

MODEL OF TAX BEHAVIOUR OF ECONOMIC AGENTS IN THE AGE OF GLOBALIZATION: VERIFICATION AND PARAMETERIZATION

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The paper focuses on testing and verification of a model of tax behaviour of economic agents. The research is based on the multi-agent approach and takes into account basic features of the existing agent models of tax behaviour. The set of experiments and analysis of the results showed that the presented model passed the verification and can be used to analyze tax behaviour.

Problem definition. Over the past decades, the globalization processes have reduced economic and political barriers, which made the movement of production factors between countries much easier. In the most general form, it is the migration of labour and capital investment. The simplified displacement of factors resulted in the competition for production factors, one of the forms of which is tax competition.

At the same time, the research of the tax behaviour of economic agents as carriers of production factors is an important tool for the development of an effective tax policy, which allows to obtain competitive advantages in the struggle of jurisdictions for resources.

This paper studies the tax behaviour of economic agents operating in the territory of model states — jurisdictions under the condition of globalization and identifies patterns that may affect it.

Purpose, objectives and methodology of the paper.

The purpose of the research is to model and study the influence of various factors of the globalized environment (represented by a set of jurisdictions) on the tax behaviour of economic agents, taking into account their heterogeneity and differentiation by possession of a certain type of production factors, ability to fulfil basic economic functions: to obtain income, consume, save and migrate to other jurisdictions. To achieve it, the following objectives have been set: 1) to test the model with the conditional values of the parameters; 2) to verify the model based on the tests results; 3) to analyze the relevant macroeconomic indicators to parameterize the model.

Since the work explores the behaviour of heterogeneous economic agents that is able affect the system state as a whole, the research was based on a multi-agent approach. The application of the multi-agent approach to modelling the behaviour of economic agents and their impact on the state policies is quite convenient, as it allows for efficient reproduction of agent behaviour at the individual level, and the global trends arise as a result of the activities of many agents.

Analysis of the recent research and publications.

The theoretical aspects of the paper were based on the studies of behavioural economics and tax competition [1, 2, 3, 4, 5, 6, 7].

There is also a relatively small number of papers in which the multi-agent approach is applied to investigate tax behaviour. Let us briefly review some of them.

The first model where the multi-agent approach was applied to model the tax behaviour was described in [8], which proposed three types of taxpayer agents: “honest taxpayers”, “imitative taxpayers” and “free riders”, each of which has its function of expected utility that takes into account the level of the consumed public goods. The utility functions are defined in such a way that they provide the additional usefulness when the agent complies with the norms of the type to which it belongs. The results of the model analysis showed that any initial categorization of taxpayers by these types in the absence of tax audits, the amount of taxes paid almost equals to a zero. Taking into account the probability of tax audits leads to an increase in tax payments. At the same time, all taxpayers become the “honest taxpayers” if they are subject to a tax audit in each period.

The next paper [9] describes the agent model in which taxpayers exist in localized social networks and have heterogeneous characteristics, such as the perception of the probability of conducting an audit and identifying an evasion. When deciding on evasion, the agents take into account their neighbours’ strategies regarding the evasion. The experiments with the model showed that in a world with limited information on payments by the neighbouring agents, there is a higher level of compliance with tax legislation than when the agents know about the neighbours’ payment strategy and take it into account while adopting their own decision.

The paper [10] is concerned with the use of the agent modelling to study the compliance with tax legislation in the context of the agents’ employment type. The paper contains description of two agent models. The first model concentrates on the impact of the occupational choice on tax compliance and explores the impact of tax evasion on risk-taking and income distribution for the employees and self-employed agents. The second model generalizes the first one, adding a recurring social interaction between the agents and exchanging the views on evasion and expectations of a possible tax audit in a dynamic mode. The experiments with the model show that evasion

increases inequality and risk-taking in the economy, and that different forms of tax behaviour can be established in the groups with different employment types.

The next paper [11] contains the description of the agent model of tax behaviour with application of such behavioural filters as rational choice, social interactions and the fairness effects. During the experiments, the main variable parameters were the frequency of tax inspections and the amount of the fine. The research showed that the frequency of tax audits is more influential in reducing tax evasion than the size of the fine.

Key findings. The model has been built which simulates a conditional world consisting of jurisdictions in which economic agents operate. It is the multi-agent model based on the following assumptions. 1) The jurisdictions have a limited capacity, that is, the number of agents that may be simultaneously located within them is limited. 2) The jurisdictions are characterized by different returns of labour and capital. 3) The jurisdictions form their income from the tax revenues from income gained on labour and capital, as well as by levying penalties from evading agents and emigration and immigration costs of agents. 4) The jurisdictions spend the obtained treasury in full on the provision of public goods of three types: affecting the return of labour, the return on capital and affecting the migration attractiveness of the jurisdictions, as well as of transaction costs. 5) The jurisdictions exercise tax control, characterized by the following parameters: the frequency of tax inspections, the probability of detecting violators, the penalty rate. 6) There are three types of economic agents operating in the world: the rentiers possessing the capital factor, the workers possessing the labour factor, the businessmen possessing both labour and capital factors. 7) Each agent obtains income from the factor that it possesses, depending, inter alia, on the return of the factor in the jurisdiction where the agent operates. 8) The income of agents is distributed between the consumption and savings.

9) Prior to consuming, agents can pay taxes on their income. 10) Each agent has two behavioural characteristics: the tendency to evasion from paying taxes and the propensity for migration. The details of the structure and program implementation of the model are described in [12].

Let us describe the main endogenous variables, which are calculated at each model step and output to the resulting file.

Rentiers, workers, businessmen are the number of agents of each type in each of the given jurisdictions. Taxes Collected per capita are the amount of taxes collected from incomes received from a certain production factor per capita. Agents emigrated This Tick are the number of economic agents that have migrated from a particular jurisdiction in the given model step. Agents immigrated This Tick are the number of economic agents that have entered a jurisdiction on the given model tick. Savings per capita are the average per capita savings in a particular jurisdiction at each model step (regardless of agent type). Rentier savings per rentiers, businessman savings per businessmen, worker savings per workers are the average savings per capita by type of agent. Total Revenues Raw per capita is the average income of economic agent in a particular jurisdiction per capita. Treasury per capita is the amount of national per each economic agent in the given jurisdiction at each model step. Penalties per capita are the amount of penalties collected per capita in a particular jurisdiction. Business Public Goods per capita is the number of public goods provided per capita that affect the return of production factors. State Public Goods per capita is the number of public goods provided to each jurisdiction per capita that affect the overall attractiveness of jurisdiction for economic agents. Violators Count per capita is the proportion of actual tax evaders per capita in a particular jurisdiction.

The following experiment was set up to verify the model. Two jurisdictions, in which the values of the

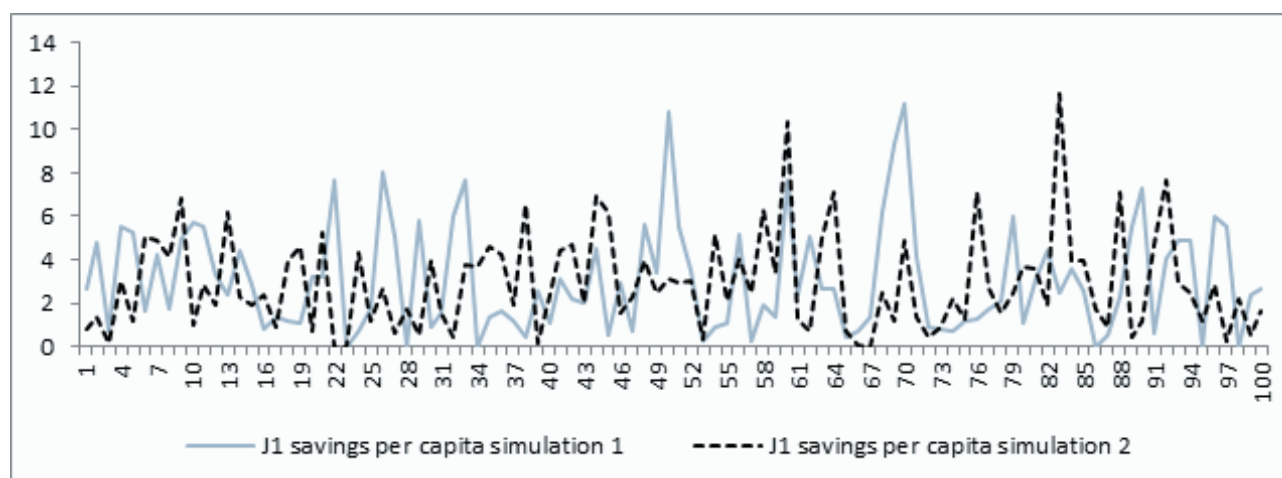


Chart. 1. The average savings per capita in the first jurisdiction for different simulations

Source: author's development

corresponding exogenous parameters are given equal in pairs, have been initialized in the model. Twenty model simulations have been conducted, each of which has one hundred model ticks. Due to a number of randomnesses caused by the actions and differences of heterogeneous agents, in each simulation, the dynamics of the same indicator in the same jurisdiction differ. For example, the average savings per capita in the first jurisdiction differs for the first and the second simulation.

For each indicator in each simulation, the average value has been calculated, after that they have been averaged for each simulation. For variables where the discrepancy between the averages is greater than zero, the experimental and critical values of the Student's *t*-test have been calculated.

Their comparison has shown that in each case the hypothesis of the equality of the general averages has not been rejected, and the received deviations between the average values of the same parameter for different jurisdictions are random. Thus, it may be concluded that the model has passed verification. The next step of the research will be the parameterization of the model.

Conclusions. The multi-agent approach is an effective approach to behaviour modelling. The built agent model has passed the verification and can be used as a tool for researching various factors on the tax behaviour of agents.

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