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XXXI International Seminar on Stability Problems for Stochastic Models

and

VII International Workshop "Applied Problems in Theory of Probabilities and Mathematical Statistics Related to Modeling of Information Systems"

and

International Workshop "Applied Probability Theory and Theoretical Informatics"

Book of Abstracts

2013

Faculty of Computational Mathematics and Cybernetics
Moscow State University
(CMC MSU)

Institute of Informatics Problems
Russian Academy of Sciences
(IPI RAN)

Department of Probability Theory and Mathematical Statistics
Peoples' Friendship University of Russia
(PTMS PFUR)

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23 – 27 April
Moscow, Russia

Book of Abstracts

Edited by
Prof. Victor Yu. Korolev and Prof. Sergey Ya. Shorgin

Moscow
Institute of Informatics Problems,
Russian Academy of Sciences

2013

XXXI International Seminar on Stability Problems for Stochastic Models (ISSPSM'2013), VII International Workshop "Applied Problems in Theory of Probabilities and Mathematical Statistics Related to Modeling of Information Systems" (APTP + MS'2013) and International Workshop "Applied Probability Theory and Theoretical Informatics" . Book of abstracts. – M.: IPI RAN, 2013. - 135 p. - ISBN 978-5-91993-020-4.

The book includes the abstracts of communications submitted to the XXXI International Seminar on Stability Problems for Stochastic Models (ISSPSM'2013), associated VII International Workshop "Applied Problems in Theory of Probabilities and Mathematical Statistics Related to Modeling of Information Systems" (APTP + MS'2013) (Spring Session) and International Workshop "Applied Probability Theory and Theoretical Informatics".

XXXI Международный семинар по проблемам устойчивости стохастических моделей (ISSPSM'2013), VII Международный рабочий семинар "Прикладные задачи теории вероятностей и математической статистики, связанные с моделированием информационных систем" (APTP + MS'2013) и Международный рабочий семинар "Прикладная теория вероятностей и теоретическая информатика". Сборник тезисов. – М.: ИПИ РАН, 2013. - 135 с. - ISBN 978-5-91993-020-4.

В сборник включены тезисы докладов, представленных на XXXI Международный семинар по проблемам устойчивости стохастических моделей (ISSPSM'2013), VII Международный рабочий семинар "Прикладные задачи теории вероятностей и математической статистики, связанные с моделированием информационных систем" (APTP + MS'2013) (весенняя сессия) и Международный рабочий семинар "Прикладная теория вероятностей и теоретическая информатика".

ISBN 978-5-91993-020-4

condition of maximum Pontryagin's function defines the structure of optimal control. Further we study adjoint equations and differential association.

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Trajectory analysis of control process for optimal control of investments in the model of a three-sector economy

Peter Shnourkoff [1], ***Veronika Pisarenko*** [2]

[1]Higher School of Economics, Russia, pshnurkov@hse.ru
[2]Higher School of Economics, Russia, pisarenkoveronika@gmail.com

In this research, we consider the optimal control problem for an economic system whose behavior is described by the dynamical model of a three-sector economy. The results are summarized in [1,2]. For the state parameters of the system we take the capital-labor ratio functions (specific capital) in each sector and for the control parameter we take the amount of specific investments in the capital generating sector. The solution of the optimal control problem under consideration is based on the Pontryagin maximum principle. We find the optimal control structure depending on some auxiliary function, which is expressed in terms of conjugate variables. Analytic solutions of the systems of differential equations for the state variables and the conjugate variables are obtained. The system of differential equations (differential association), describing the dynamics of the system states has the form:

$$\begin{cases} \dot{k}_0(t) = -\lambda_0 k_0(t) + l_0^{(1)} \rho(A_1 k_1^{\alpha_1}(t) - i_1(t)), \\ \dot{k}_1(t) = -\lambda_1 k_1(t) + i_1(t), \\ \dot{k}_2(t) = -\lambda_2 k_2(t) + l_2^{(1)}(1-\rho)(A_1 k_1^{\alpha_1}(t) - i_1(t)) \end{cases}$$

In previous papers [1, 2] there were obtained optimal control structure, and solutions of differential equations and conjugate parameters. Four basic modes of optimal control were analyzed on the time interval $[0, T]$. For each of the options issued to differential equation $k_0(t)$, $k_1(t)$, $k_2(t)$ for relative depending on the control structure.

Further it is shown how $k_0(t)$, $k_1(t)$, $k_2(t)$ behave at different optimal control regimes. Below we state stationary solutions of a differential system association for the first option of the structure of optimal control with additional condition. Suppose that $k_0(t) = k_0$, $k_1(t) = k_1$, $k_2(t) = k_2$, k_0, k_1, k_2 some values. Then the only stationary solution of the system of differential equations is:

$$\begin{cases} k_0^{(0)} = \frac{1}{\lambda_0} l_0^{(1)} \rho(1-\gamma) A_1 \left(\frac{\gamma A_1}{\lambda_1}\right)^{\frac{\alpha_1}{1-\alpha_1}}, \\ k_1^{(0)} = \left(\frac{\gamma A_1}{\lambda_1}\right)^{\frac{1}{1-\alpha_1}}, \\ k_2^{(0)} = \frac{1}{\lambda_2} l_2^{(1)} (1-\rho)(1-\gamma) A_1 \left(\frac{\gamma A_1}{\lambda_1}\right)^{\frac{\alpha_1}{1-\alpha_1}}. \end{cases}$$

Consider the behavior of the function $k_1(t)$. If, for a specific set of values for the parameter t inequality $k_1 = k_1(t) < k_1^{(0)}$ holds, then $\Delta k_1 > 0$, the function $k_1(t)$ is decreasing on t. At the same time, as can be seen from the explicit representation of function $k_1(t)$:

$$\lim_{t\to\infty} k_1(t) = k_1^{(0)} = \left(\frac{\gamma A_1}{\lambda_1}\right)^{\frac{1}{1-\alpha_1}}.$$

Based on the findings, you can depict the character of solutions of differential equation about $k_1(t)$ from the above-mentioned system, depending on the initial values $k_{1,0}$, i.e. the phase trajectory of this equation.

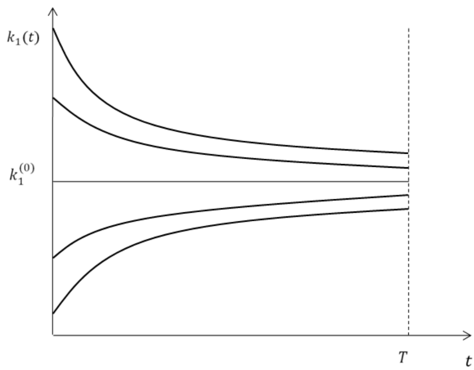

Figure 1: The behavior of functions of the capital-labor ratio of the first sector in a given interval of time

There has been stability on the trajectories of stationary solutions at corresponding control regimes. By analogy we study behavior of trajectories for functions $k_0(t)$ and $k_2(t)$ for the four best optimal control structure options.

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The estimation of financial stability of insurance company

Elena Puzikova

Peoples' Friendship University of Russia, Russia, puzikova.lena@mail.ru

In actuarial mathematics one of the main problem is to investigate how the capital of insurance company depends on some parameters of its activity.

In our report we consider the following model of surplus of insurance company:

$$U(t) = C_0 + Y_1(t) - R(t) - Y_2(t) + PI(t) \ ,$$

where

1) C_0 – initial capital;
2) $Y_1(t) = a \cdot t$ – the premium process;
3) $R(t) = b \cdot t$ – own expences;
4) $Y_2(t) = \sum_{j=1}^{N(t)} X_j$ – claims process;
5) $PI(t)$ – return from investments.

We assume that $(N(t), t \geq 0)$ is a homogeneous Poisson process, $\{X_j, j \geq 1\}$ are i.i.d.r.v.

In our report we consider the following problems:

1) optimal investment control;
2) ruin probability as a function of the parameters of insurance company activity;
3) calculating of financial stability characteristics as a function of the parameters of insurance company activity.

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