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Macroeconomics is ever-evolving

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Abstract

The evolution of macroeconomics relies primarily on the evolution of conceptual and methodological claims from classical and New Keynesian economics. This paper surveys the (in)conclusive claims at both dimensions, extensions, and new directions for the evolution of macroeconomics. Furthermore, it examines how macroeconomics can integrate the role of financial frictions, financial institutions, carbon tax, and carbon emission on the present and future claims.

JEL Classification: E24, E52, Q40, Q50

Keywords: New Keynesian economics, classical economics, DSGE model, methodological claims, conceptual claims

1. Introduction

In macroeconomics, every fact we learn leads us to the learning of another fact; what we are currently learning is the result of debates about classical (real business cycle, hereafter mentioned as RBC) and the new Keynesian models. The classical models are based on microfoundations (the behavior of individual agents, such as households or firms, that underpins a macroeconomic theory); it holds the belief that there is no need for stabilization policy; It assumes that households are rational about market conditions and that markets are not systematically wrong; free-market forces, they assert, deliver economic equilibrium through adjustments in price and wages. From a methodological point of view, the classical theory established the use of dynamic stochastic general equilibrium (DSGE) models as a central tool for macroeconomic analysis. Early DSGE models belong to Kydland and Prescott (1982), Long and Plosser (1983), Prescott (1986), and Cooley and Hansen (1989); the latter includes a monetary sector with zero lower bound nominal interest rate. The belief that there is no need for stabilization policy and that the markets are not systematically wrong contradicts the issues that Keynes (1936) mentioned as a response to the Great Depression, such as the unstable character of

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financial markets, the need for a regulatory framework, and state intervention through monetary and fiscal policy to stimulate an economy experiencing recession; this belief that monetary and fiscal policy has an impact on the economy, at least in the short-run, contradicts the belief of classical models; however, it is accepted by central banks and was confirmed by Christiano et al. (1999). Furthermore, Taylor (1999) concludes that there is ample evidence of price rigidities, thus, contradicting the classical assumption of flexible wages and prices (free market forces); other evidence on wage rigidities include Druant et al. (2012), Barattieri et al. (2014), and others, while the evidence on price rigidities are in Dhyne et al. (2006), Nakamura and Steinsson (2008). By including the issues raised by Keynes (1936) into the DSGE structure of RBC theory, the New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) models were born. It focuses on the discussion of microfoundations; an example of microfoundations is price and wage rigidities (where wages or the price of goods do not change immediately following changes in demand and supply), and it accepts the classical assumptions that economic agents have rational expectations, according to which they can make economic adjustments in advance.

In recent years, a large version of the NK-DSGE models had been developed incorporating many features that were not considered in the early works. For example, to provide a better fit to the data, Smets and Wouters (2003, 2007), Christiano et al. (2005), and Gali et al. (2012) developed models that allow for habit formation in consumption, capital accumulation with investment adjusting costs, backward-looking indexation of wages and prices, and a variety of structural shocks, including markup shocks, neutral and investment-specific technology shocks, preference shocks, monetary and fiscal policy shocks, and so on. Many central banks over the world extended these models for simulation and forecasting exercises. Smets et al. (2010) and Gali (2015) documented the key outcomes of recent NK-DSGE models: the importance of expectations by explaining the role of current inflation as a function of current and expected levels of economic activity, and the importance of the natural level of output and interest rate as the reference points for monetary policy because they reflect the constrained efficient level of economic activity. Though, despite all the progress that was made, there are conceptual and methodological claims that constitute the current debates in NK-DSGE models. The conceptual claims include price settings, the role of financial frictions, agents' heterogeneity, capital accumulation, and so on. The methodological claims include calibration, estimation techniques, and the reliability of the results.

Some of these claims are conclusive, while others are inconclusive. For example, the claim of model estimation techniques seems to be inconclusive because Smets and Wouters (2003, 2007) using the classical estimation technique that matches the model to the data, thus, ignoring the non-model component from the data, found that output and inflation fluctuations tend to be primarily explained by price markup shocks; on the other hand, Canova (2014) with a technique that builds a flexible bridge between the model and the raw data to account for a non-model component that is in the data,

with the same model and data as in Smets and Wouters (2003, 2007) found that output fluctuations tend to be primarily explained by preference shocks, and wage markup shocks explain inflation fluctuations. The debate about which financial frictions are important to include in NK-DSGE models is an additional example of an inconclusive claim. For example, the model by Bernanke et al. (1999) includes the financial accelerator as financial friction, however, the model fails to explain the 2007-2008 global financial crisis; furthermore, Christiano et al. (2018) argue that the decision of which frictions to include in the model and the role of financial institutions that are not covered by the protective umbrella of the Federal Reserve and Federal Deposit Insurance Corporation are vital to understanding the 2007-2008 global financial crisis. The claim on the price settings is also inconclusive. Gali (2015) suggests that the Calvo (1983) price approach induces much richer and more realistic dynamics; it is argued by Christiano et al. (2018) by showing that the Calvo (1983) price approach makes sense only in environments where inflation is moderate. On the other hand, Nakamura and Steinsson (2008) and Eichenbaum et al. (2011) show that the implications of Calvo (1983) price approach are inconsistent with microdata.

With all said, one may ask: how can we increase our understanding of the DSGE model by learning with the available knowledge? The best way to do so is to describe the evolution of the conceptual and methodological claims that constitutes the debates in the NK-DSGE models by describing what is conclusive and inconclusive, and why the inconclusive claims constitute the path for the extensions and new directions of NK-DSGE models. Thus, this survey aims to summarize the (in)conclusive claims at conceptual and methodological dimensions, extensions, and new directions for the evolution of macroeconomics. The remaining of the paper is as follows: section two discusses the (in)conclusive claims that constitute the debates of the NK-DSGE models, section three discusses the merits of NK-DSGE models to analyze the natural resources and environmental policy dynamics, section four discusses the extensions and new directions. Section five concludes.

2. The (in)conclusive views about NK-DSGE models

There is a wide agreement that the basic structure of the NK-DSGE models may contain the following agents: households, firms, and monetary authority. It is assumed that households reallocate consumption over time, however, this assumption ignores the existence of households that face borrowing constraints. Therefore, Mankiw (2000) proposes the existence of heterogeneous households. He shows that by doing that, the models imitate the empirical evidence of excessive dependence of consumption on current income and the presence of households that have near-zero net worth; by following what was proposed by Mankiw (2000), Oh and Reis (2012), Kaplan et al. (2018) and others included the heterogeneous households in their models. On the other hand, firm heterogeneity in DSGE models is included in Gilchrist et al. (2017), Ottonello and Winberry (2018), and

others. This is a conclusive claim and is agreed that households' heterogeneity is relevant in developing economies, where the share of the rule of thumber consumers is above 60 percent, while the firms' heterogeneity is relevant in developed economies.

The claim of short-run non-neutrality of monetary policy is conclusive and it is based on the monetary policy rules. These rules are widely agreed upon and usually referred to as "Taylor rules", from Taylor (1993). As shown by Fair (2012), these rules have a long history. The first rule with an explicitly descriptive nature that focuses on estimating reaction functions for the central bank is proposed by Dewald and Johnson (1963), then by Christian (1968), and Fair (1978); furthermore, McNees (1986, 1992) extended the rule by including some of the explanatory variables that are Fed's internal forecast of various update. The claim about the short-run non-neutrality of monetary policy goes back from Keynes (1936) and its representations and implications are widely accepted.

Another conclusive claim on identification and misspecification is in Fair (2012). Fair judged the last generation of NK-DSGE models by explaining the model of Smets and Wouters (2007), Edge et al. (2008), and Adolfson et al. (2007). He argues that in these models, the construction of the variables is the source of misspecification. For example, in Smets and Wouters (2007) the employment variable is used as civilian employment instead of jobs, however, some people have two jobs, thus, civilian employment underestimates the number of jobs in the economy. Furthermore, he argues that this is not just a level difference because the number of people with two jobs is a cyclical variable; furthermore, he suggests the inclusion of an equation explaining the number of people with two jobs as a decision equation for households. Fair (2012), argues that the choice of aggregation is another problem with the construction of the variables, by showing that these models ignore the disaggregation of consumption (consumption of durable goods, nondurables goods, and services), and investments (housing, plant and equipment, and inventory); furthermore, he argues that the model of Edge et al. (2008) has better disaggregation than Smets and Wouters (2007), however, it is misspecified. For example, service and nondurable consumption are combined, but durable consumption is treated separately. The model by Adolfson et al. (2007) is also misspecified but it has better disaggregation than the others; Adolfson et al. (2007) endogenize imports, which is important to do, otherwise, it would be similar to Smets and Wouters (2007). The misspecification problem should be taken seriously when building NK-DSGE models because the misspecification of part of the model affects the estimation of the parameters in other parts of the model. It is worth noting that the misspecification of the models presented by Fair (2012) might happen because the models focus on the important and crucial point for the researchers, thus, being abstracted from the construction of the variable and the choice of aggregation; however, we can learn from the papers that succeeded in some points and failed to capture other aspects and come up with new ideas. For example, in Edge et al. (2008) we can learn the disaggregation of durable consumption and in Adolfson et al. (2007) we can learn how imports is endogenized, and so on.

There is an inconclusive debate on the estimation technique of DSGE models. This claim of estimation technique is inconclusive because when classical estimation technique is applied the researchers match the model to data, making the model be the generating process of the actual data up to a set of serially uncorrelated measurement errors. In this case, only the cyclical portion of observable fluctuations from permanent shocks is explained, while both permanent and transitory shocks may produce cyclical fluctuations. Consequently, Canova (2014) proposes a technique that builds a flexible bridge between the model and the raw data, taking into account the uncertainty in the specification of the non-model component when driving estimates of the structural parameters; besides, the flexible estimation technique provides a natural environment to judge the goodness of fit of a model and a framework to examine the sensitivity of the estimation results to the specification of nuisance features.

Another example of inconclusive claim is the parametrization problem or how I call "inference on parameters problem". This is the result of taking the parameters estimated for developed economies to calibrate the model for developing economies. It is common and is justified by saying that some parameters are standard in the literature. If in fact, some parameters are standards, why parameters in Niu et al. (2018) differ considerably with those in He et al. (2017). Both models were built to the same economy (China). One may argue that both models are different in nature and purposes. In Niu et al. (2018) the household discount factor is set to 0.97 and was extracted from Gertler and Gilchrist (2007), the share of capital in output is set to 0.493 and was extracted from Fan et al. (2016), while in He et al. (2017) they are 0.985 and 0.39 respectively.[1)] If they were standard they would've been the same. This problem leads to the complexity of mapping parameters to the data. It makes the classical estimation being unfeasible, i.e., the likelihood function is too flat among many dimensions. Therefore, Bayesian estimation would indeed seem to be the way to proceed if indeed we had justifiably tight priors for the parameters.

There is an inconclusive debate on the key strength of NK-DSGE models. Some researchers believe that NK-DSGE models can be used not only for descriptive but also for normative purposes. Though, from the last two inconclusive claims, we can conclude that the normative implications of NK-DSGE models are not convincing; this is confirmed by Fair (2012), where he argued that the main message of NK-DSGE models is not sensible because models developed so far are highly misspecified. Therefore, we cannot make inferences on the results. To solve this claim (the reliability of the results), the misspecification and inference on parameters must be solved.

The claims discussed above and others are summarized in Table 1 below. It is the temporal representation of conceptual and methodological claims that had been the core discussion in

1) He et al. (2017) argue that the household discount factor match China's interest rates on savings and personal housing mortgages, while capital share on output is the same as the value estimated by Bai et al.(2006).

macroeconomics. As we have seen in foregoing pages, in the past, the claims at the conceptual dimension of NK-DSGE models were focused to challenge the assumption of Real Business Cycle (RBC) theory, which includes: monopolistic competition (firms set their prices, which is opposite with RBC theory), and the labor market is in a monopolistic competition (labor union set their wages); since the prices are set by firms, the economy is subject to nominal rigidities, i.e., the changes in price may occur due to menu costs (Rothenberg (1982) price approach) or due to the changes in marginal cost and aggregate demand (Guillermo Calvo (1983) price approach). At RBC theory, prices are fully flexible (no nominal rigidities). The last conceptual claim from the past is that the monetary policy is non-neutral in the short-run (opposite to the RBC theory, which emphasizes the neutrality of monetary policy). If the goods market and labor market are monopolistic because firms and labor union set prices and wages, respectively, and if this change affects the real economy negatively, the central bank shall make use of monetary policy instruments to make the economy get back to its natural equilibrium, i.e., equilibrium without nominal rigidities.

Table 1 can be read horizontally and vertically. From a vertical perspective, the table shows the claims that were discussed at a particular period, past (1982 to 1998), present (2000 to 2009, 2011 to 2020), and the future (2021-upwards). The past period represents the years following the seminal paper of Kydland and Prescott (1982) to the period where Christiano et al. (1999) shows that monetary policy is non-neutral, i.e., central banks can make use of monetary policy to influence output and employment developments, at least in the short-run. The present period represents the periods where researchers started to include monetary policy, nominal rigidities, and monopolistic competition in goods and labor markets; these assumptions were primarily adopted by Smets and Wouters (2003), Rabanal, and Rubio (2005) and others. However, the role of Keynesian economics in averting another Great Depression following the 2007-2008 global financial crisis resulted in the massive adoption of NK-DSGE models for policy analysis. This particular return to Keynesian ideas on government intervention was documented by Skidelsky (2010). The future periods is due to the adoption of NK-DSGE models to analyze natural resource and environmental dynamics. Furthermore, the table can be read vertically. Reading it vertically, we can see that the present claims at the conceptual dimension show the need for including the financial sector (or frictions) and heterogeneous households; prices follow Calvo (1983) approach, and monetary policy is non-neutral at least in short and medium-term. On the other hand, the present claims at the methodological dimension show that the models are estimated using the Bayesian approach; the results are evaluated to descriptive and normative (not convincing) implications; there is an identification problem due to the inference on parameters. Reading the table horizontally, we can see the evolution of the claims in the three periods. For example, the past claim on the nominal rigidities shows that the Rothenberg price approach was common, which is followed by the present claim of Calvo price approach; the future awaits for an alternative approach for price settings. The merits of including the natural

Table 1. Evolution of the NK-DSGE model's claims

Dimensions	Past (1982–1998)			Present (2000–2009, 2011–2020)			Future (2021-upwards)		
	Claim/debate	Authors	Findings	Claim/debate	Authors	Findings	Claim/debate	Authors	Findings
Conceptual	Monopolistic competition (Conclusive)	[4], [7] [11] [13], [26], [27], [53]	Firms setting prices and labor union setting wages	Heterogeneous agents (Conclusive)	[6], [30], [32], [34], [39], [45], [46], [50]	Difficult to prevent 2008 financial crisis	Inclusion of natural resource sector (Conclusive)	[2], [19], [25], [44]	Countries use natural resource for energy production, thus, increasing environmental concerns
	Nominal rigidities (Inconclusive)	[4], [7], [20], [21], [26], [27], [43], [49], [52], [53], [54]	Price follows Rothenberg approach (Menu cost)	Marginal cost and demand schedule (Guillermo Calvo) (Inconclusive)	[7], [26]	Low inflation economies	An alternative approach for price-setting (Inconclusive)	[9]	State-dependent price setting is being discussed
	Short-run non-neutrality of Monetary Policy (Conclusive)	[4], [26], [27], [52], [53], [55]	Fisher type rule	Short and medium-term implications of Monetary Policy (Inconclusive)	[10], [17], [40], [52], [53], [54], [55]	Simple (with no information about economic structure) and optimal monetary policy (Taylor rule)	Inclusion of environmental shocks (Conclusive)	[2], [19], [25], [44]	Inclusion of energy from fossil fuel implies carbon emission shocks
Methodological	Calibration and Simulation (Conclusive)	[25]	No inference on the results	Estimation (Bayesian Approach) (Inconclusive)	[1], [21], [48], [52], [53]	Flexible estimation (Canova approach)	Flexible estimation (Canova approach) (Conclusive)	[8]	Many studies are needed to evaluate the flexible approach
	Evaluation (Inconclusive)	[5], [8], [23], [29]	Descriptive implications	Evaluation (Conclusive)	[5], [8], [23], [29]	Descriptive and normative (not convincing)	Evaluation (Conclusive)	[5], [8], [23], [29]	Normative implications might be convincing
	Identification (Inconclusive)	[1], [21], [52], [53]	Based on shocks	Inference on parameters (Inconclusive)	[3], [25] [28], [31], [44],	Use of high-income countries to calibrate and estimate models for low-income countries	Disaggregation of the variables (Conclusive)	[1], [21], [23]	With the disaggregation of the variables and parameters estimation procedure

Source: Author

resource sector and carbon emission shocks will be discussed in the next section.

3. The merits of NK-DSGE models on environmental economics

In foregoing pages, we presented the (in)conclusive discussion of conceptual and methodological claims of NK-DSGE models. The merits of including carbon emission shocks, and the natural resource sector were not discussed, however, it is worth noting. It is a fact that natural resources are mainly used as a source for energy, fossil, and clean energy; it is also a fact that the carbon emission is an ongoing problem to the environment; however, the study of the relationship between environmental tax (or carbon tax) and carbon emissions are conducted by using the Leontief type input-output model, CGE (Computable General Equilibrium) model, OES2000 (Ocean Energy System 2000) model, and GCAM (Global Change Assessment Model) model; the data availability to CGE models makes it one of the most popular models in this field. Recently, the use of NK-DSGE models to analyze the environmental tax shocks and carbon emissions is increasing because the NK-DSGE models allow for the description of environmental tax shocks on carbon emission and, at the same time, captures the causes of such shocks, i.e., the NK-DSGE models have the advantages in obtaining more comprehensive estimation results because the theoretical framework is definitive, and the model can depict the behaviors of each sector and show its response to environmental tax shocks and other factors. Two sectors are taken into account when the NK-DSGE model is used to analyze the environmental tax shocks and carbon emissions, namely, the natural resource sector (limited to the role of the energy sector), and the environmental sector (limited to the carbon emission tax).

3.1. Natural resource sector

To evaluate the merits of NK-DSGE models with the natural resource sector, the energy sector must be included in the model. The energy sector focuses on the dynamic impact of environmental taxes on carbon emissions through the share of fossil energy in the total energy use. Fan et al. (2016) included the energy sector as an intermediate sector between households and final good firms. Furthermore, he shows that to produce the energy (fossil and clean energy), this sector employs the capital provided by households and technology; the total energy output is

$$E_t = B_t (K_t^E)^Y, \tag{1}$$

where γ represents the output elasticity of capital, K_t^E represents capital investments in time t, E_t represents total energy output in time t, and B_t represents the productivity, obeying AR (1) process; similar representation of energy sector was adopted by Niu et al. (2018).

3.2. Environmental sector

The environmental sector analyses the impact of environmental technology on the reduction of carbon emissions and low-carbon development of the economy. Following the dynamic equation of environmental quality developed by Angelopoulos et al. (2010), the low-carbon development of the economy is

$$Q_t = \rho_Q Q_{t-1} - CO_{2t} + \phi V_t(G_t), \tag{2}$$

where Q is the low-carbon development of the economy, ϕ is the reduced carbon emission through government's control, ρ_Q is the sustainability of the low-carbon development of the economy, and V_t is the green technologies used by the government to control carbon emissions in time t, obeying the AR (1) process.

With the inclusion of natural resources and environmental sectors into the NK-DSGE model, we can evaluate the environmental policy implications resulting from the model by using impulse response functions; the impulse response function in Niu et al. (2018), shows that, in China, environmental tax shocks can drive a reduction of carbon emissions, while the productivity shocks of the energy sector can raise carbon emissions. Doda (2014) shows the qualitative similarities and quantitative differences across countries. He argues that in the way emissions and GDP are related as the economy moves through business cycle fluctuations; countries are qualitatively similar because emissions are procyclical, and are quantitively different because the procyclical and cyclical volatility varies in systematic ways. The extensions and new direction are discussed in the next section.

4. Extensions and new directions

The extensions and new directions in NK-DSGE models rely on the debates from macroeconomics and other fields, such as financial markets and institutions, econometrics, environmental economics, and so on. It can be divided into the core (macroeconomics) and non-core (other fields) debates. In respect to core debates, Blanchard (2018) argues that to develop a model that explains well fluctuations in key macroeconomic variables depends on the outcomes of a realistic consumption and price-setting equations and adding capital and investment decision. However, even if we achieve what Blanchard is proposing, there are more questions for those who will build medium and large scale DSGE models: How can we deal with aggregations issues (which have been largely the source of misspecification)? Additional core discussion is in Fair (2012). He argues that we can abandon the assumption about rational expectation and the cost to abandon it seems small; his alternative of abandoning the rational expectation assumption is by going back to macro1. Alternatively, we can abandon the assumption of rational expectation by assuming the existence of rational and irrational agents, and add the adaptative expectation for irrational players; or add some noise in the equation to contaminate the decision made by households and firms. On the other hand, on the non-core debates,

one can ask: what is the best way to introduce financial intermediation? and how do we proceed with estimation (knowing that the classical and flexible approach provided different sources of output and inflation fluctuations)? For those looking to extend the NK-DSGE models for environmental analysis, how can we incorporate renewal energy support schemes in total energy output (equation 1)? How can we use environmental tax (carbon emission tax) to increase the use of green technology? The question seems endless, however, it is worth noting. Thus, we are going to address each of the extensions separately.

4.1. Price settings

The price and wage settings are an old debate in macroeconomics. It emerged from the ideological battle between the Keynesian and classical schools of thought. The battles are based on the ideology of each school. Keynesian argue that the level of employment in an economy is determined not by the price of labor, but rather by the level of aggregate demand. Thus, firms set their price based on marginal cost or aggregate demand (Calvo price setting), or because they incur a menu cost (Rothenberg price-setting); this contradicts the classical school of thought, where firms take price as given. The adoption of Calvo or Rothenberg price-setting had been widely discussed, however, its merits are not conclusive. Giovani and David (2007) show that the inconclusion of the Calvo and Rothenberg price settings is due to its welfare implications. They argue that the Calvo price setting assumption implies a different curvature of the economy than the Rotemberg price-setting assumption. Thus, by Jensen-inequality[2)], this implies that the expected value of the endogenous variables would, in general, differ across the two pricing mechanisms. Consequently, welfare is different across the two pricing settings.

Furthermore, Gali (2015) argues that the timing of price readjustments in Calvo settings for any given time is exogeneous, and hence, it is independent of the gap between its current and desired prices. He additionally argues that in a such case, if a model adopts these price-settings, it becomes a time-dependent model, the fraction of firms adjusting prices in any given period is independent of the state of the economy. Caplin and Spulber (1987) develop an economy in which each firm chooses optimally the timing of each adjustment, incurring a menu cost whenever it changes its price; the resulting implications are not convincing. The future awaits state-dependent price settings, and the level of discussion in this regard is encouraging.

2） In the simplest discrete form the Jensen-inequality is $f(\lambda_1 x_1+\cdots+\lambda_n x_n)\leq\lambda_1 f(x_1)+\cdots\lambda_n f(x_n)$, where f is a convex function on some set C in $\mathbb{R}$, $x_i\in$C, $\lambda_i\geq 0$, $i=1, \ldots, n$, and $\lambda_1+\cdots+\lambda_n=1$

4.2. Financial market and institutions

In Section 1 we introduced the reasons for the unpredictability of the 2007-2008 global financial crises by citing Bernanke et al. (1999). However, two main reasons led to the crises that are worth noting: the role of financial frictions such as liquidity evaporation and collateral shortages; and the role of highly levered shadow banks by repeatedly financing their long-term assets by short-term debt.[3)] Furthermore, Caballero (2010) argues that an enormous amount of work at the intersection of macroeconomics and corporate finance has been chasing many of the issues that played a central role during the 2007-2008 global financial crisis, including liquidity evaporation, collateral shortages, bubbles, panics, fire sales, risk-shifting, contagion and so on. Much of this literature belongs to non-core. Introducing additional financial richness into the core in such a way that the model allows for the potential of financial crises requires breaking with standard modeling choices such as a general preference to avoid ad hoc sources of frictions: limited or no time-variation in risk, and liquidity premiums; and the usual treatment of expectations formation (Kozicki, 2012). Some papers explored the policy implications of the coexistent of price and wage rigidities with different types of credit frictions, including collateral-based borrowing constraints (Monacelli, 2006), balance-sheet constraints on financial institutions/intermediaries (Gertler and Karadi, 2011), endogenous time-varying spreads between policy and loans rates (Curdia and Woodfor, 2010), time-varying volatility of idiosyncratic shocks (Christiano et al., 2014) and so on. Gali (2015) argues that those mechanisms fall short of providing an endogenous explanation for the occurrence of financial crises because the crises are gradually viewed as the consequence of the gradual building up of financial imbalances that eventually become unsustainable.

5. Conclusions

In the foregoing pages, we discussed the (in)conclusive claims of NK-DSGE models at conceptual and methodological dimensions, the merits of NK-DSGE models for environmental policy evaluation, and extensions and new directions. The following claims are conclusive at the conceptual level: agents heterogeneity, and non-neutrality of monetary policy, while identification and misspecification is a conclusive claim at the methodological dimension. The inconclusive claims that were emphasized are at the methodological dimension and cut off among the estimation technique, inference on parameters, and the reliability of the results. We have seen that the advantage of NK-DSGE models in evaluating the effectiveness of environmental tax shocks is due to its advantage in obtaining comprehensive estimation results, i.e., the model can depict the behaviors of each sector and

3) Shadow banks are financial institutions not protected by the Federal Reserve and Federal Deposit Insurance Corporation (Komatsu, 2019).

show its response to environmental tax shocks and other factors; it had been used by Niu et al. (2018) for evaluation of environmental policy in China; its implications are encouraging. The extensions and new directions were analyzed at the core and non-core debates. At core debates, we explain the need for the inclusion of state-dependent price settings, while at the non-core debate we analyzed the role of financial frictions and institutions that can be incorporated to reduce the level of financial imbalances. Despite the (in)conclusion of the claims presented above, the goal of macroeconomics does not change. As Fair (2012) states "..the main goal of macroeconomics from the beginning has been to explain the entire economy - to develop models that can explain well fluctuations in all key macroeconomic variables". Did we succeed in developing a model that can explain well fluctuations? Not yet, but despite the criticism towards the practical use of NK-DSGE models to explain fluctuations in all key macroeconomic variables, its outcomes are encouraging. Until a model that best explains fluctuations is developed, macroeconomics is ever-evolving.

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