Nobel Prize of 2011: Empirical Macroeconomics by Thomas J. Sargent and Christopher A. Sims

Introduction

Financial global crisis changed the attitude of financial environment to the macroeconomists or other financial analytics. If economic environment was more interested before the crisis about the value of assets or how to create the growth than it was focused on other tasks, one from which was the estimation of policy (monetary and financial) results. This tendency could be seen in the Nobel Prize rewards for 2011 when it was given to Thomas J. Sargent and Christopher A. Sims "for their empirical research on cause and effect in macroeconomy" according to Scientific background compiled by the Economic Science Prize Committee of the Royal Swedish Academy of Sciences (2011, p.34). Even though their main research works were done in the 1970s and mostly not connected with each other, their contribution to the empirical studies of money, expectations, and policymaking interconnectedness is still felt and maybe only is reaching the peak in interest.

The works of Nobel Prize 2011 Laureates give the macroeconomists the methodology to analyze the influence of different shocks, or unexpected events, on the other macroeconomic variables. For example, it is possible to analyze the influence of oil prices growth on the government expenditures; or the influence of interest rate growth on inflation and gross domestic products (GDP). Even though some other researchers and Nobel Prize laureates also tried to solve this task: Milton Friedman, Robert Lucas, and Edmund Phelps, it was seen as impossible to solve before Nobel Prize 2011 Laureates. Robert Lucas even thought that it is naïve to try to predict the influence of policymaking on the macroeconomic environment on the basis of historical relations between macroeconomic variables what is known as Lucas critique (Lucas, 1976). However, Thomas J. Sargent and Christopher A. Sims proposed the mathematical apparatus for solving Lucas critique not only on theoretical level, but also on practical level with adding expectations into analysis: crucial role of expectations for Philips curve (Sargent, 1971), period of high-inflation in 1970s (Sargent, 1983), impulse-response analysis of U.S. postwar data (Christiano, Eichenbaum, and Evans, 1999), etc.

Chapter 1. The contribution of Thomas J. Sargent

In the beginning of 1970s, the macroeconomics reached the critical and critique point. Most of the influenced economists: Lucas, Phelps, Prescott, etc., of that time were upset about the results which were shown by reduced form models. The main problem was not on the practical side due to the bad result, but on theoretical side due to unambiguous treatment of models. Due to starting changes, the group of economists proposed to rebuild macroeconomic theory and empirical methodology. As they thought, the main fundament of macroeconomics should be the microeconomic theory, the theory which described individual preferences and production possibilities. At this time, Sargent began his researches which also were founded on the microeconomic foundations.

Unlike other researches of that time, Sargent focused more on actual data and on problems of evaluating theoretical assumptions with using active expectations. In 1971, Sargent published the work (Sargent, 1971) which explored the role of expectations in the Philips curve, macroeconomics model which describes the connection between inflation and unemployment. The main question was whether long run Philips curve is vertical (inflation is independent from unemployment) or have some negative slope (inflation is related with unemployment) like short run curve. Before Sargent the possibilities of vertical long run Philips curve had been rejected due to interpreting expectations as passive, or that which are not influenced by Philips curve. Sargent showed that if expectations is not passive than long run Philips curve could be vertical. In 1973, Sargent (Sargent, 1973) done the first successful estimation under rational expectations which was based on a simple model of USA economy. The econometric evidence showed that Irving Fisher's theory (nominal interest changes on the same level as changes inflation, or in other words, real interest rates is stable) could be rejected (however, with the low level of significance). The another work of Sargent (Sargent,

1976) showed that the model with real shocks can be empirically estimated. Additionally, the Sargent's work developed uncommon method of index modeling (Sargent and Sims, 1977; Quah and Sargent, 1993) and showed how to use filtering methods to estimate linear models with rational expectations with the presence of errors in data (Sargent, 1989).

All Sargent's empirical works helped him to create indispensable empirical method. This methodology has creation of economic "laboratory" for analyzing policy experiments as the aim, or in other words, creates the abstract model which described the pure economic environment, before any political changes. His method consists from three steps: developing a structural macroeconomic model; solving the mathematical model; estimate the fundamental parameters. At first step, it should be done the closest descriptions of economy from possible, or in other words, the most accurate mathematical descriptions. For example, what the relation is between supply and demand on coffee: does it influence each other or there is only one way relation, or maybe even without relation. The second step investigates the relation between variables of models (the same or different) in time. For example, how connect inflation expectations one year ago and labor supply today, or supply labor one month ago and GDP growth after six months from today. The third step is the simplest, however, not always. Simply saying, on third steps are estimated unknown coefficients of model in a way to get the best descriptions of the historical data. However, in fact, only the coefficients that cannot change after policy changes should be estimated through historical data. The coefficient that could be changed after policy changes should be estimated in other way: through correction factor, additional abstract model, etc.

The Sargent's work investigated not only empirical task, but also economic policy decision dependence from rational expectations. For example, the answer on question how the rise of interest rate of Central Bank would influence GDP depends from the expectations of market participants: if this decision is unexpected than the influence will be huge, however, if

all market participants wait for the rise than effect of policy will be near zero (but if the Central Bank does not changed the interest rate than influence could also be huge). Sargent and Wallace (Sargent and Wallace, 1976) showed how replacing adaptive expectations on rational expectations altered the policy implications of standard macroeconomic models of that time. In 1981, Sargent and Wallace (Sargent and Wallace, 1981) went more deeply and investigated the connections between fiscal and monetary policy. They argued that both policies are inexorably linked and, therefore, Friedman's assertion that inflation is only monetary factor (Friedman and Schwartz, 1963) can be quite misleading. According to Sargent's and Wallace's paper, fiscal policy could force inflationary monetary policy.

One of solution for Lucas critique was proposed by Lucas himself. He argued (Lucas, 1976) that scientist should identify deep structural parameters which are not influenced by policy changes, but traditional macroeconomic instruments did not allow doing that at time of his work. Sargent has decided this problem with offering the methodological instruments to identifying structural parameters, and this is his main achievement that has the biggest influence on modern macroeconomics.

Chapter 2. The contribution of Christopher A. Sims

At the time of creation vector autoregression (VAR) methods, the main method was the Keynesian macroeconomic models which very often use the assumption of equilibrium in the long run (however, it is not reachable in fact). Sims (Sims, 1980) argued that the resulting interpretations from this model are taken too shaken position due to incredible identification assumptions. For example, it is understandable to suggest that the coffee price is dependent from weather because in time of bad weather the supply is lower. However, the models with using classical identification mechanism could show little significance of weather for coffee price. There are some explanations of such possibilities: the coffee producer could know about the possibility of bad weather and produce more in the time of good weather for reserve (not changing supply in the time of bad weather), coffee consumers could buy more for reserve in time of low prices (change in demand in time of bad weather), or both. Even though the problem of identification had been known before Sims, he highlighted specific problem for macroeconomic: it is very hard to find variables which affect only another variable, more often variables affect one other. This happens due to expectations of consumers, firms, and policymakers.

In the same work, Sims did not only criticize the macroeconomic practice of his time but also proposed the identification mechanism that is different in foundations from the estimation of large-scale Keynesian models. If it is suggested that macroeconomic models have the VAR structure than it is possible to concentrate fully on problem of identification and to develop different schemes. At first, Sims proposed a specific recursive scheme; however, later he and other researches proposed alternative VAR identification strategies (Sims, 1986; Doan, Litterman, and Sims, 1986). To illustrate how to use proposed algorithms, Sims in his initial work (Sims, 1980) estimated VAR-systems for the USA and German

economies, which were based on quarterly time series for six macroeconomic variables: money, gross national product, unemployment, wages, price level, and import prices.

In simple form, the identification of VARs could be described with the next equation:

$$x_t = H_1 x_{t-1} + \cdots + H_p x_{t-p} + u_t, \tag{2.1}$$

where u_t should be uncorrelated with x_s, $s \in$ {t-1,…,t-p} and $E(u_t u_t') = V$. The main idea is to choose P so big that u becomes uncorrelated over time. A large enough p will allow creating model of any covariance-stationary process. However, it is only first step from three of Sims methodology: forecasting with autoregression model (VAR), in which it is created the forecasting model analogous to the equation (2.1). Other two steps are extracting the fundamental shocks and impulse-response analysis. The most common method of shocks extracting, and the one Sims described in his works (Sims, 1980; Sims, 1989), is called recursive scheme. The main idea is to order the variables in such way that matrix G which helps in identification of structural shock through the next equation has triangle form:

$$u_t = G\xi_t, where \ GG^t = V. \tag{2.2}$$

The aim of special ordering is to put some limitation on the shocks and its spreading through VAR for its identification. In practical task this problem can be sometimes hard to solve; therefore, not all structural shocks could be identified. The last step of Sims methodology is analysis of macroeconomic policy effects on the variables of VAR system (impulse-response analysis). It is very simple to define the impulse responses from the equations (2.1) and (2.2):

$$x_t = [I - H_1 L + \cdots + H_p L^p]^{-1} G\xi_t, \tag{2.3}$$

where L denotes the lag operator ($L^p x_t = x_{t-p}$). In other words, x_t could be described only through historical shocks where the weights H shows how shock influence on variables (and are the same as in equation (2.1), in forecasting model).

As Sargent, Sims also investigated the policy effects on economic environment and reached some influencing results. He investigated the monetary policy in five largest countries using six variable VARs estimated on monthly time series (Sims, 1992) and found some common features but also some differences. In his paper of 1972 years (Sims, 1972), Sims found that monetary movements cause also movements in income; however, the variance decomposition showed a little influence in this movements on output, especially in the long run. Finally, the Sims methodology has helped many other scientists in investigating policy influence: narrative approach which was pioneered by Romer and Romer (Romer and Romer, 1989); or VAR model with three variables - government spending, taxes, and output, of Blanchard and Perotti (Blanchard and Perotti, 2002).

In summary of Sims achievements, it is necessary to add his way of solving Lucas critique due to its high importance. Unlike Sargent, Sims concentrated fully on ways of isolating shocks and on ways of estimating influence of shocks on the economic environment without estimating deep structural parameters.

Chapter 3. Additional achievements of Laureates

The huge work of Sargent and Sims which has been described in Chapter 1 and 2 is not only achievements of Nobel Prize 2011 Laureates; however, it is only achievements about which Economic Sciences Prize Committee and economic environment were interested in 2011. However, Sargent and Sims created the foundation in other important part of economic thinking which also should be not forgotten to mention.

Joint research by Lars P. Hansen and Sargent developed robust control theory which is part of engineering science (Hansen and Sargent, 2008). In engineering robust control is a branch of control theory and it is investigated how to deal with uncertainty in designing controller; the main idea states that the controller should work under different set of assumptions. At the same time, economic way of thinking says that decisionmakers (analog of controller) does not know the true stochastic process (analog to have different set of assumptions); furthermore, they are also averse to risk. Therefore, decisionmakers should make decisions in more sophisticated way and should work with some level of pessimism what is very different from assumptions about rational expectations or objective uncertainty. According to Hansen and Sargent, decisionmakers maximize his function under assumption that environment try to harm them.

At the same time, Sims took another approach for developing the assumptions about rational expectations. Sims, in his work of 2003 and 2006 years, developed more deeply the idea of other Laureate of Nobel Prize: Joseph E. Stiglitz (Grossman and Stiglitz, 1980), that all information is not been used on the market due to incompleteness of it. However, Sims was spoken not about incompleteness of market, but about incompleteness of people's ability. Sims said that there is a lot of information which is available to decisionmakers: books, magazines, blogs, newspapers, chats, twitter, comments, etc. However, people have only 24

hours in day and have physical limitations on processing the information. Therefore, they should mark information as highly important, less important, unimportant, etc., and process it accordingly. Or speaking in more sophisticated way, individuals have a limited amount of attention; therefore, they have to solve the task how to allocate their attention in optimal way.

Conclusion

It is understandable that Nobel Prize of 2011 years was given to Sargent and Sims only due to the financial global crisis and necessity to estimate in anyway the effects of it and stimulation programs after it. However, it is not made their achievements less important, but maybe it is also increased the probability to draw the attention on their works of not only theoretical economic specialist but also practical economic specialist like financial analysts, or politician advisers. In anyway, their achievements are huge and deserve Nobel Prize, what was approved in 2011 by the Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences.

Sargent founded modern structural macroeconometrics. He characterized and estimated modern macroeconomic models which are founded on the microeconomics basis with using expectations. Also, Sargent showed how to use his methodology for interpreting the economic policy effects on practice. At the same time, Sims founded vector autoregressions (VARs) as an empirical tool in macroeconomics. He showed how to use VARs for interpreting time series, creating forecasts, making decision in economic, and identifying structural and unexpected shocks. Also, Sims contributed to development of VARs model and its methodology and to widespread its uses. Additionally, Sargent and Sims laid in their work fundament for modernization of consumers' expectations because rational expectations have already outmoded.

The Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences summarized the achievements of Nobel Prize Laureates of 2011 years with the next paragraph (2011, p. 34): "In their entirety, the research contributions of Sargent and Sims are not merely always and everywhere central in empirical macroeconomic research – it would be nearly impossible to imagine the field without them. Thomas J. Sargent and Christopher A. Sims are

awarded the 2011 Sveriges Riskbank Prize in Economic Sciences in Memory of Alfred Nobel *for their empirical research on cause and effect in the macroeconomy*" (Economic Sciences Prize Committee, 2011). These words represent the best description of importance, significance, and necessity of Sargent and Sims works for the economic environment and for understanding economical processes which surround us.

Bibliography

1. Blanchard, O.J. and Perotti, R. (2002) 'An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output', *Quarterly Journal of Economics 117*, pp. 1329-1368.

2. Christiano, L.J., Eichenbaum M., and Evans, C.L. (1999) 'Monetary Policy Shocks: What Have We Learned and to What End?', *Handbook of Macroeconomics*, Volume 1A, pp. 65-148.

3. Doan, T., Litterman, R.B., and Sims, C.A. (1986) *Forecasting and Conditional Projection Using Realistic Prior Distribution*, Federal Reserve Bank of Minneapolis, Staff Report №93.

4. Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences (2011) *Empirical macroeconomics*, the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.

5. Hansen, L.P. and Sargent, T.J. (2008), "Formulating and Estimating Dynamic Linear Rational Expectations Models", *Journal of Economic Dynamics and Control 27,* pp. 7-46.

6. Grossman, S.J. and Stiglitz, J.E. (1980) 'On the Impossibility of Informationally Efficient Markets', *American Economic Review 70*, p.393-408.

7. Lucas R. (1976) 'Econometric Policy Evaluation: A Critique', *Carnegie-Rochester Conference Series on Public Policy 1*, pp. 19-46.

8. Quah, D. and Sargent, T.J. (1993) *A Dynamic Index Model for Large Cross Sections*, NBER Studies in Business Cycles, Volume 28.

9. Romer, C.D. and Romer, D. (1989) *Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz*, NBER Macroeconomics Annual.

10. Sargent, T.J. (1971) 'A Note on the "Accelerationist" Controversy', *Journal of Money Credit and Banking 3*, pp. 721-725.

11. Sargent, T.J. (1973) 'Rational Expectation, the Real Rate of Interest, and the Natural Rate of Unemployment', *Brookings Papers on Economic Activity 2*, pp. 429-472.

12. Sargent, T.J. (1976) 'Classical Macroeconometric Model for the United States', *Journal of Political Economy 84,* pp. 207-237.

13. Sargent, T.J. (1983) 'The Ends of Four Big Inflations', in Roberth E. Hall (ed.), *Inflation: Causes and Effects*, pp. 41-97.

14. Sargent, T.J. (1989) 'Two Models of Measurements and the Investment Accelerator', *Journal of Political Economy 97,* pp. 251-287.

15. Sargent, T.J. and Sims, C. (1977) *Business Cycle Modeling without Pretending to Have Too Much A Priori Economic Theory*, Federal Reserve Bank of Minneapolis, Working Paper №55.

16. Sargent, T.J. and Wallace, N. (1976) 'Rational Expectations and the Theory of Economic Policy', *Journal of Monetary Economics 2*, pp. 169-183.

17. Sargent, T.J. and Wallace, N. (1981) 'Some Unpleasant Monetarist Arithmetic', *Federal Reserve Bank of Minneapolis Quarterly Review 5*, pp. 1-17.

18. Sims, C.A. (1972) 'Money, Income, and Causality', *American Economic Review 62*, pp. 540-552.

19. Sims, C.A. (1980) 'Macroeconomics and Reality', *Econometrica 48*, pp. 1-48.

20. Sims, C.A. (1986) 'Are Forecasting Models Usable for Policy Analysis?', *Minneapolis Federal Reserve Bank Quarterly Review 10*, pp. 2-16.

21. Sims, C.A. (1992) 'Models and Their Uses', *American Journal of Agricultural Economics 71*, pp. 489-494.

22. Sims, C.A. (1992) "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy",, *European Economic Review 36*, pp. 975-1011.