

November 2014

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Recommended Citation

Kodheli, Mimi and Vokshi, Arjeta (2014) "Theoretical analysis of Dynamic General Equilibrium model," *International Journal of Business and Technology*: Vol. 3 : Iss. 1 , Article 3.

DOI: 10.33107/ijbte.2014.3.1.03

Available at: <https://knowledgecenter.ubt-uni.net/ijbte/vol3/iss1/3>

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Theoretical analysis of Dynamic General Equilibrium model

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Abstract. Central Bank is one of the most important institutions of a country because its responsibility is to draw and implement the monetary policy. The central bank, in order to accomplish this responsibility, has to have a clearly defined main objective, the instruments that will use to achieve the objective, and it should be able to make precise or very good forecasts of macroeconomic variables. In order to make these forecasts, the central bank should first of all understand every monetary transmission mechanism and determine the most effective one. The success or non-success of monetary policy, living apart the other factors, depends on the monetary regime implemented in the country. In the last years, a lot of countries have implemented the inflation targeting regime. One of the conditions of the implementation of the inflation targeting regime is that the central bank should be able to make precise forecasts. For this reason, the structural macroeconomic models, in these days, have become very used because the central banks have used these models as a basis for the policy decision-making based in forecasts. The main goal of these models is to provide a more structured input for the monetary policy decision making, helping to create a full ‘history’ and helping to explain the consequences of different external shocks and different policy rules. Dynamic Stochastic General Equilibrium (DSGE) model is one of the most used forecasting models in the countries that have implemented the inflation targeting regime. Albania is one of the countries that want to formally implement the inflation targeting regime and give up the monetary targeting regime. Now for now Bank of Albania is using the MEAM model as a macroeconomic model of forecasting. In we look at the experience of the other countries that have implemented the inflation targeting regime and the recommendations of the foreign experts, we can conclude that Bank of Albania should work and should evaluate a DSGE model. This is the main reason why this paper is focused on the theoretical analysis of the DSGE model. In the paper will be presented arguments that explain why this is a good forecasting model for Albania. The arguments will be given based on the analysis of the characteristics of this type of model. Also in this paper we will discuss the advantages and disadvantages of this type of model. This analysis will help us strengthen the arguments about the necessity of use of this model from Bank of Albania.

Keywords: central bank, monetary policy, forecasting model, DSGE

1 Introduction

The main objective of the estimation of a macroeconomic model is to use it in monetary policy analyses, with the aim to study the effect of possible shocks in the economy. For this reason central bank tries to estimate an as much as possible good macroeconomic model. Most of the countries that implemented Inflation Targeting regime have estimated and use DSGE model tailored to their specific needs. In Albania, the first effort was done by Dushku, Kota and Binaj (2006). The main part of the model was estimated using Vector Error Correction Model (VECM). But, in the roundtable¹ organized from Bank of Albania, the main comment of David G *Mayes* (2006)² and *Gülbin Şahinbeyoğlu* (2006)³ was that the macroeconomic model should aim to produce good short-term forecasts and also should allow the central bank to analyze the monetary policy or to make long-term forecasts. For this reason Mayers suggested to Bank of Albania to estimate a Dynamic Stochastic General Equilibrium model and he mentioned that countries like Canada, Finland, New Zealand and Great Britain have been successful in this aspect. After these comments, Kota and Dushku (2011) proposed a structural model with the argument that Bank of Albania needs an approximating model because it will help in monetary policy decision-making process. They argued that structural model is in between the IS/LM models and DSGE models. They were based in Carabenciov et.al. (2008), model, but they have included in it even the exchange rate transmission channel that is evaluated to be important for the Albanian economy.

¹ Inflacioni i Shënjestruar 2, Tryezë e Rrumbullakët, Tiranë, Shqipëri, 7-8 dhjetor 2006

² Bank of Finland

³ Central Bank of Republic of Turkey

2 Types of forecasting models

The debate of economists on the type of the macroeconomic model that is best to use was always present. Mishkin (2002) said that the VAR approach is not that does not contain any structural model of dynamics. For this reason he argues that the conclusion that inflation shocks contribute to the variance of interest rates does not imply necessarily increased focus on the control of inflation, because if inflation shocks contribute to interest rate variability, then inflation expectations would prevent inflation from deviating much from the inflation target. So Mishkin says that VAR approach does not explain the link between the inflation targeting and the conduct of monetary policy. The apparent success of IT countries is merely due to them having “high initial inflation and large decreases, but the decrease for a given initial level looks similar for targeters and non-targeters” (Ball; Sheridan, 2003, p. 16).

The modeling of the economy has always been one of the concerns of the economists. According to the forecasting models, the main phases of the modeling are the ones listed and briefly explained in this paper. The very begging of the modeling was the use of IS/LM model. Then Sargent and Wallace (1976) started a debate about the monetary policy that follows a rule with the aim to achieve the optimal position. This was the beginning of the *New Classical Criticism of Keynesian Policies*. Robert Barro (1977, 1978) stated that indeed a model where only unexpected rate of growth of money supply affects unemployment and the price level fit the United States data well expectations which in turn depend on people’s perception of government policies. The main problem of the Tinbergen model is the instability of the estimated coefficients of reduced form. Lucas noted that these coefficients are possibly nonlinear functions of the structural model. All the economists should keep in mind that economics is not physical. But the Lucas critique cannot be taken too seriously in formulating actual policies. If indeed the only source of deviation of the model from reality was the change in the coefficients of the reduced form due to a change in public perception of policy then we should be careful. The model is an approximation and can have or can produce error and deviation from the current behavior of the economy. The problems would increase if in the model would be included irrelevant variables, excluded relevant variables or even the model is not specified correctly. Also there may be the case were the estimated coefficients are far away from the “true” parameters. All these problems opened the road to a new era of modeling that was that of *Statistical models*. During the 1970s and 1980s time series analysis became the most important modeling technique. The techniques and discoveries were the Box-Jenkins or ARIMA method due to George E. P. Box and G. M. Jenkins, spurious regression discovered by Granger and Paul Newbold, vector autoregression (VAR) modeling by Christopher Sims, causality test proposed by Clive W. J. etc. All these techniques were very mathematical and were difficult to be developed from every economist. Durbin-Watson (1950–1951) proposed a statistics to detect serial correlation, and Cochrane-Orcutt (1949) and Hildreth-Lu (1960) revised techniques to “correct” for it. Even though different tests were introduced, statistical inference that is based in random sampling was creating a problem for statistical analyses. The models there were supposed to solve this problem were *Business Cycles models*. Frisch’s Theory of Cycles is the first model of that type. After this we find the Samuelson’s Model of Interaction between Multiplier and Acceleration and also we find Hicks’s Model of Two Limits. In this period economists used as a basis the Keynesian point of view and they started with the basic IS-LM model. They included the lagged variables. John Hicks added to the basic model two limits to the amount of output in the economy: the aggregate output (Y) that could not go above what could be produced with full employment and the second the amount of net investment could become negative but can never go below the amount of depreciation. Empirical evidence shows that business cycles aren’t regular because business cycles differ and rarely are similar. Hick’s model supposes that the economy stays for a non defined time at full employment and it predicts regular behavior during the cycles. Thus, the length of the cycles and the timing may not be exact. The last evolution of the forecasting models was the Real Business Cycles Theory that was firstly presented from Kydland and Prescott, that also were the first to present a *Dynamic Stochastic General Equilibrium model* as a tool to analyze the economy. Some of the economists that replaced the mechanical “empirical” models with the simpler ones were Ed Phelps, Robert Lucas, Thomas Sargent, Christopher Sims, etc. They tried to introduce these models that were based on individual households and businesses. For the first time, DSGE models explained the “stagflation”. DSGE models show the economy in the steady growth. Then economists improved the DSGE models by adding in “frictions” and “accelerators”. This type of DSGE models are known as New Keynesian models. These models are based on optimizing agents and neoclassical growth theory and, therefore, they can claim some kind of micro foundations and stochastic elements are explicitly shown and are part of the model. This sets them apart from a deterministic model that is made stochastic by addition of an error term. Also, the models are dynamic through intertemporal optimization, gestation period in capital formation, and autocorrelation of stochastic terms. The models are flexible. More recent work using DSGE models have incorporated money, international trade, and even rigidities in wages and prices. But these models leave out the fact that financial crises are specific situations that are caused from specific factors. Over time researchers have added money, government budget, and international trade to the model. These additions complicate the model but they are

essential if the DSGE models are to be used for policy analysis. The basic question left unanswered by the New Classical and by the real business cycles theory is: why demand shocks change quantities rather than prices. For this reason economists developed *New Keynesian Models with Nominal and Real Rigidities*. The New Keynesians come up with a number of reasons why there are rigidities at the micro level and prices and wages are sticky. These elements have been incorporated in many models including the dynamic general equilibrium models. The main objective of these models is to obtain a basic projection model and this is an important component of the analytical and forecasting system of the central bank and will improve the central bank decision-making process. The medium term forecast that usually is accompanied with a recommendation of the staff is the only important input of policymaking process. Central banks that implemented inflation targeting regime go through a specific process that includes techniques and phases that can't be divided from the policymaking process (Svensson 2005, Berg et al 2006). A further challenge to the New Keynesian Phillips curve is pointed out by King and Watson (2012) who found a large discrepancy between the inflation predicted by a popular DSGE model, the Smets and Wouters (2007) model, and actual inflation. Thus, they conclude that the model can successfully explain the behavior of inflation only when assuming the existence of large exogenous markup shocks.

3 Characteristics of DSGE models

The basic forecasting models are not the only tool used to forecast. There are even other models that contribute in the forecasting process and mainly are based in specific questions or even sectors and generally give more details than the basic model would give. Estimation of a DSGE model differs from country to country. It is known that there are a lot of restrictions during the evaluation of a basic projection model in the emerging economies. We are going to list some of these problems because those are problems that will be faced even from Albania during the process of evaluation of this type of model.

Firstly, emerging economies go through big structural changes and for this reason is difficult to model the economy. In most of emerging economies there is always lack of reliable data, and data inference is complicated and the possibility to understand the future is decreased. During a structural change is difficult to distinguish the signals of an economic cycle from the signals of long-term permanent movements.

Secondly central banks of emerging countries that implement inflation targeting regime generally have lack of knowledge, organizing structure, processes and ability in modeling and using the models (Coats et al 2003). For these reasons, these countries should develop alternative projection models that serve to the policymakers of these countries, and they are making efforts in evaluating the DSGE models and using them for policy inference, forecasting and policy advice.

The first effort of most of the emerging countries central banks is to create very simple medium term projection models. They need it because they can understand, communicate and can use it for the creation of typically timing restrictions forecasting scenarios. *But what are the goal and purpose of the model?* The quarterly projection model is a tool that helps to explain the basic medium term characteristics of monetary transmission mechanisms in the emerging economies. It combines the advantages of the simple models with the theories and the insights of the general equilibrium models. The model is very simple and the results are easy to interpret. Also, compared with the "gap" models, it includes more economic variables, basic shock flow consistency and answers clearly to a lot of questions. The main objective of DSGE models is to become basic projection models. This is an important component of the analytical and forecasting system of the central bank. The use of this model improves the process of decision-making of the central bank that implements the Inflation Targeting regime. The basic model represents the main medium term features of the monetary transmission mechanism and for this reason, its main goal is not exact short-term forecasts but is the main message of the policy and this is fundamental to discipline the debate on policy.

The restrictions in the evaluation of the basic models for the monetary policy forecast reflect the way these models are used. Central banks that implement Inflation targeting regime aim that the medium term forecast focus more in finding the path the interest rates will follow that matches with the achievement of inflation rate preplanned medium term goals. In this models are included even risks and uncertainty. The basic forecasting models help in creating medium term scenarios by organizing all the information that is elaborated during the forecast and providing consistency of the medium term scenarios and preparing alternative scenarios and risk evaluation (Benes et al 2003). Basic projection models help in defining accountability on the monetary policy communication to the public and on the integrity of the staff.

4 Difficulties in the evaluation of DSGE models

Sometimes General Equilibrium systems have very complex theoretical structures that are difficult to evaluate and communicate. For this reason is necessary that the staff is experienced in modeling and should exist a good planning of technical and human resources for a specific period of time. For this reason, emerging countries that implement Inflation Targeting regime may not see direct benefits from a DSGE model. The experience shows that complication and extension of the model is not so important in the first stages. The routine usage of these models for forecasting purposes requires skills that are easily developed both from the creator of the model and from the operators of the model through learning from small models.

The main challenge for the evaluation of a correct model is to clearly define the current economic problems that should be solved with the DSGE model. The evaluation of a DSGE model should not be limited only in the evaluation of a model that will be used for everything, because there is a risk that will not be included in the model some important features of the monetary transmission mechanism. It is recommended to evaluate some small models and then to work on those models.

The phases that must be followed to evaluate a good DSGE model are:

- Collection and documentation of all the important stylized facts of the economy and the staff should try to understand these facts. Then the staff can evaluate, calibrate and study some small models of the general equilibrium.

- Evaluation of a parsimonious basic model. The staff should identify the important monetary policy experiments and should understand the importance of the parsimony of the model and the flexibility to respond to different policy questions. In this phase, the staff can extend the model or even evaluate clones of it. The model should be adapted and recalibrated to fit the latest data and with the aim to use it as a projection tool. The staff should test the new model together with the existing projection framework, using different exercises.

In the very first phase there is a decision to be made. Should the staff work on an existing model or should the staff introduce a completely new one? After this, the central bank should decide about the software that should be used for the simulation and then decide for the level of theory, model parsimony and flexibility that will be used.

Despite the difficulties, construction and evaluation of DSGE models nowadays has become easier because there are a lot of institutions and researchers that are ready to share their experience with the others. Not only are the central banks trying, through workshops or seminars, to evaluate these models. There are a lot of individual researchers that are doing it.

5 Advantages and disadvantages of the DSGE models

The main advantages of using the general equilibrium models as forecasting models are:

- These models allow to have a well defined long-term equilibrium
- The trend and the dynamics of the model can be easily understood and can easily adjust to the economic theory.
- Specification of the general equilibrium model allows the broadening of the model, i.e.: include tradable and non tradable goods sector, or include the labor market.
- The model provides consistency between the flows and the stocks with a more direct definition even for the national accounts
- The microeconomics bases that refer to the underlying structures of markets and agents with objective functions and ease the simulation results interpretation.
- As a tool that analyzes the policy, the general dynamic equilibrium models give the possibility to simulate the responses to different shocks of different variables, but having different scenarios.
- These models give the possibility to isolate the shocks effects and these effects can be compared in the conditions of the different policy systems.
- With the general dynamic equilibrium is easy to make questions like: What would happen if...?
- The main advantage of these models, compared to the other models, is that the general dynamic equilibrium models can be used as a forecasting tool and allows the history to be coherent because these models make the economic phenomenon easy to understand.

The disadvantages of DSGE model are linked directly with the economic science. The main critics are linked with the theoretical basis. Some of the advantages are listed below.

- A large number of economists criticize the regime of inflation targeting itself, and with this is criticized its theoretical groundlessness.
- The initial assumption of the general equilibrium existence is most often criticized. Economists argue that the existence of a unique and sustainable solution to the system of general equilibrium has not been proven. This indicates that there are problems with the knowledge of essential characteristics of the macroeconomic system and can serve as a serious conceptual argument against the use of new neoclassical synthesis in arguing practical recommendations.
- One of the disadvantages of the general dynamic equilibrium models, relying on microeconomic analysis market, is the fact that there is little knowledge of a problem of cyclical nature of economic development. Sources of economic fluctuation, even in the real business cycle models, are considered exogenous shocks..
- Another criticism that can be seen as a disadvantage is the notion of 'rational agent'. Rational agent has all the information and he is "incredibly predictable". Individual agents are often identified with rational agents, forgetting that it is just a representative example which is used as an instrument in scientific analysis, nothing more than a theoretical abstraction. Is the rationality universal guideline for all economic participants, i.e. equal characteristic for all economic activities?
- Through this problem neoclassical mainstream exceeds "tacitly", assuming that all individuals are alike in their efforts to maximize their own utility function. However, behavioral theory questions the above mentioned assumptions of neoclassicists. It is sufficient to take into account the fact that individuals are not similar either in terms of preferences, or in terms of features.
- Economists call as a disadvantage of the DSGE models the fact that are used numerous assumptions, all in order to promote rational behavior model. The first group of assumptions concerns the relationship between the assumption about naturally determined individual preferences and, accordingly, consistent respect of the rules, on one hand, and freedom of economic choice, on the other hand. The second group of assumptions concerns the limited resources that confront the assumption of unlimited computational and analytical abilities in processing complex information.
- The dynamics of macroeconomic aggregates can be interpreted as lawful movement of the whole economic system to an equilibrium state, but can be understood as well as a result of the action of external factors. For a while it seemed that the game theory is a possible solution to the problems faced by the theory of general equilibrium.

6 Conclusions

As presented in the paper, the dynamic general equilibrium model are developed from the economists with the aim to model the economy and then to be able to make question like: What would happen if...? As every model, when we decide to use the DSGE models, we have to keep in mind their advantages and disadvantages. Economists have done different 'reparations' to the very first type of the DSGE model including what was left out at the beginning. For this reason and knowing the fact that for every model the economists should keep in mind the limitations and the assumptions of the model, we can conclude that it is worth it to evaluate a DSGE model for Albania. Maybe at the beginning it will have some assumptions, but after evaluating it for the first time, the economists will be able to broaden it, including in it the parts that were left out at the beginning.

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