The referee raises a number of points that are best dealt with individually. To this end we have separated the referee's response into four parts. Each part begins with the referee's observation quoted in bold font to distinguish it from our response that follows. We thank the referee for the opportunity to clarify these points.

1. **"The paper applies the technique of solid-state physics to economic dynamics. Notwithstanding decades of studying economic dynamics by mathematical methods, I had great difficulties in understanding the paper."**

   The nature of the paper as stated by the referee is largely correct. The paper applies two related approaches - linear response theory and the time-correlation formalism - that have been used with great success in a variety of natural science contexts (including, as pointed out by the referee, solid-state physics) to economic dynamics. We are, of course, concerned that the referee had great difficulties in understanding the paper and, having reread the paper with the referee's comment in mind, we have rewritten parts of Section 2 in terms of linear systems theory which is more familiar to economists. The paper does, however, cover quite a bit of ground as it lays out a complete solution to the problem of aggregating micro dynamics into macro observables without using a representative agent. Indeed, there is a reason why the representative agent has maintained its place in economic theory: it is by no means easy to go beyond it and we should expect that someone without prior exposure to our approach will find the paper challenging; but certainly not beyond comprehension. The formal techniques used in this paper are limited to first-order differential equations and linear algebra; consistent with the mathematical tools employed in economics research today. The perspective of this approach, however, is decidedly not that of traditional economics as one would expect in a contribution to a Special Issue of *Economics* entitled Reconstructing Macroeconomics.

2. **"I think the main problem of the paper that is starts in the middle of a field hardly known to economists. The clearest signal of this misdirection is the great number of physics papers on the subject. Why should any economist know this literature before understanding the basic idea?"**

   The referee raises a point that might be relevant in a general submission to *Economics*, but not for a contribution to this Special Issue. The call for papers for this Special Issue reads "... We solicit papers that are intrinsically probabilistic, that is, based broadly on the principle of statistical physics. Key words such as power-law (Pareto-Zipf-Gibrat law), and econophysics may give you some idea." Thus, it cannot come as a surprise that submitted papers might deal with "a field hardly known to economists". As to the "great number of physics papers", papers based on the concepts of "statistical physics" and "econophysics" are going to have a large number of references from the physics literature both because of the need to cite the appropriate statistical physics references and because this literature is where econophysics research is largely published. This can hardly be considered misdirection in a Special Issue entitled Reconstructing Macroeconomics and based on the book of the same title that cites some

of these physics papers as well. There are 49 references in the bibliography of which 37 are from physics journals or physics books. Of these 37, 16 are econophysics papers; most focussed on the analysis of capital markets from an ultrametric (i.e. statistical mechanics) perspective. This leaves 21 references from physics journals or books that do not directly discuss economics. These "pure physics" references are from statistical physics; split between the formalism of linear response theory and of ultrametric trees. Our paper begins with material that should be accessible to econometricians and macroeconomists (cf. discussion of mathematical tools above). The references to non-econophysics work in the physics literature begins later in the paper in the section on linear response theory. This is needed because we are going beyond linear systems theory and econometric modeling approaches as currently practiced; in keeping with the theme of Reconstructing Macroeconomics. In the latter part of the paper the physics papers deal with the dynamics of ultrametric trees and, while these dynamics are discussed in the book *Reconstructing Macroeconomics*, they are both new to the economics profession and needed in the modeling of reconstructed macroeconomics.

There is indeed no reason why an economist should know this literature before understanding the basic idea. For further analysis, however, we have included a solid bibliography for use by the economics community.

3. **"I also have a simple question. While in physics, it is natural to work with continuous time, this is not so in economics. Note that it took a year for the NBER to decide that the latest recession started early 2008. Can you apply continuous time models under such circumstances?"**

   The referee raises a number of issues in this "simple question".

   First, we do not agree with the notion that is it is not natural for economists to work with continuous time in economics. Books such as Merton's *Continuous-Time Finance*, or Dixit and Pindyck's *Investment Under Uncertainty*, and papers such as Dornbusch's celebrated *Expectations and Exchange-Rate Dynamics* show that economists do work rather naturally with continuous time: indeed, papers on the Black-Scholes model using continuous time resulted in an Economics Nobel Prize for Merton and Scholes. Not to belabor the point, but the book *Reconstructing Macroeconomics* from which this Special Issue of *Economics*, in part, originated was written by two economists and uses continuous time.

   Second, the delay in the NBER's identification of a recession is a consequence of definition and measurement. As indicated in the NBER's statement on this recession: "A recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in production, employment, real income, and other indicators. A recession begins when the economy reaches a peak of activity and ends when the economy reaches its trough." Clearly the NBER will by definition not be able to identify a recession until "more than a few months" have passed and that, combined with the conflicting and occasionally restated signals that bear on the measurement of "significant decline" (discussed later in the NBER statement) explain

clearly why it took a year to identify the beginning of the recession. Indeed, viewing the problem of declaring the beginning of a recession as a problem of first crossing of a stochastic process of GDP, there is every reason to expect that a continuous-time stochastic process formulation may be appropriate.

Finally, the choice of model representation, like any tool, is largely one of convenience and proven explanatory power. We employed a continuous-time approach because it is used in economics and has been shown to solve a problem formally identical to the micro- to macro-economic aggregation problem.

4. **"I presume that the paper is valuable to specialists, I do not see the point to publish it in such a form to a wide audience."**

   We believe this paper to be of value beyond specialists: indeed, anyone with an interest in Reconstructing Macroeconomics using "statistical physics" and "econophysics" will likely expect papers of this type. Our approach is consistent with both the spirit and the letter of the call for papers and is, thus, appropriate for the Special Issue on Reconstructing Macroeconomics being prepared for *Economics*. Indeed, given that over 140 people have already downloaded this paper, there does appear to be strong interest among the wide audience of *Economics*.