

Computer problems 08

Task 1. In the country of Utopia, firms try to maximize their own profits, using citizens' labour and capital as resources, producing a unique product "Unicus", which satisfies citizens' needs for food, material and spiritual needs. All workers determine the individual labour supply (y_i - labour activity of the i -th individual), based on the Stone welfare function with individual parameters:

r_i - rental income of the i -th individual (has a random distribution on the user-specified interval and depends on the wage level);

d_i - the limit of physical capabilities of the i -th individual (has a uniform distribution on the user-specified interval);

a_i - the indicator of the i -th individual's propensity to consume and work (has a uniform distribution on the interval from 0 to 1).

The government sets each period the optimal personal income tax rate γ , as well as the corporate income tax rate T , to maximize tax revenues to the budget (based on data from previous periods). All tax revenues are spent on technology development, which leads to an increase in output efficiency through N periods after the investment by $W\%$ for every Z of investments.

Develop and implement a simulation model of the functioning of such an economy, assuming that:

- 1) all unknown values should be set parametrically by the user at the beginning of the program;
- 2) there is no informal economy and corruption component in the country;
- 3) there are no other types of taxes in the country;
- 4) there are no children, pensioners, disabled people and other socially unprotected groups in the country;
- 5) all products produced in the country are consumed on the domestic market;
- 6) the level of available capital in the country is determined by the level of savings of employees.

Task 2. Art City holds auctions for the sale of paintings. There are three auction participants: Collector 1, Collector 2, and Collector 3. Each collector has his own estimate of the painting (V_1, V_2, V_3), which is a random variable uniformly distributed on the interval $[100, 500]$ (in monetary units). The auction is held according to the rules of the second-price auction (Vickrey auction): each participant submits a closed bid, the winner pays a price equal to the second-highest bid. Develop a model to determine the optimal bidding strategies for each collector, given their estimates of the painting. Simulate 200 auctions where collectors' estimates are generated randomly, and determine the average sale price of the painting and the probability of each collector winning. In the 100th auction, a new condition is introduced: if the winner pays more than 400 currency units, the auctioneer charges an additional tax of 10% of the price. Model the impact of this change on collectors' strategies,

the average sale price, and the probability of winning for each bidder over the next 100 auctions.

Task 3. There are two companies in Invest City that raise capital for their projects: Company 1 (technology) and Company 2 (manufacturing). Each company can issue shares or bonds to raise funds. Investors in the capital market have different risk appetites: 60% of investors are risk averse (preferring shares with an expected return of 8% and a standard deviation of 4%), and 40% are conservative (preferring bonds with a fixed return of 4%). The amount of capital that investors are willing to invest increases by $R\%$ each period. Develop a model to determine the amount of capital that each company can raise through shares and bonds, taking into account the preferences of investors. Simulate the capital market for 150 periods and show the dynamics of the share of shares and bonds in each company's portfolio, as well as the total amount of capital raised. In the 75th period, a shock occurs: the expected stock return falls to 6% due to economic instability, and the bond return rises to 5%. Model the impact of this shock on the allocation of capital between stocks and bonds, as well as on the total amount of funds raised for each company over the next 75 periods.