Industrial and Corporate Change, 2021, Vol. 30, No. 2, 273–296
doi: 10.1093/icc/dtaa065
Advance Access Publication Date: 5 May 2021
Original article

Disarray at the headquarters: Economists and Central bankers tested by the subprime and the COVID recessions

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Abstract

The article explores the discussions among economic modelers and central banks research staff and decision makers, namely on the adequacy of unconventional monetary policy and fiscal expansionary measures after the subprime crisis and as the COVID recession is developing. First, the article investigates the arguments, models and policy proposals of several mainstream schools of economics that challenged the traditional Chicagoan orthodoxy based on Milton Friedman's views, and developed the Lucas Critique, the New Classical synthesis and Real Business Cycle approach that replaced monetarism as the main rivals to old-time Keynesianism. Second, the transformation of Real Business Cycle models into Dynamic Stochastic General Equilibrium (DSGE) models is mapped, as it extended the ideas of the iniquity of government intervention and unified academic and central bank research. Yet, a battery of criticism was levied against the DSGE models and, as the debate emerged over quantitative easing and other tools of unconventional monetary policy, the need for policy pragmatism shattered the previous consensus. The article then proceeds to discuss how the leading mainstream academic economists reacted to changes in central banks' practices, noticing a visible dissonance within Chicago-school and DSGE economists, as well as major contortions of central bankers in order to justify their new postures. The article concludes with a call for an extensive menu of fiscal, industrial and innovation policies in order to respond to recessions and structural crises.

JEL classification: B.26, E13, E32, E50, E58

1. Introduction

In early October 2020, while the IMF anticipated a global recession of 3% triggered by the pandemic, John Cochrane, formerly of the University of Chicago and now at the Hoover Institution in Stanford and the Cato Institute, announced that there was an easy solution for the sorrows of the world: "How would you like the recession to be over in a month? Here's the ticket." The ticket was the expanded availability of COVID tests. According to

Cochrane (2020c), if everyone could buy their own test, then the market would work and confinement would not be necessary, and the equilibrium in the world economy would be restored within a month.

A decade before, Cochrane's solution for the crisis that ravaged the world and the recession that would follow was also very simple. A full 2 years into the global financial crisis, Cochrane breezily asserted, "The economy can recover very quickly from a credit crunch if left on its own" (Cochrane, 2010). Cochrane had already been the head of the movement of economists who condemned the rescue plan of George W. Bush's administration in September 2008, when shock waves were sent through the financial system after the collapses of Lehman Brothers (on September 15) and AIG (on September 16) and the flight of investors from "safe" money market mutual funds. The crisis was aggravated by Congress's rejection of the first version of the Treasury plan (on September 24), the very same day that Cochrane's petition, signed by three Nobel Prize winners, Robert Lucas, Vernon Smith and James Heckman, future winners Dale Mortensen and Lars Peter Hansen, and others such as Acemoğlu, Eichenbaum, Gordon, Boldrin, and Hodrick, accused the project of being "ambiguous," "unfair," and of provoking "pernicious long-term effects." As they put it, "weakening those [private capital] markets in order to calm short-run disruptions is desperately short-sighted."

On October 1, 2008, Cochrane said to a journalist that "I still don't see what is coming over the horizon that is so absolutely awful" (Kestenbaum, 2008). The next day he published a long article denouncing the "disaster" of the bailout plan (which was finally approved on October 3) and instead proposed an orderly insolvency of some banks: "Let banks fail, but in an orderly fashion. When a bank 'fails,' it does not leave a huge crater in the ground. The people, knowledge, computers, buildings, and so forth are sold to new owners—who provide new capital—and business goes on as usual; a new sign goes in the window, new capital comes in the back door, and new loans go out the front door. Current shareholders are wiped out, and some of the senior debt holders don't get all their money back. They complain loudly to Congress and the administration—nobody likes losing money—but their losses do not imperil the financial system. They earned great returns on the way up in return for bearing this risk; now they get to bear the risk. (. . .) This process does need government intervention; 'in an orderly fashion' is an important qualifier" (Cochrane, 2008). This suggestion echoes the famous advice given by the Treasury Secretary Andrew Mellon to President Herbert Hoover, as the deep impact of the 1929 crisis was looming, "liquidate labor, liquidate stocks, liquidate the farmers, liquidate real estate. It will purge the rottenness out of the system. High costs of living and high living will come down. People will work harder, live a more moral life. Values will be adjusted, and enterprising people will pick up the wrecks from less competent people." Hoover added in his "Memoirs" that Mellon "insisted that, when the people get an inflation brainstorm, the only way to get it out of their blood is to let it collapse" and that therefore "even a panic was not altogether a bad thing" (Hoover, 1952: 30).

With regard to the COVID threat, Robert Barro offered an uncommon sanitary version of this strategy, opposing counter-cyclical measures for the sake of the curative effects of confinement and, therefore, of recession: "What are reasonable monetary and fiscal responses to this fall in GDP? The usual idea would be to consider forms of economic stimulus that raise aggregate demand and, therefore, offset the fall in GDP during a recession. But this reasoning does not apply here, because we have already determined that a sharp, short-term reduction in GDP—for example, by 20% for a year—is a good idea. From this perspective, it is puzzling that the Federal Reserve recently cut its main short-term nominal interest rate to zero and also implemented large-scale asset purchases." And then Barro went on to conclude by pointing out the ghost of inflation in the room: "If the Fed's actions stimulate the economy and, thereby, offset the fall in GDP, we would not regard that as a good thing, because the resulting increase in economic activity would presumably lead to an increase in the virus's spread. Moreover, the present environment contains a serious threat of inflation—from the negative supply shock—and the Fed's expansionary response will exacerbate that threat" (Barro, 2020).

As shown by these examples amongst many others, Cochrane, Barro, and other leading conservative economists have remained steadfast in their opposition to fiscal and monetary stimulus even as, within the space of barely a decade, the world has faced the most serious recession since the 1930s and now the coronavirus crisis.

In this article, we investigate how neoclassical economists have confronted the challenges of the past decade, including stagnation and deflation, while the predominant practical orientation in monetary, fiscal, trade, and industrial policy started to gradually move away from the 40-year consensus on orthodox policy prescriptions. The arguments, models and policy proposals of several mainstream schools of economics, namely New Classicals and New Keynesians, are confronted with the traditional monetarist view. For the purpose of this article, we analyze recent publications (papers in prestigious scientific journals, documents of central banks and official institutions, working

papers of research centers, and blogs and newspaper articles by influential economists). We concentrate on the evolving assessments of fiscal stimulus and novel tools such as quantitative easing (QE). We note a growing dissonance within the mainstream ranks between actors in academia, central banks' research departments, central banks' policy makers, and international institutions, in sharp contrast to the previous consensus during the "Great Moderation." The divergent assessments of the policies required to fight recessions concern both the predicted impacts of those policies and also the choice of appropriate models to undertake the assessment itself. As a consequence, policies hailed as saviors by some are denigrated by others as stark threats, with these divergences tending to grow into insurmountable opposition. As we stand facing the current recession, we suggest that this discord and disarray amongst the mainstream core of the economics profession expresses the inadequacy of their worldviews and highlights the need for alternative policies and tools.

Thus, the first section of this article briefly summarizes how the consensus of the past four decades came to be established based on Milton Friedman's views, which lay the foundations of the Chicagoan orthodoxy. The following section discusses how, under the Lucas Critique, the New Classical synthesis and Real Business Cycle (RBC) theory replaced monetarism as the main rivals to old-time Keynesianism. The third section explores how, after the RBC models were regarded as having taken the ideas of the ineffectiveness and iniquity of government intervention a step too far, Dynamic Stochastic General Equilibrium (DSGE) models once again unified academic and central bank research. Some of the criticism levied against the DSGE models is summed up in Section 4. Section 5 presents the debate which emerged over QE when the need for policy pragmatism shattered the previous consensus, and proceeds to discuss how the leading mainstream academic economists reacted to changes in central banks' practices. Section 6 explores the evolving intellectual landscape through a detailed case study: the apparent split within Chicago-school economists in their assessment of unorthodox monetary policy. As we note in Section 7, these quarrels were not restricted to academia, for throughout the last decade the arguments of central bankers themselves have been subject to major contortions in order to justify their new postures. Finally, Section 8 concludes with a call for an extensive menu of fiscal, industrial, and innovation policies which are better prepared to tackle the structural crises.

2. A changing consensus

Samuelson's (1955) third edition of his textbook, *Economics*, claimed that "In recent years 90% of American economists have stopped being 'Keynesian economists' or 'anti-Keynesian economists.' Instead, they have worked towards a synthesis of whatever is valuable in older economics and in modern theories of income determination. The result might be called neoclassical economics" (Samuelson, 1955: 212). Samuelson, then 40 years old, was the powerful prime mover of that synthesis, which benefited from a favorable reception from Roy Harrod, a close collaborator of Keynes, and also from a young generation of mathematically inclined economists, the most prominent of whom was John Hicks. Samuelson was untroubled by the fundamental disagreements between the two camps which he sought to unify: Keynes had built his "older economics" theory on the dynamics of aggregate demand and had flatly rejected the self-adjusting mechanisms of "classical" economics (Pigou's version of neoclassical economics), which led him to conclude that a fall in nominal wages was not capable of restoring the aggregate supply curve and full employment, neither in the 1930s, nor in general. The success of the neoclassical synthesis across the economics profession eventually displaced competing views, even though its ascendancy involved some skirmishes, some of which have been described in previous contributions (Louçã, 1999, 2007). For the purpose of this article, it suffices to mention that the renewed map of post-World War II neoclassical economics inherited these tensions and became a patchwork of different components. Yet, up until the 1970s, a summary of these developments could conclude, even at the risk of a certain oversimplification, that the general macroeconomic framework for designing and assessing stabilization policies consisted of the Phillips curve-augmented IS-LM model (i.e., with changing prices). Despite the general equilibrium context, interventionist policies would still be required to remedy unemployment equilibria if elements of rigidity, such as an inelastic IS curve, prevented automatic adjustment.

Milton Friedman challenged this approach and made a career out of fighting it. His point of departure was an analysis of the Great Depression which assigned blame to the Fed's failure to prevent reductions in the supply of money from 1929 to 1933 (Friedman and Schwartz, 1963). Insofar as he saw changes in the money supply as a major cause of fluctuations, he regarded them an option available to policy makers as a control variable. However, given the destabilizing potential of monetary policy and its susceptibility to political short-termist manipulation, Friedman argued for a stable rule, rather than discretion, as the best way to manage the money supply. Rejecting the Keynesian

view of aggregate demand, Friedman assumed a vertical long-run Phillips curve that is, the absence of a stable trade-off between inflation and unemployment, and he posited the existence of a "natural rate of unemployment." Money, he concluded, is neutral in the long run, and even large monetary shocks are unable to permanently affect aggregate demand. This trio of Friedman propositions paved the way for two fundamental policy implications: governance of the money stock should be undertaken by an independent central bank which applies a largely fixed monetary rule to exactly accommodate the evolution of the economy, and the supply-side measures—such as tax reductions and de-unionization—should be used to promote profitability and investment.

Friedman initiated the debate on rules versus discretion in 1948 as a means to combat the previous Keynesian consensus on stabilization policies. He initially formulated his principle as a simple restriction to fiscal policy: "no attempt should be made to vary expenditures, either directly or inversely, in response to cyclical fluctuations in business activity" (Friedman, 1948: 248). Automatic negative feedback mechanisms, operating under private firms and clearing markets, would be enough to absorb any shock (Chatelain and Ralf, 2020). It was only in 1960 that Friedman elaborated a monetary rule: "The stock of money [should be] increased at a fixed rate year-in and year-out without any variation in the rate of increase to meet cyclical needs" (Friedman, 1960: 47). This view came to dominate the strategies of central bankers and other decision makers when the conditions were met by the coming to power of Margaret Thatcher and Ronald Reagan in the UK and the USA. Samuelson's synthesis was toppled from the pedestal of neoclassical economics and monetarist views came to dominate, beginning in the 1980s. After this assault on Keynesianism, monetary policy was reduced to routine management of the money supply, and fiscal policy to the containment of public debt.

As a consequence of this new ascendancy, central banks were legally transformed into independent entities and came to focus on inflation and the punishment of fiscal profligacy. Powerful governments, most scholars, and virtually all central bankers were aligned in their celebration of the Great Moderation (the period of low inflation between 1985 and 2006) as the "Age of Friedman." In this vein, Michael Bordo argues that, after Bretton Woods—which he considered a failure, since "policy makers at the time had an incomplete understanding of the role and effect of monetary policy and they prioritized the pursuit of full employment over price stability"—the acceptance of the monetarist rule since the 1980s was the "return to a consensus" (Bordo, 2020). In any case, even during this period of consensus (and of consensus about the consensus) some inconvenient inconsistencies and deviations from the rules were manifested, in particular the series of discretionary banking rescues in developed and developing economies during the 1990s.

3. The consensus threatened by the dark ages

Success is fleeting. As monetarism, Friedman's rule and institutional design swept through central banks during the 1980s, some erstwhile allies moved beyond Friedman's policy views. The first shot was fired by another Chicagoan, and it came to be recognized as a general methodological point—the Lucas critique (1976), which posited that the parameters in the large-scale macro models in use at the time could not be identified and, therefore, that empirically based modeling was not viable. This problem had been raised before. Ragnar Frisch had rejected Jan Tinbergen's analysis of autonomous equations in the late 1930s (Frisch, 1938; Louçã, 2007: 204–247), as did Keynes (1939), and the Cowles Commission had abandoned the program of simultaneous equations estimation by the late 1940s, in each case for reasons related to the identification problem. The Cowles Commission's solution to the conundrum had been to turn to Bourbakism, promoting deductive mathematical modeling rather than estimation (Mirowski, 2002: 390–394; also Weintraub, 2002), while Lucas', which would earn him the Nobel prize in 1995, involved embracing and further developing the rational expectations hypothesis (REH) that had been originally introduced by Muth (1961).

REH articulated the radical assumptions of: (i) the optimizing behavior of foresighted agents, (ii) permanent, instantaneous, Walrasian market clearing, and (iii) the continuous adjustment of the supply of inputs, depending on their relative prices. All three elements appeared in previous versions of neoclassical economics, but were now combined as a complete description of nature. The consequence was policy ineffectiveness, due to the fact that agents adapt to and neutralize all changes in monetary policy, and Ricardian equivalence cancels out any fiscal efforts to stabilize demand.

This hypothesis had powerful implications. Lucas concluded that Friedman's prescription of predictable monetary policy offered rather small potential gains in welfare, "on the order of hundredths of a percent of consumption"

(Lucas, 2003: 11). Likewise, the policy itself is suspect, since "costly efforts at stabilization are likely to be counterproductive" (Prescott, 1986). If agents are fully rational, at most transient effects can be obtained. Lucas's new skepticism created a schism between, to one side, the central bank's monetarist decision makers and, to the other, REH theorists in academia and central banks' research department under Lucas's influence (Louçã, 2004). This marked the beginning of a long-lasting trend of detachment of monetary theory literature from monetary policy making. The second implication of REH further aggravated this divide, as it provided a narrative for Lucas's critique: if agents adapt their expectations to new information coming from monetary institutions, then estimation is not feasible. Lucas, Sargent, Barro, and Prescott all contributed to this revolution in different ways.

A second generation of New Classical economics sought to square Lucas's points with the reality of booms and recessions by proposing the recourse to *ad hoc* exogenous shocks in order to identify the system (Sergi, 2018). RBC models, as this approach became known, were inaugurated by Finn Kydland and Edward Prescott in the early 1980s (Kydland and Prescott, 1982) and portrayed the economy as a representative, rational, infinitely lived and utility-maximizing household subject to exogenous shocks and random fluctuations in the rate of technical progress. The emerging cycles that obtained as a result constituted an optimal, efficient adaptation to those unforeseeable perturbations. Stabilization policy had no role to play in the business cycle, for the latter was an optimal response, not a problem to be addressed (Kydland and Prescott, 1982: 1345).

Stationarity of the shocks was established as a condition for the model (Kydland and Prescott, 1982: 1352) and calibration was used to simulate the dynamics of the purely toy representation. The explanatory power of RBC theory was assessed through a comparison between real data and simulations calibrated with data. The model was proposed as a device for predicting the largely harmful effects of different policy choices. The economics profession was thus moving wildly into post-Friedman territory—precisely at a time when Friedman's thought had established itself in central banks, some universities and other institutions.

In 1998, 6 years before he received the Nobel prize for RBC theory, Edward Prescott persisted in his critique against Friedman's focus on monetary shocks as the cause for cycles—because a "theoretical foundation was lacking" (Prescott, 1998: 19). Prescott's case was of course far from watertight. Prescott himself acknowledged the existence of a positive money-output correlation and the fact that the Great Depression was a deviation from his own theory, insofar as it was "not accounted for by variations in total factor productivity" (Prescott, 1998). But he also proposed, as a way to reconcile all of this, the idea that monetary policy can affect output if there are lags:

> researchers using the RBC methodology and a transactions-based theory of money found that money contributes little to business cycle fluctuations. I, however, see these exercises as being far from conclusive in establishing that monetary policy cannot be used to stabilize the economy. The reason is the failure of these theories at the intermediate frequencies (Prescott, 1998: 20).

In other words, in the short-term money can count.

Prescott (1998) is an interesting persuasion exercise, not so much because it emphasized the RBC concepts and models, but more because it claimed the ground of scientific method, prolonging Lucas critique against empirical estimation. For Prescott, "inductive or empirical inference proved sterile in business cycle research," since "the existence of policy invariate laws governing the evolution of an economic system is inconsistent with dynamic economic theory" (Prescott, 1998: 2). Therefore, the task of the business cycle analyst is to "construct a model economy," using theory as "a set of instructions for constructing an instrument to measure something or predict the consequences of some policy" (Prescott, 1998: 3). He further stated that "many have argued that Hodrick and my facts are not interesting because we did not correctly measure the business cycle. This criticism is spurious. An operational definition can be neither right nor wrong and our definition is an operational definition," and he went on to add a "principle" defining a relativistic concept of measurement, so that:

> a model that better fits the data may be a worse measurement instrument. Indeed, a model matching the data on certain dimensions can be the basis for rejecting that model economy as being a useful instrument for estimating the question of interest (Prescott, 1998: 5, 13).

This could not move farther from Friedman's economics, even if there was no quarrel about the long-term neutrality of money. RBC theory certainly vindicated further the idea of rules-based monetary policy, based on the argument that, if expectations are rational, then no discretionary policy can maximize the outcome (an argument anticipated in Kydland and Prescott, 1977). At the same time, however, it turned away from monetarism in the sense

that it ignored empirical estimation and concentrated on deductive models which completely ignored the monetary dimension.

The RBC framework came to be challenged by many. For example, it has been shown that the granular origins of aggregate fluctuations owe more to investment, or demand-side shocks, than to residual oscillations interpreted as technological movements (Dosi *et al.*, 2019). Other economists have pointed to other evidence of demand-driven cycles as grounds for rejecting the RBC explanation (Angeletos *et al.*, 2020: 3033, 3054).

The monetarists, too, could not accept the RBC explanation. When RBC emerged, the monetarists were celebrating the victories of Reagan and Thatcher as well as the imposition of deflationary policies to force adjustment to the economic crises of the late 1970s. Success against inflation was claimed as vindication of their theory (Volcker's 1979–1982 restrictive policy is also Romer's (2016) favorite illustration of the effectiveness of monetary policy). John Taylor, the current president of the Mont Pelerin Society and a distinguished Stanford scholar, and a co-author with Cochrane on monetary policy (Cochrane and Taylor, 2020), issued a blistering indictment that RBC distracted from the real business of setting monetary policy. Taylor complained that darkness had descended on the province of economics as the Lucas flag advanced and practical analysis was abandoned: "after the flurry of work in the late 1970s and early 1980s, a sort of 'dark age' for this type of modeling began to set in" (Taylor, 2007). He cautioned his colleagues again some years later, saying:

> I call it 'dark ages' in another paper; it seemed like everyone interested in the new rational expectations methods in the 1980s was working on real business cycle models without a role for monetary policy (Leeson and Taylor, 2012).

In 1993, Taylor formulated his own version of Friedman's strategy, which came to be called the "Taylor rule": adjusting the nominal interest rate upward or downward in reaction to deviations from the target inflation rate and potential GDP. Although still firmly a rules-based approach to monetary policy, this constituted a more flexible mode of action than Friedman's constant growth approach:

> There is considerable agreement among economists that a policy rule need not be interpreted narrowly as entailing fixed settings for the policy instruments. Although the classic rules-versus-discretion debate was usually carried on as if the only policy rule were the constant growth rate rule for the money supply, feedback rules in which the money supply responds to changes in unemployment or inflation are also policy rules (. . .). A policy rule is a contingency plan that lasts forever unless there is an explicit cancellation clause" (Taylor, 1993: 198).

In any case, Taylor held on to a relatively restrictive view of monetary policy, suggesting a target equilibrium real interest rate at 2% (Taylor, 1993). Taylor's recommendations were addressed to the Federal Reserve and other central banks' staff more than to "dark age" academics (Chatelain and Ralf, 2020: 9–10), and he was remarkably influential in this respect. His rule, which he modestly presented as "just one way of many to characterize reasonably good monetary" policy (Taylor, 2018a), was indeed adopted by many central banks—until the Great Recession, that is.

Before we discuss the major shifts that occurred in the wake of the 2008–2009 crisis; however, the next section discusses the emerging divergence within central banks themselves, as practitioners and decision makers supported Friedman and Taylor, while the research centers tended to opt for an improved version of the Lucas and RBC approach.

4. How DSGE prevailed in Central banks' research, and how was it challenged

By taking the Lucas Critique to its extreme, RBC models failed both to account for business cycles—operationalizing the technological shocks as the total factor productivity residual proved unintelligible—and to provide any guidance regarding the pragmatic choices required to address recessions. Furthermore, as both monetarists and heterodox economists have observed, RBC models largely ignored the monetary and credit structures of the economy. A new generation of models thus emerged that sought to fill these gaps: the DSGE apparatus.

DSGE was the result of a convenient convergence with New Keynesians. Unlike Lucas and Prescott, the New Keynesians observe that coordination failures, market imperfections and price rigidities render money non-neutral and thereby open the door for monetary and fiscal policies to be able to influence aggregate demand. However, the Lucas/RBC and New Keynesian schools share a common ground in their shared acceptance of assumed rationality in the radical form of rational expectations. The combination of these two brands of neoclassical economics gave rise to

the DSGE models, which became the main workhorse for analysis and forecasting by central banks. In that sense, DSGE established a bridge between academic research and the research departments of the central banks.

Nevertheless, despite its thorough uptake across central banks' research departments—thanks to the recruitment of PhD economists from top neoclassical programs—DSGE showed limited capacity to influence decision making. There is no record of substantial policy undertaken by central bankers that was ever expressly based on these models. As we will see in Section 5, at some point they were even dismissed by central bankers, as when Bernanke noted that they were usually not used for policy choices (Bernanke, 2020). We leave its explanation for future research and merely register the peculiar fact that major central banks have devoted their research departments' resources to produce models whose usefulness for policy making was null.

Woodford, a champion of DSGE, presented their case with an explicit hat tip to the Lucas Critique, portraying them as models

> with clear foundations in individual optimization [which] is important, in our view, [. . .because it. . .] allows us to evaluate alternative monetary policies in a way that avoids the flaw in policy evaluation exercises using traditional Keynesian macroeconometric models stressed by Lucas (1976) (Woodford, 2003: 13).

In contrast, RBC was a much more fragile attempt to address the points made by Lucas, insofar as it was incapable of simulating the effects of choices, given that the latter requires parameters to be invariant to policies (Hurtado, 2014). The argument of irrelevance of RBC for policy contributed to the incremental acceptance of DSGE as the main standard bearer of the Lucas Critique. The latter's microfoundations and assumption of intertemporal optimizing agents justifies the assumption of policy-invariant parameters, namely the elasticities for defining preferences and technology, which thus enables policy evaluation (Sergi, 2018). This did not convince all economists. RBC promoter Charles Plosser, who served for the first years of the post-subprime crash as chair of the Federal Reserve Bank of Philadelphia, rejected the view that DSGE is able to address Lucas's point:

> In my view, the current rules of the game of New Keynesian DSGE models run afoul of the Lucas critique—a seminal work for my generation of macroeconomists and for each generation since. (Plosser, 2012: 5).

The first waves of these DSGE models updated the RBC model by introducing nominal rigidities, usually through adopting sticky prices, and monopolistic competition. These rigidities and market frictions meant that nominal wages and prices fail to adjust instantaneously to changes in the quantity of money. As a result, unanticipated monetary shocks can affect real variables, since they create a prolonged mismatch between agents' expectations of nominal variables and their realized value. Price expectations are corrected, but slowly. The economy then returns to its structural equilibrium and, accordingly, money is neutral in the long-run. Some early examples of such models include Rotemberg and Woodford (1995), Yun (1996), McCallum and Nelson (1999), and Woodford (2003).

These models found their way the central banks' research departments, as these organizations set up large-scale DSGE models for policy analysis and forecasting. Some examples include BEQM of the Bank of England, replacing by 2004 the previous structural econometric model, to be followed by COMPASS in 2011 (Hendry and Muellbauer, 2018: 296); NAWM of the European Central Bank; and SIGMA of the Federal Reserve. These large-scale DSGE models built on the first wave of models mentioned above and included additional sources of rigidities, including persistence in consumption habits as well as adjustment costs for labor and capital, following Christiano et al. (2005), as well as Smets and Wouters (2003). Additional rigidities for open economies included sticky foreign exchange rates (i.e., local currency pricing) and costs of adjusting trade flows, following Betts and Devereux (1996) and Devereux and Engel (2002). Although there are some non-negligible differences among these models, such as regarding the setup of Ricardian (NAWM) or non-Ricardian households (BEQM and SIGMA), all have an undeveloped government sector, disregarding the value that consumers assign to public goods and public investment. The models impose the notion that fiscal stimulus crowds out private investment and consumption.

As we will see in the following section, these analytical tools, both those emerging in academia and their counterparts in the central banks' research departments, were based on debatable assumptions, and indeed were unable to inform policy makers on the build-up of structural risks that led to the Great Recession. Policy makers felt "abandoned" by these tools in "the face of the crisis," as described by Trichet (2010). These shortcomings were also recognized by Frank Smets and Rafael Wouters, two champions of the DSGE framework and the driving force for the adoption of the DSGE framework within the ECB research department, who acknowledged that "apart from failing to predict the crisis in the first place, both the BVAR and the DSGE model also have a clear tendency to forecast a

quick recovery" (Lindé, Smets and Wouters, 2016). Indeed, this inability to deal with crises was acknowledged by no less than Robert Lucas:

> The problem is that the new theories, the theories embedded in general equilibrium dynamics of the sort that we know how to use pretty well now—there's a residue of things they don't let us think about. They don't let us think about the U.S. experience in the 1930s or about financial crises and their real consequences in Asia and Latin America. They don't let us think, I don't think, very well about Japan in the 1990s. (Lucas, 2004: 23).

The broad criticism that DSGE modeling faced after the onset of the Great Recession inspired its main proponents to better account for the workings of the financial sector, for monetary transmission, and for financial frictions. Such an adaptive strategy allowed these modelers to realign with central bankers in their support for unorthodox monetary policies. Christiano et al. (2014) is an example of such an effort, with these authors proposing a DSGE model with shocks to the "riskiness of individual firms." Another example is Jermann and Quadrini (2012), who put forward a model in which financial frictions result from rigidities that affect firms' substitution between debt and equity. The ECB research department followed suit, and proposed the NAWM II. This model adds to its predecessor by including wholesale and retail banks, "two distinct types of financial intermediaries that are exposed to sector-specific shocks" (Coenen et al., 2018). According to this model, QE can influence the economy through "credit easing and the exchange-rate channel." Nevertheless, there is no role in the model for the increased room for maneuver that QE bestows upon governments through the reduction of public bond yields. Taking a somewhat different route, the Bank of England research department, while replacing the BEQM with the COMPASS model, opted for reaffirming the importance of using multiple models for forecasting purposes and recognized the limitations of large-scale DSGE models: "The new forecasting platform recognizes more explicitly the importance of the suite of models and the costs of operating large, intractable models" (Burgess et al., 2013). Other authors accepted, along the same lines, that rebuilding the theory would be necessary to introduce major corrections, namely considering financial frictions, relaxing RE, including heterogeneous agents, or changing all behavioral equations, since the benchmark DSGE "has let us down" (Vines and Wills, 2018: 2).

Other efforts to rescue the DSGE framework from its post-2008 debacle included adaptations aimed at including a zero-lower bound (ZLB) on interest rates and a flattening of the Philips curve. In that spirit, a team of researchers based at the ECB, the Fed and Northwestern University concluded recently that the economy has become more Keynesian and susceptible to business cycles dominated by demand shocks, implying a Phillips curve with a flatter slope (Negro et al., 2020). Using a DSGE model, IMF researchers suggest that the effect of fiscal measures, namely capital tax cuts, can be expansionary or contractionary, depending on the level of debt (Fotion *et al.*, 2020). Woodford and Xie (2020) accepted that:

> the events of the period since the financial crisis of 2008 have required a significant reappraisal of the previous conventional wisdom, according to which interest-rate policy alone—and more specifically, a policy of adjusting the central bank's operating target for a short-term interest rate in response to contemporaneous economic conditions (as proposed, for example, by Taylor, 1993) – should suffice to maintain macroeconomic stability.

In order to allow for such a reappraisal, they propose a DSGE model with agents with limited foresight and a finite planning horizon. Under those conditions, and with a ZLB restriction, Ricardian equivalence ceases to apply, insofar as it depends on rational expectations, and fiscal transfers become a powerful tool, provided there is monetary accommodation. Yet, the authors recommend the return to traditional policies whenever the ZLB episode ends (Woodford and Xie, 2020).

In sum, the last 10 years have been a race against the clock for these modelers, as they have sought to adapt to a new economic reality that their framework was originally unable to account for. Many of these economists, who claim that these tools are the state of the art for projecting the future that is, for forecasting and assessing policy changes, have therefore spent the last decade seeking to coming to terms with the recent past. Despite these efforts, the DSGE modeling framework has left much of its criticism unresolved, as we will see in the following section.

5. DSGE under fire

Although quite successful in academia and central banks' research centers, the family of DSGE models has been subjected to vigorous criticism by a variety of economists. Their criticism has tended to concentrate on four topics: the

extreme simplicity of the micro foundations (Solow and Stiglitz), the intellectual regression implied by an *ad hoc* notion of causality (Romer), the flawed assumptions and methods (Blanchard) and the inadequate normative implications (Krugman).

In the very context of the Great Recession, Robert Solow, a key architect of the post-World War II synthesis alongside Samuelson, provided one of the first major attacks on DSGE, namely on their basic assumptions and calibration method. Solow denounced:

> a macroeconomics that is deduced from a model in which a single immortal consumer-worker-owner maximizes a perfectly conventional time-additive utility function over an infinite horizon, under perfect foresight and rational expectations, and in an institutional and technological environment that favors price taking behavior (Solow, 2008: 243).

He rejected that this could be traced back to his own seminal work establishing the neoclassical growth model, since there were some crucial differences in terms of the basic assumptions:

I deliberately avoided recourse to the optimizing representative agent and instead used as building blocks only aggregative relationships that are in principle observable (Solow, 2008: 244).

Furthermore, he went on to add that calibration deviates from science, as "in fact 'modern macro' has been notable for paying very little attention to data" (Solow, 2008: 245). His conclusion was combative:

> I suppose it could be also true that the bow to the Ramsey model is like wearing the school colors or singing the Notre Dame fight song: a harmless way of providing the apparent intellectual unity and may be even a minimal commonality of approach. That seems hardly worthy of grown-ups, especially because there is always a danger that some of the in-group come to believe the slogans, and it distorts their work (Solow, 2008: 245).

Later on, in a testimony on the state of economics to the US House of Representatives, Solow insisted:

> They [the DSGE models] take it for granted that the whole economy can be thought about as if it were a single, consistent person or dynasty carrying out a rationally designed, long-term plan, occasionally disturbed by unexpected shocks, but adapting to them in a rational, consistent way. I do not think that this picture passes the smell test. The protagonists of this idea make a claim to respectability by asserting that it is founded on what we know about microeconomic behavior, but I think that this claim is generally phony. (. . .) Under pressure from skeptics and from the need to deal with actual data, DSGE modelers have worked hard to allow for various market frictions and imperfections, like rigid prices and wages, asymmetries of information, time lags, and so on. This is all to the good. But the basic story always treats the whole economy as if it were like a person, trying consciously and rationally to do the best it can on behalf of the representative agent, given its circumstances. This can not be an adequate description of a national economy, which is pretty conspicuously not pursuing a consistent goal (Solow, 2010).

Stiglitz developed his own criticism in a 2011 paper called "Rethinking economics: what failed, and how to repair it." According to Stiglitz, DSGE proved "not [to be] a good starting point," as these models "have failed (to) predict that the financial crisis would happen; and when it did they understated its effects" (Stiglitz, 2011: 591). This was acknowledged by Thomas Sargent, who nevertheless countered, in an interview, that RBC and DSGE do not claim to explain economic crises:

> The criticism of real business cycle models and their close cousins, the so-called New Keynesian models, is misdirected and reflects a misunderstanding of the purpose for which those models were devised. These models were designed to describe aggregate economic fluctuations during normal times when markets can bring borrowers and lenders together in orderly ways, not during financial crises and market breakdowns (Sargent, 2010).

In any case, Stiglitz developed his criticism, largely on the same topics as Solow's, in two directions. The first is the implausibility of the core assumptions, as DSGE models are predicated on intertemporal utility maximization and rational expectations, which are inconsistent with available evidence and do not account for the diversity of agents' behavior. As is the case with other families of models, the representative agent assumption ignores, and does away with, issues of distribution, information asymmetries, externalities, agency problems and power. The result is *ad hocery* describing markets that clear perfectly as they are bombarded by technological shocks which are large enough to change the trend but small enough to remain unaccounted for in the model.

The second direction, which is the most relevant for the theme of this article, is that these models tend to ignore the functioning of the financial system, insofar as they disregard endogenously generated credit, which is "at the heart of understanding economic fluctuations," since the impact of central banks is mediated by banks through loans,

which is the essential channel for monetary policy (Stiglitz, 2011: 607). Looking back at a subprime crash that was generated by shadow banking, Stiglitz pointed out that the modern financial system accentuates risks of contagion, as institutional vulnerabilities are magnified by banking concentration, securitization, high leverage and the regulatory changes that have taken place since the end of the Glass-Steagall act. For all these reasons, Stiglitz lamented the disproportionally large intellectual influence of DSGE (Stiglitz, 2011: 636).

More recently, Stiglitz returned to the argument in another paper in which he once again criticized the representative agent approach and the inadequate attention to the financial sector: "The central problems of finance—bankruptcy, debt, and asymmetric information—simply cannot arise in a representative agent model," he claims (Stiglitz, 2017: 9). In other words, these models' microfoundations are simply wrong and unable to address the questions around policy design, namely when it comes to understanding the amplification and persistence of shocks and crises. At face value, these criticisms by Solow and Stiglitz extend beyond DSGE to challenge the core assumptions of neoclassical economics. This is not unprecedented. Even Walras rejected the assumption of perfect foresight as the basis for rationality, in his famous 1875 text discussing why railways should be publicly owned:

> The preceding reasoning has been founded on the hypothesis, generally accepted in matters of economic questions, that private interests are at the same time selfish and clear-sighted. However, as we have observed, this hypothesis is not quite consistent with reality. Selfish, private interests certainly always are, but clear-sighted is another matter (Walras, 1875: 182).

Christiano et al. (2017: 2) reacted, accusing Stiglitz of "egregious mischaracterization" and bluntly affirming that "people who don't like DSGE models are dilettantes. By this we mean they aren't serious about policy analysis." Even if this level of emotion is uncommon in scientific discourse, the argument was audacious: according to the DSGE performers, only in models can the economist conduct experiments just as in a laboratory, and therefore compare policy outcomes. In a later and milder version of the same paper, which was published in an academic journal, the authors claimed that DSGE is "the leading tool" to carry out policy simulation and that "there is simply no credible alternative to policy analysis" (Christiano *et al.*, 2018: 124, 136). Their argument rests on a demarcation of the "dubious assumptions" of previous RBC models (Christiano *et al.*, 2018: 115) and on the results from several developments to address the fragility of the DSGE assumptions, such as allowing for the heterogeneity of agents, the existence of financial markets and nonlinearities, such as the ZLB for the interest rate. The authors pursue Friedman's view regarding the absence of the impact of monetary policy in the long term.

Several other critiques were aligned with those of Solow and Stiglitz. For instance, Romer (2016) delivered an aggressive indictment of the "more than three decades of intellectual regress" of macroeconomics brought about by Lucas, Prescott, and Sargent, the leaders of this movement, as he himself was abandoning academia. In particular, he criticized two concepts used by RBC and then DSGE. The first critique is that fluctuations in macroeconomic aggregates are caused by imaginary shocks, which he satirically called *phlogistons*, measured as the deviation between the data and the simulation of the deterministic part of the model, thereby constituting an index of the modeler's ignorance. Romer highlights the example of Prescott's (1986) calculation that 84% of output variability is due to these shocks. If this is the case, then the explanation rests on the ignorance of the modeler, even though such a level of ignorance may have no ontological counterpart and may bear no meaning. The second critique by Romer focuses on the identification problem in systems of simultaneous equations, which is addressed in these models by adding *ad hoc* assumptions, for example regarding the way that errors are distributed or the values that certain parameters take. This is what Romer calls "post real" economics.

Other economists had already pointed to this lack of identification in aggregate models. For instance, Hansen and Heckman concluded that the models inspired by Lucas were only able to illustrate qualitative properties and could not provide the ground for policy choices, as "the deliberately limited use of available information in such computational experiments runs the danger of making many economic models with very different welfare implications compatible with the evidence" (Hansen and Heckman, 1996: 87–88). In other words, everything goes.

Blanchard advanced a third type of critique of DSGE, despite claiming they "have a future" if they become "less insular" and "less imperialistic," in spite of being "seriously flawed." According to his view, the main flaws are the "unappealing assumptions," which are "profoundly at odds with what we know about consumers and firms," such as: "infinitely lived and foresighted consumers"; the "unconvincing" methods of estimation, or the identification problem; the "unconvincing normative implications"; and, finally, the fact that these models are "bad communication devices" (Blanchard, 2016a,b, 2017a,b).

The fourth type of challenge to DSGE concentrated on the policy implications of DSGE models. Krugman formulated his criticism in 2015 (Krugman and Madrick, 2015) and also in a *New York Times* piece, in which he noted the "sad" description of DSGE by Blanchard. He argued that its modelers wrongly opposed well established policies:

> old-fashioned Hicksian IS-LM type analysis made some strong predictions after the financial crisis that were very much at odds with what lay commentators, and quite a few economists, were saying. They—OK, we—declared that with interest rates near zero massive increases in the monetary base would not cause high inflation, that large budget deficits would not drive interest rates up or crowd out private investment, and that fiscal multipliers would be positive, in fact more than one, and would be considerably larger than estimates based on non-liquidity-trap episodes suggested" (Krugman, 2016).

For Krugman, the old framework of IS-LM performed well as a guide for government responses to recessions, except it did not anticipate deflation (Krugman, 2018). In a curious coincidence and like Taylor (2007), he regarded the takeover of macroeconomics by RBC and DSGE modelers as the onset of a Dark Age, and praised central bank policy makers as "monasteries" for not adopting these modelers' policy implications and keeping the older tradition alive (Krugman, 2011).

6. Time for pragmatism at the Central banks

The mandate of Jean-Claude Trichet at the head of the European Central Bank was controversial, especially because he imposed a pro-cyclical increase of the interest rate in 2011, when the impacts of the Great Recession were still not dissipated and the debt crisis ravaged the Southern European countries. But Trichet stands alone, to the best of our knowledge, as a central banker who publicly blamed the models used by his institution for their inadequate assumptions and inability to predict the crisis. In a speech in 2010, he complained about the deficient analytical tools of the bank and explained why DSGE could mislead policy makers:

> [In] the face of crisis, we felt abandoned by conventional tools. (. . .) The key lesson (. . .) is the danger of relying on a single tool, methodology or paradigm (Trichet, 2010).
> According to Trichet, three reasons diminish the analytical ability of these models: they ignore the heterogeneity of agents, they simplify the formation of expectations, and they misread the financial system. His argument posited that:
> First, we have to think about how to characterize the homo economicus at the heart of any model. The atomistic, optimizing agents underlying existing models do not capture behavior during a crisis period. We need to deal better with heterogeneity across agents and the interaction among those heterogeneous agents.
> As a consequence, he added,
> we need to better integrate the crucial role played by the financial system into our macroeconomic models. One approach appends a financial sector to the existing framework, but more far-reaching amendments may be required. In particular, dealing with the non-linear behavior of the financial system will be important, so as to account for the pro-cyclical buildup of leverage and vulnerabilities. An important perspective that researchers in other fields bring to economics is a focus on identifying the features that explain economic systems as we know them. A large number of aspects of the observed behavior of financial markets is hard to reconcile with the efficient markets hypothesis, at the heart of most conventional models (Trichet, 2010, his emphasis).
> This is exactly what Solow and Stiglitz had argued. Indeed, Trichet concluded by suggesting the need to resort to other analytical tools: "We do not need to throw out our DSGE and asset-pricing models: rather we need to develop complementary tools to improve the robustness of our overall framework," such as "agent-based modeling, [which] allows for more complex interactions between agents" (Trichet, 2010). In fact, agent-based models have been proposed to explore new ways of approaching policy simulation, namely on the effects of fiscal and industrial policies (Dosi *et al.*, 2010; Haldane and Turrell, 2018; Dosi *et al.*, 2020), but their adoption by the research departments of central banks has been residual.

As Trichet expressed, the discomfort of central bankers grew over time. In his own case, despite lamenting the narrowness of the DSGE models and prescriptions, he did not adopt anti-cyclical measures. But, the time would soon come for other central bankers to promote alternative policies, amongst which QE would emerge as the most important. This policy was not unknown to the profession, for it had been recently used by the Bank of Japan, from March 2001 until 2006, albeit with unimpressive results (to date, Japan has lived for 30 years in a regime of short-term interest rates and long-term public bond yields near zero). But, it was only after the 2008 crash and the subsequent recession that QE became a common monetary policy tool. The Fed expanded its balance with asset purchases since September 2008 and then established its first QE program in 2009, followed by QE2 in November 2010 and QE3 in September 2012 QE3, which eventually amounted to 22% of the 2014 GDP. The Bank of England followed in

March 2009, as did the Bank of Japan, which launched a new program in October 2010. The ECB, for reasons to do with its own idiosyncratic rules, waited until January 2015 to initiate its own QE program, but its mandate came to be more extensive at that juncture than the Fed's.

Mario Draghi, who replaced Trichet at the head of the ECB, argued that the world had changed. Instead of Friedman's (or Taylor's) rule, which had been designed for controlling inflation, a massive expansion in the balance sheet of the central bank was what was called for in these new times. In his "Farewell Remarks" at the end of his mandate on October 28, 2019, he stated that:

> When the ECB was established, its dominant concern was to keep inflation down. The ECB was a new central bank with no track record, so its policy framework was expressly designed to build strong anti-inflationary credibility. It achieved this quickly, and it is to the tremendous credit of the ECB's early leaders that its first decade went so smoothly. But no one could have foreseen that the environment facing monetary policy globally was soon to abruptly reverse: that inflationary forces would turn into deflationary ones. In all advanced economies, this called for a new paradigm for central banking, which comprised two elements: the determination to fight deflation as strongly as inflation, and flexibility in the choice of instruments to do so (Draghi, 2019).
> To his credit, Draghi insisted on national expansionary fiscal policies by the dominant European economies as the only substantial solution to the demand shortage, in complement to QE—a point that he reiterated after leaving the presidency of the bank, by asking for more public "good debt" (Draghi, 2020). This was in stark contrast to the previous head of the ECB, Trichet, who had championed austerity measures and even claimed that "the idea that austerity measures could trigger stagnation is incorrect" (Trichet, 2010).

Ben Bernanke, who, unlike Draghi, was at the command of a central bank, the Fed, during the crash, reviewed his actions in January 2020 in his presidential address to the American Economic Association. His topic was "The New Tools of Monetary Policy" in the context of an effective lower bound for interest rates. In these circumstances, QE was regarded as a necessary alternative to traditional monetary policies:

> After cutting short-term rates to zero (or nearly so), the Federal Reserve and other central banks turned to alternative policy tools to provide stimulus, including large-scale purchases of financial assets ('quantitative easing'), increasingly explicit communication about the central bank's outlook and policy plans ('forward guidance'), and, outside the United States, some other tools as well. (...) On one point we can be certain: The old methods won't do. For example, simulations of the Fed's main macroeconometric model suggest that the use of policy rules developed before the crisis would result in short-term rates being constrained by zero as much as one-third of the time, with severe consequences for economic performance. If monetary policy is to remain relevant, policymakers will have to adopt new tools, tactics, and frameworks (Bernanke, 2020).

Bernanke explained in his address why he favored pragmatic movements rather than model-based alternatives, which do not fully incorporate uncertainty and confidence:

> My reading of the post-crisis experience is that, in both the United States and elsewhere, the new policy tools helped ease financial conditions and led ultimately to significantly better economic outcomes than would have otherwise occurred. In particular, model simulations do not fully account for the beneficial effects of the policy interventions on confidence, risk-taking, and credit flows, each of which was badly damaged by the crisis" (Bernanke, 2020).

QE and forward guidance, together with other tools, such as credit emergency facilities, currency swaps and sovereign debt markets interventions, were used extensively by different central banks as new tools, in sharp contrast to the monetarist policy rules that Taylor and others defended. Monetary policy was redefined in this new horizon and, according to Bernanke, should be combined with fiscal policy if the "neutral interest rate" remained below 2% (Bernanke, 2020), although he reiterated his belief that monetary policy would be sufficient to deliver stabilization.

Bernanke restated his policy after balancing the persistent effects, including the "[small] distributional effect of expansionary monetary policies," and also the possible dangers of QE, namely that it can create significant financial instability as asset bubbles emerge and risk-taking is encouraged. He dismissed the contribution of in-house DSGE models, noting that only a "small literature" used these to discuss the topic of policy choices, and noted the better performance of macro models (Bernanke, 2020).

Jerome Powell, the current chair of the Fed, provided a candid recognition of the failure of dominant models and tools at the 2018 Jackson Hole seminar. Resorting to a nautical metaphor (he referred to the "natural" rate of unemployment, potential output and the inflation target as the orienting "stars"), Powell recognized that "[n]avigating by the stars can sound straightforward. Guiding policy by the stars in practice, however, has been quite challenging of late," and it is so because "the economy has been changing in ways that are difficult to detect and measure in real

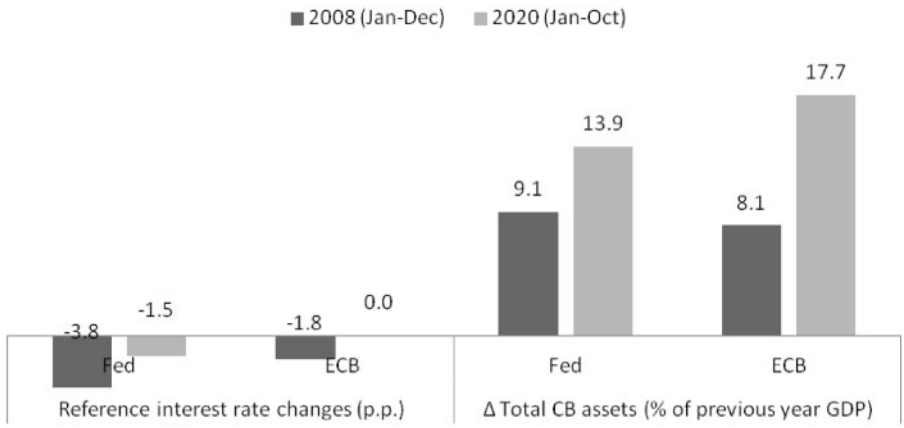

Figure 1. Counter-cyclical monetary policy measures by the Federal Reserve Bank and European Central Bank in 2008 and 2020 (reference interest rate cuts and net asset purchases). Notes: Reference interest changes in percentage points. Change calculated over period: 2008: January 1 to December 31; 2020: January 1 to October 31. Reference interest considered: Fed, Effective Federal Funds Rate; ECB, Main Refinancing Operations Rate. Change in total assets in percent of nominal GDP (of the US and Euro zone, respectively) of the previous year (2008 and 2019, respectively). *Sources*: FRED St Louis (Effective Federal Funds Rate, ECB total assets, Fed total assets, and US nominal GDP), European Central Bank (ECB rates), AMECO (Euro zone nominal GDP), and own calculations.

time." Citing the flattening of the Phillips curve and the anchoring of inflation expectations, Powell (2018b) noted that inflation is no longer the "best indicator of a tight labor market and rising pressures on resource utilization."

It is interesting to note that neither Powell, nor any other participant of the Jackson Hole seminar devoted any time to discussing why the Phillips curve had flattened, or why tight labor markets no longer create inflation. This indication of changing structure—which last raised its head during the late 1990s boom—also suggests a crumbling consensus. Despite that disarray, and in contrast to the pre-crisis 2008 consensus, the Fed was no longer shy in admitting that "no single, simple approach to monetary policy is likely to be appropriate across a broad range of plausible scenarios." In that vein, it is also remarkable to record when the chair of the Fed dismissed the "monetary policy inflation-bias" hypothesis, and claimed instead that there are no reasons for inflation-phobia, since "low inflation seems to be the problem of this era, not high inflation" (Powell, 2018b).

The fact is that in the context of the 2020 coronavirus-induced recession, not only QE, but also fiscal policy have been extensively used and coordinated (see Figures 1 and 2, which estimate the initial magnitude of both types of policies): by the end of the first half of 2020, no more than 3 months into the COVID crisis, the advanced economies central banks' balance sheet had grown by 10% of GDP, and fiscal stimulus was up to $4.2 trillion with the possibility of reaching 15% of global GDP (IMF, 2020), which generated a global deficit close to 17% of global GDP. Some, like Christine Lagarde, the current head of the ECB, have asked for a permanent stabilization fund (Charles, 2020).

We close this section with a word of caution regarding the social context of scientific research. Fabo *et al.* (2020) studied the institutional bias of different pieces of research on the impact of QE, including conflict of interests. Based on 54 studies from 116 authors up until 2018, they found that central bank staff produce more favorable evaluations on the impact of QE than do their academic counterparts. During the period under study, all central bank researchers, except those of the Bundesbank, report statistically significant effects of QE on GDP and inflation, while only half of the academic papers suggest the same. Furthermore, the central banks papers rely more heavily on DSGE than on alternative econometric methods, although they more rarely disclose the width of the confidence intervals of their computations. In addition, and more disturbingly, the authors found that central bank staff who report larger impacts tend to enjoy better career outcomes.

7. The rift among monetarists

In the previous sections, the work of some influential neoclassical economists was summarized, discussing how monetarism prevailed as a policy-orienting alternative to Keynesianism, and then how the Lucasian challenge promoted

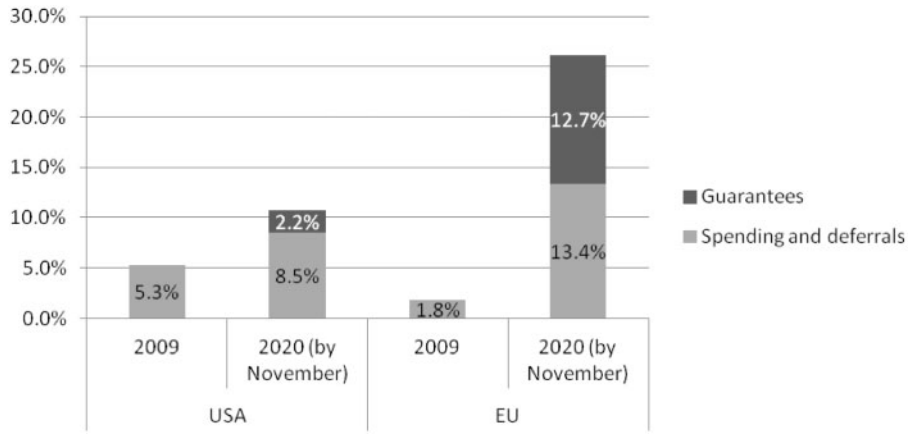

Figure 2. Estimated amount of counter-cyclical fiscal stimulus measures announced in 2009 and 2020 by the US and EU governments (percent of GDP). Notes: The following fiscal stimulus elements were considered: USA 2009: ARRA Act ($787 billion); USA 2020: CARES Act ($2.2 trillion); EU 2009: European Economic Recovery Plan (EU and member-states, $200 billion); EU 2020: all measures included in the IMF Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic (EU and member-states) as of November 5, 2020. All measures in percent of previous year nominal GDP (2008 and 2019, respectively). *Sources*: IMF Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic, Congressional Budget Office, European Commission, FRED St Louis, AMECO, and own calculations.

RBC and DSGE models. Although these models proposed different views of macroeconomic policy, the monetarist rule remained dominant among the heads of the central banks throughout the Great Moderation. Yet, when the 2008 financial crash demanded extraordinary measures, the central banks moved away from these longstanding rules. Although Cochrane and his associates retained Chicago-school discipline in the face of the crisis, the alarm of the practicing monetarist central bankers led them to exit the burning building.

Some monetarists, especially Bernanke in the USA, responded to the extreme circumstances, and argued that the emergency strategy remained within the broad scope of their common identity. David Laidler, who was a research assistant for Friedman's and Schwarz's *Monetary History*, recalled how his tutor addressed QE in the last phase of his life. After a keynote speech at a Bank of Canada conference in 2000, Laidler had asked Friedman what he thought the Japanese central bank should do to address the problem of a prolonged recession and liquidity trap. The reply was:

> It's very simple. They can buy long-term government securities, and they can keep buying them and providing high-powered money until the high-powered money starts getting the economy in an expansion. What Japan needs is a more expansive domestic monetary policy (Friedman, 2000: 421).

Bernanke and the other central bankers followed this lead.

Other monetarists, including John Taylor of eponymous rule fame, were vehemently opposed. Taylor was undersecretary of Treasury of George W. Bush from 2001 to 2005, at the very end of the Great Moderation consensus and on the eve of the subprime crash and the controversial bailout. To this day, Taylor continues to criticize the abandonment of his rule in 2008, when the Fed joined forces with the Treasury to inject large amounts of liquidity and organize the bailout of major financial agencies: "I have argued that the Fed turned away from the policy rule that had been working well" (Taylor, 2017: 11). Unlike Cochrane, Taylor accepted the emergency package as an immediate step, but rejected the ensuing QE programs:

> 2008 was the panic, and so the Federal Reserve provided loans to financial institutions to prevent runs on them. It was in 2009 and 2010 when they purchased large amounts of mortgages and mortgage-backed and government securities that I tended to question the practice, since these programs were ineffective, and potentially harmful (Taylor, 2012).

Taylor condemned the Fed's QE as well the subsequent fiscal policy, observing that the 2007–2009 stimulus package "did little or nothing to stimulate the economy," and—claiming a tendency towards cash hoarding by households and State governments—he computed a fiscal multiplier that was not significantly different from zero. Instead of

these stimuli, he proposed the need to move back to the "gradual, credible reductions in the deficit through control of growth of spending [that] can be beneficial to the economy in the short run and the long run" (Taylor, 2018a: 2, 17, 29).

Cochrane, in turn, opposed QE from top to bottom. He proposed two arguments. The first is that QE only alters the basket of maturities: "In my opinion, QE has essentially no effect. Interest rates are zero, so short-term bonds are a perfect substitute for reserves. QE creates a minor change to the maturity structure of government debt" (Cochrane, 2013: 35; also 2020), but it is integrated in dangerous fiscal and regulatory policy, such that "bailouts are back" and bankruptcies are prevented, in spite of "the point of bankruptcy [being] precisely to keep the business going" (Cochrane, 2020a). Cochrane then asserts that QE only amounts to political posturing by the central banks, as "QE allowed the Fed to make a big and important sounding gesture, to say they were saving the world" (Cochrane, 2018; also 2020c). Eugene Fama concurred: "Frankly, I think this is just posturing. Actually, the central banks don't do anything real. They are issuing one form of debt to buy another form of debt" (Fama, 2020). Fama extended this critique to a radical rejection of the very notion of action by the central banks: "I use to say that the business of central banks is like pornography: in essence, it's just entertainment and it doesn't have any real effects," and penalized the banks for abandoning the task of controlling inflation, since "there is no control over the stock of what qualifies as money, since reserves aren't really money anymore because they are paying interest. That means you can't control the currency supply. In other words: inflation is totally out of the control of central banks" (Fama, 2020).

Other economists shared the same rejection of the exceptional measures adopted by the central banks and governments since the 2008 crash. In the *Wall Street Journal*, Edmund Phelps published an indictment of Keynesian stimulus, since it would lead to low growth (Phelps, 2018), and Robert Barro rejected expansionary fiscal policies, measuring the multiplier close to zero, and he proposed that "eliminating the federal corporate income tax would be brilliant" (Barro, 2009), together with adopting fiscal austerity (Barro, 2012), and avoiding crowding out (Barro, 2020).

As the monetarist camp became divided over resorting to unorthodox tools of monetary policy, the rift was elevated to the level of the decision making of the central banks.

8. Mapping the contortions of Central bankers

The pre-2008 consensus which prevailed amongst central bankers and a majority of other policy-makers during the Great Moderation revolved around a small number of key ideas, namely: central banks should be independent; price stability should be their primary goal; financial markets are efficient at assessing and pooling risk, with systemic crises being a thing of the past (or limited to peripheral countries which lack sufficient financial development); short-term aggregate demand management should be undertaken though rules-based (rather than discretionary) and monetary (rather than fiscal) policy; changes in policy rates work by affecting longer-term interest rates and asset prices, and also by changing expectations of future inflation; and fiscal policy should be limited to the work of automatic stabilizers.

This consensus came tumbling down in the early 21st Century. For while some incidents predate 2008 (such as the Bank of Japan engaging in QE from as early as 2001), the real watershed was the financial crisis and the ensuing Great Recession. In particular, the lasting grip of the Great Recession led to replacement of the previous consensus with a willingness to embrace much more pragmatic and activist stances on monetary and fiscal policy. This shift was swifter in some contexts and for some institutions (e.g., Japan, the UK, and the USA) than for others (the EU, especially the ECB), but sooner or later doing "whatever it takes" became the norm across all the major advanced economies. On the intellectual and discursive planes, this shift involved a decade-long contortionist's exercise of trying to combine elements of the pre-crisis consensus with the need to justify the adoption of pragmatic and activist policy actions. This shifting landscape, which was certainly not without its clashes and inconsistencies, is illustrated by the evolving debates at the Federal Reserve of Kansas City seminars in Jackson Hole in the years after the crisis.

With regard to fiscal policy, the contortions took the form of a constant balancing act between calls for countercyclical fiscal stimulus, which was increasingly regarded as a necessary complement to monetary expansion, and "responsible" fiscal consolidation. Ben Bernanke, the former chair of the Federal Reserve, provides a number of examples of this. In his opening remarks at the 2010 Jackson Hole meeting, for example, he argued that "fiscal policy—including stimulus packages, expansions of the social safety net, and the countercyclical spending and tax

policies known collectively as automatic stabilizers—also helped to arrest the global decline" and that "expansionary fiscal policies and a powerful inventory cycle, helped by a recovery in international trade and improved financial conditions, fueled a significant pickup in growth" (Bernanke, 2010). One year later, Bernanke's emphasis had shifted back to consolidation: while calling on policymakers not to "disregard the fragility of the current economic recovery," he nevertheless argued that "fiscal sustainability must urgently be addressed" and that fiscal policy must ensure "that debt relative to national income is at least stable or, preferably, declining over time" (Bernanke, 2011). The Chair of the Fed was effectively suggesting that fiscal policy should be simultaneously expansionary and contractionary, and did not necessarily regard this as inconsistent: "Fortunately, the two goals of achieving fiscal sustainability (. . .) and avoiding the creation of fiscal headwinds for the current recovery are not incompatible" (Bernanke, 2011). Bernanke once again attempted the same balancing act in 2012: on the one hand, he maintained that "it is critical that fiscal policy makers put in place a credible plan that sets the federal budget on a sustainable trajectory in the medium and longer runs"; whereas on the other, he urged policymakers to "take care to avoid a sharp near-term fiscal contraction that could endanger the recovery" (Bernanke, 2012).

Bernanke's successor, Janet Yellen, did not diverge substantially on this matter. In her opening remarks to the 2014 Jackson Hole meeting, for example, while arguing that:

> [a] wide range of possible fiscal policy tools and approaches could enhance the cyclical stability of the economy. For example, steps could be taken to increase the effectiveness of the automatic stabilizers, and some economists have proposed that greater fiscal support could be usefully provided to state and local governments during recessions.

She also took pains to point out that "it would be important to ensure that any fiscal policy changes did not compromise long-run fiscal sustainability" (Yellen, 2014). Neither did Mario Draghi, who had been appointed as the President of the ECB in 2011, differ in this respect. He also persistently sought to combine calls for fiscal expansion:

> it would be helpful for the overall stance of policy if fiscal policy could play a greater role alongside monetary policy, and I believe there is scope for this, while taking into account our specific initial conditions and legal constraints" (Draghi, 2014)

with reminders of the inexorable need for fiscal consolidation to appease investors' confidence, such that "a fiscal drag and a downturn in public sector employment which added to the ongoing contraction in employment in other sectors" was effectively "necessary" (Draghi, 2014). Draghi became increasingly cavalier in his call for activist fiscal stimulus towards the end of his period at the helm of the ECB, but never quite overcame this arguably inconsistent attempt at squaring the circle between fiscal expansion and fiscal consolidation and the previously dominant argument for expansionary austerity.

The contortions aimed at justifying the shattering of the pre-existing orthodoxy as far as monetary policy was concerned were perhaps even more spectacular. As central bankers were forced to resort to pragmatism, breaking every rule in the book and engaging in large-scale unconventional actions to support the economic recovery, they initially sought to justify their actions through the theoretical lenses that supported the previous consensus. For example, at the 2012 Jackson Hole meeting, Bernanke suggested that QE works because of a

> portfolio balance channel, which is based on the ideas of a number of well-known monetary economists, including James Tobin, Milton Friedman, Franco Modigliani, Karl Brunner and Allan Meltzer. The key premise underlying this channel is that, for a variety of reasons, different classes of financial assets are not perfect substitutes in investors' portfolios (Bernanke, 2012).

On the other hand, seeking to justify the abandonment of Taylor-like rules, Bernanke went on to suggest that this may be necessary because of "the need to take out insurance against the realization of downside risks, which are particularly difficult to manage when rates are close to their effective lower bound" (Bernanke, 2012). Another example of this contortion exercise is the attempt to justify QE by reference to its effect on managing expectations, with QE:

> signal[ling] that the central bank intends to pursue a persistently more accommodative policy stance than previously thought, thereby lowering investors' expectations for the future path of the federal funds rate and putting additional downward pressure on long-term interest rates, particularly in real terms (Bernanke, 2012).

In this respect, Yellen's departure from the pre-2008 consensus was certainly more outright, as she unapologetically embraced pragmatism in conducting monetary policy:

> monetary policy ultimately must be conducted in a pragmatic manner that relies not on any particular indicator or model, but instead reflects an ongoing assessment of a wide range of information in the context of our ever-evolving understanding of the economy (Yellen, 2014).

Two years later, she went further in stressing the need for central bankers to exercise their discretionary power ("as ever, the economic outlook is uncertain, and so monetary policy is not on a preset course"; Yellen, 2014) and in criticizing the pre-crisis consensus:

> The global financial crisis revealed two main shortcomings of this [pre-2008] simple toolkit. The first was an inability to control the federal funds rate once reserves were no longer relatively scarce [and the second was] its inability to generate substantially more accommodation than could be provided by a near-zero federal funds rate (Yellen, 2014).

This question of the liquidity trap and the extent to which the zero lower bound constrains monetary policy would make frequent appearances in the debates at Jackson Hole throughout the decade. As Yellen (2016) stated:

Forecasts now show the federal funds rate settling at about 3% in the longer run. In contrast, the federal funds rate averaged more than 7% between 1965 and 2000. Thus, we expect to have less scope for interest rate cuts than we have had historically.

At the same time, however, Yellen regarded this state of affairs as likely to be exceptional and short-lived:

> the federal funds rate at the onset of the [next] recession would be well above its normal level, and the FOMC [Federal Open Market Committee] would be able to cut short-term interest rates by substantially more than 3% (Yellen, 2016).

But that prediction would be proved incorrect in 2020, for as the decade progressed, the more or less permanent character of this new reality gradually sunk in, as illustrated by Jerome Powell's first intervention at Jackson Hole after his appointment to be the Chair of the Fed:

> As we look back over the decade since the end of the financial crisis, we can again see fundamental economic changes that call for a reassessment of our policy framework. The current era has been characterized by much lower neutral interest rates, disinflationary pressures and slower growth (Powell, 2018b).

Pragmatism and the increasing realization that the world had changed then combined to nudge the leading central bankers towards embracing unconventional monetary policy, particularly QE. In 2010, Bernanke had already argued that "QE is effective in easing financial conditions," though he was initially wary of the possibility that expanding QE too much could hurt public confidence in the Fed's "ability to execute a smooth exit from its accommodative policies at the appropriate time" that "might lead to an undesired increase in inflation expectations"—a concern which failed to materialize (Bernanke, 2012). The IMF was also quick in its praise of unconventional monetary policy (UMP). Speaking at the Jackson Hole meeting in 2013, Christine Lagarde made it clear that the IMF's assessment of UMP was that "its impact so far has been positive" and that "UMP helped support economic activity *and* financial stability," reducing long-term US bond yields by "more than 100 basis points (. . .), boosting world output by more than 1%," and increasing financial stability by "reducing market uncertainty during periods of elevated financial stress" (Lagarde, 2013). Clearly aware of the growing rift between central bankers and the world of mainstream academic economists, Lagarde tellingly called for a new consensus acknowledging the effectiveness of QE and other UMP: "We can best meet these challenges by working openly together (. . .) we need to work better together to understand more fully the impact of these unconventional policies" (Lagarde, 2013). Although such a consensus among all of academia failed to materialize, this change in paradigm had certainly become uncontroversial amongst central bankers when Janet Yellen addressed the Jackson Hole meeting in 2016 to defend the legacy of the Fed's QE and UMP actions:

> our asset purchases and extended forward rate guidance put appreciable downward pressure on long-term interest rates and, as a result, helped spur growth in demand for goods and services, lower the unemployment rate and prevent inflation from falling further below our 2% objective (Yellen, 2016).

Against this rapidly changing background, even the old dogma of central bank independence was ultimately brought into question by the high priests of central banking, as a consequence of its subordination to the need for coordination between monetary and fiscal policies when faced with an imminent collapse. This was explicit in

Bernanke's unambiguous acknowledgment that the coordinated actions of central banks and governments had played a positive and necessary role to mitigate the crisis:

> governments and central banks worked forcefully and in close coordination to avert the looming collapse. The actions to stabilize the financial system were accompanied, both in the United States and abroad, by substantial monetary and fiscal stimulus (Bernanke, 2011).

9. The missing link

A decade after the Great Recession and amidst a long period of zero or negative reference interest rates, a new paradigm seems to be emerging as economic debates interpret the lessons of the two recessions. This can be framed by the following principles:

1. Active monetary policies are important tools for anti-cyclical action;
2. Long-term low interest rates are constrained by the lack of aggregate demand, by chronically low inflation, and by the dynamics of savings in times of uncertainty and scarred consumption;
3. Inflation appears insensitive to unemployment;
4. Crowding out vanishes in the presence of zero or negative interest-rate;
5. Intermediation by capital markets and shadow banking tends to be more important than that of traditional banks;
6. Budgets tend to become inflated as fiscal policy becomes the central instrument for stabilization, and as ageing and climate change become part of the public decision agenda;
7. Bailouts in times of crises are largely unavoidable;
8. High inequality, high debt, and low nominal interest rates all emerge as secular trends.
9. While high inequality has many drivers, QE may contribute to it (by raising bond prices and enabling stock-market speculation), which consequently results in a new policy tradeoff.

This paradigm does not indicate a full consensus that is similar to the neoliberal convergence that it replaces. For it is favored to a degree by pragmatism, and has been reinforced by recurrent recessions. The disarray among monetarists (some of whom have followed Friedman and favored QE, whereas others have denounced it) and among RBC and DSGE modelers (who acknowledged the inadequacy of their tools to predict crises) contrasts with the adaptability of central bankers and decision makers to the combination of monetary expansion and fiscal activism. As the option for QE tended to dominate and generate convergence, the role of fiscal policy has remained a highly contested battleground among economists. Most neoclassical devotees were able to overcome their doctrinal differences on monetary policy to reject fiscal approaches and instead converged towards advocating supply side measures to improve market flexibility.

As previously noted, the monetarist critique of counter-cyclical measures was reinforced by rigid adherence to multiplier estimates close to zero, even in the depths of the 2009 recession, and also the implied worthlessness of fiscal policy (Taylor, 2018a). Likewise, Cochrane found a multiplier "significantly less than one" for the 2009 package (Cochrane, 2018), as did Ramey (2020). Yet, other researchers and the IMF Fiscal Affairs Department challenge this conclusion, with the latter reporting that six to eight jobs were created in the short term by each million USD$ of investment under the 2009 US American Recovery and Reinvestment Act (Wilson, 2012; Garin, 2019; IMF, 2020: 37–38) and finding a large positive multiplier for current fiscal expenditures. In the introduction to the "2020 Fiscal Monitor," the head of the IMF Department explains why the report deviates from conventional visions that deny the dimension of the positive multiplier:

> But the novel argument in the *Fiscal Monitor* relates to uncertainty. Investment multipliers are particularly high when macroeconomic uncertainty is elevated—and uncertainty in the current *World Economic Outlook* is 'unusually large.' Under such conditions, public investment acts as a catalyst for private investment to take off. The 2020 *Fiscal Monitor* estimates that a 1% of GDP increase in public investment, in advanced economies and emerging markets has the potential to push GDP up by 2.7%, private investment by 10% and, most importantly, to create between 20 and 33 million jobs, directly and indirectly. Investment in health and education and in digital and green infrastructure can connect people, improve economy-wide productivity, and improve resilience to climate change and future pandemics (IMF, 2020: also 40–41).

Bachmann and Sims also found multipliers of public investment larger than 2 in periods of uncertainty (Bachmann and Sims, 2012). Based on those findings, "fiscal policy [should be] on the front line" in advanced economies, targeting low income households and using discretionary policy, rather than only automatic stabilizers (IMF, 2020: 5).

At the time of writing this article, it is uncertain when and how a recovery will take place. A study of previous pandemics suggests that in earlier centuries it took decades to restore the economy (Jordà *et al.*, 2020), although this refers to societies which can hardly be compared with our present-day ones. This article also suggests the existence of a common trend in all those occasions: a rise of precautionary savings. The same conclusion is established by recent research on the COVID-19 recession, which has identified high unemployment and persistent pessimism, scarred consumption (Malmendier and Shen, 2019) and the fact that, as the perceived risk of financial assets remains high, the demand for safe assets depresses the riskless rate (Kozlowski *et al.*, 2018). Consequently, the effects of a ZLB on interest rates can be prolonged and, as a consequence, fiscal action becomes the essential tool for anti-cyclical policies.

Although this conclusion is challenged by monetarists, calls for activist fiscal policy have started to gain momentum, an example being the work of Angeletos and Lian (2018), who favor the "front-loading of fiscal stimuli," just as the IMF does. However, this poses two major difficulties for general equilibrium models. The first is that the theoretical justifications prove paradoxical, in particular when the models are extended to account for uncertainty. In the research of Angeletos and Lian, the use of applied game theory to model private exogenous information for each agent is encapsulated in a general equilibrium framework. As a consequence, a vague concept is proposed:

> It [the high level of uncertainty] can thus be interpreted interchangeably as a form of coordination failure that is consistent with equilibrium uniqueness, and as a form of bounded rationality that is consistent with the rational expectations equilibrium concept (Angeletos and Lian, 2018: 2478).

In contrast to the universe of typical rational expectations, the authors "assume that the observation of all the relevant variables, including the available market signals, is contaminated by idiosyncratic noise due to rational inattention" (Angeletos and Lian, 2018: 2484). Contemporary economic thought has moved a long way since the justification for this family of models was the claim that they were the only ones that were based on the solid microfoundations of optimizing behavior and the rational expectations of the agents.

The second difficulty emerges when the models are extended to take account of financial networks, or when they include any form of feedback loops among heterogeneous agents and strategies. Most large DSGE models are solved by imposing a "certainty equivalent," as they are log linearized in order to address nonlinearities and to solve the deterministic systems, and they also assume the shocks to be Gaussian. Normality is assumed for obtaining the tractability of impulse-response functions, because, if that were not the case, then the system would be nonlinear and the shocks non-Gaussian, with their joint predictive distribution generally being unknown and the existence of fat tails being a possibility (Andrle and Hunt, 2020). The asymmetry of recessions and recovery periods suggests nonlinear structures, given the time-dependence of variables, and non-Gaussian shocks, just as nonlinearities such as the ZLB are acknowledged. In this case, discretionary, adaptive and monitored policies are more valuable than a rules-based orientation, which is time-independent. Either way, financial networks are a relevant example of nonlinearity, even though some economists argue that financial factors only played a limited role in the Great Recession in the case of the euro zone (Hirschbuhl *et al.*, 2020). Consequently, the need to pay attention to banking and credit became a central challenge for modeling. The implications are challenging. For instance, Ferrari proposes a framework comprised of an endogenous network of banks that is built on a traditional DSGE model, but obtains chaotic outcomes, with no defined steady state, as a consequence of the possible cascade effects of banking contagion (Ferrari, 2020). This justifies the option to carry out fiscal policy monitoring of the model economy that can lead to small but persistent effects.

Well before the subprime crash, and decidedly not in the DSGE tradition, Shiller (2000) warned of the danger of catastrophic events and contagion effects. Ormerod and Colbaugh (2006), following Perrow, analyzed cascades of failure in evolving complex systems and emphasized the nonlinear character of economic recurrences. Battiston *et al.* (2007) investigated credit chains and the propagation bankruptcy in production networks. After the subprime crash, the study of catastrophe and contagion gained momentum. For instance, Haldane and May (2011), an economist, and Robert May, a zoologist, identified systemic risk in banking ecosystems. In complex systems, contagion can prevail over equilibrating forces.

In their research on pandemics, Pasquale Cirillo, a statistician, and Nassim Taleb, a mathematician, computed the risk of contagion and tail risk for 72 observations of large-scale pandemic events over 2500 years, and they found evidence of a Pareto distribution of the number of victims, or a fat-tailed process, since the survival function decays as a power law as one moves to the right of the tail (Cirillo and Taleb, 2020). In this case, second moments are rendered useless for inference and the law of small numbers applies (Taleb, 2020).

There is a long tradition of heterodox studies of complex adaptive systems in economics that point to cascade processes, mostly in cases of financial instability, such as the 1987 crisis or the subprime crashes. Complexity operates at different levels in the context of these social frameworks, independently from natural systems, since purposefulness and coordination are present. In any case, although the standard model supposes that markets are able to manage risk and dissipate perturbations, experience shows that the amplification of shocks can contradict the self-regulating model, and thus the conditions for contagion can emerge as the result of changing expectations and social adaptation to perturbations. Nonlinearities in these complex adaptive systems also lead to structural instability and multiple equilibria, as Kirman argued (Kirman, 2010; Helbing and Kirman, 2013). Instability can also emerge from strategies, as those of the shadow finance agencies, which, for example, prevent valuable information from being disseminated in public, just as exemptions from securities regulations are facilitated to qualified investors (Bolton *et al.*, 2016). This is why financial crises have been diagnosed as systemic failures of economic theories (Colander *et al.*, 2009).

A promising new avenue for economics is suggested by many of the critical views that have been discussed throughout this article. As the 'proof of the pudding is eating it,' the proof of economics is how to address a major crisis, and accordingly we see no reason to abandon the notion of realistic and policy-oriented economics that can evaluate a large array of actions as a response to a recession. The adaptation of different agencies, including central banks and international institutions, to disregard monetarist rules and favor fiscal expansion could be a sign of this new concept. For this concept to take hold, it appears that the missing link is the necessity for new macrofoundations for microeconomics, where relevant features will include complex adaptive models for predicting and measuring financial instability, as well as an agenda for counter-cyclical and structural tools, such as aggregate demand impulses, namely the creation of investment and industrial and innovation stimuli, both at the macroeconomic and the firm level.

Acknowledgments

We thank Michael Ash, Giovanni Dosi, Gerald Epstein, and Paul Krugman for comments and suggestions, and Mark Crathorne for revising the text. The usual disclaimer applies.

Funding

F.L. acknowledges financial support from FCT, Fundação para a Ciência e Tecnologia (Portugal), and national funding through research grant UIDB/05069/2020.

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