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TAX EVASION AND TAX BEHAVIOUR EFFICIENCY:
A SYSTEM DYNAMICS APPROACH

Introduction and research task

The problem of tax evasion remains actual for scientific research from the middle of the XX-th century. The attention paid to this subject in post soviet countries is stipulated by its importance for the creation of effective tax policy in conditions of spreading of free ride behaviour and opportunistic motivation of taxpayers.

Most of the models of taxpayers' behaviour are optimization problems of choice, which use the expected utility theory in criterion forming. The main questions, which were studied using such models, deal with the analysis of the influence of taxation and control parameters on declared/shadow income ratio. Models differ in detailing degree of types of taxation, modes of tax charges and penalties, of taking into account revenue "shadowzation" costs etc.

A generic model by M. Allingham and A. Sandmo [1992], based on "homo economicus" conception, implying that an agent is guided in his behaviour by maximization of expected utility, shows that taxpayer's choice to evade taxes depends on tax rates and tax inspection parameters, among which the most important are the probability of inspection and penalty degree (penalty rates).

This model was advanced in a number of later works. For example in [Andreoni J. et al, 1998] the influence of the penalty function form on tax evasion diffusion is examined; in [Chander P., Wilde L., 1998] the effective scheme of tax enforcement is proposed, including tax rates, penalties and inspections probability; in [Chander P., Wilde L.,1992] corruption in tax administration is taken into consideration: a possibility to get a bribe by a tax officer and a corresponding punishment for it; and in [Hindriks J. et al, 1999] three parties of tax process are examined – government, taxpayers and tax officers.

Such models direct toward using punishment and enforcement and give grounds for tax inspection strengthening with the aim of raising of taxpayers' discipline.

This approach is based exceptionally on the compulsory character of taxes, with the assumption that tax payment is beyond the framework of individual utility and presents net loss for an economic agent. It comes from the conflict between personal interest (individual effect) and necessity of public goods financing (public or joint effect) and it uses economic approach for substantiation of crimes (Becker G. , 1968).

However these models, based on enforcement, use the assumptions which are substantially simplifying real people's behaviour. As practice shows, many people with normal risk perception usually pay taxes, even in those situations, when the probability of hidden income disclosure and amercement is enough low. In experimental research it's registered that people behave more honestly than it's assumed in taxation models, based on enforcement, in particular it's shown that individuals declare higher income level, than the one, predicted by the model, based on expected utility maximization (Torgler, Benno, 2002).

In modern approaches to tax problems research one may see shifting of attention from compulsory character of taxes to contractual principals of taxation and its consideration in the context of cooperation theories, as a form of voluntary interaction of people apropos of public goods financing. The works on experimental economics confirm that people's behaviour in

relation to tax rules observance, is influenced by morality (Frey B.S., Torgler B., 2007) and culture (Gachter S., Herrmann B., 2008).

We may note that in the studies, devoted to tax evasion and tax inspection effectiveness and punishment, mostly analytical models and optimization theory are used. Inclusion of non-linear relations and stochastic variables considerably complicates the analysis of models results.

Our task was to develop a system dynamics model, taking into consideration economic factors of choice as well as institutional restrictions and psychological features of economic agents when taking decision about their income "shadowzation", and to analyse comparative effectiveness of tax behaviour types, dependant on different instruments of tax policy, and possible situations of conflict of interests of the state and a taxpayer.

2. Model assumptions

1. Economic agent's behaviour in relation to income hiding from taxes depends on three factors: economic effectiveness of evasion (its' profitability by net income criteria), the existing social norms, restricting propensity towards violation of rules (opportunistic behaviour) and psychological peculiarities of an agent, which define his caution and riskiness while taking decision about hiding of income.

2. An economic agent has exogenous constant income, which he divides between declared and shadow parts by the rules, which depend on agent's tax behaviour type.

3. Declared and shadow incomes are charged: the first one – according to a tax rate, the second one – by a tax rate and a penalty rate in case of disclosure of tax evasion. The fact that hiding of income needs certain expenditures is not considered (it could be reflected as a given part of shadow income)

4. Shadow income may be disclosed as a result of inspections, which take place with certain y an extensive factor – frequency of inspections – and by an intensive one – effectiveness of inspections (a ratio probability, but it may be disclosed partially. Thus, efficiency of inspections is reflected in the model of disclosed shadow income). Both factors are random variables.

5. Restrictions on maximum and minimum ratios of shadow income are introduced, which is reflecting some bounding norms of social behaviour. Definition of minimum ratio of shadowzation allows to take into account the level of taxpayers' orderliness, the degree of latent opportunism diffusion. The higher this coefficient is, the less is the potential level of shadowzation independently of economic efficiency of tax evasion. The maximum ratio of income shadowzation characterizes taxpayers' inclination towards opportunism, its "natural" level. It's known that in the society there is always people, who are principal antagonists of taxes and are not willing to pay taxes in any circumstances. The level of "natural" opportunism depends on different factors, among which an important role belongs to taxpayers' appraisal of tax system fairness and of its equivalence in the sense of public goods, afforded by the state. By defining the minimum ratio of shadowzation we take into consideration the fact, that in the society there is always a "sprout of opportunism", which in certain conditions, providing its efficiency, may develop actively, and thus opportunistic behaviour becomes a social norm and a stereotype of behaviour.

6. Two basic types of tax behaviour are reflected in the model. We'll call them conventionally – opportunistic and soft (or flexible) ones.

7. Rigid opportunism is described as such a behaviour of an economic agent, when his choice of declared/shadow ratio is not at all influenced by the efficiency of tax inspections: he is always hiding the maximum ratio of his income. This type of taxpayer is highly risk inclined.

8. Flexible type of behaviour (soft opportunism) implicates that an economic agent, while choosing shadow income ratio takes into consideration two indicators: shadow sector profitability in comparison to official one and dynamics of this profitability. If tax evasion profitability (net shadow/joint income ratio) is less than declared income profitability, then the whole income is legalized (within the stated maximum ratio). If "shadow" is more profitable, then an agent makes a decision to change its ratio depending on its profitability in the current period in comparison to the previous one. The following logic is inherent to this type of behaviour: if the profitability of income hiding is growing, then the shadow income ratio should

be increased. The elasticity of agent's reaction is modelled using standard adjustment mechanism, including coefficient, inversely proportional to the time of adjustment. This coefficient reflects the degree of agent's caution.

Tax evasion profitability comes down due to inspections and corresponding penalties, that is why decreasing of shadow sector profitability alerts a taxpayer, who is not inclined to excessive risk, and thus considers it to be more safe to raise a declared income ratio. Therefore, even in those conditions when tax evasion is economically more profitable, a taxpayer may lower a shadow ratio, which to our mind, reflects the real phenomena in taxation practice.

9. Costs of inspections depend on their efficiency. The reason is that a more qualified (and therefore more expensive) expert has more chances to provide a more effective inspection and thus to discover a larger part of hidden income. Therefore the average cost of inspection (a constant) is multiplied by 1.5 when effectiveness of inspections is 40 to 80% and is doubled when the hidden income ratio, which is discovered, exceeds 80%.

10. The main results of economic agent's behaviour are represented by a number of indicators: his joint net income (declared income plus shadow income minus contribution to the state in case of shadow income disclosure), integral joint net income and joint profitability (joint net income/income ratio)

The interests of the state are represented by integral (cumulative) indicators: integral real state revenue, integral potential state revenue (contribution to the state, provided all the income is declared), integral real state revenue (declared income taxation plus revealed shadow income taxation plus penalties) and integral net state revenue (real state revenue minus inspections costs). State loss fraction is also computed as a characteristic of tax policy efficiency.

11. In order to regulate economic agents' behaviour the state uses tax policy instruments, such as tax rate, penalty rate, frequency of inspections (inspection probability) and quality of inspections (ratio of hidden income disclosure). Frequency and quality of inspections are assumed to be random variables with normal distribution.

12. Psychological features of economic agents with soft behaviour are represented by adjustment coefficient, which is binding the raise in shadow income ratio with the increase of tax evasion profitability in the preceding periods.

3. Model structural interrelationships

Mathematically the listed assumptions and interrelationships could be presented in the following way (time step index is omitted):

Table 1

Mathematical explication of model variables relationships

Income distribution:	$R_1 = d_1 R$; $R_2 = d_2 R$; $d_1 + d_2 = 1$; $d_1, d_2 \geq 0$, where R is exogenous constant income; d_1 – declared income ratio; d_2 – shadow income ratio
Net income:	$NR_1 = (1-\tau)R_1$; $NR_2 = R_2 - L$, where NR_1 (NR_2) is net declared (shadow) income; τ – a tax rate; L – losses through inspection
Losses through inspection	$L = I(\tau + P)R_2 D$; where I is inspection probability; P is a penalty rate and D is a ratio of hidden income disclosure
Joint net income	$NR = NR_1 + NR_2$
Profitability of official and shadow sectors	$r_1 = NR_1 / R_1$; $r_2 = NR_2 / R_2$
Joint profitability	$r = NR / R$
Shadow ratio limits	$d_{min} \leq d_2 \leq d_{max}$
Shadow ratio calculation (soft behaviour)	$\Delta = 0, if\ r_1 \geq r_2$; $\Delta = 1, if\ r_1 < r_2$ $d_2 = \Delta\{d_2(t-1) + k[r_2(t-1) - r_2(t-2)]\}, k \geq 0$
State revenue	$G = \tau R_1 + L$ – real state revenue, $G_0 = \tau R$ – potential state revenue $NG = G - C$ – net state revenue, where C is an inspection cost
State loss ratio	$g = 1 - G / G_0$
Costs of inspection	$c = f(D)$

Exogenous variables in the model are: tax rate τ, penalty rate P, inspection probability I, probability of shadow income disclosure D, adjustment coefficient k, shadow ratio limits d_{min} and d_{max}, taxpayer's income R.

Economic efficiency of taxpayer's behaviour type was assessed by the maximum of cumulative net income, and the effect for the state – by the amount of tax and penalty revenues.

4. SD model structure

Opportunistic and soft types of taxpayer's behaviour were presented in two modifications of the model. Their structural diagrams differ in feedback loops, influencing the way of calculation of shadow income ratio (fig.1,2).
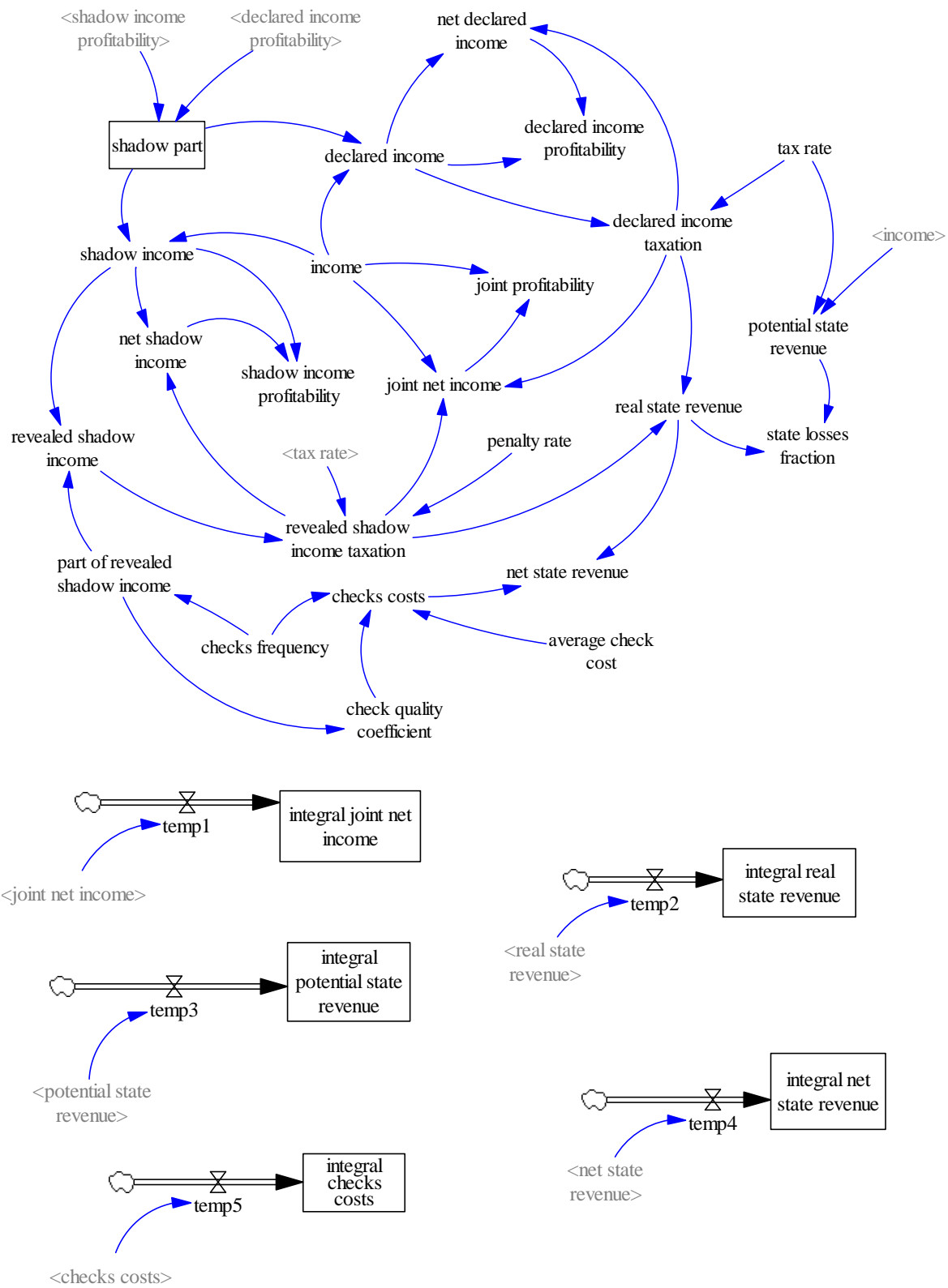

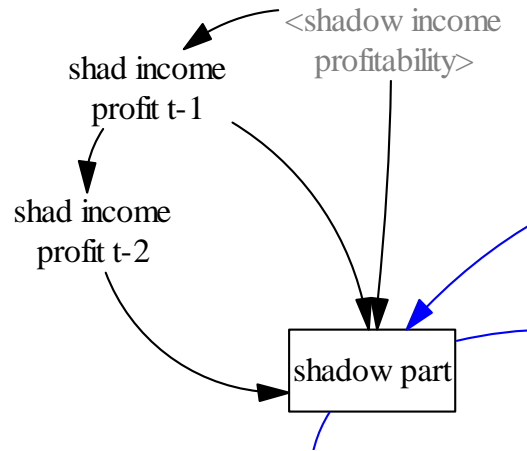*Figure 1. SD model structure (opportunistic behaviour)*

Figure 2. Fragment of SD model structure (soft behaviour mechanism)

4. Simulation results and their interpretation

Model base run conditions: tax rate $\tau = 0.45$, penalty rate $P = 0.5$, shadow ratio limits $d_{min} = 0.1, d_{max} = 0.9$, inspection probability I and hidden income ratio D – normally distributed random variables with mean = 0.5, adjustment coefficient for the soft behaviour model modification k = 0.5.

Simulation experiments were aimed at studying the influence of different exogenous factors on the efficiency of agent's behaviour.

4.1. Penalty rate influence.

The results of the simulation experiments show that with relatively low and low-middle penalty rates opportunistic behaviour of an agent secures him a greater joint net income than in case of soft behaviour. In these conditions agents' soft behaviour is more beneficial for the state. With penalty rates growth the situation changes: tax evasion becomes disadvantageous for taxpayers and profitable for the state – large penalties compensate tax arrears, caused by evasion.

Taking into account tax inspection costs reduces state's income, increases the difference between variants and may break some of them out of economic reasonability (fig. 3), i.e. entails state's losses.
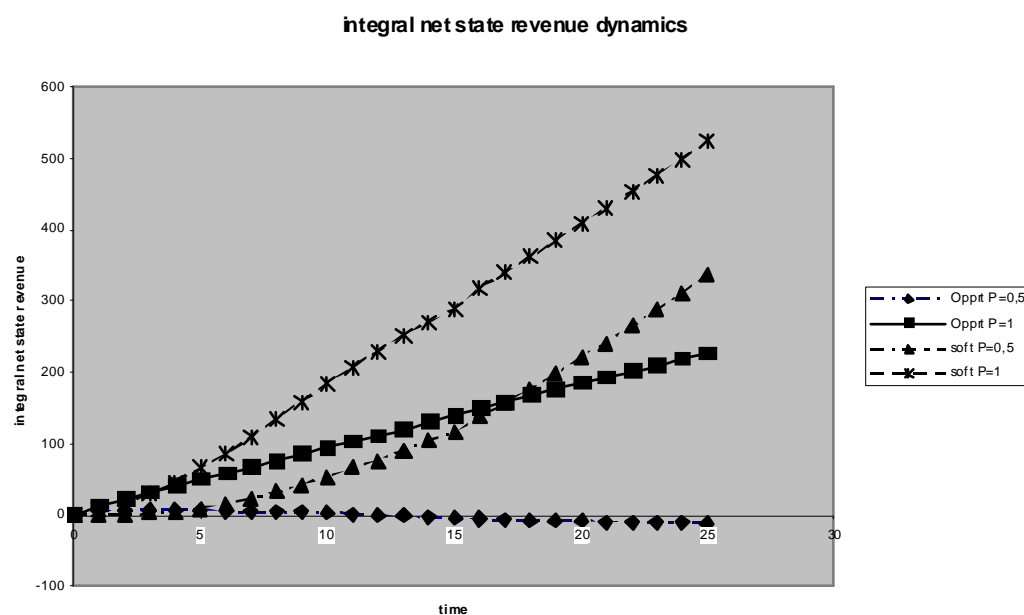

Figure 3. Integral net state revenue dynamics subject to penalty rate

4.2. Influence of intensive factor of tax inspection.

Quality of regulatory bodies' operation (intensive control factor) is represented in the model by the parameter characterizing detection of evasion, i.e. elicitation of a certain percentage of hidden income in case of inspection. Share of the shadow income, which is revealed when checking, depends mainly on inspectors' qualification and corruptness. We may assume that the improvement of these characteristics, i.e. professional training and reduction of corruption will result in increasing of the share of disclosed shadow income.

In case of higher quality of inspection ($D = 0.9$ against $D = 0.5$ in the base run) cumulative amount of budget in-payments shows preference of soft behaviour for the state in case of low and middle penalty rates ($P = 0.5; P = 1.0$). Meanwhile for taxpayers more advantageous is rigid opportunism. Raising of a penalty rate is leading to reduction of the gap between state income values, earned due to different types of agents' behaviour, and a penalty rate $P = 1.5$ entails changing of parties' preferences: agents are choosing more law-abiding type of behaviour, while for the state rigid opportunism is more remunerative[1]

4.3. Influence of tax inspection extensive factor.

This factor is represented in the model by inspections frequency (variable I). Its increment also entails changing in comparative attractiveness of types of behaviour: with given parameters switching takes place, when $P = 1.5$. Such a penalty rate makes rigid and soft opportunism equivalent both for an agent and for the state (both types provide almost equal budget in-payments). This situation could be considered as a trade-off one in terms of agreement of parties' interests.

5. Conclusions.

Computations have confirmed that with relatively low penalties and middle level of inspection opportunistic behaviour is more effective for taxpayers. When opportunistic motivation is mass-spread, this type of behaviour becomes predominant, which leads to substantial losses of the state. Such a state of tax environment is characterised by the conflict of interests of the parties: tax evasion is profitable for the agents and un-remunerative for the state.

Increment of penalty sanctions changes attractiveness of evasion (its efficiency): for it's going down for taxpayers and going up – for the state. With certain values of penalty rates efficiency of both types of behaviour line up, and these values one may consider to be compromise, matching the interests of both parties of tax process.

A special feature of regulation by means of penalty rates is that exceeding of certain threshold values, which one may consider as compromise ones, entails such an increase in in-payments at the expense of penalties that tax evasion becomes remunerative for the state and more attractive than law-abiding behaviour, to which taxpayer is striving for. Such a situation is fraught with the threat of tendentious search for infringements and "wresting" of penalties, i.e. inadequate punishment of taxpayers. The state is interested in creation of such conditions of taxation and inspection, which allow to impose the maximum penalty upon a taxpayer. At the same time the second party – taxpayers – aim at more careful behaviour (soft opportunism), which is characterized by internal restrictions and flexible reaction on inspection and punishment measures.

Patterns of such a conflict of interests one may observe in tax practice of post-socialist countries, particularly in Ukraine. It's largely favoured by discretionary character of taxation, which was formed in the period of market transformation of economy of those countries, and which allows to fill their budgets by penalties and punishments. Overcoming of this conflict, to our mind, is one of the main problems of forming of effective taxation mechanism.

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[1] High percentage of shadow income disclosure is leading to lower marginal penalty, which provides the changing of comparative evasion preference; I the base run it happened when P=3,5 against P=1,5 in this case.

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ДОСЛІДЖЕННЯ ВПЛИВУ ОБМІННОГО КАНАЛУ ТРАНСМІСІЙНОГО МЕХАНІЗМУ НА РЕАЛЬНИЙ СЕКТОР УКРАЇНСЬКОЇ ЕКОНОМІКИ

Вступ та постановка проблеми.

Характерною рисою сучасних світових економічних відносин стає інтенсивний розвиток фінансової глобалізації із залученням національних економік до світового ринку капіталу та посилення їх взаємозалежності. Ці процеси мають подвійний вплив на економіку окремих країн: з одного боку, скасування обмежень на приплив капіталу дає змогу повніше задовольнити потреби суб'єктів господарювання у фінансових коштах і стимулює інвестиційний процес та економічний розвиток, з іншого - підвищується вразливість економіки до негативного впливу зовнішніх факторів, обмежуються можливості центрального банку у здійсненні незалежної грошово-кредитної політики, ускладнюється утримання стабільного обмінного курсу та регулювання його впливу на реальний сектор економіки окремої країни. Проблема ускладнюється і тим, що традиційний механізм функціонування передачі імпульсів від грошово-кредитної політики до реального сектору зазнає значних змін під впливом нових світових економічних реалій. Деякі канали трансмісійного механізму втрачають свою значимість, інші ж, навпаки, стають основними. Зміни трансмісійної потужності та важливості окремих каналів є особливо характерними для країн з трансформаційною економікою, зокрема для України. Відповідно, все більшої актуальності набувають проблеми, пов'язані з комплексною оцінкою змін, що відбулися протягом останніх років в монетарному передавальному механізмі української економіки; аналізом ефективності дії