

So the representative agent provides microfoundations and a "natural" welfare function, but how does this produce the Walrasian general equilibrium output, employment, etc.? The key is the familiar second fundamental theorem of welfare economics. The second theorem says that every Pareto optimal allocation can be supported by competitive equilibrium prices, and since Pareto optimality in a one-agent world is equivalent to utility-maximization, solving the representative agent's problem subject to the economy's resource and technology constraints gives the equilibrium (and optimal) allocation; finding a (any) set of competitive prices that supports this allocation gives a competitive equilibrium. As James Hartley summarized it: "Thus, we have a representative agent whose utility is being maximized as a social planner's problem which yields a solution that is Pareto optimal, and finally, by adding in prices, we arrive at a competitive

equilibrium" (Hartley, 1997, p. 68). Given the commitment to microfoundations and general equilibrium, the representative agent is considered to be a convenient analytical tool to harmonize all of these various theoretical and methodological commitments.[5]

Turning now to contemporary *microeconomics*, we encounter the representative agent entering in a quite different way. It has come about primarily through the development of *empirical revealed preference theory* (ERPT),[6] and ERPT is a very different kind of economic theory than DSGE. For one thing, ERPT is more empirically-focused, but perhaps more relevant here, the representative agent enters ERPT *implicitly*, rather than *explicitly,* as it does in the macroeconomic literature. By this I mean that in the case of DSGE the representative agent is a core assumption and thus enters quite explicitly in the construction of such models. In the case of ERPT on the other hand, the representative agent is an implication of the underlying theory, but is is seldom explicitly acknowledged. In other words, the representative agent is an *assumption* of most DSGE models, while the representative agent is an *implication* of ERPT-based empirical research.

Revealed preference theory began with Paul Samuelson's famous 1938 paper, but Samuelson's version of revealed preference – what later came to be called the *weak axiom of revealed preference* (WARP) – was primarily an alternative characterization of individual consumer choice theory rather than a tool for empirical analysis. Samuelson assumed individual demand functions defined over the entire price domain and demonstrated that if those functions satisfied WARP then they would also satisfy most of the standard restrictions from ordinal utility theory (all except Slutsky symmetry), and did so without assuming the maximization, or even the existence, of an individual utility function. The full equivalence of revealed preference theory and ordinal utility theory came in 1950 with Hendrik Houthakker's Strong Axiom of Revealed Preference (SARP). If an individual demand function satisfies SARP then it could have been generated by (it is consistent with) budget-constrained ordinal utility-maximization – demand is *as if* it had been generated by a utility-maximizing consumer – but like Samuelson's WARP, Houthakker's SARP did not provide a

[5] It is important to note that increasingly DSGE models involve some type of *heterogeneous agents* (e.g. Cúrdia and Woodford 2010), but this fact does not detract from the discussion of DSGE in this paper. There are many reasons why this is the case. First, although this literature is growing, the representative agent still remains the dominant modeling strategy within the DSGE literature. Secondly, the heterogeneity often reduces to only two, or a few, different types of agents and is thus not the type of heterogeneity traditionally associated with Walrasian general equilibrium models. Finally, and perhaps most importantly for this (historical) paper, the rise and acceptability of the representative agent in Walrasian models is still an important *historical question* even if at some point in the future these modeling practices have significantly changed.

[6] For a more detailed discussion of ERPT and its relationship to other versions of revealed preference theory see Hands (2013, 2016). See Cherchye, Crawford, De Rock, and Vermeulen (2009) and Crawford and De Rock (2014) for detailed surveys of the empirical methods associated with ERPT.

convenient way of conducting empirical research or finding such a utility function. It wasn't until later when Sidney Afriat's results (1967) led to the Generalized Axiom of Revealed Preference (GARP), that the theory could be effectively applied to choice data and a relevant utility function could be determined (Diewert, 1973; Varian, 1983, 2006). It is this GARP-based literature that has prompted ERPT and the recent expansion in revealed preference-based research.

In order to see how this literature brings in the representative agent, it is necessary to review how empirical ERPT-based research is typically conducted. It is roughly this. Start with finite observations of choice data from an individual consumer, and test it using GARP or one of the related revealed preference conditions. If the data passes the test and is consistent, then there exists a utility function that rationalizes the data and GARP techniques can be used to find such a function. Once a utility function is found, it can be used to predict how the consumer would respond to different prices and income, conduct various comparative statics exercises, and analyze how the individual's welfare would change in response to changes in various parameters. ERPT is thus an empirical technique for demand analysis – often called *non-parametric* demand analysis – that competes with other more traditional econometric approaches to demand theory. If the initial data is from an individual consumer then ERPT does not involve a representative agent in any way. But now suppose that the initial prices and quantities were *market*, rather than individual, data (as is generally the case). If market data satisfies GARP then it says that market prices and quantities can be rationalized – it is *as if* it were generated by a (single) utility maximizing consumer – and that consumer's demand is the entire market demand and is thus involves a *representative agent*. Not only can market demand be characterized as the demand of an individual, the GARP techniques provide a way of determining a utility function for that representative agent. Some supporters of ERPT consider its direct application to market data to be one of the program's main virtues (Ross, 2014a, 2014b).[7]

Applying ERPT to market data not only implies a representative agent, it does so in an *eliminative* way. Individual consumers – or their preferences, endowments,

[7] Just as there exist DSGE models with some degree of heterogeneity among agents, there exist ERPT models where the consistency condition involves a broader notion of rationality than budget-constrained ordinal utility-maximization. For example Manzini and Mariotti (2007, 2012, 2014) defend what they call a "model-based approach" that employs a weaker version of revealed preference in order to accommodate types of bounded rationality. Grüne-Yanoff, Marchionni, and Moscati (2014) call this approach the *heuristics-and-revealed-preference* program because it attempts to combine elements of the behavioral and ERPT programs. The above criticism obviously would not apply to this, or other revealed preference-based approaches that attempt to expand the concept of rationality while staying broadly within the empirical research program of ERPT. But the vast majority of the ERPT literature applies traditional GARP-based approaches and is not attempting to broaden the approach in this way.

or income – need not be mentioned at all; the analysis goes directly from a consistency condition on market data to a utility function of a representative agent that could have generated it. The market itself becomes a rational economic agent.[8] There is much to say about the representative agent being used in this way, but one fairly striking fact is that it immediately circumvents the problems associated with the Sonnenschein-Mantel-Debreu (SMD) results on market demand functions.[9] The SMD results say that individual utility-maximization imposes almost no restrictions on market demand functions and ERPT produces market demand functions that have all of the standard properties of individual demand functions.

Although the representative agent assumption in modern macroeconomics and the representative agent implication of empirical revealed preference theory have been presented as two separate aspects of contemporary economics, there is some overlap between the two literatures and it seems to be increasing. The main overlap is the application of GARP-based techniques to macroeconomic variables such as aggregate consumption, money, and other financial assets. A sample of this literature includes: Chavas and Cox, 1997; Cherchye, De Rock, and Vermeulen, 2012; Drake, 1997; Fisher and Fleissig, 1997; Fleissig, Hall, and Seater, 2000; Serletis, 2013; Swofford and Whitney 1987; and Varian 1982. At this point it is not clear whether this research will support the increased role of the representative agent, or provide evidence against it, but it certainly draws attention to the possible unification of these two literatures.

2. How Not to Motivate the Rise of the Representative Agent

While there is historical literature that discusses the representative agent, most of it is critical and specifically aimed at DSGE; the representative agent gets mixed in with a critique of other aspects of DSGE. On the other hand, the macroeconomists who readily employ the representative agent almost never explain why it is an appropriate assumption (empirically, theoretically, or methodologically) explain how they came to employ it in the way they do; "there is little-to-no explicit justification of the representative-agent simplification" it is as if "macroeconomists sleepwalked into their most characteristic methodological position" (Hoover, 2012, p. 50). But while there is very little justification of the increased use of the representative agent in macroeconomics, there is even less in ERPT. Many who use GARP-based techniques in empirical research on market data do not acknowledge they are employing a

[8] It should also be noted that it is not *only* ERPT that imposes individual-demand restrictions on market demand. Some empirical work employing traditional ordinal utility theory and standard econometric tools does so as well (for example Phlips 1983).

[9] Debreu (1974), Mantel (1974), and Sonnenschein (1973). This is also a common criticism of the use of the representative agent in the DSGE literature (e.g., Hoover, 2012; Kirman, 1992).

representative agent. So given all this, the main task of the remainder of this paper will be to discuss some of the developments – both within and outside of economic theory – that have accommodated the rise of the representative agent. Section three provides the main argument; the rest of this section critiques one suggestion about this development.

The suggestion[10] is that *the representative agent is nothing new; it has always been a mainstay of modern economic theory and thus there is nothing to explain*. My reply is that as a matter of the historical record this is simply not the case; economists have rarely modeled markets and entire economies in this way. Of course there are examples of this kind of representative agent in the history of economic thought; the *Robinson Crusoe* models of late 19th and early 20th century are examples – von Wieser 1927 for instance – but these are fairly rare cases. It isn't the same as Jevons's concept of a trading body (White 2001), it isn't in Pareto's mature economics (Boianovsky, 2013), it isn't in Walras (see below), it isn't the way that Samuelson modeled competitive markets (Hands, 2016), with one "partial exception" it is not in Wicksell (Boianovsky, 2016), and the list could go on and on. But the issue runs much deeper. DSGE models are self-consciously Walrasian models and ERPT models are self-consciously revealed preference models, and *the representative agent has not traditionally been a part of either Walrasian general equilibrium theory or revealed preference theory*. This is an important point – it means that not only was the representative agent not a mainstay of economics in general before the last few decades, *it wasn't a mainstay of either Walrasian or revealed preference economics either* – and this requires some discussion. I will start with Walrasian general equilibrium theory.

The representative agent is not part of Walras's original *Elements* in 1874 (Walras, 1954). There is historical research on this topic – van Daal and Walker (1990) for example – but the main point is clear from even a cursory examination of the *Elements*. Even in the pure exchange case, the fewest number of traders Walras considers is two and there is always the presumption that the traders have potentially different tastes and endowments. His goal was to explain how competitive markets could possibly coordinate the actions of a large number of dissimilar agents; if the economy consisted of only one agent, there would be no coordination problem and no need for general equilibrium theory.

Although Walras did not employ the representative agent, a more important question is whether the *Walrasian* economics that DSGE is explicitly committed to – Arrow-Debreu general equilibrium theory – employed such an agent, and the answer is clearly *no*. Even in the simplest, pure exchange case, the Arrow-Debreu model assumes a potentially large number of individual agents with different tastes and endowments. The utility-maximizing behavior of these agents gives each individual's demand for each good, which added-up give the

[10] This is the most common comment that I have heard when discussing the ideas in this paper.

market demand (and market demand functions do *not* inherit the Slutsky, or WARP, or SARP, properties of individual demand functions). These market demands being equal to the total supply of each good give the competitive equilibrium. This is the core framework for all of the canonical texts of the mid-twentieth century Walrasian literature (e.g. Arrow and Hahn, 1971; Debreu, 1959). But any reader who is interested enough to make it this far into this paper probably already knows this. Perhaps it is less well-known that many of the major figures in the Walrasian literature, not only did not employ the representative agent, they argued explicitly against it. For example:

> In particular, the homogeneity assumption seems to me to be especially dangerous. It denies the fundamental assumption of the economy, that it is built on gains from trading arising from individual differences. Further, it takes attention away from a very important aspect of the economy, namely, the effects of the distribution of income and of other individual characteristics on the workings of the economy. (Arrow, 1986, p. 390)

> If the rest of economic theory proceeded on these assumptions, welfare economics, for instance would become extremely simple and stability analysis would be child's play … Much of what we have regarded as interesting and important would be lost. (Hahn, 1981, p. 42)[11]

The Walrasian literature did sometimes employ mathematical assumptions that come close to assuming a representative agent. One example that appeared in the literature during the 1950s and 1960s was assuming that market excess demand functions satisfied WARP. Based on Houthakker's 1950 results, if a market demand function satisfies SARP then it can be rationalized by a representative agent, and while WARP is a little weaker than SARP and does not guarantee full rationalization, it is in many ways a similar assumption. However, the way WARP was actually used in this literature is very revealing about how much

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[11] Hahn's remarks in correspondence are also of interest. The following is from a letter from Hahn to Samuelson dated June 22, 1993 (in Box 36 Paul A. Samuelson Papers in the David M. Rubinstein Rare Book and Manuscript Library at Duke University): "Rather it is the use of the 'representative agent' – a disastrous concept. Certainly no way to start and analysis of 'coordination' failures … It is *not* General Equilibrium analysis."

The importance of heterogeneous individual agents is also stressed by theorists who defend the traditional characterization of Walrasian economics against more recent RA versions. As Donald Katzner explains: "Economists have always intended that the Walrasian model … be encompassed within the tradition of methodological individualism, which generally understands individuals, with given preferences and endowments, … to enter the market process as autonomous entities. Among other things, this tradition means that all assumptions should be made on individuals and their preferences, and all market-level entities and their properties should be built up from individual level entities and their properties." (2010, p. 212).

these economic theorists *resisted* the representative agent (even though it would have made the mathematics much easier[12]). In 1936 Abraham Wald (1951) had applied WARP directly to market excess demand functions in an *ad hoc* way, but this was not how the assumption entered the later Walrasian literature. WARP was implied by other restrictions on market demand functions that were considered to be empirically acceptable – the most important of these being the *gross substitute* assumption – and WARP entered through such assumptions. A representative agent was not assumed directly, nor were specific assumptions like homotheticity imposed on the models that would guarantee aggregation. If the representative agent had been acceptable to these economists, they would have imposed SARP directly on market excess demand functions since it would have made their mathematical analysis much simpler. But it wasn't acceptable – and its convenience and tractability were not sufficient to make it acceptable – hence the indirect use of the mathematical implications of WARP through gross substitutes and other more acceptable assumptions.

The main way that market demand (or excess demand) came up in revealed preference theory was in the context of the application of WARP directly to excess demand functions discussed above, and on that issue all of the relevant players were quite clear: WARP was a property of individual demand functions, not market demand functions. It was implied by certain special conditions – like gross substitutes – but applying it in general it was a category mistake; rationality was a property of individual agents not market demand. As Dorfman, Samuelson, and Solow noted in 1958:

> Why is this [revealed preference] assumption peculiar? Because the demand functions … are market demand functions, not individual demand functions. "Rationality" cannot be required of market demand functions because changes in prices normally change the distribution of income. With a changed income distribution, *different* "preferences" will be revealed. (Dorfman, Samuelson, and Solow, 1958, p. 368)

The authors of the more recent ERPT literature generally do not address the motivation for, or appropriateness of, applying GARP to market data – one way or the other. The position of most practitioners in the field seems to be that all price-quantity data is methodologically the same: one can do the same analysis with it regardless of whether it comes from an individual or a market. So for revealed preference theory as for Walrasian theory, the representative agent is *not* something the relevant economic theorists have always been doing. The rise of the representative agent in DSGE and ERPT is relatively new to both of their parent research programs.

[12] See Hands (2010) and (2016) for a discussion of some of the technical details associated with this point.

Concluding this section, the discussion so far leaves us with at least two historical conundrums about the representative agent. First, perhaps more a curiosum than a conundrum, is the timing issue. Why extend the utility maximizing agent to markets and whole economies at a time when the profession is so conflicted regarding the proper role of utility-maximization in the study of individual behavior? The second historical conundrum is more substantive. What persuaded economists who were self-consciously committed to Walrasian general equilibrium theory and revealed preference theory to embrace – either explicitly or implicitly – the representative agent, when the economic theorists most responsible for developing these fields in the 1950s and 1960s were so steadfastly opposed to such a move?

3. Three of the (Many Possible) Features of Economic Theorizing during the 1960-1980 Period that May Have Decreased Resistance to the Representative Agent

3.A. In this first subsection I would like to discuss a few specific theoretical developments that may have contributed to the ease at which economists could slide from the traditional individual agent-based version of utility maximization to the representative agent versions that have been discussed here. The problems – the empirical problems associated with behavioral anomalies, the theoretical problems associated with SMD, and other concerns – certainly challenged the traditional individual agent, but the move toward the representative agent involved more than simply escaping the problems of the individual agent. After all, the utility-maximizing individual agent was not abandoned; rather, what was abandoned in DSGE and ERPT was the previous commitment to individualism and the long-standing emphasis on the interaction and coordination of a large number of different economic agents. So the kind of developments that we are looking for are ones that rationalize the *turn away* from the traditional individual agent while simultaneously keeping the same *kind* of rationality – *utility maximization and the implications of such rationality* – at a higher level.

My argument is that there was a wide arrange of influential economic research suggesting that rationality is more a characteristic of various types of institutions – particularly markets – than of individual agents. This research, some of it coming well before the challenges of empirical anomalies and SMD, showed that it was possible to keep the optimization-based mathematical tools as well as the optimality of the final outcome, without involving the (potentially problematic) rational individual agent. I will discuss three such results although there were many others pointing in the same direction.

One of these results is Gary Becker's 1962 paper on irrational agents and the related literature. Becker's paper was an explicit endorsement of market

rationality as a substitute for traditional individual rationality. Using the negative substitution effect – the downward slope of the own compensated demand curve – as the relevant concept of rationality, he demonstrated that certain types of *irrational* individual behavior could produce market demand curves that exhibited such rationality. The bottom line of Becker's argument was that "the market would act 'as if' it were rational not only when households were rational, but also when they were inert, impulsive, or otherwise irrational" (p. 7).

> I believe it does provide an important defense of the *theorems* of modern economics, … Since, however, these theorems are shown to be consistent also with an extremely wide class of irrational behavior, a defense of them is not necessarily a defense of individual rational behavior. (ibid., p. 2)

So the optimization-based results of economic theory ("the *theorems* of modern economics") could be preserved as a property of market demand even though individual agents may act irrationally.[13]

The second, and related, research is Dhananjay Gode and Shyam Sunder's work on zero-intelligence traders (e.g. Gode & Sunder 1993, 1997; Sunder 2006). This work, inspired in part by the criticism of program trading after the 1987 stock market crash and in part as a teaching exercise in trading algorithms, produced surprising results, even to the author's themselves (Sunder, 2006). Computer trading algorithms were programed to conduct trades irrationally – taking bids and asks from a uniform distribution of prices – and these zero-intelligence traders converged to the market equilibrium with almost one hundred percent efficiency. Like Becker's result, this research suggests that economists can reasonably ignore psychological research and move from individual to market rationality. Such implications were clearly recognized:

> The marriage of economics and computers led to a serendipitous discovery: there is no internal contradiction in suboptimal behavior of individuals yielding aggregate-level outcomes derivable from assuming individual optimization. Individual behavior and aggregate outcomes are related but distinct phenomena. (Sunder, 2006, pp. 322-323)

The final body of literature to discuss is one of the major developments in late twentieth economic theory – experimental economics – specifically the work of

[13] See Moscati and Tubaro (2011) for a detailed discussion of Becker's paper and the related methodological literature and Kirman (2006) for a discussion of some of the broader implications of this approach.

Vernon Smith and the experimental-market-economics research program.[14] Smith shared the Nobel Prize in economics with Kahneman in 2002, but his research is quite different from the behavioral economics program and contributes to an emphasis on institutional/market rationality rather than individual rationality.

One of the many results from the experimental market-economics literature that helps clarify how this approach to experimental economics accommodated the shift from individual to market rationality is the influential 1979 paper by David Grether and Charles Plott. The paper was explicitly "designed to discredit the psychologists' works as applied to economics" (ibid., p. 623) – specifically the literature on *preference reversals*[15] – and yet, much to the authors' surprise, rather than falsifying the psychological research on preference reversals, the experiments actually confirmed the anomaly for individual choice. But as in the research discussed above, irrationalities such as preference reversals in individual behavior need not imply the irrationality of market outcomes. As Floris Heukelom explains:

> Grether and Plott did not imply that utility maximization and rational choice as a description of market behavior were invalidated. With respect to market behavior the experimental results only showed that economic subjects, who in the final market equilibrium behave according to rational choice and utility maximization, initially behave according to a to-be-developed theory that is completely unlike utility maximization and rational choice. Because of the disciplining *rationalizing* institutions of the market operates between individual behavior and market behavior, a falsification of individual rational optimization did not falsify rational choice as a description of equilibrium market behavior. (Heukelom, 2014, pp. 140-41)

Such arguments, like the arguments of Becker and Gode & Sunder, justify shifting the locus of rationality away from individual agents and toward market institutions. Although these are only three of the many possible examples from the relevant literature, the underlying message is the same; the problems of individualistic rational choice theory are red herrings, since markets should be the main focus and the rationality of agents is not necessary for the rationality of markets.

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[14] The relevant literature is far too extensive to reference in any comprehensive way, but a key source for the topics here is Smith (2008). Again, Lee (2011) provides a nice discussion of how experimental market economics differs from other experimental literatures.

[15] For example Lichtenstein and Slovic (1971, 1973) and Slovic and Lichtenstein (1983).

Before moving on to more macro-oriented topics in the next section, it is useful to consider one additional literature that involves well-behaved market demand (and excess demand) functions without building them up from the rational utility-maximizing behavior of individual economic agents. It is the market demand literature associated with the work of Werner Hildenbrand (1994) and his associates. Although there is an empirical aspect to some of this literature, the origin of the approach and the theoretical tools involved are products of mid-twentieth century Walrasian general equilibrium theory. The main concern is circumventing the problems raised by the SMD results; if excess demand functions have very little structure then it is fairly easy to produce Walrasian equilibria that are non-unique and unstable, undermining any hope of doing comparative statics analysis on Walrasian systems. Since rational, utility-maximizing, individuals are not sufficient for well-behaved market demand functions, Hildenbrand turned away from individual agents and began to look elsewhere for the source of desirable market-level properties. For example, one of the properties that provide sufficient market-level structure – what Hildenbrand calls the "law of market demand" or monotone demand – is an increasing dispersion of individual household demand as income increases. This condition, unlike the assumptions that all agents are well-behaved rational utility maximizers, is sufficient for uniqueness and stability (Hildenbrand, 1994, p. 169). In one sense this is like the use of the representative agent – the representative agent puts additional structure on economic models that are not available from the assumption that all agents are utility maximizing – but in another sense it is a more radical approach. Hildenbrand's market level results do not come from the extension of rational individual behavior to markets or entire economies, but rather from moving away from any form of rational utility maximization as the source for market level structure. As Alan Kirman put it:

> Hildenbrand (1994) suggested a much more radical departure from traditional theory and proposed that we start with individual demands without deriving them from preferences and that we then see if we could find some condition on the dispersal of consumption choices that would give us back uniqueness and stability. What he showed … was that if, with increasing income, the consumption choices of individuals became more dispersed in a very precise sense, then the aggregate demand will satisfy the aggregate 'Law of Demand' … This property guarantees the uniqueness and stability of equilibrium … (Kirman, 2006, p. 94)

Also note that Hildenbrand's approach preserves the heterogeneity of individual agents and since dispersion is a type of heterogeneity, it is a source of market level structure. Again, as Kirman explains: "A crucial feature of Hildenbrand's argument is that individuals are heterogeneous and, indeed, it is this heterogeneity that gives structure to the demand behavior at the aggregate

market level" (Kirman, 2011, p. 22). Like the Walrasian economists from the middle of the twentieth century, Hildenbrand sought general equilibrium models with desirable properties like stability, uniqueness, and determinant comparative statics, but post-SMD that was not possible by simply assuming well-behaved individual economic agents. Instead of turning to the representative agent, Hildenbrand held on to the Walrasian idea of agent heterogeneity and developed an approach to market demand that found other ways to obtain the desired market properties.

3.B. This second subsection will discuss research that helped encourage the use of the representative agent in macroeconomics. Although DSGE accommodates many New Keynesian theoretical and policy interests, its methodological foundations are more grounded in New Classical than in traditional Keynesian macroeconomics and one of these shared features is the representative agent, but the shared commitment to rational expectations is probably the best starting point here.

Rational expectations implies that agents in the model do not make systematic errors – precisely the opposite of much the behavioral economics literature – and in a Walrasian world that means that (on average) agents in the model expect the equilibrium outcomes of the model. Rational expectations are thus *model-consistent expectations*: the agents in the model form their expectations on the basis of the predictions of the model. If the agents of the model are going to form expectations that are (on average) consistent with the model, they need to know the model's solution. This, as argued above, was one of the reasons for employing the representative agent. Put simply, if there is only one agent then rational expectations only requires knowledge of the behavior of that agent (since the representative agent's optimal choices are the model's equilibrium outcomes). There is just one optimization problem and the solution to the problem is both the representative agent's optimal and the general equilibrium of the model.

Mathematical tools for solving such models (at least non-stochastic versions) have a long tradition in economics. Frank Ramsey's (1928) model of optimal savings was an infinite horizon optimization model with a representative agent which he solved using the calculus of variations. This model was relatively neglected for decades but revived during the 1960s when a number of key papers – Cass (1965), Koopmans (1965), Malinvaud (1965), and others – introduced ideas from optimal control theory which became a standard tool in optimal growth models.[16] These models were considered to be *normative growth models* because they involved a social planner's problem of how the economy ought to grow in

[16] See Spear and Young (2014) and McKenzie (2002) for discussions of the early history of the optimal growth literature and Duarte (2009) for a discussion of the relationship between this literature, the Ramsey model, and later macroeconomics.

order to maximize the utility of the representative agent. This literature often did not involve stochastic decision-making, but nonetheless it provided the starting point for the development of a set of convenient mathematical tools for macroeconomics. Mathematical economists who had been working on optimal growth theory for years suddenly discovered they were doing macroeconomics.

So the existence of this earlier optimal growth literature facilitated the development of New Classical macro models with representative agents and in turn the development of DSGE. It is interesting to note there was a general tendency in the move from early New Classical to DSGE to increase the reliance on the representative agent, and this is at least in part be because of the available mathematical tools. DSGE models involve dynamics, optimization, and general equilibrium – three things that were kept fairly separate in both the micro- and macroeconomics during the 1950s and 1960s – and having a formalism that could bring all three things together in a single set of first order conditions was an impetus to this type of theorizing.[17]

3.C. The discussion so far has involved specific economic research, this section will discuss factors that are more general – historical, political economic, and technological – and as a result the argument will focus more on the general filiation of economic ideas. The bottom line for this section is that there was a *change in the theoretical character* of mainstream economics between the middle of the twentieth century and the more recent literature. The change in the theoretical character of economics has come about because of innumerable changes in the social, political, economic, technological, and undoubtedly other, characteristics of the world in which the economics profession is embedded.[18] However interesting such a grand narrative about the changing theoretical character of economics might be, it is not possible here, so I will just note two

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[17] What Sargent called the "communism of models": "All agents inside the model, the econometrician, and God share the same model" (Evans and Honkapohja, 2005, p. 566).

[18] Granted the term "theoretical character" is not the way that economists talk about economic research. But the idea is quite straightforward. It is common to talk about the character of an individual. The character of an individual involves the person's distinctive qualities and judgments. So too for theoretical character; it is the distinctive qualities and judgments associated with a particular body of theory. In simplest terms it is what is considered to be a reasonable given, what the general goal of the inquiry is, what counts as evidence, what is considered to be a contribution, and so forth. Such qualities and judgments are seldom explicit, but every research program has them. I certainly do not know what all defines the theoretical character of either the older or the newer research discussed here, but such comprehensiveness is not needed. My point is relatively simple; the theoretical character of the Walrasian literature from the middle of the twentieth century is different from DSGE, and the theoretical character of the earlier generation of revealed preference theory is different from ERPT. This is not to say that the younger and the older literatures do not have features in common any more than saying that person x and person y have different characters implies that they have no common beliefs or values. My concern here is with the differences and how those differences contributed to resisting the use of the representative agent in the earlier case and being completely comfortable with it in the later.

aspects of the larger story. Both are broad-sweeping, but the first is social-political and more macro, while the second involves changes in technology and information and is more micro.

My central theme regarding both of these broader influences is that *there was a great amount of resistance to the representative agent in both Walrasian general equilibrium theory and in the early revealed preference literature, but that resistance faded away in later decades*. The change that has taken place in recent years seems to be less that the representative agent was actively embraced and more that the *forces resisting it ceased to be operative*. The two influences I will note are things which weakened the resistance to the representative agent, or at least help to explain why the earlier generation of economists might feel the need to resist while the later generation felt no such need. The economists who developed Walrasian general equilibrium theory in the middle of the twentieth century were very aware how much assuming a representative agent would have simplified getting the desired results and yet they successfully *resisted the temptation*; and early contributors to revealed preference theory were fully aware that WARP or SARP could be applied to market demand and yet they too successfully *resisted the temptation*. I will note two of the many possible broader changes that weakened the resistance and contributed to this change in theoretical character.

The first of these is historical in the everyday use of the term. The generation of economists who made significant contributions to the development of Arrow-Debreu theory were products of the historical context of the Great Depression and World War II. These were times when neither *rationality* nor *equilibrium* came obviously or easily to most economists. Even those who were comfortable with the idea that an individual might be in equilibrium (maximizing utility), typically argued such stability and rationality needed to be explained – not assumed – for markets or entire economies. The optimization of an individual agent, the equilibrium of a market, and the macroeconomic equilibrium of the entire economy, were – and given the times, needed to be – three quite separate things. Assuming a representative agent buries the interaction, coordination, and disequilibrium that seemed to be important characteristics of markets and economies. The use of the representative agent also implies that markets (micro) and/or the market economy (macro) exhibit *rationality*, and that was a difficult presupposition to accept during the Great Depression and its aftermath. This was a world that produced economists, even mainstream economists committed to individual maximization and Walrasian general equilibrium, who *strongly resisted* the idea that either a market or an entire economy is adequately represented by one big rational agent who is always in equilibrium and thus left no room for any discussion of coordination, adjustment, or unintended consequences. On the other hand, these issues were much less a concern for the

economists who developed New Classical and later DSGE. These were different contexts and they supported different theoretical characters.

Unlike such broad-ranging historical changes, the second change I will note involves information and technology. It is easy to think of many ways that technology was different at the end of the twentieth century than it was in say 1960, but I would like to emphasize one change that has influenced the character of revealed preference theory in particular. The ERPT literature is of the world of big data and fast computers; the WARP and SARP literature was of the world of set theory, real analysis, and advanced calculus. The typical revealed preference paper of the earlier literature involved deductive mathematical exercises on various specific assumptions (WARP, SARP, boundary conditions, etc.) and specific results from ordinal utility theory (Slutsky symmetry, transitivity of the associated preferences, etc.). On the other hand, the typical ERPT paper starts with a matrix of empirical price-quantity data and the analysis involves the GARP-based consistency tests, utility function estimation, and the type of empirical analysis discussed above. These two ways of doing revealed preference theory are products of *two different techno-scientific worlds*. For the earlier generation the acceptable framework was set by ordinal utility theory: deductive analysis based on the first and second order conditions associated with an idealized *individual* consumer maximizing a well-behaved ordinal utility function. For that generation to think of market demand as anything other than the sum of such individual demand functions was to *cease doing modern demand theory*. There were of course economists who thought about market demand in different ways than this – from various heterodox economists, to mathematicians like Griffith Evans, to statistical economists like Henry Moore – but these were not the economists who developed revealed preference theory. For those who did, the conceptual frame was set by abstract ordinal utility theory. On the other hand, for the empirically oriented economists doing ERPT today the point of reference is quite different; a matrix of price-quantity data is just a matrix of price-quantity data. It may or may not be possible to extract anything interesting out of it, but that depends on the data, the computational tools, and the question under consideration. There does not seem to be any particular *a priori* mandate whether the techniques should be applied to individual or market data. The change in theoretical character did not necessarily require the move to the representative agent, but as the resistance to it faded away, so did the prohibition against it.

4. Conclusion

Let me close by summarizing the argument. Perhaps a good place to start is with the issue of convenience or tractability. The representative agent clearly made the analysis easier – in both macroeconomics (for mathematical-theoretical reasons) and revealed preference theory (for empirical reasons) – and scientists in every

field consider the convenience and tractability of their theoretical tools. But tractability is not alone sufficient to explain the rise of the representative agent. The Walrasian general equilibrium theorists of the middle of the twentieth century clearly *could have* employed the representative agent and it certainly would have made their theorizing easier – as Hahn put it in a quote used above "welfare economics … would have been extremely simple and stability analysis would be child's play" (Hahn, 1981, p. 42) – but they didn't; they resisted it at every turn. So too with revealed preference theory. Samuelson's original WARP condition *could have* been applied to market demand or excess demand functions, but it wasn't. Samuelson himself was explicitly against it, the second generation of revealed preference literature focused on individual demand functions, and so did the early empirical applications of revealed preference theory. Although convenience and tractability was undoubtedly a factor, other factors were necessary to overcome the strong resistance to the representative agent.

I suggest one impetus came from the general recognition of the problems associated with individual agent-based rational choice theory: particularly the empirical problems raised by the anomalies literature (for expected utility theory) and the theoretical problems raised by the SMD results (for ordinal utility theory). At some point it became evident that the individual utility-maximizing agent was less able to carry the theoretical weight it had traditionally carried. But the change did not come quickly. There was no immediate flight to the representative agent in mainstream economic research and much of the literature continued to, and still does, focus on individual optimization. The representative agent was not part of the early push-back against the behavioral literature by economists and even after the SMD results were well-known there was no immediate movement within Walrasian general equilibrium theory to adopt the representative agent. It took more than the positive consequences of tractability and the negative influences of anomalies and SMD – it also needed to be helped along by developments such as those discussed in the previous section.

Since markets could exhibit rationality even with irrational agents, migration toward rational agency at the market, rather than individual, level seemed to be appropriate. Work like Becker (1962) existed prior to the literature on behavioral economics and SMD, but remained a curiosity until individual rationality became problematic. Heterogeneous agent Walrasian economics fit to some degree with the IS-LM Keynesian of the 1960s, but not with rational expectations and the Lucas critique, and given the core commitments of New Classical macroeconomics and the practical support provided by the tools of optimal growth theory, the move to the representative agent seemed to be natural. But there was also a change in the theoretical character of economics. The leading economists of the middle of the twentieth century were influenced by the Great Depression and problems of coordination – where the unintended consequences

of the interaction of large numbers of self-interested agents was high unemployment, human suffering, and the rise of totalitarian political regimes – and for most of these economists the idea that the competitive market has no coordination problems or unintended consequences was an anathema. But the generation of economists who followed did not share their concerns (at least to the same degree) and some aspects of theorizing that the earlier generation considered off the table, became acceptable. Finally, add to this the changes in information technology and computational power, and how they changed the quantity and quality of economic data as well the depth and speed of analysis, and we have a very reasonable story about the rise of the representative agent and the associated theoretical developments.

This paper has discussed some of the forces accommodating the move to the representative agent and the associated historical conundrums. In the process one possible explanation was criticized and several possible contributing forces were defended. The change in the role of the representative agent is not generally recognized as a characteristic of contemporary economic theorizing (particularly in microeconomics), so suggesting something that might seem to be relevant to this development but isn't, and suggesting a number of things that probably are relevant to this development, are important first steps in helping us understand the conundrums of the representative agent.

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