The optimal level of government debt and wealth inequality

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Current debt crisis in many developed and developing countries makes the question of the optimal level of public debt extremely relevant. The country where the government bonds are considered as the most reliable in the world, the United States, is accumulating its debt quite rapidly, especially under current extreme circumstances in 2020. The answer to the research question "What is the optimal level of government debt to GDP in the U.S." will help to explore whether U.S. government should conduct a contractionary fiscal policy in order to reduce the debt burden and increase social welfare or there should be no concerns about debt sustainability and reliability of government bonds.

Necessary fiscal policy addressing this issue has to take into account its effect on different parts of the population, which is not possible under representative agent models in Macroeconomics. Consumption behavior in representative agent models is inconsistent with empirical evidence: there are growing concerns about increasing wealth and income inequality. There is no trade of assets in a representative agent model, while there is a lot of trade of financial assets in reality. That is why the representative agent approach will lead to wrong conclusions and unrealistic policy implications.

Because there is no aggregation theorem, highly non-normal distribution of wealth and income matters for aggregate outcomes. People of different wealth levels and employment status have different propensities to save, to work, contrastive portfolio choices (nonidentical relative demands for contingent claims) and ex-post returns on investments. The efficient modelling of heterogeneous agents model is now possible due to the increasing availability of high-quality micro data, more powerful computational methods. These models have become an extensively used tool in macroeconomics for the study and evaluation of the precautionary savings behavior of agents, wealth inequality, the welfare implications of business cycle stabilization policies, social security reforms, employment and intergenerational mobility, etc.

This thesis is devoted to the evaluation of the optimal level of government debt by solving the heterogeneous agents model in continuous time with various extensions to

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account for more realistic wealth and income distributions. The main feature of this model is that agents are subject to uninsured idiosyncratic shocks and borrowing constraints. This concept was introduced in Aiyagari (1994), Aiyagari and McGrattan (1998) papers, but the model was solved in discrete time. After these fundamental papers the plenty of work has been done with various extensions (for example, Le Grand and Ragot (2017), Jesús Fernàndez-Villaverde et al. (2019), Bornstein (2020) etc.). The majority of models were evaluated in discrete time, while much fewer papers have studied general equilibrium models with heterogeneous households in continuous time because of lack of a general approach to solving such models.

One of the breakthrough elaborations in macroeconomics during the past years has been the application of continuous time methods to incomplete markets models: Brunnermeier and Sannikov (2014) studied financial frictions; Kaplan et al. (2018) investigated the monetary policy effect on heterogeneous agents; Gabaix et al. (2016) analyzed the dynamics of income and wealth inequality. After the emergence of the concept of Mean-field-games, the Aiyagari-Bewley-Hugget model with borrowing constraints (without social planner) was solved in continuous time by Achdou et al. (2017, 2020). They addressed the construction of theoretical wealth distribution in line with the micro-data, but they did not address the fiscal policy and the optimal level of government debt.

I build the heterogeneous agents model in continuous time, using such tools as the Hamilton-Jacobi-Bellman equation, Kolmogorov forward equation with Poisson process, finite differences approach and implementing implicit method in dynamic optimization to build the steady-state distribution of assets. Wages of each type of individuals are subject to idiosyncratic shocks which follow the Poisson process. The modification I made in comparison to Aiyagari, McGrattan (1998) is building the model in continuous time, the introduction of portfolio choice where each agent has an opportunity to invest in the risk-free government bonds and in the risky capital; introduction of a rare jump shock hitting the whole economy, which significantly influence the perception of the optimal government debt during crisis events and disasters. This makes the work extremely relevant to the current worldwide crisis. I also used 11 states of the Markov transition matrix in comparison to two in the model in Achdou et al. (2017, 2020) to account for the more realistic fat tailed wealth distribution and show the more general approach with bigger number of states. In contrary to the basic model of Aiyagari and McGrattan (1998), where the authors calibrated the 7 states Markov chain with normal innovations to calibrate the income process, I used the autoregressive process with normal mixture innovations (NMAR) process for Markov transition matrix discretization with 11 states, which differs from the standard lognormal income process widely used in the literature. This approach allowed to discretize the real income process in the U.S. to the model, and to reach more reliable policy implications. The choice of the country is based on the plenty of literature addressing the debt in the U.S., the availability of the high-quality income and wealth

data and on the widespread opinion of the U.S. government bonds as a safe asset.

Optimality of the government debt is considered in the context of social welfare maximization, taking into account the wealth and income distributions (inequality), as well as the incompleteness of markets because of the borrowing constraints. The rise of government debt has two contrary effects. Increased interest rate makes government debt less costly to hold for the household and more effective instrument of consumption smoothing, individuals borrowing constraints loosening. Together with transfers it contributes to the redistribution and insurance effects. Negative consequence consists of the distortionary effect, because the debt is mostly financed by proportional taxes. Additionally, the capital is partially crowded out because of higher interest rates, output and wages decrease. This leads to the reduction in consumption and thus, decrease in social welfare.

In the result I obtained the asymptotic distribution of wealth, welfare implications, which allowed to evaluate the optimal level of government debt to GDP in the U.S. and corresponding equilibrium interest rate and tax rate. The optimal level of government debt varies from 120% to 140%, which corresponds to the data and the literature. I implemented robustness checks by introducing various extensions of the model and checking the sensitivity of the model to different calibrations of the parameters, borrowing constraints.