

Do we really need to start from scratch?¹

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Abstract

This paper presents views and beliefs of the authors on the relevance of the current economic theory for the understanding of the complex world we live in. Has the crisis indeed demonstrated that as profession we are misled by the beauty of the mathematical models and the only useful, workable solutions at hand were provided in early 1930s? The purpose of this paper is to provide a review of the current state-of-the-art literature from the perspective of its usefulness in the context of economic crises. We argue that although we might be unable to answer many questions or to “predict” crises, the path we are following is the right one. Furthermore, going back to Keynes would not solve any of the identified problems and would generate problems on its own. Analysing the state of economics after the crisis it is argued that (i) we need models with micro-foundations, (ii) we need better models with micro-foundations and already existing and promising directions for future research are discussed.

Key words: financial crisis, economic modelling, micro-foundations

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Introduction

With the criticism of the recent Noble prize winner Paul Krugman and the initiative of British economists to apologise the Queen of England for the emergence of the global financial crisis – most of the profession might have experienced second thoughts of whether indeed economics is such an honourable and useful science. On the other hand, the reach and the profoundness of the crisis make policy makers and commentators alike uncommonly nervous about decision making or expressing publicly their views without at least coherent – if not strong – economic justification. Is indeed economics dead?

In this paper we will argue that although the scale of how wrong the profession has been about the facts may be unprecedented, we were not really that wrong about the theories. Namely, the micro-foundations of the economic models were not undermined by the events we currently observe, while the relevant weaknesses have been known for a long time and there are numerous prosperous research agendas dealing with these issues. On the other hand, the handling of it in the macroeconomic models is still at its infancy stage – too young to be dismissed as unpromising, but also too inexperienced to comprehend all crucial building blocks. In other words, together with the policy makers, we might have failed on adequately applying the theory but not in its underlying micro-foundations or the resulting macro- implications. While this view does not seem to have many followers nowadays, there is conclusive and strikingly solid evidence that indeed – had we listened to our own models, we would have behaved otherwise. Would that prevent the emergence and subsequent outburst of the real estate bubble in the US? Most likely yes. Does that imply we would thus avoid a crisis of different roots but comparable scale? Most likely not.

The principal disclaimer for the remainder of this paper is crucial: in the remainder we will not analyse the finance and risk evaluation models. Over the past years, finance has grown to a vast and highly specialised field, while only experts on it are in position to judge whether the current models are sufficiently comprehensive or need to undergo an evolution to newer, better ones. As economists, we feel insufficiently trained in this area to formulate any conclusive judgments.

Analysing the sources and the reinforcing of the crisis over the past quarters we will try to (i) demonstrate explanations rooted in the current theory and (ii) suggest some of the shortcomings these models still have. While we are convinced to pursue the former and attempt to defend economics, the latter is to a large extent fruitless effort. Every time in the history of economic thought, economists were able to understand a crisis creating mechanism, it was transformed into policies preventing its occurrence. New crises were always consequences of the stochastic in nature and therefore unforeseeable in practice random shocks. Whatever the direction in which economic theory will develop *ensuite* the recent global financial turmoil, it is not where the next crisis is going to find us. Still, better safe than sorry – It is useful to constrain the potential sources of crisis by increasing our understanding of the economic process.

The paper is organized along the question of how is economics – as it stands right now – useful for comprehending the nature of the economic crises in general². To this end, we will divide our discussion into two parts. First, we will try to defend the micro-foundations of the economic theory, including the assumptions of rational optimisation and Arrow-Debreu rules for designing the markets. Subsequently, the argumentation will shift macro level, focusing on the threads of rules for the central banking and the government.

Part I – Micro-foundations of economic models

One of the main criticisms towards Keynesian economics of the early post-war period – just as grounded against the pre-Keynesian modelling – grew from the contention, that macroeconomic models in fact *assume* the relationships between macro aggregates instead of deriving them from the underlying microeconomic fundamentals. The post-war developments in economics focused significantly on providing strong micro-economic foundations to macro-level models. As a result of a consensus modern macroeconomic models comprise:

- a. consumers' decision-making process: the inter-temporal choice of consumption and savings and the intra-temporal choice of work and leisure;
- b. firms' optimisation of the production process (the use of inputs as well as the resulting pricing strategies);
- c. markets as an equilibrating mechanism (whether perfect or imperfect).

These building blocks are currently fundamental for any macroeconomic general equilibrium model. In addition, depending on the nature of the research question, models include as well the choices for the government, central bank, international links as well as potentially diverse institutional arrangements. Interplay between agents (e.g. fiscal authorities of units forming one monetary union) is frequently enriched by comprising the strategic elements (e.g. cooperative versus non-cooperative equilibria). As a natural consequence, models become more complex, mathematically advanced and thus perhaps sometimes also less tractable even at the analytical level.

Importantly, in fact it is irrelevant for the construct of the model, whether author wanted to implement new classical or new Keynesian assumptions, as these were reflected in the way each of the blocks is being modelled. Thus, currently, the absolute majority of models at the frontier are general equilibrium while the differences in policy implications result not that much from the “schools” of economic research as from the complexity of addressed problems and thus the number of potential interactions between the elements of economic system.

Criticism towards this class of economic models is rather well known. In such models obtaining analytical solutions is a painful and frequently problematic process, sometimes necessitating additional assumptions about the agents or their choices for the very existence of the unique equilibrium. They are indeed time-consuming in derivation, while in the literature they are frequently referred to as large compile-time and small run-time models. Large compile-time is sometimes equivalent to six-eight months for a skilled macroeconomist to deliver the final solutions. Critics say, naturally,

² Current turmoil – as forcefully argued by many – may indeed have been a new type of “event”. But regardless of its origins, resulted in a negative demand shock and many of its outcomes – and treatments – were actually “by the book”.

that during the crisis policy makers do not have six months to wait for the results, while it would be naïve to expect that the scientific community is in fact able to predict which models will be needed beforehand.

Currently, the innovations in economic modelling do not target to prove that one school of economics is more valid than another. As Olivier Blanchard and Stanley Fischer argue in the foreword for currently the most popular textbook in advanced macroeconomics, “[O]n the surface, macroeconomics appears to be a field divided among schools, Keynesians, monetarists, new classical, new Keynesian, and no doubt others. [...] It is not our assessment of the field. Behind the public relations gimmicks and the strong incentives that exist in the academia to differentiate products, macroeconomics shares many models and views” (Blanchard & Fischer, 2006, p. xi) . The three building blocks of the macroeconomic models (the consumers, the firms and the markets) combined to provide insights into any economic problem all build on similar workhorses and resort to similar, universal tools for the simplification – a.k.a. modelling – of the complex reality. These tools include (i) rationality; (ii) representative agent; and (iii) markets. These are the issues we now move to.

Rational expectations

Rational expectation hypothesis³ is a standard assumption in contemporary economics, mainly because rational expectations are model-consistent. This way of modelling expectations was introduced by Muth [1961] and later popularized by Lucas [1972], and others. According to the rational expectations hypothesis agents - while forming their expectations - use all the available information, thus outcomes that are being forecasted do not differ systematically from equilibrium results. Rational expectations hypothesis was introduced in response to the flaws of adaptive expectations identified at the time⁴.

Introduction of rational expectations fuelled the development of dynamic stochastic general equilibrium (DSGE) models after the seminal paper by Kydland & Prescott [1982], since it allowed introducing into the model the expectations in a consistent manner. From a philosophical perspective, in contrast to previous approaches, it introduced scientific rigour to macroeconomic models – with rational expectations we cannot provide simple answers like “agents make mistakes” in explaining the economic phenomena. On the other hand, from the very beginning the rational expectations hypothesis had its critics⁵. The main criticism was that it implicitly requires the agents to gather enormous amount of information and to actually possess the ability to process it. Naturally, in reality people have only limited access to information (or gathering information is costly) as well as only limited ability to derive conclusions.

But economists have known it for a long time. It is enough to cite the seminal paper by the Noble prize winner Simon [1957] on bounded rationality. Thus, why have economists kept and still keep the rational expectations hypothesis? The main reason is

³ Although rational expectations and rationality are not exactly the same thing, they share most of the criticism, thus while describing the weak points in those hypotheses, we will neglect the differences.

⁴ Under adaptive expectations it is possible for people to make systematic mistakes (for example to systematically underestimate inflation). This was considered to be an important weakness of the adaptive expectations as it was believed that from the point of view of policy issues it is an important feature of the real world that a government cannot systematically fool agents.

⁵ The rational expectation hypothesis is also the basis for efficient market hypothesis (see Fama, 1970), but since it concerns the financial markets it is beyond the scope of this article.

that there are about million ways of forming expectations that are not “rational” in the canonical understanding. How would we choose then the one that best describes human behaviour? Even if “best” is simplified to just three dimensions: tractability, consistency and presence of some key determinants of human behaviour (only features important from the economics point of view). For that there is no answer yet.

Nonetheless, there still is an enormous amount of problems that can be addressed without deviating from rational expectations hypothesis. Furthermore, there is growing body of literature on rational deviations from the rational expectations hypothesis (or more generally, modelling the decision making process). These extensions are subsequently implemented in the DSGE models, enabling a directly practical application. For example there is theoretical research on how to incorporate the limitations on information processing into economic models, including a paper on bounded memory by Mullainathan [2002] as well as somewhat more practical research on behavioural economics founded by the two seminal papers, i.e. Kahneman & Tversky [1973] and Tversky & Kahneman [1974]. This field has been subsequently developing with the works of Laibson [1997], Benabou & Tirole [2001], Gul & Pasendorfer [2001] as well as even Kenning & Plassmann [2005], who work on the neurological component of the decision making process. All these – and other – works attempt to identify the economically relevant aspects of the decision making, with the expectation formation being explicitly the dominant part of this research agenda.

In macroeconomics there are also approaches deviating from rationality, knocking at the doors of the mainstream economics. There are several branches of such literature: (i) learning, e.g. Sargent, [1993], Evans & Honkapohja, [2001]⁶; (ii) robust control, e.g. Hansen & Sargent [2001], Giannoni [1999] and (iii) rational inattention, e.g. Mankiw & Reis [2002], Sims [2003, 2005], Maćkowiak & Wiederholt [2009].

All these research efforts date prior to crisis, while they do not restrain from innovation in economics (instead of resorting back to Keynesian prescriptions), with rigorously mathematical formulations and pinning the findings back to the data. In other words, all the advantages and disadvantages of the rational expectations models were well known before the financial crisis and despite them approaches without explicit expectations framework cannot even attempt to compete with the standard workhorses. There is a wide consensus in the profession that rational expectations can only be abandoned in a rational manner. Thus, the financial crises can at best fuel some of research in this spirit. While this definitely creates a new space for the further evolution of expectations formation approaches, that line of research has already been started.

Representative agent

Economists use the term representative agent to describe the stand in economics that makes decision for all the agents. Formally, for existence of the representative agent it is required that either preferences are homothetic and markets are complete or agents are identical. Thus this assumption makes sense whenever differences between agents are not crucial from the point of view of analyzed problem. After the Lucas critique [Lucas, 1976] of econometric policy evaluation, micro-foundations, especially in policy analysis, have become to be widely used making the notion of representative agent more

⁶ For review of more recent literature see Evans & Honkapohja [2007]

prominent. On the other hand, using the concept of the representative agent simplifies the problems and usually makes them tractable, making the notion of representative agent increasingly popular.

Nevertheless, because representative agent models ignore valid aggregation concerns, they were criticised from that angle since the beginning. The importance of agents' heterogeneity originates from the two possible problems of the representative agent models: aggregation problems and the interest in analyzing differences between agents. There is also a problem with using DSGE models for analysing phenomena of potentially explosive nature, like in the famous case of the "black swan" types of issues, the use of expected value can indeed lead to misleading results. Thus, again the problems associated with the representative agent assumption were identified before the crises. Furthermore, economists have already found very promising ways of addressing these issues: heterogeneous agents and agent-based simulation models.

One could therefore try to think of relaxing this assumption in order to comprehend distribution effects to the models. The development of computational techniques together with the rapid increase in processing capabilities of computers allowed for incorporating explicitly the heterogeneity of agents into macroeconomic models. The most important paper on introducing heterogeneity into the DSGE models include e.g. Rios-Rull [1995], Colander, Howitt, Kirman, Leijonhufvud & Mehrling [2008] or Rudebush & Swanson [2008]. By now the literature is vast and covers many diverse topics including the studies on: wealth and/or income inequalities (e.g. Krusell & Smith, 1998; Castaneda, Diaz-Gimenez & Rios-Rull, 2003), asset prices (e.g. Krusell & Smith, 1997; Constantinides and Duffie, 1996), inequality and growth (e.g. Krebs, 2003, Cordoba & Verdier, 2007), labor supply and unemployment (e.g. Chang & Kim, 2006, 2007, Obiols-Homs, 2003), effects of fiscal policy (e.g. Heathcote, 2005) and the cost of business cycles (e.g. Atkeson & Phelan, 1994; Krusell & Smith, 1999; Storesletten, Telmer & Yaron, 2001; Storesletten, Telmer & Yaron 2004; Mukoyama & Sahin, 2005; Krusell, Mukoyama, Sahin & Smith, 2009). Nevertheless this approach has its limitations. The main are that all those models are highly complex and one can only introduce heterogeneity across limited dimensions.

Another possible alternative to the representative agent approach is agent-based simulation models which are capable of dealing with many heterogeneous agent. One potential way to do so is being developed within Multi-Agent Systems (MAS), Axtell [1996], Phan & Amblard [2007]. In fact, there are three major ways in which MAS allow economists to achieve results unattainable by regular, representative agent economics. First, agents are equipped with individual preferences (*quasi*-random distributions), which replicate the original world only on the aggregate. These distributions are usually benchmarked to real-world data, while it is customary to analyse the susceptibility of the results to these calibrations.

Secondly, the real world works roughly this way: individuals (firms, consumers, government, regulatory institutions, etc.) take fairly independent decisions based on their expectations of what others will do. In a sense, it is natural to expect that individuals will chose what they think is best for them based on the information set available to them, along the criteria they choose and with the beliefs about other agents' information and their criteria. These beliefs may – or may not – be updated with the

repeated choices of all agents. These statements – as simple as they are – convey no constraining assumptions about the nature of the choices, beliefs and their updating. What this effectively implies is that in the real world societies are self-organising, while classical representative agent models are to some extent “centrally” designed. This is the second advantage of using the MAS models, because they indeed are “self-organised systems” – agents make choices to assure/find the best solution for their problems “without intervention”.

Thirdly, they are frequently referred to as small compile-time, and small run-time models. As already presented above, MAS models encompass the *interactions* between – and under potentially the changing conditions – among *heterogeneous* agents. What the modeller has to do is to specify the types of heterogeneity (distributions of choice-driving parameters) and the nature of the interactions. The actual solution of the model is obtained through “running” it, which implies that both the duration aspects and the distributional effects are model outputs, rather than inputs. Consequently, unlike traditional econometrics which needs actual data and thus is always an *ex-post* tool, MAS models may be designed and applied *before* materialisations (in terms of data available from the economy) actually happen. For this reason, they can be extensively used for policy guidance – also to evaluate the effects of the alternative policy options against each other.

Nonetheless, there are some principal pitfalls in using MAS in policy guidance. First, to run MAS it is imperative to formulate the model first. It can be any model. In other words, it does not have to be a general equilibrium model, while partial equilibrium approaches are easier, more tractable and faster to design. However, *before* anything happens, one cannot have prior certainty as to what to model. Consequently, authors are running a considerable risk of misplacing models focus by modelling in a detailed manner a process that will only marginally affect the economy equilibrium⁷, while MAS models have no immunity to scientists’ blindness to the potential sources of shocks or distortions.

Moreover, in order to design agents’ interactions, the modeller needs to specify the spheres of these interactions. In other words, one needs to specify the choice set as well as decision criteria. Although, unlike in econometric models, these assumptions may be tested for sensitivity of results to numerous different specifications, they may be just as wrong, while the model does not automatically “signal” the misspecification to its author. One cure to this problem may be specifying the models in the ways that produce – in addition to the variables of interest – outcomes that can be calibrated to the actual economy. Naturally, on the other hand this may result in constraining the range and complexity of analysed problems. The other cure consists of providing potentially general equilibrium approach, because in the case of misspecification, running MAS should simply produce senseless findings, lacking any useful interpretation. This,

⁷ Authors have experienced such *faux pas* themselves: designed and implemented a model analyzing the potential effect of labour market shocks to households’ liquidity and availability to service debts. The model was calibrated to evaluate the risk of households’ failure on servicing mortgage debts, producing estimates of the aggregate risk to the financial system. In practice, households have proven to service mortgages more thoroughly than other financial obligations (e.g. consumer debt, credit cards, some obligatory payments like phone or electricity bills, etc). Model has proven too narrow in scope (focused too much on the mortgages), which is only possible in partial equilibrium framework.

however, brings MAS back to the misery of classical, representative agents' formulation of comprehensive models of the whole economy,

Getting models closer to the real world: frictional markets

One of the possible reasons that one could blame the standard and widely used stochastic, dynamic models for not being properly suited to describe reality, especially during a crisis is the assumption of market functioning. Namely, most the DSGE models, also build in the new-Keynesian tradition assume that the markets are frictionless and clear instantly, according to the Arrow-Debreu model. But we know that the real world is much more complicated – not everything that was produced can find its demand and not everyone who is willing to work can find a job. These considerations are mostly visible in the labour market, which is of course translating into fluctuating unemployment. It is worth noting, that the unemployment phenomenon is absent in widely used, standard macro models, both in new-classical paradigm, so called RBC (see e.g. King & Rebelo, 1999) and also in new Keynesian one, often referred as DSGE (see e.g. Smets & Wouters, 2007). In the latter case the unemployment is not a part of a model even when the prices and wages are assumed to be rigid, which triggers additional adjustments of factor employment in production purposes after unexpected shocks hitting the economy.

One of the possible ways to introduce unemployment into the standard general equilibrium way of describing the economy is to introduce inherent friction in the functioning of the labour market, such as a search-matching friction in the spirit of Diamond [1982], Mortensen [1982] and Pissarides [1985]. In this setting, where both workers are looking for a job and employers are looking for labour, there are always some vacancies left unfilled and workers unemployed. So the labour market does not clear in traditional way, which makes this setting particularly interesting from our perspective, as it assures that that frictions are deeply embedded into the model and the Arrow-Debreu theorem does not hold. Additionally, in this world wages lose its allocating role, which is another departure from the standard model implications.

But the question is whether this kind of frictions could help us to better predict recessions? For sure they allow us to differentiate the labour adjustments on both the intensive and the extensive margin into the description of the evolution of the economic system and how does it affect the other decisions of the agents populating the economy. Moreover, it allows us to introduce changes in the regulations of the economic system and labour market reforms and to simulate the effects of these changes on the behaviour of the economic system. It also allows us to better understand the mechanics of recession, especially in this particularly important part of the economic system.

Unfortunately introducing frictional labour markets into GE models does not allow us – and was not designed with this purpose in mind – to better predict recessions. The only additional enhancement of these models in this context is the ability to simulate the impact and consequences of recessions originating from the misalignments in the labour market itself. So, the recent attempts to introduce the search-matching frictions into the standard (see e.g. Krause, Lopez-Salido & Lubik, 2007) new-Keynesian models, frequently used in the context of monetary policy, are for sure a huge step forward in understanding the mechanism of the economic system and the adjustments within it – but not in better predicting recessions better.

The same reasoning applies to another kind of frictions in the market functioning, namely informational frictions. Since the seminal paper by Akerlof [1970], the idea of asymmetric information was increasingly used in macroeconomics. The applications include the seminal paper on monetary policy in general equilibrium by Lucas [1972], another seminal paper on banking by Diamond & Dybvik [1983], the important paper on efficiency wages by Shapiro & Stiglitz [1984], and the recently getting more and more recognition paper on optimal degree of transparency in policy making by Morris & Shin [2002].

Another view on the impact of information was explored by, among others, Mankiw & Reis [2002]. This strand of research argues that sticky information could lead to outcomes similar to the ones associated with stickiness of prices and/or wages in the standard new-Keynesian models. They reach similar conclusions concerning the functioning of the aggregate economy as well as the non-neutrality of money and the monetary policy. We are able to understand better the economic mechanisms, comprehend better the complexity of the real world and thus derive more accurate predictions of the economy reaction to shocks. But it does not – and will not – bring us any closer to predicting the shocks.

Weakness of micro-foundations?

Are there any weaknesses of current micro-foundations then? In fact, as the current financial crisis exposed, one of the Achilles' heels of the standard models used for monetary policy analysis has been a relatively shallow comprehension of the financial sector. So far it was widely believed that the financial sector is not crucial for analysis of the monetary policy since the key information about the monetary policy was included in the interest rate. First of all countries that used the DSGE models at central banks were the developed countries and it was widely believed that developed countries with its financial sector architecture are immune to this problem (these are the developing countries that are expected to suffer from financial sector instabilities). Naturally, this contention finds no longer support in real world. However, conceptually – again – a lot of pieces to the puzzle were already developed before the collapse of the Lehman Brothers.

The research on incorporating the financial sector into the DSGE models was conducted in the last two decades. The seminal paper in this literature is Bernanke & Gertler [1989] who introduced financial frictions into a general equilibrium model. Later it was further developed and merged into the DSGE framework by Bernanke, Gertler, & Gilchrist [1996], becoming the workhorse financial frictions model. For example it was used by Choi & Cook [2004] to analyse the balance sheet channel in emerging markets, by Christiano, Motto, & Rostagno [2007] to study business cycle implications of financial frictions. There are also important papers by Goodfriend & McCallum [2007] who provided an endogenous explanation for steady state differentials between lending and money market rates and by Curdia & Woodford [2008] who derived optimal monetary policy in the presence of time-varying interest rate spreads in a model with heterogeneous agents. The main impact of the financial sector in this approach is through prices. More recently another line of literature started with the paper by Iacoviello [2005] who introduced the credit constraints into the DSGE model. In his paper households can only take collateralized loans against housing. Thus he focuses on

the impact through credit constraints rather than prices. This literature is very promising and there is a good chance that very soon we will have the DSGE models with financial frictions used for policy analysis in central banks.

The current global turmoil exposed as well another issue: adequately measuring the risk is far more challenging than actually conceptualising it or putting it in a broader economic framework. Economists have been taking the products of financial experts and analysts for their face value, which has proven to be drastically at odds with reality. Part of the reasoning which provided the foundations for Fed's comfort about the sustainability of the US real estate market were the consistently high and unchanging ratings for the financial institutions. The time has proven that the rating agencies were not able to keep pace with the race of financial products innovations. However, as much as they will change in response to the current crisis – the regulator is never able outpace the regulated.

Stochastic nature of crisis and its implication for the policymaking

In fact, crises always are a stochastic, unexpected, sudden thing. If we ever knew more than that, a policy could be implemented to counteract and avoid crisis. If the policy were wrong, the recession would rather be an outcome of the inadequate policy response than the initial shock. If the policy were right, there would be no result of the initial impulse. What is the role of economics in the context of crisis then?

One of the most often raised criticisms is that economists failed to predict the crisis. For the sake of argument suppose that this is a true statement (even though there are economists that claim they actually did predict the crisis). There might be two possible reasons why economists did not predict the crisis: they either did not see the bubble developing in the housing market or they underestimated the impact of the burst of the bubble on the whole economy (naturally, it can also be a little bit of both). But the problems with bubbles are well recognized in the literature and the fact that the recent crisis was preceded by the burst of the bubble will not change much here. Economists have hard time recognizing the bubbles early on and once they are too big and easily recognizable it is usually too late. As far as the second the impact of the financial sector on the economy it is true that economists underplayed its impact, but to fix that – as we argued earlier – one does not need to revolutionize the profession since all the pieces to the puzzle are already on the table.

Furthermore, one should not use this argument to criticize the current state-of-the-art macroeconomic methodology (whichever the school) since these models are not built to predict future recessions. They treat them as results of stochastic shocks, thus they at best estimate the probability of the recession and not the actual timing of it. Like geologists cannot be blamed for the earthquake (or not foreseeing it), economists should be – if anything – blamed only for working too slow on the approaches and ideas that are already put on the table. By the very nature of the science, we employ different models to different problems or questions. Macroeconomics does not claim the ability to predict the crises, as it was not constructed to do so. It provides guidance on the potential effects of policies, and was widely used throughout the current financial turmoil all over the world. Understanding the economy better does not imply better prediction of random shocks – perhaps only better identification of the areas, where they may appear

and the scale of its aftermath. As John Cochrane argues⁸, abandoning it, brings us back to calculations. Thus, this fact should not be used as an argument for dropping it in favour of any different methodology.

If one wants to have the tools of forecasting recessions one needs to look for them elsewhere. But like finance people, who embarked on a long and highly mathematicised endeavour to find robust ways to beat the market only to fail again and again, and again – macroeconomists interested in finding ways to foresee the evolution of the whole setting of markets in an international context are bound to fail as well.

Part II. The implications for the macroeconomic models

Micro-foundations of economics are crucial for the better understanding of the evolution of economic process. However, this is the macroeconomic level where the policies are designed. It is still debatable whether actually fiscal or monetary policy can react to shocks, as these are never observable. One can – at best – observe the reactions of the economy to the shocks, which already contaminates the reception of the initial signal. By its nature, then, macroeconomic policy responds to the agents' response to shocks – and not the shocks themselves. Designing an optimal policy – be it fiscal or monetary – is thus intellectually a challenging problem.

Fiscal policy

Before the crisis emerged, there had been a fragile consensus between classical and Keynesian economists in the area of the fiscal policy and optimal tax system. As Chari & Kehoe [2006] stated: "*Studies of optimal fiscal policy have argued that optimal policies should be based on two principles. First, similar goods should be taxed at similar rates. More specifically, the consumption of commodities that enter preferences and production technologies in similar ways should be distorted in similar ways. Second, if preferences are homothetic in commodities and separable from labour, then all commodities should be taxed at a uniform rate*". And it follows that: "*First, tax rates on labour and consumption should be roughly constant over time. Second, capital income taxes should be roughly zero. Third, returns on debt and taxes on assets should fluctuate so as to balance the government's budget in a present value sense at each state*". Also the literature on fiscal multipliers and the consequences of increased government deficit identified the channels through which increased government spending affect the economic growth and what are the conditions for the fiscal multipliers to be effective⁹.

But the depth of the crisis and the scope of government interventions to help the economic recovery renewed a debate, also in economic magazines¹⁰, part of which focused on the Keynesian-style management of demand. We do not want to elaborate much on that issue, but it seems that the crisis pushed again both mainstream group of economists (Keynesians and classicalist) into polar corners. But the truth is that both groups have hardly anything new to say and the dispute is rather dogmatic one and is not creating a new value in the economic literature.

⁸ http://faculty.chicagobooth.edu/john.cochrane/research/Papers/krugman_response.htm

⁹ For a literature review see Splilimbergo, Symansky, Schindler [2009]

¹⁰ E.g. in New York Times or in the Economist, including Paul Krugman, John Cochrane or Robert E. Lucas

Chari & Kehoe [2006], when discussing the interactions between development of theory and the practice of policymaking, pointed out that monetary policy has been extensively shaped by the theoretical considerations, while the fiscal policy hardly changed and incorporated a limited number of theoretical considerations in the policy making process. One of the issues leading to more convergence of the theory and practice of fiscal policymaking is to introduce effective fiscal rules and medium-term budget planning, advised by external, non-political councils. These kind of adjustments in fiscal policy making are beginning to be introduced in a limited number of countries (e.g. in some Scandinavian one), but the exit strategy from the current crisis and future process of government debt reduction will call for these additional changes in the conduct of fiscal policy.

Monetary policy

The current recession has proved to be an important challenge for the monetary policy, but it also showed the shortcomings of the economic theory in this area. There are several issues worth emphasizing, as they are important potential directions of future research. The first issue concerns the conduct of monetary policy in the case of reaching zero nominal interest rate bound. The second issue concerns the way the monetary policy decisions are introduced into economic models and what are the possible alternatives. The third issue, possibly less prone to develop due to the crisis considerations, but still interesting and potentially creating huge value added in the economic theory and practice is connected with frictions in the money market, giving rise to micro founded money demand, namely search in money market. So, let us start with the first of highlighted issues.

The depth of the recent recession has also influenced the way of conducting monetary policy, especially in inflation targeting countries. The widely known analyses of Rudebusch [2009] have shown in case of US (but the case is valid in most developed countries) that with deeply negative output gap and deflation the nominal interest rates that the Fed should set to stabilize the economy was, according to the Taylor rule, negative. As Rudebusch emphasized: *“Therefore, the Fed has eased financial conditions by employing a variety of unconventional monetary policy tools that alter the size and composition of its balance sheet. It has also communicated more explicitly its expectations for the course of monetary policy and the economy in order to help guide households and businesses during these uncertain times”*. So, the Fed has set its main interest rate at the level close to 0 and engaged, as previously the Bank of Japan, in the so called quantitative easing (QE), fuelling the economy with money¹¹. So, the zero nominal interest rate became, during a current recession, a binding constraint on central bank interest setting. More importantly, the literature on negative interest rate and its consequences is limited and will probably develop in the next few years, as this phenomenon proved to be an important issue. There are several recent publications in this area, we will focus on two of them, although it is worth having in mind that the literature here is in its infant stage.

The paper of Buiter [2009] lays out the origins of the zero nominal interest rate bound and discusses three ways to overcome it, ranging from abolishing currency and charging taxes on currency to decoupling the *numéraire* from the currency as a medium of

¹¹ Moreover, the Riksbank, the Swedish central bank cut the deposit rate to -0.25%, effectively charging savers interest on deposited money.

exchange and a mean of payment. The Buiter's proposals seem strange and radical and it seems that QE is a working alternative, but still the research on the consequences and medium term effectiveness of QE type of policy is scarce, especially with regard to the development of future inflation and inflation expectations. If in the future these kind of circumstances reappear, the academics and decision-makers should be aware of the best possible choices they face. But the zero nominal interest rate bound, if effective, could also change the behaviour of economic agents in other areas and introduce nonlinearities of the reaction of the economy to various shocks. The literature in this area is starting to appear and shows that restriction of this kind is not neutral to the economic system. The example of the importance of the research in this filed is the paper by Christiano, Eichenbaum & Rebelo [2009] arguing that fiscal policy becomes far more effective in output stabilization when the conduct of monetary policy is limited.

The second issue concerns the way the conduct of monetary policy is introduced into the economic models, especially in case of the DSGE-type of modelling. The usual and widely used monetary policy formulation is co called Taylor rule (see Taylor, 1993), which assume that the monetary policy makers react to output and inflation deviating from long-run levels (or targets) with some additional interest smoothing, reflecting their preferences not to move interest rates too quickly. There are different forms of Taylor rules used in modelling practice, but the question remains whether this is indeed the right way of modelling interest rate setting. The simple trade-off between inflation and output within economic growth stabilization is for sure valid in policy making, but the ongoing discussion in the recent years on the role of asset prices in monetary policy decisions, amplified by the recent crisis shows that the trade-offs the central banks face are a little more complicated. Moreover, the Taylor rules implies the term structure of the interest rates that is at odds with the data.

The existing literature in this area is limited, with the important exception of Atkenson & Kehoe [2008], who discuss the drawbacks of Taylor rules and propose a framework of monetary policy modelling that is coherent with the data. It also seems that their approach helps to solve the other shortcoming of the standard new-Keynesian DSGE models (see the discussion in Chari, Kehoe & McGrattan. 2009), namely tracking the inflation persistence, as the usual way this phenomenon is addressed in also incoherent with the results of the research on prices setting behaviour (see e.g. Golosov & Lucas, 2007). So this line of research seems very promising, although one should have in mind that it is in a very infant stage, but the crisis should speed it up.

The last issue, we would like to emphasize, is the role that money plays in the standard DSGE models. It is remarkable, that in most DSGE models (see e.g. Smets & Wouters, 2007) the money demand equation is redundant and money itself is treated mainly as a *numéraire*. And if money is needed in the analysis¹², the demand for money is usually introduced via augmenting household's utility or with some type of cash-in-advance motive. These approaches introduce money demand into the economic system but still the role of money is relatively limited. An alternative is to introduce the demand for money derived form micro-foundations and the role of money as a medium of exchange. This strand of literature is not new; the early results can be found e.g. in Kiyotaki & Wright [1989], although the search in the money market has not, till now, found its place

¹² It is worth mentioning that the current crisis and the central banks' reaction to deep recession (Quantitative Easing) call for more research in this area.

in the standard models used for monetary policy purposes. What is more important, the results derived from standard way of modelling money are not always valid in case of microfounded money demand, like in the case of optimal monetary policy - see e.g. the discussion in Kocherlakota [2005]. Additionally, the important paper of Berentsen, Menzio & Wright [2008] shows that the deeply rooted in the economic thinking idea of long run money neutrality is not supported by the data and the combination of the search in the money and labor markets frameworks are jointly able to account for this fact. The recent crisis and the future outcomes of quantitative easing policies may “undust” this strand of the literature, operationalise it and give it much greater role in economic modelling.

Conclusions

In this paper we have argued that the profession has gone a long way to derive reliable and informative micro-foundations, while the research agenda addressing the weaknesses of the current assumptions are promising and have been developing for a many years already before the crisis. Neither are they less mathemacised than the currently used approaches. On the other hand, some of these concepts are only beginning to be implemented in the macroeconomic models. For one, macroeconomic models cannot comprise too many elements and maintain tractability at the first time. Since the first all-in-one macroeconomic model, i.e. Smets & Wouters [2003] has not been in the profession even for a decade, it seems justifiable to state that this class of models is still at its infancy stage. Further, innovative developments in the field are crucial for the adequate response to future crises.

It may well be true that the crisis has demonstrated some weakness of economic policies implementation: each crisis always does. However, these events are not evidence against the economic theories. Practical implementations of the economic theories – as argued already by many (e.g. Taylor, 2009, on the “wrong” application of the Taylor rule and excessively loose monetary policy, etc.) – have in fact been sometimes at odds with theoretical implications. However, in a widely reprinted article, Paul Krugman¹³ argued that economists have mistaken the mathematical beauty of their models for the economic truth. Although the extent to which one fancies the mathematical elegance is highly individual, one must agree that without modelling with the use of mathematics, we would not be able to provide any coherent theoretical framework of the economic phenomena. This is just as true for economics, as is for any other empirical science.

The current economic crisis originated – undoubtedly – from a financial crash resulting from a real estate bubble in the US. Whether it was reinforced by inadequate monetary policy of the Fed will remain a matter of individual evaluation of many economists throughout the World and the History. However, the emergence of the bubble itself is an undeniable evidence of (i) peoples’ rationality in the micro-scale and (ii) inadequate treatment of it – wishful thinking– vis-à-vis the macro-scale. We call currently inadequate or wrong regulating mechanisms of the financial sector. If the building blocks of rationality and utility maximisation were abandoned, we would be in fact further away, not closer to comprehension of the origins of the current global crisis. If

¹³ New York Times Magazine, Sept 16th, 2009

comprehension is replaced by naively Keynesian easy solutions of fiscal stimulus and replacing the invisible hand of the markets with the visible hand of the regulators – it is not likely that economics, as a science, moves forward any further.

The real challenge before economics as a science is not to return to old recipes, but to provide tailor cut recommendations in increasingly complex frameworks corresponding to the increasing comprehension of this complexity. Mathematical sophistication – frequently accused and equally frequently inducing hermetic nature of economic research – is not an aim of its own but only a way to handle the willingness to construct models which actually reflect reality, instead of postulating its nature. The question we face now is whether in fact our models of rationality can be improved to provide policy guidance. The question we face now is whether in fact models with heterogeneity of the agents is important for the better understanding of the economic aggregates. The question we face right now is how to expand the comprehensiveness and maintain the tractability of macroeconomic models based on these micro-foundations. The question we face right now is to what extent how we should measure risk in the increasingly complex environments, with multiple reinforcing channels and bidirectional interactions. These are the questions on moving the science forwards – not back to 1930s.

Bibliography

- Akerlof, G. A., [1970], "The market for lemons: quality uncertainty and the market mechanism," *Quarterly Journal of Economics*, vol. 84, pp. 488-500.
- Atkeson, A. & C. Phelan, [1994], "Reconsidering the Costs of Business Cycles with Incomplete Markets," in: *NBER Macroeconomics Annual, 1994, Volume 9*, pages 187-218.
- Atkeson, A. & P. J. Kehoe, [2008], "On the need for a new approach to analyzing monetary policy," *Staff Report 412*, Federal Reserve Bank of Minneapolis
- Axtell, R., [1996], "Growing Artificial Societies: Social Science from the Bottom Up", MIT Press.
- Benabou, R. and J. Tirole [2001], "Self-Knowledge and Self-Regulation: An Economic Approach," Discussion paper, Princeton University.
- Berentsen, A & G. Menzio & R. Wright, [2008], "Inflation and Unemployment in the Long Run," NBER Working Paper, 13924.
- Bernanke, B., and M. Gertler [1989], "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, 79(1), 14-31.
- Bernanke, B., M. Gertler, and S. Gilchrist [1996], "The Financial Accelerator and the Flight to Quality," *The Review of Economics and Statistics*, 78(1), pages 1-15.
- Blanchard, O. & S. Fischer, [2006], "Lectures on Macroeconomics", MIT Press, 10th edition.
- Buiter, W. H., [2009], "Negative Nominal Interest Rates: Three ways to overcome the zero lower bound," NBER Working Papers, 15118.
- Castaneda, A. & J. Diaz-Gimenez & Jose-Victor Rios-Rull, [2003], "Accounting for the U.S. Earnings and Wealth Inequality," *Journal of Political Economy*, vol. 111(4), pages 818-857.
- Chang, Y. & S. Kim, [2006], "From Individual To Aggregate Labor Supply: A Quantitative Analysis Based On A Heterogeneous Agent Macroeconomy," *International Economic Review*, vol. 47(1), pages 1-27.
- Chang, Y. & S. Kim, [2007], "Heterogeneity and Aggregation: Implications for Labor-Market Fluctuations," *American Economic Review*, vol. 97(5), pages 1939-1956.
- Chari, V. V. & P. J. Kehoe & E. R. McGrattan, [2009], "New Keynesian Models: Not Yet Useful for Policy Analysis," *American Economic Journal: Macroeconomics*, vol. 1(1), pages 242-66.
- Chari, V. V. & P. J. Kehoe, [2006] "Modern Macroeconomics in Practice: How Theory Is Shaping Policy," *Journal of Economic Perspectives*, American Economic Association, vol. 20(4), pages 3-28
- Choi, W. G., and D. Cook, [2004], "Liability dollarization and the bank balance sheet channel," *Journal of International Economics*, 64(2), 247-275.
- Christiano, L., R. Motto, and M. Rostagno [2007], "Financial Factors in Business Cycle," Discussion paper.

- Christiano, L. & M. Eichenbaum & S. Rebelo, [2009], "When is the government spending multiplier large?," NBER Working Papers, 15394.
- Colander, D. & P. Howitt & A. Kirman & A. Leijonhufvud & P. Mehrling, [2008], "Beyond DSGE Models: Toward an Empirically Based Macroeconomics", *American Economic Review*, American Economic Association, vol. 98(2), pages 236-40.
- Constantinides, G. M & Duffie, D., [1996], "Asset Pricing with Heterogeneous Consumers," *Journal of Political Economy*, vol. 104(2), pages 219-40.
- Cordoba, J. C. & . Verdier, [2007], "Lucas vs. Lucas: On Inequality and Growth," IMF Working Papers 07/17, International Monetary Fund.
- Cúrdia, V., and M. Woodford [2008], "Credit frictions and optimal monetary policy," National Bank of Belgium Working Paper 146, National Bank of Belgium.
- Diamond, D and P. Dybvig, [1983], Bank runs, deposit insurance, and liquidity, *Journal of Political Economy*, vol. 91, pages 401 - 419.
- Diamond, P. A. [1982], "Wage Determination and Efficiency in Search Equilibrium", *Review of Economic Studies*, 49(2), pages 217-227.
- Evans, G. W. and S. Honkapohja [2007], "Expectations, Learning and Monetary Policy: an Overview of Recent Research", Bank of Finland Research Discussion Papers 32.
- Evans, G. W., and S. Honkapohja [2001], "Learning and Expectations in Macroeconomics," Princeton University Press, Princeton.
- Fama, E. F., [1965], "The behavior of stock market prices," *Journal of Business*, 38, pages 34-105.
- Fama, E. [1970], "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance*, vol. 25, pages 383-417.
- Giannoni, M. P. [1999], "Does Model Uncertainty Justify Caution? Robust Optimal Monetary Policy in a Forward-Looking Model," discussion paper, Princeton University.
- Golosov, M. & R. E. Lucas, Jr., [2007], "Menu Costs and Phillips Curves," *Journal of Political Economy*, 115 (2, April): 171—99.
- Goodfriend, M., and B. T. McCallum [2007], "Banking and interest rates in monetary policy analysis: A quantitative exploration," *Journal of Monetary Economics*, 54(5), 1480- 1507.
- Gul, F. and W. Pesendorfer [2001], "Temptation and Self-Control," *Econometrica*, vol. 69(6), pages 1403-1435
- Hansen, L. P., and T. J. Sargent [2001], "Robust Control and Model Uncertainty," *American Economic Review*, 91(2), pages 60 -66.
- Heathcote, J. [2005], "Fiscal Policy with Heterogeneous Agents and Incomplete Markets," *Review of Economic Studies*, vol. 72(1), pages 161-188.
- Iacoviello, M. [2005], "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle," *American Economic Review*, 95(3), pages 739_764.
- Kahneman, D. and Tversky, A. [1973], "On the psychology of prediction," *Psychological Review* 80, pages 237-251.
- Kenning, P. and H. Plassmann, [2005], "Neuroeconomics: an overview from an economic perspective," *Brain Research Bulletin*, 67 (5), pages 343–54
- King, Robert G. & Rebelo, Sergio T., [1999], "Resuscitating real business cycles," *Handbook of Macroeconomics*, in: J. B. Taylor & M. Woodford (ed.), *Handbook of Macroeconomics*, edition 1, volume 1, chapter 14, pages 927-1007.
- Kiyotaki, N. & R. Wright, 1989, "On Money as a Medium of Exchange," *Journal of Political Economy*, University of Chicago Press, vol. 97(4), pages 927-54
- Kocherlakota, N. R., [2005], "Optimal monetary policy: what we know and what we don't know," *Quarterly Review*, Federal Reserve Bank of Minneapolis, issue Oct, pages 10-19
- Krause, Michael U. & Lopez-Salido, David J. & Lubik, Thomas A., [2008], "Do search frictions matter for inflation dynamics?," *European Economic Review*, vol. 52(8), pages 1464-147.
- Krebs, T, [2003], "Growth and Welfare Effects of Business Cycles in Economies with Idiosyncratic Human Capital Risk," *Review of Economic Dynamics*, vol. 6(4), pages 846-868.
- Krusell, P & A. A. Smith, Jr., [1997], "Income And Wealth Heterogeneity, Portfolio Choice, And Equilibrium Asset Returns," *Macroeconomic Dynamics*, vol. 1(02), pages 387-422.
- Krusell, P. & A. A. Smith, Jr., [1998], "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, vol. 106(5), pages 867-896.
- Krusell, P. & A. A. Smith, Jr., [1999], "On the Welfare Effects of Eliminating Business Cycles," *Review of Economic Dynamics*, vol. 2(1), pages 245-272.
- Krusell, P. & T. Mukoyama & A. Sahin & A. A. Smith, Jr., [2009], "Revisiting the Welfare Effects of Eliminating Business Cycles," *Review of Economic Dynamics*, vol. 12(3), pages 393-402.

- Kydland, F. E & E. C Prescott, , [1982], "Time to Build and Aggregate Fluctuations," *Econometrica*, vol. 50(6), pages 1345-70.
- Laibson, D. [1997], "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics*, vol 112, pp. 443-478.
- Lucas, R. E. Jr, [1971], "Econometric testing of the natural rate hypothesis," In: O. Eckstein (ed.) *The econometrics of price determination Conference*. Board of Governors of the Federal Reserve System and Social Science Research Council.
- Lucas, R. Jr., [1972], "Expectations and the neutrality of money," *Journal of Economic Theory*, vol. 4(2), pages 103-124.
- Lucas, R. E. Jr., [1973], "Some International Evidence on Output-Inflation Tradeoffs," *American Economic Review*, 63(3), pages 326-334.
- Lucas, R. E. Jr, [1976], "Econometric policy evaluation: A critique," *Carnegie-Rochester Conference Series on Public Policy*, vol. 1(1), pages 19-46.
- Mackowiak, B. and M. Wiederholt, [2009], "Optimal Sticky Prices under Rational Inattention," *American Economic Review*, vol. 99(3), pages 769-803.
- Mankiw, N. G. & R. Reis, [2002], "Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve," *Quarterly Journal of Economics*, 117(4), pages 1295-1328.
- Morris, S. and H. S. Shin, [2002], "Social Value of Public Information." *American Economic Review*, 92(5), pp. 1521-34.
- Mortensen, Dale. T. [1982], "Property Rights and Efficiency in Matching, Racing, and Related Games," *American Economic Review*, 72(5), pages 968-979.
- Mukoyama, T. & A. Sahin, [2006], "Costs of business cycles for unskilled workers," *Journal of Monetary Economics*, vol. 53(8), pages 2179-2193.
- Mukoyama, T. & A. Sahin, [2006], "Costs of business cycles for unskilled workers," *Journal of Monetary Economics*, vol. 53(8), pages 2179-2193.
- Mullainathan, S. [2002], "A Memory-Based Model Of Bounded Rationality," *The Quarterly Journal of Economics*, vol. 117(3), pages 735-774.
- Muth, J. F. [1961] "Rational Expectations and the Theory of Price Movements," reprinted in "The new classical macroeconomics". Volume 1. [1992]: 3-23 (International Library of Critical Writings in Economics, vol. 19. Aldershot, UK: Elgar.)
- Obiols-Homs, F, [2003], "Incomplete Unemployment Insurance and Aggregate Fluctuations," *Review of Economic Dynamics*, vol. 6(3), pages 602-636.
- Onatski, A., and J. H. Stock, [1999], "Robust Monetary Policy Under Model Uncertainty in a Small Model of the U.S. Economy," manuscript, Harvard University.
- Phan, D., & F. Amblard, (eds), [2007], "Agent-Based Modelling and Simulation in the Social and Human Sciences", The Bardwell Press, Oxford.
- Pissarides, C. A. [1985], "Short-run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages", *American Economic Review*, 75(4), pages 676-690
- Rios-Rull, J., [1995], "Models with Heterogenous Agents" in: *Frontiers of Business Cycle Research*, Thomas F. Cooley (ed), Princeton University Press, pages 98-125
- Rudebusch, G. D. & E. T. Swanson, [2008]. "Examining the bond premium puzzle with a DSGE model," *Journal of Monetary Economics*, Elsevier, vol. 55, pages S111-S126, October.
- Rudebusch G. D. [2009], "The Fed's monetary policy response to the current crisis," *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco, issue: May, 22
- Sargent, T. J. [1993], "Bounded Rationality in Economics," Oxford University Press, Oxford.
- Shapiro, C. & J. E Stiglitz, , [1984], "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, vol. 74(3), pages 433-44.
- Simon, H. [1957]. "A Behavioral Model of Rational Choice," in *Models of Man, Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting*, New York: Wiley.
- Sims, C. A. [2003], "Implications of Rational Inattention," *Journal of Monetary Economics*, 50(3), pages 665-690.
- Sims, C. A., [2005] "Rational inattention: a research agenda," *Discussion Paper Series 1: Economic Studies 2005, 34*, Deutsche Bundesbank, Research Centre.
- Smets, F. & R. Wouters, [2007], "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review*, vol. 97(3), pages 586-606
- A. Splilimbergo, S. Symansky & M. Schindler, [2009], "Fiscal Multipliers," *IMF Staff Position Note*, SPN/09/11.

- Storesletten, K., C. I. Telmer, A. Yaron, [2001], "The welfare cost of business cycles revisited: Finite lives and cyclical variation in idiosyncratic risk," *European Economic Review*, vol. 45(7), pages 1311-1339.
- Storesletten, K., C. I. Telmer, A. Yaron [2004], "Consumption and risk sharing over the life cycle," *Journal of Monetary Economics*, vol. 51(3), pages 609-633.
- Taylor, J. B., [1993], "Discretion versus policy rules in practice", *Carnegie-Rochester Conference Series on Public Policy*, Elsevier, vol. 39(1), pages 195-214.
- Taylor, J. B., [2009], "The Financial Crisis and the Policy Responses: An Empirical Analysis of What Went Wrong", NBER Working Paper, 14631
- Tversky, A. and Kahneman, D. [1974], "Judgment under uncertainty: heuristics and biases," *Science* 185, pages 1124-1131.