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Труды конференции «Математическое моделирование физических, экономических, технических, социальных систем и процессов» содержат материалы докладов участников конференции по математическому моделированию. Конференция проходила 2-5 февраля 2009 года на базе Ульяновского государственного университета **при поддержке РФФИ, грант 09-01-99700-р_г.**

ON SOCIETY-WIDE MODELING

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In the 21st century, the uncertainty external to any long-range decision problem is much more important than the uncertainty internal to the problem. The harmful outcomes under the external scenarios dwarf those of internal scenarios, and the likelihood of such outcomes is quite high. This is caused by the combined impact of geopolitical disturbances, including terrorism and possible use of weapons of mass destruction, potential pandemics, deterioration of the planet's environment, and so on. The future may drastically change even in a matter of days. We do not know the future, even in short-term, even in probabilistic sense. It is a situation of radical, "uninsurable" uncertainty. For the sake of generality, I will define an externality of a social or economic decision to be both its impact ("spillover") on any party not directly involved in that decision, and any unforeseen consequence of the decision, even if it impacts a directly involved party. Because of sharply rising uncertainty, externalities become critically important. Externalities arise at the local (micro), the whole economy (macro), societal, and global levels. Individual economic actors, both producers and consumers of goods and services, do not want to take negative externalities into account; they want to use common goods for free. Therefore the "invisible hand" of a laissez-faire market, or a combined effect of individual decision models, never leads to even a short-term optimum, no matter how defined – neither at the level of whole economy, nor at the level of society. Both A. Smith and M. Friedman are dead, wrong. Price-driven greed is an extremely powerful stimulus. But it can be both constructive and (as can be seen from the present crisis) destructive. It has to be bridled and "nudged" in proper direction. Indeed, a major legacy of Keynes is that, even for a current consumption market, the low-level activities of the market's "invisible hand" should be controlled and constrained at the macro level by a non-market entity. (Generalization of that principle from a single country to the global economy see in [1]). Moreover, it turns out that not one but rather two "invisible hands" are needed: one for the current production and one for developing new production capacity to satisfy the future demand [2]. Basically, an individual producer needs data about the future of not only his industry, but also all related industry sectors. Since the market knows nothing about the future, the results are bad. That might have been acceptable in earlier, more tolerant times, but not in time of sharply reduced domestic investment and economic crises. Additional information about the future is badly needed for any capital investment. Similarly, we need better data to deal with both present and future externalities. All currently used

methods of solving the problems of negative externalities (except direct criminalization of obviously harmful activities), such as regulation and pigovian taxes and subsidies, as a rule are insufficient, because they underestimate the potential effect and the ultimate top level of these externalities, when they are aggregated. Both types of data – of course, extremely approximate, but still providing helpful information – can only be derived from a society-wide decision model.[1]

An optimization model under radical uncertainty naturally suggests itself. The ultimate goal of such a model should be the development of a strategy that leads both to sufficient satisfaction of current needs and wants of society members and to a long-term sustainable survival of the society in an acceptable state.

To provide information about separate sectors of industry, the economic core of the model has to be formulated in input/output analysis terms, possibly with some geographical aspects included [3]–[5]. Obviously, to achieve some kind of an optimum at the level of society, the model should internalize all externalities up to that level, as well as global externalities related to the protection of global environment. The main short-term objectives and constraints for the society-wide model are: sufficient growth, low unemployment, stable prices, sufficient satisfaction of needs and wants of population, and a healthy balance of payments. The main long-term objectives and constraints are: preservation of the industrial base, preservation of the middle class, and the attainment of social and geopolitical goals of the country.

Very little is known about connections of these objectives and constraints to the ultimate goal of long-term survival of the society. Therefore such a model cannot be formulated as a conventional mathematical programming model, where the paradigm is maximization of a single criterion or multiple criteria. Instead, we have to adopt a new paradigm of "catastrophe avoidance." In that framework:[2]

- Model is dynamic, with several short- and long-term goals and constraints designated as "risk types" and expressed quantitatively, and for each "risk type" a minimally or maximally acceptable limit value is set.

[1] There undoubtedly exists a pressing need for a society-wide model. This paper is not, however, a call for immediate formulating, filling in by input data, and solving such a model. Below is just what I consider to be the main requirements for such an endeavor, if and when it would be undertaken.

[2] The described below "catastrophe avoidance" paradigm and solution process, or something similar, seem to be mandatory for dealing with society-wide models. That paradigm and process are also, however, parts of a more general "Risk-Constrained Optimization"® approach [6]-[7]. RCO is applicable not only to such models, but also to any decision models dealing with radical or substantial uncertainty, for instance – intelligent adaptive planning, or any long-range planning and strategic risk management models. Society-wide models need adaptability, too, but I do not have space to dwell here on that issue.

- A number of “uncertainty generators” is established, both internal and global, with several values possible and a “guesstimate” probability attached for each value.
- A scenario is a combination of these values, one for each “uncertainty generator,” and an initial scenario probability is based on probabilities of the associated values of “uncertainty generators.”
- Model is multiscenario and includes probable and possible (zero probability), as well as both “internal” and “external” scenarios (the latter taking into account global “uncertainty generators”).
- Initial scenario probabilities are overridden in the iterative process of solving the model.
- Maximization algorithms are used for solving the model – though not for finding the “best” solution, but rather as auxiliary analytic tools, for revealing dangers lurking in individual scenarios and for finding new candidate strategies.
- Each candidate strategy is found as a result of solving a new maximization model, with a different set of “risk-limiting constraints” that cut off undesirable outcomes for all “risk types” (in a “strong screening” procedure).
- No candidate strategy, after implementing the necessary contingency plans (adaptations of the strategy to scenarios) for each scenario, should violate the limit for any “risk type” in any scenario.
- If no feasible candidate strategy can be found, the limits may be relaxed.
- The strategies that “post-contingency-plans” meet all limits are additionally “weakly screened” to derive a small subset of reasonably good, flexible, risk-protected candidates.

The final selection of the strategy to be implemented is made subjectively from that subset. A set of contingency plans over the whole range of scenarios is derived for the selected strategy from the model’s solution.

In the model solution for the selected strategy, the Lagrangean equivalents of externality constraints could serve as the basis for pigovian taxes and subsidies. Other systems of taking into account the long-term dual-price-based values of goods and services also can be used for price-based evaluation of projects. It is too early to determine the best approach. But it is already evident that, without such correctives, individualistic planning is likely to result in commercially or/and socially bad outcomes.

Society-wide modeling thus may become a necessary major component of a market economy. It probably is the only way of transforming all externality concerns into price signals, which would preserve the best features of capitalism while neutralizing a substantial part of its drawbacks.

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“COMPENSATED FREE TRADE”

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The existing Anglo-American model of international trade is one of the worst blunders of economics. Its pseudo-scientific recommendations cost the USA about $700 billion a year and are among the main causes of the present economic crisis. Its theoretical justification, the “law of comparative advantage,” is invalid, inapplicable, and irrelevant in the real world of “externality costs” (that is, the costs of the economic and social adjustment to the upheaval of the industry), trade imbalances, global movement of capital and technology, omnipresent technological progress, “learning curves,” excess production capacity, persistent unemployment, worker specialization, large wage-level gaps between countries, “sticky” prices, currency rates and wages, economies of scale, geopolitical and economic instability, and unprecedented uncertainty. This list of forbidden by the theory but unavoidable conditions of the 21st century can be prolonged further. To satisfy “the fierce urgency of now,” the trade situation must be improved immediately. If the trade policy is not changed, the USA will either turn to “hard” protectionism, or suffer dire geopolitical, social, and economic consequences. No currently existing approach leads to sound improvement. I propose a policy of “compensated free trade.” That is how the policy would work:

- Congress sets annual limits (upper bounds) on the overall USA trade deficit in consumer goods and undesirable capital goods (oil, gas, and other commodities are excluded as necessary).
- The President of the United States allocates the allowed deficit for each of our trading counterparts – countries or groups of countries.
- A country may exceed its limit if its government pays the USA Treasury a stipulated percentage (up to the full amount) of the excess deficit, also approved for each country by the President of the US. The President can cap the allowed amounts of intergovernmental payments.

To raise the money for excess deficit payments, the trading partners may either use export taxes and export certificate auctions, or pay from their currency reserves. Most important: the system would restrain the clearly unsustainable current rate of growth of the world economy. Mankind should live within limits determined by the current combination of the natural resources available, the environmental harm acceptable, and the existing technologies. We would be able to return to substantial global growth only if and when novel technologies, particularly including a breakthrough in non-fuel energy generation, would not just emerge, but also be massively enrooted. Both theoretically and from practical point of view, the proposed policy is very sound. It is powerful and versatile. Here is the first dozen of its main advantages.

- It generalizes to the global economy the idea of J. M. Keynes that the lower-level market activities should be controlled and constrained at the macro level, while also achieving his another important goal of (automatically) allocating the burden of economic adjustment between the surplus and deficit countries.
- It takes into account the concerns of J. S. Mill and Keynes about the social and political consequences of economic policy.
- The theory of international trade demands (instant) flexibility of currency rates, prices, and wages, so that trade becomes barter and each trading country has a zero total trade balance. Trade surpluses and deficits are created only because of violating these tenets. The proposed policy acts as a neutralizer of violations of the theoretical rules. It goes straight for the jugular and – at one bold stroke – destroys the combined pileup of Machiavellian manipulations of currency rates, prices, and wages. It moves the global economy toward a balanced equilibrium, the dream of economists, politicians, and bankers.
- It “strongly dominates” the current economic policy: if the USA enacts the proposed legislation, but sets the overall trade deficits limits high, not really fighting at the moment the deficit growth, that will create a trade policy having no disadvantages compared with the current policy, but still providing some new

major advantages. For instance, all countries that brazenly employ predatory trade techniques now, may rethink their behavior overnight. (This consideration is especially important at a time of low demand: it will be shortcut insurance for future. “Don’t ever waste a crisis!”)

- The system is minimally intrusive and minimally harmful, while highly effective. Its impact on the USA economy will just boil down to a once-a-year change of prices of resources and products, which will “nudge” the economy in the desired direction.
- It provides a novel way of dealing with externalities – pushing out abroad their transformation into Lagrangean price changes; see [1].
- It brings the trade deficit down to a sustainable level, while following Article XII of GATT and avoiding violation of anti-protectionist anti-tariff clauses in existing trade agreements and WTO regulations;
- It establishes the government control over the currently open-accessed (and openly abused) public good, the current account of the country.
- It would prevent trade wars: since it imposes constraints not on the import from a country per se, but rather on the trade deficit, a country’s attempt to decrease the import from the USA would also automatically decrease its export to the USA.
- The inherent flexibility of the policy makes it a superb short-term risk-management tool. But it works well in long-term risk management, too [2].
- No less important is that the system allows using trade policy as a geopolitical tool, a powerful weapon of diplomatic persuasion, which again will give us a long-lost capability to reward our friends and penalize our enemies.

- Above all and best of all, the system will be a priceless tool of geopolitical containment, a la Kennan, of potential rivals and adversaries [3]. Perhaps the least confrontational, too. We need it now much more than 60 years ago.

As every radical proposal, “compensated free trade” has disadvantages, too. But all its major risks are unavoidable under any other policy and any probable future scenario. Indeed, it is better to deal with such phenomena when we at least have a powerful weapon for fighting them, rather than otherwise. This is crucially important: even the most serious possible faults of the proposed system pale in comparison with the likely suicidal consequences of the present policy of unbridled free trade and uncontrolled globalization. Even were any economic apprehensions valid, they still should yield to social and geopolitical considerations. The former are relatively short-term, while the latter may lead to very long-term, perhaps perpetual, negative changes of the country and the world – and, ultimately, to yet greater economic harm.

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MODELING OF OPTICAL PROPERTIES OF ORDERED NANOCOMPOSITES

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The idea about unusual optical properties of nano-aggregates was stated for the first time by Maxwell-Garnett in his fundamental paper [1]. It was based on the principal that nano-particles of metal embedded into a dielectric host medium can be treated as dipoles and the resulting composite medium must behave itself as a continuous dielectric with modified optical properties. Composites consisting of regularly arranged in space particles are supposed to have most interesting optical properties because of interference and coherent scattering effects rise greatly in such a structure [2]. It was shown previously that those effects modify system’s spectrum radically [2].

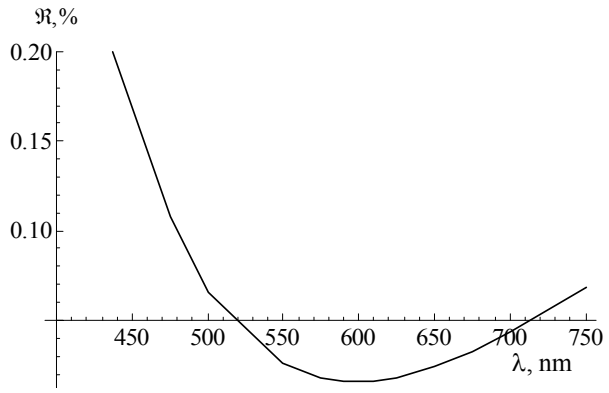

Fig. 1. Reflectance dependence of a substrate covered with nano-particles layer on the wavelength of incident light.

The method being presented in this report is based on integral equations formalism and doesn’t employ Maxwell’s boundary conditions while calculating particles’ interaction. It also allows taking into account interaction between nano-composite and a substrate without any approximations which must be used in such methods as: Generalized Mie Theory, Transition-Matrices Method, KKR-method and others [2]. The only approximation we employ is long-wave limit ($k_0 a << 1,\ k_0 n a << 1$, where k_0 - wavevector of an incident light, a, n - characteristic linear size and refraction index of a nano-particle respectively) and interparticle distance is taken to be large enough to neglect multipole components in scattered field expansion (only dipolar part is considered). It is necessary to underline that approximations mentioned above