Where Modern Macroeconomics Went Wrong

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Dynamic Stochastic General Equilibrium (DSGE) models, which have played such an important role in modern discussions of macroeconomics, in my judgment fail to serve the functions which a well-designed macroeconomic model should perform. The most important challenge facing any macro-model is to provide insights into the deep downturns that have occurred repeatedly and what should be done in response. It would, of course, be even better if we had models that could predict these crises. From a social perspective, whether the economy grows next year at 3.1% or 3.2% makes little difference. But crises, when GDP falls and unemployment increases, have large consequences for individual well-being now as well as for future growth. In particular, it is now well recognized that periods of extended economic weakness such as confronted by the US and Europe after 2008 have significant implications for future potential growth.[2] [3]

While the 2008 crisis, and the inability of the DSGE model to predict that crisis or to provide policy guidance on how to deal with the consequences, precipitated current dissatisfaction with the model, the failings are deeper: the DSGE model fails similarly in the context of other deep downturns.

The DSGE models fail in explaining these major downturns, including the source of the perturbation in the economy which gives rise to them, why shocks, which the system (in these models) should have been able to absorb, get amplified with such serious consequences, and

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[2] This implies that macro-econometrics should use a Bayesian loss function with a high weight in explaining/predicting deep downturns. This is markedly different from assessing models by looking at how well they match particular co-variances or moments. Practitioners of DSGE macro-econometrics claim to use Bayesian estimation approaches, by which they mean they include priors (e.g. concerning the values of certain parameters). I emphasize here another aspect: a loss function which puts high weight on being able to predict the events we care about. In terms of priors, the following discussion make clear that I find some of the priors embedded in the standard model less than persuasive.

[3] DSGE models are, of course, not really a model of medium to long term growth: that is determined by factors like the pace of innovation and the accumulation of human capital on which they provide little insight. To understand the former, for instance, one needs a much more detailed analysis of technological progress, including investments in basic research and the transmission of knowledge across and within firms than any standard macro-model can provide.

why they persist, i.e. why the economy does not quickly return to full employment, as one would have expected in an *equilibrium* model. These are not minor failings, but go to the root of the deficiencies in the model.[4]

What we seek from a "bench mark model" in macroeconomics is not always clear. Vines (written correspondence) suggests that we should be looking

> for a *simple* model which we could teach to graduate students to provide them with a less misleading framework on which to build whatever research project they are engaged.

Blanchard (2017) suggests:

> The models should capture what we believe are the macro-essential characteristics of the behavior of firms and people, and not try to capture all relevant dynamics. Only then can they serve their purpose, remain simple enough, and provide a platform for theoretical discussions.

Thus, a distinction is often made between the core DSGE model as a benchmark model and the variety of expanded models, which introduces a large number of complexities—more shocks than just technology shocks, friction--more frictions than just nominal wage and price rigidities.[5] To be sure, as many users of DSGE models have become aware of one or more of the weaknesses of these models, they have "broadened" the model, typically in an ad hoc manner.[6] There has ensued a Ptolemaic attempt to incorporate some feature or another that seems important that had previously been left out of the model. The result is that the models loose whatever elegance they might have had and claims that they are based on solid micro-foundations are weakened[7], as is confidence in the analyses of policies relying on them. The resulting complexity often makes it even more difficult to interpret what is really going on.

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[4] There are a myriad of versions of the DSGE model, and some versions may have attempted to address one or the other of the concerns I raise. I cannot in the confines of this short article explain why the purported remedies do not adequately address the problems.

[5] See Smets and Wouters (2003). They introduce a total of ten "shocks" : two "supply" shocks, a productivity and a labour supply shock… three "demand" shocks (a preference shock, a shock to the investment adjustment cost function, and a government consumption shock), three "cost-push" shocks (… to the mark-up in the goods and labour markets and …to the required risk premium on capital) and two "monetary policy" shocks and multiple frictions, including "external habit formation in consumption," a "cost of adjusting the capital stock" and "partial indexation of the prices and wages that cannot be re-optimised."

[6] Thus, the Smets-Wouters model introduces individual heterogeneity, but everyone has the same preferences, there are no capitalists or workers, and accordingly no differences in marginal propensities to consume. In this context, redistributions have no effect on aggregate demand. Below, we argue that redistributions may matter.

[7] A claim that is already stretched when it comes to the use of an aggregate production function (see below) and the derivation of the demand for money. There are, of course, assumptions that *seem* to provide micro-foundations, e.g. the derivation of the demand for money based on the assumption that there is a "cash in advance" requirement. But credit, not cash, or money as it is usually defined, is typically required. See Greenwald and Stiglitz (2003). Many models embrace a "cop-out," putting money into the utility function. Later, I will explain

And with so many parameters, macro-econometrics becomes little more than an exercise in curve fitting, with an arbitrarily chosen set of moments generated by the model contrasted with reality. Standard statistical standards are shunted aside. Korinek (2017) provides a devastating critique:

> First, the time series employed are typically detrended using methods such as the HP filter to focus the analysis on stationary fluctuations at business cycle frequencies. Although this is useful in some applications, it risks throwing the baby out with the bathwater as many important macroeconomic phenomena are non-stationary or occur at lower frequencies. An example of particular relevance in recent years are the growth effects of financial crises.
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> Second, for given detrended time series, the set of moments chosen to evaluate the model and compare it to the data is largely arbitrary – there is no strong scientific basis for one particular set of moments over another. The macro profession has developed certain conventions, focusing largely on second moments, i.e. variances and covariances. However, this is problematic for some of the most important macroeconomic events, such as financial crises, which are not well captured by second moments. Financial crises are rare tail events that introduce a lot of skewness and fat tails into time series. As a result, a good model of financial crises may well distinguish itself by not matching the traditional second moments used to evaluate regular business cycle models, which are driven by a different set of shocks. In such instances, the criterion of matching traditional moments may even be a dangerous guide for how useful a model is for the real world. For example, matching the variance of output during the 2000s does not generally imply that a model is a good description of output dynamics over the decade.
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> Third, for a given set of moments, there is no well-defined statistic to measure the goodness of fit of a DSGE model or to establish what constitutes an improvement in such a framework. Whether the moments generated by the model satisfactorily match the moments observed in the real world is often determined by an eyeball comparison and is largely at the discretion of the reader. The scientific rigor of this method is questionable.
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> Fourth… frequently impose a number of restrictions that are in direct conflict with micro evidence. If a model has been rejected along some dimensions, then a statistic that measures the goodness-of-fit along other dimensions is meaningless.

why one can't rely for policy analyses on results derived from these "toy" models, or models embracing such ad hoc assumptions.

He concludes, in what must be considered an understatement, that "the scientific rigor" of this methodology is "questionable."[8]

Sometimes, too, a distinction is made between a "policy model," giving practical advice on what to do in different circumstances, and a model with sound theoretical underpinnings. Thus, the standard Keynesian model might (it could be argued) be good enough for telling us whether and how to stimulate the economy, but the fact that its underlying equations are not micro-founded makes it theoretically unacceptable; for good theory, we have to turn to DSGE models. These distinctions are, I think, wrong on two accounts. First, as I explain below, I believe the core DSGE models is not good theory: good theory is based on how firms and households actually behave and markets actually work.[9] If credit availability is more important than interest rates, then a model which assumes that there is no credit rationing is bad theory. In the crisis, banks couldn't get access to funds; they were liquidity constrained. Such constraints are not consistent with the underlying DSGE model. And secondly, the reason for having a model derived with micro-foundations is that a policy change *could* change certain aspects of previously observed reduced form relationship. One has to have a theory to ascertain whether it would. Good policy requires an understanding of the underlying determinants of behavior.

So too, *short term* policy involves short term forecasting. As Chairman of the Council of Economic Advisers—established by the US Congress to help ensure that the economy remain at full employment through appropriate macroeconomic interventions—under President Clinton, I had the responsibility for overseeing our forecasts, which were also used in budgetary projections. Though it was before the development of the current generation of DSGE models, many of the considerations upon which we focused are excluded from the standard models. We were, for instance, concerned with changes in expectations. But analyses of expectations were (correctly, in my view) not based on what those might be if it were assumed that individuals had rational expectations, or acted as if they did, but on survey data of what expectations are and have been.[10]

So too, we were concerned with changes in consumption. The determination of consumption is, clearly, a key aspect of any good macro-model. But it is clear that in the short to medium

[8] I should emphasize: empirical tests should not be limited to standard statistics. On average, black holes don't exist. They are rare events, but their existence plays a crucial role in confirming the theory. They would not be uncovered through a standard regression. A single experiment (observation) was enough to largely confirm Einstein's relativity theory.

[9] Thus, what is sometimes meant by providing micro-foundations is providing foundations based on a particular model of human behavior, rational individuals with perfect information operating in competitive markets, a model which has been widely discredited. Note that in the micro-foundation jihadist view, an analysis of a giraffe's behavior could not include the *assumption* that it had a long neck, because we cannot explain either why it has a long neck or how it can survive, given that it has a long neck (assuming that standard models of circulatory systems could not explain how blood could be pumped that high).

[10] Moreover, these surveys show that different groups in the population have distinctly different beliefs (expectations), inconsistent with assumptions of rational expectations and common knowledge. See e.g. Jonung (1981), Jonung and Laidler (1988) and Bruine de Bruin *et. al.* (2010).

term, the shifts in household savings rates are little related to the considerations on which the intertemporal utility maximization of a representative agent focuses. That model cannot provide accurate predictions of such changes, identifying either shifts in preferences or technology, or even of expectations (especially if those are supposed to be "rational") that give rise to changes in consumption.[11]

Nor has the DSGE model been useful for policy design, e.g. the best way to "deliver" a tax cut. Behavioral economics has provided I believe a persuasive case that savings behavior is subject to nudges, in ways that are inconsistent with the standard model. [12] Importantly, differences in responses to the US tax cuts of 2008 and 2009 have more to do with behavioral economics than the determinants of savings behavior incorporated into DSGE models.[13]

But DSGE models seem to take it as a religious tenet that consumption should be explained by a model of a representative agent maximizing his utility over an infinite lifetime *without* borrowing constraints.[14] Doing so is called *micro-founding* the model. But economics is a behavioral science. If Keynes was right that individuals saved a constant fraction of their income, an aggregate model based on that assumption *is* micro-founded. Of course, the economy consists of individuals who are different, but all of whom have a finite life and most of whom are credit constrained, and who do adjust their consumption behavior, if slowly, in response to changes in their economic environment. Thus, we also know that individuals do not save a constant fraction of their income, come what may. So *both* stories, the DSGE and the old-fashioned Keynesian, are simplifications. When they are incorporated into a simple macro-model, one is saying the economy acts *as if*….And then the question is, which provides a better description; a better set of prescriptions; and a better basis for future elaboration of the model. The answer is not obvious. The criticism of DSGE is thus not that it involves simplification: all models do. It is that it has made the wrong modelling choices, choosing complexity in areas where the core story of macroeconomic fluctuations could be told using simpler hypotheses, but simplifying in areas where much of the macroeconomic action takes place.

The complexities of the DSGE model require drastic simplifications: to analyze the model strong parameterizations are required. We know that the parameterizations used in the DSGE

[11] Of course, ex post, one can sometimes interpret changes in consumption *as if* there were a change in intertemporal preferences. The theory of consumer behavior is meaningful, however, only if preferences are stable or change in predictable ways.

[12] See Camerer, Loewenstein and Rabin (2011) and the discussion of behavioral economics and savings in the context of macroeconomics. There is ample evidence that individuals' retirement savings cannot be explained within the standard model. See Hamermesh (1984) and Banks, Blundell and Tanner (1998).

[13] See Parker, Souleles, Johnson and McClelland (2013).

[14] The fact that these constraints markedly change savings behavior has been long recognized. See, e.g. Newbery and Stiglitz (1982). Deaton (1991), Aiyagari (1993), Carroll (1992, 1997, 2001) provide empirical support. A major criticism of standard DSGE models provided by Hendry and Muelbauer (forthcoming) is that they assume that they ignore these constraints and assume "cash and other liquid assets, stock market and pension wealth minus household debt, and housing wealth as equally spendable."

models (e.g. constant elasticity utility functions[15]) yield predictions that can easily be rejected (e.g. all individuals have exactly the same portfolio of risky assets, homothetic preferences—unitary income elasticities for all goods and unitary wealth elasticities for all assets.[16]) To make matters worse, even with all the implausible parameterizations, the large DSGE models that account for some of the more realistic features of the macroeconomy can only be "solved" for linear approximations and small shocks—precluding the big shocks that take us far away from the domain over which the linear approximation has validity.

The core of the failing: the wrong micro-foundations

The core of the failings of the DSGE model can be traced to the attempt, decades ago, to reconcile macroeconomics with micro-economics. There were two approaches. The first was taken by real business cycle theory and its descendants, DSGE, which attempted to reformulate macroeconomics by taking the micro-foundations of a simplified version of the competitive equilibrium model—just as that model was being discredited by advances in behavioral economics, game theory, and the economics of information. That strand attempted to explain unemployment and other deviations from predictions of the standard competitive model by looking for the minimal change in that model—assuming (typically nominal) price and wage rigidities.

The second strand (see, for example, Bernanke and Gertler. (1989), Kiyotaki and Moore (1997), Greenwald and Stiglitz, 1987, 1988a, 1998b, 1993a, 1993b, 2003) and the references cited there), only entering into the mainstream in the aftermath of the Great Recession, attempted to bring together *modern* micro with macro, incorporating one or more of the ways in which actual markets are far from perfect ("market failures")—besides the possibility of nominal wage and price rigidities, to which they gave a different interpretation and explanation.[17] In doing so, this strand resurrected a quite different strand of Keynesian economics than the Hicksian interpretation based on wage and price rigidity, that of Irving Fisher (1933), with his emphasis on the consequences of flexibility and debt-deflation. The departures from the standard competitive equilibrium model which play a critical role in these models include incomplete contracts and capital market imperfections, including those

[15] It is never made clear why we should feel better about a model that assume a constant elasticity of marginal utility than a model that assumes a constant savings rate.

[16] This is true if there is more than one good or more than one asset—and clearly, "good theory" has to be consistent with that being the case. See Stiglitz (1969). Our toy models shouldn't break down when we move from one good to two goods. See the discussion below.

[17] Indeed, information economics had identified the possibility of real rigidities—in competitive equilibrium, real wages and interest rates could be set at levels at which markets do not clear. Risk aversion and instrument uncertainty provide an explanation for slow adjustments. See Greenwald and Stiglitz (1989). More recently, Fajgelbaum and Tascheral-Dumouchel (2017) have provided a simple general model in which information flows more slowly during recessions, and so uncertainty is higher and persists.

associated with imperfect information, incomplete risk markets[18] and market irrationalities. (Minsky (1986) was particularly influential in the latter.) It is perhaps worth noting that policymakers in recent downturns—in Japan, Europe, and even the US—have been focused on deflation, on the possibility that prices might fall, not on price rigidities.[19]

In the discussion below, I shall illustrate the inadequacies of the DSGE framework by focusing on the 2008 crisis. Some advocates of DSGE models say these models were not meant to address "once in a hundred year floods." There are several responses to this defense. The first is by way of analogy: what would one think of a medical doctor who, when a patient comes with a serious disease, responded by saying, "I am sorry, but I only deal with colds."

The second is that not only didn't the model fail to predict the crisis; it effectively said that it couldn't happen. Under the core hypotheses (rational expectation, exogenous shocks), a crisis of that form and magnitude simply couldn't occur.

Crises bring out into the open deficiencies in the model that are not so apparent in our smaller and more frequent fluctuations. I believe that most of the core constituents of the DSGE model are flawed—sufficiently badly flawed that they do not provide even a good starting point for constructing a good macroeconomic model. These include (a) the theory of consumption; (b) the theory of expectations—rational expectations and common knowledge; (c) the theory of investment; (d) the use of the representative agent model (and the simple extensions to incorporate heterogeneity that so far have found favor in the literature): distribution matters; (e) the theory of financial markets and money; (f) aggregation—excessive aggregation hides much that is of first order macroeconomic significance; (g) shocks—the sources of perturbation to the economy and (h) the theory of adjustment to shocks—including hypotheses about the speed of and mechanism for adjustment to equilibrium or about out of equilibrium behavior. I cannot review in detail all of these and other failings—such as the failure to include crucial institutional details—in this brief note, and so I will be selective, highlighting a few as examples of more general problems. Many of these are related. For instance, the presence of imperfect and asymmetric information leads to credit and equity rationing. Thus, individuals in maximizing their lifetime utility have to take into account credit constraints, and as we have already noted, this gives rise to a markedly different problem than that analyzed in the standard DSGE model. One of the reasons that the representative agent model doesn't work well is that some individuals are credit constrained, others are not. Moreover, numerous studies (see e.g. Kim, Setterfield and Mei, 2014; Mian and Suffi, 2015, Drehmann, Juselius and Korinek,2017) have emphasized the importance of debt for aggregative behavior; but in a representative agent model, debt (held domestically) nets out, and therefore should have no

[18] The contrast with the Smets-Wouters (2003) model is clear: they assume a complete set of state-contingent securities insuring households against variations in their income.

[19] Greenwald and Stiglitz show that there will be real consequences to unexpected *disinflation,* including through real balance effects. They show that this will be so, whether the resulting redistributive effects are between bank lenders and firms or amongst firms.

role.[20] At least at times, short run to medium term macroeconomic analysis needs to pay careful attention to debt and real debt-dynamics. And here, institutional details can matter. The shift from 30 year fixed rate mortgages to variable rate mortgages with shorter terms—played an important role, especially when combined with expectations that were not fully rational and credit constraints: when house prices didn't increase as expected (and it should have been clear that they couldn't increase forever at those rates) and homeowners faced constraints in refinancing, the bubble broke, and the crisis ensued.[21]

As I noted earlier, my approach and that of DSGE models begins with the same starting point: the competitive equilibrium model of Arrow and Debreu. It is clear that that model cannot explain many aspects of the economy, *including* macroeconomic fluctuations. DSGE models begin with the question, what is the minimum deviation from that model required to match macroeconomic behavior *interpreted largely as matching moments*; their first answer was price and wage rigidities, with unanticipated and not fully insured technology shocks. When that failed to do an adequate job, they add multiple shocks and distortions, in a fairly ad hoc way. Standards for what was meant by "micro-founding" were similarly ad hoc: putting money into a utility function "explains" money holdings, but informs us nothing about what happens if, for instance, credit availability changes or the probability distribution of monetary emissions changes as a result of a change in monetary policy.[22]

Explaining Deep Downturns

The approach that I am advocating begins by ascertaining which of the advances in modern micro-economics are most relevant for understanding the fundamental questions of macroeconomic fluctuations—the source of the shocks; amplification—why seemingly small or moderate shocks can have such large effects on macroeconomic variables and individual well-being; and persistence—why the effects of the shocks persist, with say high levels of unemployment long after the initial shock. The interpretation of these deep downturns should translate into policy, explaining, for instance, why government expenditure multipliers may be quite large (consistent with the earlier amplification analysis) and why monetary policy may be relatively ineffective. In this analysis, information imperfections and asymmetries and behavioral economics often play a central role, as do institutions and distributional effects. As I argue below, for instance, the ineffectiveness of monetary policy is not really attributable to

[20] The introduction of corporations, with corporate debt owed to households (discussed later), does not address the issues raised here, focusing on *household debt.*

[21] This part of the story of the 2008 crisis is now well accepted. See Stiglitz 2010b, 2010c and Financial Crisis Inquiry Commission, 2011.

[22] The former might affect the transactions demand for money (credit, not money, is used in most transactions, as noted by Greenwald and Stiglitz 2003a); the latter affects the demand for money as a store of value. See, e.g. Tobin (1958), the critique of the portfolio separation theorem (Cass-Stiglitz, 1970), and the implications for monetary and macro-theory (Stiglitz, forthcoming).

the zero lower bound but to the behavior of banks, the central institution in providing credit to all but the largest firms.[23]

Because the 2008 crisis was a *financial* crisis the standard DSGE models are particularly poorly designed to analyze its origins and evolution: The central problems of finance—bankruptcy, debt, and asymmetric information—simply cannot arise in a representative agent model.[24] Who is supposed to lend to whom? And only if the representative agent is suffering from acute schizophrenia can there be issues of information asymmetries, and it is hard to reconcile such schizophrenia with the usual assumptions concerning rationality.

Some DSGE models (e.g. Smets and Wouters (2003)) try to introduce rudimentary finance through having a corporate and a household sector. But the 2008 crisis can't be explained within that model: it was some households borrowing from others that gave rise to the crisis. Besides with a representative agent, with or without firms, finance would always be provided in the form of equity—so there still wouldn't be bankruptcies and debt crises.[25]

The Shocks

The critique of the DSGE models relevance for deep downturns in general and the 2008 crisis in particular begins with the source of the crisis itself. For instance, in (most) DSGE models, downturns are caused by an exogenous technology shock. In agriculture, we know what a negative technology shock means—bad weather or a plague of locusts. But what does that mean in a modern industrial economy—an Alzheimer's epidemic?[26]

[23] My argument corresponds closely to that of Hendry and Mulbauer (forthcoming), who note that "A major problem with the claim of 'theory consistency' is the question of `which theory?' For example, text-book theory, which assumes efficient and close-to-complete markets, well-informed relatively homogeneous agents, little uncertainty, no credit or liquidity constraints, and a stable economy, contrasts with theory that takes account of the asymmetric information revolution of the 1970s and early 1980s associated with Nobel prize winners Stiglitz, Akerlof and Spence. Relevant theory must incorporate credit and liquidity constraints, incomplete markets with incomplete insurance and high levels of individual and macro uncertainty."

[24] The Congressional inquiry into the 2008 crisis called itself the Financial Crisis Inquiry Commission and focused on aspects of the financial sector like credit rating agencies and the role of CDS's, derivatives, and other complex financial instruments. The standard DSGE models have nothing to say about either of these: these are failings related to its inadequate treatment of the financial sector.

[25] There are further criticisms of their particular formulation: with a corporate sector, wealth would have to include the capitalized value of future dividends (they ignore this aspect of wealth). Recent research in macroeconomics has focused on variations in the value of corporations relative to the value of their capital goods, as a result of changes, e.g. in tax laws and market power. See, for instance, Gonzales (2016, 2017) and Stiglitz (2015).

[26] Conceptually, there can be a shock to (beliefs about) the total supply of a critical natural resource—with a belief that, for instance, there was a large supply of oil underneath Saudi Arabia being disappointed. While the oil crises of the 1970s were a result of an oil shock, it was politics, not a technology shock of the kind incorporated in DSGE models.

By contrast the shocks giving rise to economic fluctuations in many, if not most cases, is clearly endogenous.[27] The 2008 shock was endogenous, caused by the breaking of the housing bubble—something that markets created, and to which misguided policies may have contributed.[28] And to the extent that there are exogenous shocks, the extent to which firms and households are exposed to those shocks is endogenous, affected by the structure of the market.

Finance: Preventing excessive risks and designing stable systems

The central problem in crisis prevention today centers around preventing the financial sector from undertaking excessive risks and ensuring the stability of the financial system. Policy makers recognize that some of the most important shocks to the economy can come from the financial sector.

In standard models, the money demand equation is supposed to summarize all that is relevant for finance; and indeed, not even that is very relevant—all that matters is that somehow the central bank is able to control the interest rate. [29] But the interest rate for T-bills is not the interest rate confronting households and firms; the spread between the two is a critical *endogenous* variable[30]. While large firms may turn to capital markets, SMEs rely on the banking system. Under current arrangements, the links between aggregate credit creation and the levers controlled by the regulatory authorities, including the central bank, are tenuous and variable. Importantly, among the most important levers are regulations that have typically not been included within the ambit of macroeconomic analysis.[31]

Moreover, finance and the structure of the financial system matters for stability. Understanding the structures that are most conducive to stability, and the central trade-offs (e.g. between the ability to withstand small and large shocks) represents one of the areas of

[27] E.g. inventory fluctuations. Later, we note that the economy is best described as adjusting to shocks through a decentralized process of wage and price adjustments. Such adjustment processes themselves may give rise to economic fluctuations. See, e.g. Stiglitz (2016).

The one exception to the view just expressed, that shocks are endogenous, relates to open emerging economies, where there is some evidence that many, if not most, come from abroad. But here too, the DSGE models fail. The economy's exposure to exogenous risks is endogenous. The "rules of engagement," e.g. the rules governing capital market liberalization, determine the extent to which a country is affected by shocks occurring elsewhere. See Ocampo and Stiglitz, 2008 and Stiglitz 2010a, 2010b.

[28] See e.g. Bernanke (2009), Demyanyk and Hemert (2009), Sowell (2009) and Mian and Sufi (2015).

[29] This hypothesis can be directly tested, and rejected. See Fama (2013).

[30] This is one of the central points in Greenwald and Stiglitz (2003), who develop a simple model of banking in which the spread is determined. The importance of this spread has been noted in other papers in this issue. See, e.g. Vines and Willis (forthcoming). Gilchrist and Zakrajsek (2012) shows that the spread has a predictive power on economic activity.

[31] And again, these levers are typically left out of the standard DSGE model, even though they may be far more effective. The point is simple: if banks are constrained in their lending by capital adequacy or liquidity constraints, changes in those constraints can have large effects, far greater than those generated by the "substitution effects" that arise as returns to T-bills and loans changes. See Greenwald and Stiglitz (2003). Changes in these rules was part of the policy strategy that helped the economy emerge from the 1991-1992 recession. Stiglitz (2003).

important advances since the crisis.[32] These were questions not even posed within the DSGE framework—could not be posed because they do not arise in the absence of a well specified financial sector, and would not arise within a model with a representative financial institution.

One of the key reasons that representative agent models fail in enhancing understanding of macro-fluctuations is the pervasiveness of macroeconomic externalities—the actions of each agent (in the aggregate) has macroeconomic consequences which they do not take into account. These externalities help us understand why markets, on their own may be excessively fragile and excessively exposed to risks. Such macroeconomic externalities do not arise in real business cycle models, and only to a limited extent in standard DSGE models. In the presence of incomplete risk markets and imperfect and asymmetric information, pecuniary externalities matter, and the market equilibrium is in general not Pareto efficient. (Greenwald and Stiglitz, 1986, Geanakoplos and Polemaarchakis, 1986.) Corporations may, for instance, undertake excessive debt (in open economies, excessive dollar denominated debt), implying that in a downturn, there may be fire sales, with the resulting decrease in prices having balance sheet effects, amplifying the downturn (see the next section).[33] Banks engage in contracts with each other that may be individually rational, but result in greater systemic risk, particularly in the face of a large shock.[34] Real business cycle models are structured so that these macroeconomic externalities don't arise, and so markets are always efficient, even in their response to shocks; and in the new Keynesian models with rigid wages and prices that are their successors, they arise only to a limited extent.[35] By contrast, they are at the center of the alternative models for which we are arguing in this paper, and help explain the significant deviations from efficient outcomes.

In the standard model, issues of systemic risk simply do not arise. The focus was on inflation, as if excessive inflation was the major threat to economic stability. That has not been the case for a third of a century; but the problems posed by financial instability have been recurrent.

One particularly important implication of the kind of models for which I am arguing here, in contrast to the standard DSGE models, is that in the presence of bankruptcy costs, excessive diversification (capital market integration) may result in shocks being amplified, rather than dampened and dissipated—as assumed by the Federal Reserve and predicted by the standard

[32] While some work had begun in this area before the crisis (see Allen and Gale, 2000, Greenwald and Stiglitz (2003), and Gallegati, Greenwald, Richiardi and Stiglitz (2008), the crisis itself provided enormous impetus to research in this area: See Stiglitz (2010a,d), Gai and Kapadia (2011), Acemoglu, Ozdaglar and Tahbaz-Salehi (2016), Allen, Babus, and Carletti (2010), Battiston, Gallegati, Greenwald, and Stiglitz (2012) Roitman, Korinek, and Végh (2010) and Battiston, Caldarelli, May, Roukny, and Stiglitz (2016). Complexity in financial structures may make it even impossible to ascertain whether a system is systemically stable. See Battiston, Roukny and Stiglitz (2017).

[33] See Korinek (2010, 2011a, b, 2012), Jeanne and Korinek (2011) and Davila and Korinek (2017). Shleifer and Vishny (2011) provide a partial review of firesale models.

[34] See, for instance, chapter 7 of Greenwald and Stiglitz (2003) and De Masi et al (2009).

[35] See Farhi and Werning (2016).

models.[36] Indeed, policy discourse based on assumptions underlying DSGE models had a kind of incoherence: before a crisis, the conventional wisdom called for diversification—as much as possible, e.g. through securitization and financial linkages/risk sharing. After the onset of a crisis, discourse at turned to contagion. The word itself, borrowed from epidemiology, suggest the opposite of diversification: Were a 100 individuals with Ebola to arrive in New York, no one would recommend a policy if diversification, sending two to each state. Contagion arises *because* of such linkages. Unless one has succeeded in eliminating the prospect of future crises, the design of an economic system has to take into account the functioning of the system both before and after a crisis, balancing the benefits of linkages before and the costs afterwards. The conventional wisdom never did that. This is not a minor failing, but a major one.

Amplification and persistence

Beyond explaining the origins of shocks and the extent to which economies get exposed to shocks, an adequate macro-model needs to explain how even a moderate shock has large macroeconomic consequences. One of the key failures in the 2008 crisis was the prediction that even a large sub-prime crisis would not have large economic consequences because the risks had been diversified. Within the DSGE frame that was being used at the time by key policymakers, this was a natural conclusion. Other models, however, had predicted otherwise, focusing on important amplifiers within the economy—and indeed, some of these became part of the standard "explanations" of the crisis.

One source of amplification are "balance sheet effects," the contraction in production and investment that arises when firms suffer a shock to their balance sheet. Providing micro-foundations for balance sheet effects requires an analysis of why firms can't replace the lost equity with new equity, i.e. an explanation of equity rationing. (See, e.g. Greenwald, Stiglitz, and Weiss, 1984.) Modern information based finance provides such a theory, and these ideas have already been integrated into simple theoretical and applied macro-models, in models in which firms' supply and demand decisions are a function of their balance sheets. (See Greenwald and Stiglitz, 1993b and Koo, 2008.)[37] Greenwald and Stiglitz show, for instance, how a price shock (resulting from say a shock to demand for the product) gets amplified through the

[36] See, for instance, Bernanke's remarks concerning the risk posed by the collapse of the sub-prime market (See Bernanke, 2009). Bankruptcy costs introduce a non-convexity in the analysis—suggesting a fundamental way in which the mathematics of DSGE models would have to be altered. Recent models with financial linkages and bankruptcy costs have shown that dense networks, with many linkages, while better able to handle small and uncorrelated shocks, perform more poorly in response to large shocks.

For analyses of optimal diversification, see, e.g. Stiglitz (2010a,d) and Battiston *et al* (2012a, b).

[37] One implication of equity constrained firms is that firms will act in a risk averse manner—behavior which is markedly different from that assumed in the standard DSGE models. See Greenwald and Stiglitz (1990, 2003).

An important implication of GS (1993b) is that aggregate behavior is not just a function of *averages*, e.g. a shock that increases the balance sheet of some firms (oil exporters) but decreases that of other firms (oil importers) in the same amount will have an adverse effect on aggregate demand and supply. Empirically, it should be possible to incorporate this effect, at least partially.

firm's subsequent decisions on how much to produce, how much labor to hire, and how much to invest.

The effects are amplified still further if there is credit rationing. Not only is there a well-developed theory of credit rationing (e. g. Stiglitz and Weiss, 1981), Calomiris and Hubbard (1989) among others has shown that these constraints are binding in important sectors of the economy, and it appears that they are particularly relevant in those sectors subject to large fluctuations in investment. This played out strongly in the evolution of the 2008 crisis, where by 2010, large firms seemed to be sitting on a couple trillion dollars of cash, while small and medium sized firms remained credit constrained.

At the center of the modern theory of credit rationing, as observed at the macro-level, are banks—a critical institution which was missing from DSGE models, a particularly peculiar omission because without banks, there presumably would be no central banks (CB), and it is the CB's conduct of monetary policy that is central in those models. The fact that credit is allocated by institutions, banks, rather than through conventional markets (auctions) is an important distinction lost in the DSGE framework. Greenwald and Stiglitz (2003) model banks as firms, which take others' capital, in combination with their own, obtaining and processing information, making decisions about which loans to make. They too are by and large equity constrained, but in addition face a large number of regulatory constraints. Shocks to their balance sheet, changes in the available set of loans and their expectations about returns, and alterations in regulations lead to large changes in loan supply and the terms at which loans are made available. Variations in regulations and circumstances of banks across states in the US is helping validate the importance of variation in the supply conditions in banking in the 2008 crisis and its aftermath.[38]

Given how long it takes balance sheets to be restored when confronted with a shock of the size of that of 2008, it is not surprising that the effects persisted.[39] But they seem to have persisted even after bank and firm balance sheets have been restored. That suggests that this crisis (like the Great Depression) is more than a balance sheet crisis. It is part of a structural transformation, in the advanced countries, the most notable aspects of which are a shift from manufacturing to a service sector economy and an outsourcing of unskilled production to emerging markets; for developing countries, the structural transformation involves industrialization and globalization. Not surprisingly, such structural transformations have large macroeconomic consequences and are an essential part of growth processes. DSGE models are particularly unsuited to address their implications for several reasons: (a) the assumption of

[38] Hamid Rashid in some recent unpublished analyses has been able to demonstrate this.

[39] Rogoff and Reinhardt (2009) emphasize that financial crises tend to be long and persistent. But when the economy experiences a deep real shock, it is inevitable that *eventually* there will be consequences for the financial sector, including banking. The stock market crash of 1929 didn't turn into a full scale banking crisis until several years later. Italy's current banking crisis is the *result* of its prolonged stagnation. If financial crisis are large the result of deep and prolonged real shocks, then the statement that economic crises associated with financial crises are long lasting says nothing more than deep and prolonged crises and deep and prolonged.

rational expectations, and even more importantly, common knowledge, might be relevant in the context of understanding fluctuations and growth in an agricultural environment with well-defined weather shocks described by a stationary distribution[40], it cannot describe changes, like these, that happen rarely[41]; (b) studying these changes requires at least a two sector model; and (c) a key market failure is the free mobility of resources, especially labor, across sectors. Again, simple models have been constructed investigating how structural transformation can lead to a persistent high level of unemployment, and how even then, standard Keynesian policies can restore full employment, but by contrast, increasing wage flexibility can increase unemployment. (See Delli Gatti *et al* 2012a, 2012b)

Adjustment and equilibrium

One of the reasons that downturns with high levels of unemployment persist relates to the process of adjustment.[42] DSGE models don't address that issue: they simply *assume* that the economy jumps to the new equilibrium path.[43] Though in a model with a single individual, solving for the value of current values of wages and prices which ensures that the transversality condition is satisfied is conceptually clear (the super smart individual simply thinks through the consequences of choosing any other set of current wages and prices), it is not apparent how that is to be done in the context of a world without common knowledge. If there were a full set of markets extending infinitely far into the future, the problem I described would not occur. But there are not—this is one of the key market failures.[44] That the consequences could be "resolved" by the existence of a representative agent provides no insight into how the absence of these markets are addressed in the actual world. Indeed, this problem arises even if the only differences among individuals is their date of birth; with overlapping generations, and at least some individuals not behaving as if there is a dynastic utility function extending over infinity,

[40] With global warming, even the assumption that variations in weather are described by a stationary distribution is clearly not correct.

[41] Knight (1921) distinguished between risk and uncertainty. The standard model with rational expectations models risk. Here, there is fundamental uncertainty.

[42] As we have noted, empirical DSGE models have introduced a large number of factors to smooth out behavior, e.g. costs of adjustment in investment and habit formation in consumption. Many of these prolong booms, but some should have the effect of shortening the downturn.

[43] If, of course, there are costs of adjustment, the size of the jump may be affected by the structure and magnitude of those costs.

My critique here parallels that of Hendry and Mulbauer (this issue) who noted… "the notion that the economy follows a stable long-run trend is highly questionable, despite heroic attempts by policy makers to stabilize the path." My critique goes further: DSGE models assume that even without government intervention, the economy is on the (unique) convergent path. Hendry and Mulbaeur go on to argue that "… the world is always in disequilibrium: economies are wide-sense non-stationary from evolution and sudden, often unanticipated, shifts both affecting key variables directly and many more as a consequence. The assumption made in the business-cycle accounting framework …that the economy is never very far from its steady-state trend, assumes that financial crises can never occur—despite the historical evidence—and ignores the shock amplifying, propagating and potentially destabilizing processes in the financial accelerator."

[44] Discussed long ago by Hahn (1966). See also Shell and Stiglitz (1967).

there can not only exist sunspot equilibrium (Cass and Shell, 1983), but there can be an infinity of paths consistent with rational expectations. (See Hirano and Stiglitz, 2017.)

Indeed, there is a disparity between that analysis, instantaneous adjustment to a new equilibrium, and what actually happens—and what most policy economists assume. There is a decentralized process of wage and price adjustment, with wages and prices in each market responding to the tightness in that market (in the labor market, that is the simple Phillips' curve, asserting that wages rise when labor markets become tight.) Obviously, adjustments processes may be more complicated in a macroeconomic environment with inflation, where nominal adjustments would be expected to take into account inflationary expectations.

In the short run, such adjustment processes may be disequilibrating: the fall in wages as a result of unemployment may result in a decrease in aggregate demand, increasing the level of unemployment. This is especially true (an implicit assumption in Keynes, an explicit assumption in Kaldor (1957) and Pasinetti (1962)) if the marginal propensity to consume (MPC) differs across groups; the lowering of wages shifts income towards profits, and capitalists' MPC is lower than that of workers.

What matters is, of course, real wages, and that depends on the adjustment of wages relative to prices. (See Solow and Stiglitz, 1968.) Wages and prices may both be falling, at the same rate, resulting in *real wages being constant,* a kind of real wage rigidity. The increase in real balances (real value of money holdings) would normally be expected to increase spending, but this effect is relatively small, so that the unemployment equilibrium could still persist for a long time. Moreover, the deflation itself has a depressing effect, since it increases the real interest rate (holding everything else constant.) In addition, if, as assumed in the previous paragraph, different groups in the economy have different MPC's, the (unexpected) deflation[45] redistributes income from debtors to creditors, and this depresses aggregate consumption even more (See Eggertsson and Krugman (QJE 2012) and Korinek and Simsek (AER 2016).) (Even more so, in an open economy, where the creditor is abroad: it is akin to a transfer of income to foreigners, with especially great effect then on demand for non-traded goods.)[46] Similarly, these adjustments of prices have balance sheet effects of the kind already discussed, with large macroeconomic consequences.

Financial Frictions

Not surprisingly, in the aftermath of the 2008 *financial crisis* there is a growing consensus that at least one critical failing of the standard model is its (non-)treatment of the financial sector.[47] Financial frictions, as they have come to be called, are important. These include credit and equity rationing and the corollary importance of collateral constraints and the importance of banks, to all of which I already referred. There are, of course, a variety of information and

[45] i.e. not incorporated into an adjustment in the interest rate charged. This particular effect would not arise if debt contracts were fully indexed, but arises whenever there is unexpected disinflation.
[46] There can also be balance sheet effects (financial accelerator), as described earlier.
[47] See Vines and Wills, this issue.

enforcement problems that can give rise to financial frictions. Those that might provide the simplest textbook treatment—showing their potential importance—may not be the most important. This may matter, because they may differ in their policy consequences. (In particular, theories based on costly enforcement (e.g. Eaton and Gersovitz, 1981) or costly state verification (Townsend, 1979) differ markedly from those based on adverse selection and incentives, noted earlier. Similarly, though important macroeconomic externalities may arise in any of these models (e.g. with incentive compatibility, self-selection, or collateral constraints), and typically, the latter are easiest to analyze, that is partly because the constraint is not adequately endogenized.[48]

Still, for purposes of a simple benchmark model, it may be far better to incorporate *some* financial frictions than to ignore them altogether. Indeed, the core teaching model for macroeconomics that I use entails a three period model, this period, the next, and a valuation function summarizing the future beyond tomorrow, with value maximizing firms facing equity constraints (in the short run, they can't raise equity), and a rising cost of borrowing (reflecting a higher leverage and an increasing expected value of bankruptcy), with a standard production function, and two classes of households, workers who consume their income and capitalists who maximize their three period utility function with borrowing constraints. Wages are determined by an expanded Phillips curve. The central bank sets the T-bill rate, and the loan curve is a function of that rate and the state of the economy. An adverse shock shifts the loan curve up (i.e. at any level of borrowing, the representative firm has to pay a higher interest rate.) The model can then be expanded, depending on the question being posed. If one is focusing on monetary policy, one has to add a banking sector. If one is focusing on distribution, one has to add a third group of individuals, life-cycle savers.

Policy

One of the main reasons we want a good, benchmark model is for policy. As we have already noted, short run forecasting models, even when they conceptually begin within a DSGE framework, add in a variety of variables to increase forecasting accuracy. Having a model which matches moments says little about forecasting accuracy. Especially when there is a deep downturn, governments want to do something. Models constructed for analyzing small fluctuations are likely to provide little guidance.

Governments make decisions about specific expenditures, and there is no reason to believe expenditure multipliers associated with public investment that is complementary to private investment will be the same, e.g. as for public consumption expenditures. The former crowds

[48] That is, plausibly, the constraint may change with changes in policy and should be endogenously derived (see Stiglitz and Weiss, 1986. In the short run, that often does not appear to be the case, so that the standard approach may not be unreasonable for the development of benchmark models.

in private investment. But DSGE models are unlikely to be able to handle this kind of subtlety which is at the core of public policy discourse.

Conventional wisdom, partly based on the standard model, is that over time public deficits designed to stimulate the economy lead to public debt which can crowd out private capital accumulation, harming growth. But that depends on a host of assumptions: (a) if the public expenditure goes to public capital goods or human capital or technology which are complementary to private capital goods, it can crowd in private capital accumulation; (b) in an economy at a zero lower bound, the government can just print money to finance the expenditures. At such times, one is often worried about deflation; any inflationary effects of such money-printing are thus beneficial.

So too, the conventional insight that with rational expectations, multipliers will be low (zero) because of the expectation of future tax increases depends on special assumptions: (a) if the expenditures are for productivity enhancing public investments, the conventional multiplier is actually increased with rational expectations; (b) so too, if there had been the expectation of a prolonged economic downturn; some of the "leakages" from spending today are reflected in spending in future demand constrained periods, increasing incomes in those periods; consumers, taking this into account, spend more today than they otherwise would have spent.[49]

With financial frictions, monetary policy may be relatively ineffective not because of the zero lower bound (if that were really the problem, changes in investment tax credits and consumption taxes over time could have altered individual's marginal rates of substitution), but because lowering the T-bill rate (or the Fed discount rate) may not alter bank lending much. If that is the case, policies aimed more directly at increasing credit availability of those borrowers for whom it is constrained may prove more effective than conventional monetary policy.[50]

The central point is that there are a wide range of policies with significant macroeconomic effects that governments consider, and we have to be able to tailor make models—building off the core model described earlier-- to ascertain the effects. Many policies, for instance, may affect a country's exposure to shocks (full capital market liberalization); others may affect the strength of a country's automatic stabilizers. Having a simple model that can analyze these

[49] See Neary and Stiglitz (1983). So too, this standard result does not hold if there are binding credit constraints and/or if there are life-cycle savers, who are unconcerned about tax payments beyond their horizon.

[50] These remarks may provide insight into the relative ineffectiveness of even the so-called non-conventional policies in bringing the economy back to full employment. Without paying due attention to effects on banks' balance sheets, negative interest rates could even lead to reduce lending activity. We have already noted how these ideas did play a role in the response to the 1991-1992 recession by the Clinton Administration. So too, behavioral economics played an important role in the design of the tax cut in the Obama administration.

effects is crucial. Building such a model off of a DSGE framework is unlikely to be as helpful as building one off of the framework described above.[51]

The economy today is going through a structural transformation. The result may be that with current levels and forms of government expenditure and taxation and private expenditures, the economy might fall short of full employment. For all the reasons discussed above and others, the adjustment to a full employment equilibrium may be slow. But even with sticky wages and prices, there exists a set of fiscal policy interventions over time (taxes, expenditures) which could bring the economy back to full employment in the short run, or at least bring it back to full employment faster than would otherwise be the case: not just one, but a multiplicity of such paths, differing, for instance, in their levels of public investment and growth in the short run. Even if one were concerned about the level of debt, there is a balanced budget multiplier—and if the taxes and expenditures are chosen carefully, that multiplier can be quite large. Thus, "secular stagnation" associated with persistent unemployment is not a disease that happens to a country: it is a consequence of policies that can be changed. Again, as we noted earlier, building off of a DSGE model, with its assumptions of common knowledge and rational expectations, is not likely to be as helpful in designing policies responding to the structural transformation as beginning with a model focusing on financial frictions, as described earlier.[52]

Further Critiques

One could go through each of the underlying assumptions of the DSGE model, to explain the role they play—and why they result in a model that fails to predict and explain important aspects of macroeconomic fluctuations, and why "reforms" which are supposed to improve economic efficiency may actually increase macroeconomic volatility.

On the importance of differences in beliefs

I have, for instance, alluded to the assumption of rational expectations. I strongly believe that one cannot fully explain the growth of the housing bubble that played such a large role in the recent crisis within a rational expectations framework.[53] But clearly, some of the "reforms" in

[51] As we have noted, DSGE models begin with the competitive equilibrium model. Variations in that model focused on open economies therefore include an equation assuming uncovered interest parity (UIP). As Hendry and Mulbaeur (this issue) point out: "There is strong empirical evidence against UIP. Evidence tends to suggest that for small deviations from long-run equilibrium in which purchasing power parity plays an important role, the exchange rate is not far from a random walk, but for large deviations, equilibrium correction is important."

[52] In such structural transformation, differences in views are likely to be large, giving rise to the possibility of an increase in pseudo-wealth as described in the next section and subsequent volatility. Financial structural reform, allowing for more betting, will increase this volatility, and this should have been taken into account in evaluating the benefits. Again, our critique of the use of rational expectations in such situations parallels that of Hendry and Mulbaeur (this issue) who note "The revolution since 1979 in the UK's credit market architecture is only one of a number of important structural changes. When there are such structural shifts, uncertainty becomes radical."

[53] See Shiller (2007) and Stiglitz (2010b).

mortgage markets (strongly supported by the Fed Chair at the time) contributed to the creation of the bubble.

Differences in beliefs too can play an important role in macroeconomic fluctuations, through what Guzman and Stiglitz call the creation and destruction of pseudo-wealth. When two individuals differ in beliefs, they have an incentive to engage in a bet (or economic transactions which are similar to bets). Both sides, of course, think that they are going to win, so that the sum of their "perceived" wealth is greater than "true" wealth. Until the bet gets resolved, there is an incentive for both to spend more than they otherwise would, if necessary, going into debt. The resolution of the bet (the occurrence of the event) means that one side becomes wealthier, the other side less wealthy; but there is more than just a transfer of income: there is a destruction in aggregate wealth leading to a decrease in aggregate consumption. Pseudo-wealth is being created and destroyed all the time, but certain changes—like the creation of new betting markets, e.g. associated with "improvements" in finance, associated with the creation of markets in derivatives and CDS's—can lead to significant increases in aggregate pseudo-wealth; and certain events, like the collapse of the housing bubble, can lead to its net destruction. Fluctuations in pseudo-wealth help explain one of the paradoxes of macroeconomics: the large fluctuations in the economy in spite of small changes in the *physical* state variables, the stock of capital, labor, and natural capital.[54] [55]

Aggregation

One set of assumptions that is critical, and to which too little attention is given in macroeconomic analyses, concerns aggregation.

Long ago we learned the difficulties of constructing an aggregate production function.[56] The "putty-putty" model provides great simplification, but one should not claim that any analysis based on it is really "micro-founded." While earlier analyses provided a critique of the use of the standard model for equilibrium analysis, e.g. when there is production of commodities by means of commodities or when there are production processes involving capital goods of markedly different durability[57]; the use is even more questionable for analyses of dynamics: the dynamics of putty-clay models and vintage capital models, for instance, are markedly

[54] There is ample evidence that individuals differ in their beliefs. Note these theories are consistent with each individual believing that he has rational expectations—he is forming his expectations on the basis of all information available to him. But they are not consistent with common knowledge, where everyone has the same beliefs.
There can also be "negative" pseudo-wealth, where what individuals believe they are going to pay to creditors is greater than the creditor believes he receives. See Guzman and Stiglitz (2016a,b).

[55] There are, of course, other possible explanations for this, e.g. sunspot theories, where there may be multiple equilibria. In this short note, I cannot explain the relative strengths of these alternative explanations.

[56] See Fisher (1969).

[57] That is, the relationship between the value of capital (per capita) and output (per capita) may be far different than suggested by the standard production function. For a review, see Stiglitz (1974).

different from those of putty models.[58] It would thus be foolhardy to rely on the putty clay model for any analysis of dynamics in the short to medium term when such vintage effects can be important.

Even more important is perhaps the aggregation of the whole economy into a single sector, particularly when the underlying stress on the economy is one of structural change, requiring the movement of resources from one sector to another (say agriculture to manufacturing), when there are market imperfections (say in access to credit) impeding the reallocation[59].

Policy analyses are also likely to be misguided. Monetary policy is typically presented as an efficient tool. But monetary policy has disproportionate effects on interest sensitive sectors, thus inducing a distortion in the economy that simply is not evident in a one-sector model. (See Kreamer, 2015).

Finally, the use of a representative agent represents an aggregation of the household sector. It is understandable that macro-economists attempting to micro-found macro-theory would want to impose some restrictions: otherwise, any set of demand functions could be claimed to be micro-founded.[60] But assuming a representative agent goes too far, because it eliminates any possibility of distribution matters. There is at least a significant body of thought that argues that the increase in inequality played some, and possibly a critical role, in the buildup to the crisis and to the slow recovery; there are large differences in the marginal propensity to consume between the top 1% and the bottom 80%, and accordingly, anything that affects distribution significantly affects aggregate demand significantly, i.e. has macroeconomic consequences.[61]

Going Still Further Beyond the Standard Model

[58] For instance, if, during a period of low interest rates, firms install very capital-intensive machines (with a high output per worker), it will be more difficult for the economy to return to full employment: the necessary increase in aggregate demand will have to be greater than it otherwise would have been. See Morin (2014), Cass and Stiglitz (1969) For a more popular discussion, see Man vs. Machine, a Jobless Recovery, Thimothy Aeppel in the Wall Street Journal, January 17, 2012, available at: http://www.deanza.edu/faculty/lillybyron/pdf/ch2_manvmachineajoblessrecovery_jan2012.pdf.

[59] Emphasized in the work of Delli Gatti *et al* noted earlier.

[60] That is, a according to the Mantel-Sonnenschein theorem, in the absence of *some* restriction, such as the "representative agent" assumption (where all individuals are assumed identical), virtually any aggregate function can be consistent with the standard competitive model. See Mantel (1974), Sonnenschein (1972) and Kirman (1992).

There is also a large literature describing the very restrictive conditions under which such household aggregation can be done.

[61] Thus, the critique is far more than that the conditions allowing for such aggregation are not satisfied. That is obviously the case, and the fact that it is raises too questions about claims that DSGE models are well micro-founded.

The micro-economics of the basic competitive model—as formulated in Arrow and Debreu--has been shown to be flawed by forty years of economic research. Why should we expect a macroeconomic model based on such micro-foundations to work? Most deeply, the standard model is intellectually incoherent and implicitly encourages society to move in a direction which would undermine both efficiency and well-being. For it assumes that all individuals are purely selfish and yet that contracts are always fully honored. Individuals who are fully selfish know that there are enforcement costs, and will not honor their contracts fully, even if the consequence is a loss in reputation. Thus, the Department of Justice and a number of private suits have uncovered the role of pervasive fraud in the securitization process, by many if not most of the credit rating agencies, mortgage originators, and investment banks, consistent with Kindleberger's (1978) analysis of earlier depressions and panics.[62] While incorporating such behavior in a standard economic model is difficult[63], the prevalence of such behavior is surely out of the spirit of standard DSGE models and more consistent with those models emphasizing institutional arrangements to prevent such behavior and the exploitation of imperfections of information. Surely, both policies to prevent a recurrence of similar crises and analyses of market dynamics will need to take into account both market and regulatory responses. Most importantly, the inculcation and normalization of a culture of selfishness without moral bounds will lead to an economy which is less efficient with lower individual and societal well-being. Behavioral economics has noted both that most individuals systematically behave differently from that model but that embedding individuals within a culture of selfishness (where that is taken as the norm) leads to changes in behavior in that direction.[64] Macroeconomics is supposed to provide us with models of how the economy *actually* behaves, rather than how it might behave in a mythical world of infinitely selfish people but amongst whom contracts are always honored. Adam Smith, often described as the father of modern "selfish" economics, in his invisible hand conjecture[65], reminds us in his *Theory of Moral Sentiments*

> How selfish soever man may be supposed there are evidently some principles in his nature which interest him in the fortunes of others and render their happiness important to him, though he derives nothing from it except the pleasure of seeing it.

[62] Interestingly, there were provisions of standard contracts in the securitization process designed to mitigate the consequences of moral hazard, but these provisions failed to work as intended, both because of widespread fraud and breach of contract.

[63] Though there have been some attempts to incorporate them and their implications into simple micro-economic models, these have not yet been fully brought into macroeconomic analysis. One important variant of the strand of standard macroeconomics does incorporate insights from one particular variant of financial frictions centering around costly state verification.

[64] For a discussion of some of the recent empirical evidence, see Hoff and Stiglitz (2016).

[65] A conjecture, which we noted, turned out to be false whenever there were imperfect risk markets and asymmetric information, except in the *very* special conditions underlying real business cycle theory and its descendants.

The earlier Smith was fortunately right, and a modern macroeconomics should strive to incorporate behavior which is consistent with these impulses, just as it does that are consistent with those that may be less noble.[66] One of the critiques of DSGE modelling is that it and its underlying assumptions have become a dogma, with little incentives to call them into question especially in a context of peer-reviewed publications.

Concluding Comments

Assumptions matter. All models make simplifications. The question is, as we have said, what simplifications are appropriate for asking what questions. The danger is that the simplifications *bias* the answers, sometimes in ways that we are not aware of. The DSGE model ignored issues that turned out to be key in the 2008 crisis; not surprisingly, the model neither predicted the most important macroeconomic event in the past three quarters of a century *nor provided good guidance as to the appropriate policy responses*. Given the way the models are structured, they could not have predicted such an event. In the run up to the crisis, monetary authorities focused on inflation rather than on what they should have been focusing—financial stability; and some of their (especially deregulatory) actions clearly contributed to financial instability. The DSGE models provided them (false) assurance that they were doing the right thing.

Of course, any good macroeconomic model has to be dynamic and stochastic, and present an analysis of the entire economy. But specific assumptions, as we have noted, went into each of these components. We have already discussed several aspects of the assumed dynamics.

Some of the greatest deficiencies, I believe, relate to the treatment of uncertainty, the stochastic element in DSGE models. We have already questioned the underlying presumption in the model of how risks get dissipated through diversification, and that the underlying shocks are exogenous. Also questionable are the typically unstated assumptions concerning risk management. There is ample evidence that risk has first order effects on firms, households and banks that are not adequately incorporated into the standard DSGE models. That's why those models had nothing to say about one of the critical questions confronting policymakers in the 2008 crisis: how best to recapitalize banks. The objective was to enhance lending, especially to SMEs. The way chosen by the US and some other countries, entailing the issuance of preferred shares, can be shown to be far from optimal. There were other ways of bank recapitalization which would have led risk-averse banks to have lent more.

In the course of this paper, we have provided many examples of insights that are revealed by simple macroeconomic models with finite periods—insights that are typically obfuscated by the simplifications required by DSGE modelling.

[66] For an excellent discussion of these two contrasting views of human nature and their implications for economics, see Vines and Morris (2015). For an attempt to incorporate some aspects of these considerations into a formal model, see Greenwald and Stiglitz (1992).

To me, small and big models should be viewed as complementary: one needs to use each to check the results of the other. Perhaps there is some effect that got lost in the three-period simplification. More often than not, it goes the other way. But it is not really a question of small vs. big. It is a matter of the careful choice of assumptions. As I have noted, sectoral aggregation is problematic when the underlying macro-disturbance is that of structural change.

That having been said, our models do affect how we think: DSGE models encourage us to think in terms of the economy always moving along a dynamic equilibrium path, and focus our attention on intertemporal substitution. Neither, I suspect, is at the heart of what is really going on in the short to medium term; and as I have suggested, the DSGE has little to say concerning long term growth. For instance, the belief in the effectiveness of monetary policy has led to the conclusion that its current obvious ineffectiveness is only because of the zero lower bound: if only we could break through that bound the economy could be restored to full employment.[67] Of course, if there were a large enough negative interest rate—if people never had to pay back their loans—there is little doubt that the economy could be stimulated. The question, though, is whether moderate changes, from a real interest rate of say -2% to -4% would have done the trick, when much larger changes have proven ineffective. The reason for the ineffectiveness lies partly in the fact that lowering the nominal interest rate on T-bills may not lead to a lower of the lending rate or that lowering the T-bill rate may not lead to an increase in credit availability, as we have already noted. But, as we have also noted, if one really thought that what was crucial were intertemporal prices, one could have changed those through tax policies, through changing consumption tax rates and investment tax credits over time.

In the end, all models, no matter how theoretical, are tested in one way or the other, against observations. Their components—like the consumption behavior—are tested with a variety of micro- and macro-data. But deep downturns, like the 2008 crisis, occur sufficiently rarely that we cannot use the usual econometric techniques for assessing how well our model does in explaining/predicting these events—the things we really care about. That's why, as I have suggested, simply using a least squares fit won't do. One needs a Bayesian approach—with heavier weight associated with predictions when we care about the answer. Comparing certain co-variances in calibrated models is even less helpful. There are so many assumptions and so many parameters you can choose for your model, way over the number of moments you can get from the data; so being able to match all moments in the data does not tell you that your assumptions were correct and thus provide much confidence that forecasts or policies based on that model will be accurate.

[67] This belief encouraged some central banks to move towards negative interest rates, with little success in restoring the economies to robust growth. In some cases, the effects seem negative. Japan's Central Bank was particularly sensitive to the issues raised here (issues, as we have noted, that were not central in the DSGE models): they worked to mitigate any adverse bank balance sheet effects while maintaining substitution effects.

Defenders of DSGE models counter that other models did little better than the DSGE models. That is not correct. There were several economists (such as Rob Shiller) who, using less fully articulated models, could see that there was clear evidence of a high probability of a housing bubble. There were models of financial contagion (described earlier in this paper, developed further since the crisis), which predicted that the collapse of the housing bubble would likely have systemic effects. The conviction that this would happen would have been even stronger had the data that the Fed had available to it before the crisis been publicly available. Policymakers using alternative models of the kind described here would have done far better both in anticipating the crisis and coping with it than those relying on DSGE models.

Models have consequences even when their predictions and explanatory power are less than stellar. For they affect how households, firms, and most importantly policymakers think about the economy. Models which say that the fundamental market failure arises from wage rigidities may be induced to argue for more wage flexibility—to argue that if only we could achieve that, economic performance would be improved.

This essay has argued that the standard DSGE model provides a poor basis for policy, and tweaks to it are unlikely to be helpful. Fortunately, there are alternative frameworks to which modern policymakers can turn. I have tried here to describe some of the core elements that need to be incorporated into the benchmark *models* with we teach macroeconomics to our students. The challenge we should be posing to them is how to develop increasingly sophisticated versions of these into models, small and large, incorporating the various insights provided by a range of "partial" models (such as that of the banking sector) that help us understand the important fluctuations in our economy and what more we might do to reduce their magnitude and frequency and the human suffering that so often results.

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