NUMERICAL AND ANALITICAL SCHEMES OF
DISTRIBUTED MODELING OF ECONOMIC SYSTEMS

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Abstract. This paper purpose is to construct maximally parallel algorithms for solving economy problems that are described by dynamic models. The problems of mathematical modeling of a similar class of problems on parallel *cluster-type* computing systems are considered. Most conventional algorithms for solving such problems (methods of runs, decomposition of a matrix into two diagonal matrices, doubling, etc.), with several processors, usually work no faster than with a single processor. This is caused by significant computations' sequence of such algorithms. The developed procedure of numerical and analytical sampling is quite simply generalized to other types of differential equations of mathematical physics. In particular, in stationary problems it is easier to localize features and apply high-order schemes in the smoothness areas.

Keywords: economy problem, numerical and analytical methods, parallel computing systems, recurrent structure, methods and models.

Introduction. The economists, in most cases, face complex problems. It is caused by many factors that not only affect each other, but are also determined by time dependencies [1]. Therefore, the specified class of problems is investigated by economic and mathematical modeling [2]. The mathematical model allows including the variety of parameters that affect the economic system as a whole.

It should be noted that in recent decades, the dynamics research of economic systems have possessed a steady trend towards continuous time [3]. Economical class of problems with continuous time allows adapting methods and models, and experience of research of linear and nonlinear dynamic systems, accumulated in engineering sciences. At the same time, an important feature of the solution to such class of problems is their high computational complexity. For this reason, the effective research of problems can be run only by multiprocessor computer systems.

So, distributed modeling of applied problems of economy based on schemes of the higher order of accuracy is an essential and actual problem.

Research main material statement. At present, macroeconomic processes are being studied as transients in dynamic systems. Hence, the study of macroeconomic processes is run by mathematical methods and models, first of all, by the theory of dynamic systems (mainly the theory of automatic control), which relies on means of differential equations and Laplace transformations. The research of transients in unstructured macroeconomics applies the dynamic Keynes model and the Samuelson – Hicks model [3]. Moreover, the processes of modeling monetary and material savings, the securities value dynamics are considered as large systems.

Note that the specified class of problems, as a rule, is described by differential equations and is solved by means of difference circuits, which essence is that the derivatives are replaced by difference relations. In this case, from the numerical algorithm point of view, the solution to the difference equations is divided into explicit and implicit schemes. In the explicit scheme, the values of the desired function are determined sequentially, layer by layer. In this regard, this approach cannot be used for parallel computations. Implicit schemes allow large-scale computations to be performed without significantly degrading accuracy, but this approach requires more computations. The above analysis shows that the methods of solving such class of problems should not only be diverse, but also combine quantitative assessments with analysis. Nowadays, there have been some trends in development of numerical-analytical methods with a complex logical structure, but they have a higher order of accuracy and possibility of constructing algorithms with adaptation in order of approximation compared to piecewise-difference methods. In computation terms, this approach is somewhat cumbersome, but it shows a kind of benchmark for comparison with other practical methods. However, despite the fact that the computational experiment is run on a multiprocessor system, it can be argued that the circumstance that hindered the development of the numerical-analytical approach is now losing its relevance

Existing methods of solving economy problems are not always suitable for the reasons of accuracy, speed, required memory, structure of algorithms, and applicability for multiprocessor computing systems. In this respect, new ideas in computational mathematics are emerging and get implemented. Ultimately, for

more sophisticated mathematical models it is necessary to construct new methods for implementing numerical experiments.

This paper purpose is to construct maximally parallel algorithms for solving economy problems that are described by dynamic models. The problems of mathematical modeling of a similar class of problems on parallel *cluster-type* computing systems are considered. Most conventional algorithms for solving such problems (methods of runs, decomposition of a matrix into two diagonal matrices, doubling, etc.), with several processors, usually work no faster than with a single processor. This is caused by significant computations' sequence of such algorithms.

The developed procedure of numerical and analytical sampling is quite simply generalized to other types of differential equations of mathematical physics. In particular, in stationary problems it is easier to localize features and apply high-order schemes in the smoothness areas. The approximation order value along with the computation on the crushed grids allows being guided in estimation of the computation accuracy.

Conclusions. So, this paper shows the efficiency of parallelization of dynamic systems by the example of solving economy problem. Particular attention is paid to numerical and analytical methods of solving the set problems. The higher acceleration of computation compared to the finite-difference approach is explained by analytical solutions that allow performing computations simultaneously and in parallel across all the time layers without combined memory. This approach eliminates the recurrent structure of computation of the required solution vectors; which usually results in accumulation of rounding errors. The parallel form of such a constructed algorithm is maximal, and therefore has the least possible time for the algorithm to be implemented on parallel computing systems.

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