



THE SYSTEM ANALYSIS OF RUSSIAN ECONOMIC REFORM:
MODELS, ACHIEVEMENTS AND PROBLEMS

by

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THE SYSTEM ANALYSIS OF RUSSIAN ECONOMIC REFORM: MODELS, ACHIEVEMENTS, PROBLEMS.

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1. Introduction: Modelling a Transition Period Economy

1.1 The Problem

From the very beginning the progress of Russian economic reform does not meet objectives and expectations declared. Moreover, the reconstruction of economic system under a deep general crisis of the economy has resulted in polarization of points of view on objectives and tools of economic policy themselves. Probably the processes going on in Russian economy are not those examined by traditional macroeconomic theories. For socio-economic stability of Russia and the global community it is reasonable to develop a common language that will allow to carry out system analysis of economic structures emerging in Russia. It will enable us to collate constructively different points of view and estimate the outcomes of macroeconomic policy on the basis of different criteria.

We believe that the appropriate language can be that of relatively compact but well structured mathematical models describing explicitly interaction of main economic agents involved into production, exchange and distribution.

During 20 years our research group has been developing such models within the framework of approach named "System Analysis of Evolving Economy" in the Computer Center of Russian Academy of Science.

¹ I am grateful to my colloquies I.Pospelov, A. Shananin and S. Guriev for significant contributions to the preparation this paper.

The forthcoming discussion is devoted to the following issues.

- Basic ideas of system analysis of evolving economy (1.2)
- Results that can be obtained by system analysis of evolving economy and examples of previously developed models (1.3)
- System analysis of economic structures arisen in Russia (1992 and the first quarter of 1993) and investigation of the government's chances to regulate the economy under given circumstances and critical variants of the economic policy (sections 2, 3 and 4 - the main part of this report)
- Problems to be solved and the program of research proposed (5)

1.2 System Analysis of Evolving Economy

What differs our models from those used commonly for economic forecasts?

There are two widely spread kinds of models namely econometric ones and those of general equilibrium. Econometric models (see, e.g., [1]) are used for quantitative forecasting of certain economic indices and are based on past observations of statistical correlations between these indices. Econometric models assume that there are some pertinent relationships between the macroeconomic indices. The conditions under which these assumptions are valid can be determined only by microeconomic analysis. Conventional econometric relationships are built formally by regression procedures and can hardly be interpreted in terms of microeconomics. That is why the traditional econometric technology of modelling can not be applied in the period of essential structure changes in the economy and should be refined. (For example, econometric models failed to describe the outcomes of the oil price shock in 1970s).

Equilibrium models (neoclassical or Keynesian), [2] are often used for qualitative forecasts of government regulation outcomes. They are structured better than the econometric models. Economic agents and their assets are described explicitly in equilibrium models. But the equilibrium models are based upon certain a priori assumptions on solution of agents' conflicts in the market. This solution is called the market equilibrium. It corresponds to certain set-up of economic relations which is the case in developed countries, but is not the case in contemporary Russia.

We do not neglect the experience accumulated by econometric and equilibrium models. We often use some approaches developed by their contributors, but the basis of our models (see [3],[4]) is different.

One should realize that in the perturbation period it is hardly plausible to obtain a reliable quantitative forecast. It is the change of qualitative structure features of the systems that is worth to be modelled and discussed. The proposed models are based on a complete system of balance equations describing the flows of material and financial assets of economic agents. Formation of the balance equations is not a formal procedure. At this stage we actually specify agents that are significant under given circumstances and define

the notions which will be used for describing the agents' activity. The choice of these notions is essential and may be the most difficult step in building a model.

The point is that the regularities to be described by the model arise as an outcome of interaction, learning and self-organization of a great number of individuals. They are these processes that distinguish relatively independent areas of economic life and allow us to describe them by means of traditional economic indices like, e.g., aggregate price and rates, demand functions, production capacities, stable input-output proportions etc. Therefore individuals can find their way in a complex system such as the modern economy, and researchers can build models of the system. In case of too detailed description economic categories just lose their meaning. There exists no demand function of a separate consumer, no input-output coefficients for several thousand industries. There is no common price if single shops are taken into considerations. Formal increase of detailing of the description does not ensure an increase in adequacy of the model. That is why we propose compact aggregated models.

Balance relationships do not describe the system completely. It is necessary to add an appropriate description of the economic agents' behavior. This part of the model is far less standardized than the balance one. While the reliable principles are developed to describe the supply of and demand for goods under perfect competition, the descriptions of labor supply, savings supply, monopolistic behavior etc. are based on assumptions still to be tested. We persist that all the assumptions on agents' behavior should be formulated explicitly so that anyone could substantially discuss and criticize them.

The proposed modelling approach is neither simple nor free of disadvantages, but it has got the properties necessary for qualitative and quantitative analysis of the current situation and possible variants of its development, namely:

- **clarity of assumptions**
- **transparency of description**
- **explicit correspondence of model's structure and observed structure of economic relations**
- **possibility to interpret meaningfully results and compare them with the reality**

1.3 The Research Background

We will briefly discuss some mathematical models built during 1976-1990 in order to explain what problems we were concerned with and what results can be worked out by means of the system analysis of evolving economy.

1.3.1 System of Models of Market Economy

Here we will mention five models of market economy united by common composition, common set of basic economic variables and common principles of description of the main economic processes. The models differ from each other by the accents made on certain problems. Each model describes major qualitative features of dynamics of a market economy such as economic growth accompanied by business cycles and inflation processes arising in case of either scarcity of some resources or excessive government spending. Consider briefly some qualitative results obtained within each model.

Model of Market Economy for Study of Government Spending, Borrowing and Taxation Policy ([5]) showed that

- (i) increase of government spending may have different impact on the real income distribution in different current states of the economy
- (ii) for a financial system based upon government bonds (like in the U.S.A.) it is difficult to determine a rational level of the budget deficit: too high deficit gives rise to inflation, too low deficit (particularly, no deficit - the balanced budget) gives rise to recession.

Hence, *models can distinguish the situations in which a given economic policy might be effective. Therefore a model provides on an objective basis for the arguments of supporters of different concepts of economic policy.* For example, neoconservative policy turns out to be not the ultimate truth, but simply a reasonable policy appropriate in some situations and inadequate in the others.

Model for Study of Influence of the Power Industry in Market Economy ([6,7])

- (i) describes correctly the evolution of technological structure of production due to labor-energy substitution
- (ii) gives a correct dynamics of prices and real values after shock of prices of imported energy resources (energy crisis)

The investigation of this model proved that *relatively compact and well structured models can adequately describe not only a steady growth of an economy, but its structural change as well.*

Model for Study of International Trade ([8]) under the gold standard of currencies

- (i) describes the known relationships of international trade, e.g. that devaluation causes an increase in exports at the expense of domestic consumption
- (ii) reveals that if two economic structures mismatch each other, the trade can destabilize both of these.

Comparing the simulation results with economic statistics we found that different sources on the oscillations in terms of trade give significantly different figures. Only special mathematical procedures reveal latent common quantitative characteristic features of the time series which turned out to be reproduced by the model.

This result displays that the *ability to reproduce time series exactly can not be the major criterion of model adequacy*. Statistic data are always just a result of aggregation of the original economic information. The methods of aggregation are not rigorously proved yet and suffer from subjectivism. That is why *the model should deal with quantitative features of the economy that are invariant to the procedure of collecting and processing statistical information*.

Model for Study of Technology Change ([9,10]) includes enhanced description of the technology change processes which was used in modelling the transition period (see 1.3.3). This model

- (i) describes business cycles associated with the periods of capital regeneration
- (ii) estimates the period of business cycles and describes correctly their phases in real (output levels, employment, accumulation, consumption), financial (prices, rates, loans and savings) and structural (age of capital, number of bankrupts) indices
- (iii) exhibits the meaning of capital depreciation rate which is an important variable of government regulation

The model *opened a way for non-equilibrium description of economic growth..*

Model for Study of Environmental Issues ([11]). In order to consider environmental consequences of using "dirty technology" the environment submodel was added to the same model of structural change (see 1.3.1.4). The results are basically negative; namely

- (i) a flexible pollution tax is not sufficient to keep reasonable level of pollution
- (ii) to fight pollution effectively one has to increase the pollution tax in advance, i.e. to make producers to pay for the pollution that has not really happened yet

Thus, *alternative environment regulation should be developed*.

1.3.2 Models of Planned Economy ([12])

The model of actual processes in a centrally planned economy gives the following results:

- (i) the model describes and explains the known phenomenon of "paper" economy when the "plans are fulfilled, production and performance grow" in reports while in the real life one has

- decrease in product quality
- payment of non-deserved wages
- growth of enforced savings
- excessive loans to the enterprises etc.

These phenomena were observed in 1970-80s in the Soviet economy.

- (ii) private *leasing* of some production capacities does not help. Such a private sector that does not have opportunities and incentives to enhance production will lower the commodity scarcity, but will also generate inflation processes. Moreover such private sector will become a sort of unnecessary appendage to the public sector, since it is constrained by extra money emitted by the public sector ([13])

General principles that the models mentioned above are based on, turned out to be quite appropriate for modelling a non-market economy.

1.3.3 Models of Transition to Market Economy

On the basis of models of market and planned economy we developed models of transition period. Short-term and long-term consequences of the reforms turned out to be a clearly distinct. We have constructed the special short-term model ([14]) which *allowed us to predict correctly in 1990 the level of inflation and decrease in consumption that the price liberalization gave rise to in Russia in 1992.*

2. Russian Economy in 1992-1993 and a Framework of Economic Relations

The actual administrative control of economy in Russia began to weaken already in 1960s, when the economy became less centralized. In January 1992, the economic reform canceled the government control in production, distribution and expenses of producers. The structures of communist party were destroyed, but the enterprise management had gained additional power. However, the government is still in charge of the industry. The credit-financial links between the government and producers have remained too.

The influence of employees increased also. In 1992 the wage bill grew faster than the total households' income. The wage bill took the major part of enterprise incomes. The wage bill grew along with the decrease of productivity, and the wages seemed to be covered essentially by loans of the Central Bank.

Price liberalization started price-forming mechanisms of monopolistic markets. The increase of retail prices was followed by that of wholesale prices, which, in turn, forced the retail prices to increase more and more.

The reform had stimulated business activity of economic agents. In liberalized conditions, the existing structure of production and distribution turned out to be far from the equilibrium. At first, this revealed in decrease of production, because the products having no demand are not produced now. At second, the trade, export-import and exchange operations became the most profitable.

Influential groups exporting raw materials and importing consumer goods arose. Export-import operations determine substantially the exchange rate of USD and influence the shift of internal prices. Importers and trade intermediaries control prices in the domestic consumer market. The major part of incomes in hard currency was taken out of the country.

The price growth has destroyed the households' savings, and has generated stable inflation expectations. Money in circulation substituted savings as the major credit resource. Payments had been delayed for several weeks, mutual *arrears* arose, and *preferential loans* of the Central Bank became the main tool of government economic policy. *Preferential loans* became the subject of hot public discussion.

Until summer 1993 the Central Bank did not operate actively on the domestic currency market. Net currency incomes of exporters and importers can be considered as not returned on the domestic currency market.

The information on the structure and situation in the Russian economy in 1992 and the first three months of 1993 was analyzed systematically. As a result, a *framework* was elaborated, i.e. the descriptions of *main economic agents* and their *relations* determining the economic mechanisms of reproduction regulation. *The framework* involves the following economic agents: *households, producers (enterprises), importers, exporters, commercial banks, government together with the Central Bank*. The framework includes the following assumptions on interrelations between the economic agents.

1. **Households** receive money as direct payments from the **government budget** (salaries, pensions, scholarships, relieves etc.) and as wages in **enterprises**. **Households** demand money to have a stock for buying durable goods.
2. **Inter-industrial structure** is represented in an aggregated form by three sectors. *The first sector* includes consumer goods and food industries, *the second* includes the manufacturing industry, and *the third* includes the basic industries (the raw material industry and power industry).
3. Employees of enterprises in the sectors want to increase the wage. Therefore the management regulates the production to *maximize the value added*. The major part of value added turns into the *wage bill*. The rest is absorbed by taxes, paybacks of short-term loans and replenishing working capital. Delays in payments and demand constraints still cause the growth of enterprise debts. *Net investments are suppressed completely. Production capacities depreciate.*
4. Changes in enterprise profitability influence the *wage rate* but not the employment. Bankruptcies are absent. *Unemployment* is negligible.
5. The **Central Bank** gives *preferential loans* against *arrears*. The solvency requirement is determined as a compromise between the government and producers.
6. Export involves only raw materials. Import involves only consumer goods. Export-import operations are run through **commercial banks** and **currency exchange**. **Importers** get short-term loans in rubles to purchase currency in the currency exchange. The currency is supplied by **exporters** who demand rubles to pay **producers** for exported raw materials. **Exporters** and **importers** take the *net currency income* out of the country. The **Central Bank** does not operate actively in the currency exchange.
7. **Markets** are controlled by a *hierarchy of oligopolies*.
 - (i) **Producers** act as a *cartel* regulating wholesale prices to obtain the *maximum revenue at a given level of preferential loans*
 - (ii) **Importers** of consumer goods control domestic prices in order to *maximize* their *net currency revenue* under given domestic demand and supply, *exchange rate* of USD and *interest rate* for commercial loans
 - (iii) **Commercial banks** determine the interest rate to *maximize* their *profit* at given *exchange rate*
 - (iv) **Exporters** of raw materials occupy the top of oligopoly hierarchy. They control the *exchange rate* of USD in the currency exchange to *maximize* their *net currency revenue*
 - (v) **Inflation rate** is influenced substantially by the growth of raw *material prices*. Domestic raw material prices depend on export supplies of raw materials by producers and ruble demand of exporters. The prices are changed so that the demand is balanced with the supply

7. The **government** economic policy includes

- (i) decisions on monthly volumes of *preferential loans* given by the Central Bank to producers
- (ii) decisions on monthly *real purchases* (in constant prices of 1990) of goods for public consumption and national defense
- (iii) decisions on monthly *transfers* to households from the government budget
- (iv) decisions on monthly² *subsidies* for enterprises
- (v) decisions on *tax rates* for economic agents

8. External conditions are characterized by world prices for exported and imported goods. Foreign debts were not taken into account, because recently these are rather a political than economic aspect.

The framework reflects some system assumptions on economic relations arisen in Russia after January 1992. This allows us to analyze in the system way the mechanisms of production regulation, distribution and circulation in Russian economy. We can analyze the general situation in economy and make short-term forecasts depending on variants of government economic policy.

It should be emphasized that both the analysis and forecasts below are based essentially on the assumed *framework*. Therefore the study of real economic relations between the main economic agents is fundamental in the transition period.

²Below, for the brevity's sake, we omit the term "monthly" and consider volumes, purchases, etc. instead of monthly volumes, monthly purchases etc., respectively.

3. Interrelations Between the Main Macroeconomic Indices and Parameters of Government Economic Policy

A mathematical model based on the *framework* above has been developed [3]. It allowed us

- to reveal some **qualitative features** of modern economic situation in Russia
- to find systemly consistent **quantitative relations** between the main economic indices
- to make **short-term forecasts** for various variants of government economic policy. Consider these results successively

3.1 Some qualitative features of modern economic situation in Russia

3.1.1 Inefficient market equilibrium

The structures described tend to generate the inflation. We proved that a nonclassical **inefficient equilibrium** can exist in the economy at high inflation rates, [16]. In this paradoxical situation, the production decreases because of delay in money circulation, and consumption decreases as well. Economic agents do not save and invest. Credit sources of banks consist of money in circulation. Banks lend money against the delayed payments of enterprises; the interest rate is less than the inflation rate (*the real interest rate is negative*). However, banks have a positive profit, because they do not pay for credit sources.

It is interesting how preferential loans influence the equilibrium discussed. The more is the delay in circulation, the more the production decreases, i.e. consumers receive less goods, but the profit of banks is higher. In other words, the equilibrium is less efficient. Preferential loans push forward the inflation, but compensate delays in circulation, increases the production, and increases the equilibrium efficiency.

Therefore if the inflation rate is high, the lack of loans is as bad as the excess of these.

3.1.2 Coalition of commercial banks and exporters of raw materials

Goals of exporters and commercial banks turn out to be congruent. Therefore it is logical to expect the formation of a *stable powerful coalition which can dominate* other economic agents.

3.1.3 Economic stability boundaries

We have found the **deflation** and **hyper-inflation boundaries** for volumes of preferential *loans*. Beyond these the given economic structures are not stable. There exist no self-consistent inflation expectations; and import and/or banking become unprofitable in rubles.

Similar **stability boundaries** are found for real government purchases of goods, and prices for raw materials on the world market. These all bound a **stable domain**, i.e. the ranges of economically safe parameters of government macroeconomic policy.

3.1.4 Influence of volume of preferential loans within the stable domain

In *the stable domain* the increase in preferential loans or increase in transfers increase essentially only the inflation rate and money demand. The latter is due to the increase of enterprise assets or increase of cash in hands. The other macroeconomic indices change slightly.

In both cases the share of the third sector is somewhat increased in GDP. The price ratios also change slightly so that relative prices of raw materials increase.

The increase of real government purchases of manufactured goods (the second sector) increases substantially not only the inflation rate and money demand, but also the GDP (to a large extent, due to the third sector). However relative prices of raw materials decrease.

3.1.5 Some general conclusions

- Macroindices and indices characterizing the branch structure of industrial output, prices and so on are the most sensitive to changes of real government purchases of products
- The loan policy, or policy of real government purchases do not influence substantially the net domestic product or index of households' consumption, i.e. the macroeconomic parameters characterizing the economy's efficiency
- Alteration of preferential loan volumes, real government purchases of products, and government transfers to households causes a more substantial change of the inflation rate than that of the exchange rate of USD. Both the inflation rate and exchange rate change always in one and the same direction

3.2 Quantitative analysis of development of Russian economy in January, 1992-March, 1993

Quantitative analysis was aimed at two purposes:

- to verify the developed mathematical model
- to investigate actual ranges of government economic policy in 1992

3.2.1 Actual economic policy observed

First of all, we have estimated parameters of economic policy conducted actually by the Russian government in January, 1992 - March, 1993.

The statistics shows that the public enterprises received only 34% of preferential loans. Trade intermediary enterprises had 37% of these. The sources give no information on the

other 29%. Thus we have taken 34% of loans given by the Central Bank in January, 1992 - March, 1993 as **the first parameter of government macroeconomic policy**. Fig. 1 shows the statistics of preferential loans in January-December, 1992. Note that the credit policy seems rather sophisticated.

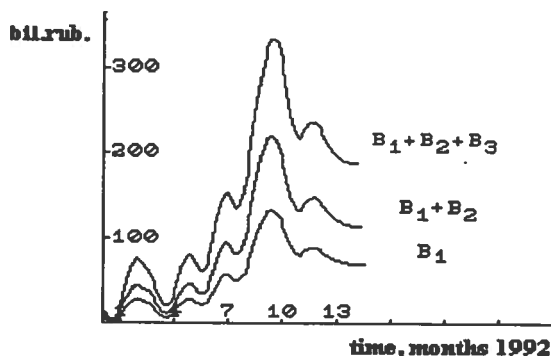


Fig. 1 B_1 , B_2 and B_3 are actual flows of preferential loans into sectors 1, 2 and 3, respectively. $B_1+B_2+B_3$ is the total volume of preferential loans.

We were not able to find reliable statistical data on monthly government purchases. We estimated those indirectly as 30%, 65% and 5% of January 1992 outputs in the sectors 1, 2 and 3, respectively. The government purchases decrease during 1992. We assume that during 1992 government purchases have been decreasing with constant monthly rates 2%, 5% and 7% in the sectors 1, 2 and 3, respectively. This gave us **the second parameter of government macroeconomic policy**.

We have also estimated the depreciation rate of production capacities as 1.5% a month .

3.2.2 Verification of the mathematical model

In Figs. A1-A5 (Appendix 1) the computer simulations are compared with statistical time series. One can see that, in general, the model reproduces correctly the time series of various economic indices. Industrial output indices (Fig. 2) demonstrate the worst correspondence. But this does not exceed 20%.

Verification shows that the model is adequate enough to give reasonable quantitative estimations of Russian economy situation.

3.2.3 An alternative variant of government economic policy in 1992

The main aim of our study was to find *economically dangerous combinations of parameters in the macroeconomic policy*, i.e. the combinations leading to destabilization of the economy.

Fig.1 demonstrates that, in the first three months of 1992, the government pursued the tight credit policy. If we continued the tendency, we would see that no preferential loans were given from May 1992, as it is presented in Fig. 2.

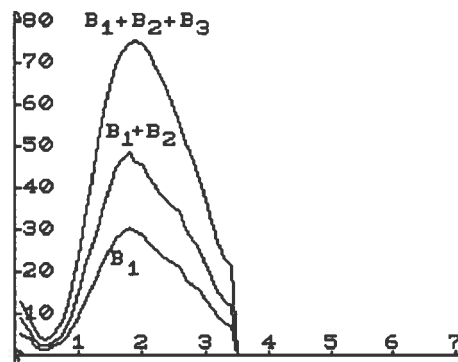


Fig. 2 B_1 , B_2 and B_3 are flows of preferential loans into sectors 1, 2 and 3, respectively, according to the tendency observed up to April 1992.

The tough credit policy was broken by the Congress of People Deputies in spring 1992. By means of the model, we reconstructed the economic situation which would occur, if the tough credit policy continued up to end of 1992.

The simulation showed that were the tough credit policy pursued after May 1992, the consequences would depend essentially on the policy of government purchases.

The tough credit policy combined with the assumed policy of government purchases does not disturb the picture.. The simulated time series do not differ from observed ones in more than 20%.

But if the policy of government purchases were less tough, namely the real purchases of manufactured goods were not diminished in 1992, up to the end of July 1992 the economy could fall even into **mega-inflation**, not a hyperinflation. The incomes of producers were depreciated during the time of money circulation, and the production would *entirely stop in spite of the money emission*. One can see the picture in Figs A6-A11, Appendix 1

3.3 Variants of Government Economic Policy in April-December 1993

The following results were obtained and reported in summer 1993, but had not yet published. Now one can compare these with the actual development.

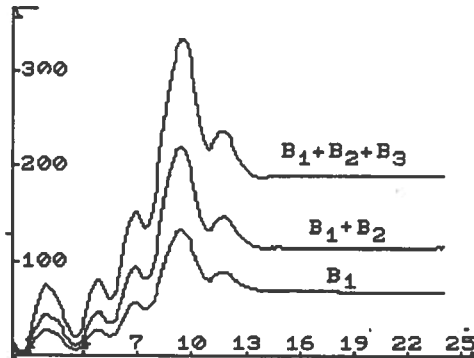
The framework of macroeconomic relations *was enhanced* by the hypotheses on *trends of diminishing in production capacity* (three variants). Thus we obtained three *scenarios*, namely the pessimistic, optimistic and shock ones.

- According to the **pessimistic scenario**, the capacities decrease by 1.5% per month up to the end of 1993. This corresponds to statistical data on Russian economy in January, 1992 - March, 1993
- According to the **optimistic scenario**, the production decrease stops in July 1993
- The **shock scenario** assumes a temporary fall in basic industry's output caused by strikes

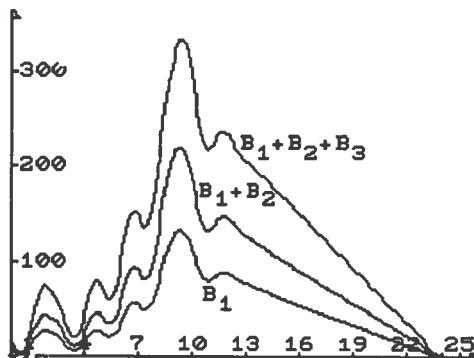
The pessimistic and optimistic scenarios were used as a basis for analysis of consequences at different combinations of preferential loan volumes given by the Central Bank and real government purchases.

Three variants of the *Central Bank credit policy* for March-December 1993 were considered:

moderately tough credit policy



tough credit policy



credit expansion

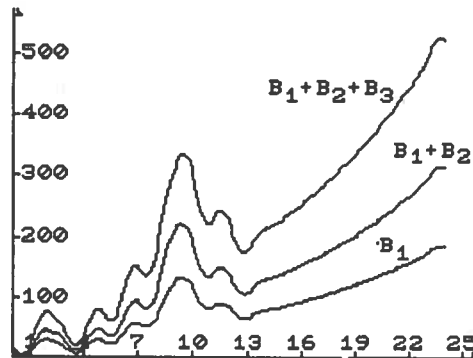


Fig. 3 B_1 , B_2 and B_3 are flows of preferential loans into sectors 1, 2 and 3, respectively, according to the tendency observed up to April 1992.

Two variants of government purchase policy were considered

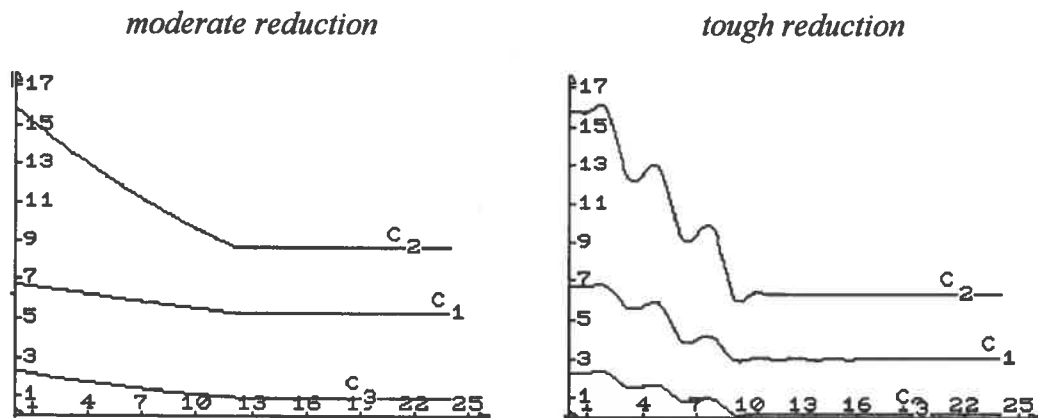


Fig 4. C₁, C₂ and C₃ are government purchases (billions of 1990 rubles) in the sectors 1, 2 and 3, respectively.

The *pessimistic scenario* with a *moderately tight credit policy* and *moderate reduction of government purchases* appears to match the actual economic situation in Russia. This variant is considered as a basis for comparisons. Simulations for this variant are presented in Figs. A1-A5 (Appendix 1). The *moderately tight credit policy* and *moderate reduction of government purchases* were also assumed in the *shock scenario*.

For both the pessimistic and optimistic scenarios we tried various combinations of variants in credit policy and government purchase policy. The results for some of the combinations are presented in Figs. A12-A26 (Appendix 1) and discussed below. The simulations for each policy combination are presented in comparison with the basis variant. Table 1 shows the correspondence between Figures in Appendix 1 and variants of scenarios.

Government purchase	Pessimistic scenario			Optimistic scenario
	Credit policy			Credit policy
	Credit expansion	Tight	Moderately tight	Moderately tight
Moderate			Figs. A22-A26	
	Figs. A12-A16			
Tight			Figs. A17-A21	

3.3.1 Pessimistic scenario: variants of credit policy (Figs. A12-A16)

All the economic indices presented increase when the volumes of preferential loans does so. It is essential to note that the increments of money demand, budget deficit and inflation rates are the largest, the increments of production and real incomes of households are smaller.

3.3.2 Pessimistic scenario: variants of real government purchases (Figs. A17-A21)

One can see that the government policy of real purchases influences the economic indices to a larger extent than the credit policy.

The financial indices differ essentially from the basis ones. The consumer price index attains only 90% at the end of 1993 (recall that the basis level corresponds to December 1991). The inflation rate falls to 15% a month. However the price structure does not differ from the basis one. The prices for manufactured goods grow faster than those for the consumer goods and raw materials. The production levels in the first and second sectors change less than the other. The exchange rate of USD will be 1100--1200 rubles/\$ at the end 1993. The increasing net currency income of exporters and importers attains \$32 billions at the end 1993. The deficit of government budget decreases in 6 times and the money demand does so in 2.5 times with respect to the basis levels.

3.3.3 Optimistic scenario (Figs. A22-A26)

Under these conditions, the basis combination of moderately tight credit policy, moderate diminishing of real government purchases, and moderately tight income policy leads to other consequences.

The consumer price index attains only 130 at the end 1993, the inflation rate falls to 10% at the end 1993. However the price structure will not change, namely the prices for manufactured goods will grow faster. The exchange rate of the USD will be not higher than 1300 rubles/\$ at the end 1993. The net currency incomes of exporters will grow up to \$34 billions at the end 1993. The circulating money demand will not decrease essentially, however the deficit of government budget will decrease in three times with respect to the pessimistic variant. The decrease of real incomes of households will stop on 25 billions of rubles per month in prices of 1990 year (versus 15 billions of rubles in the pessimistic scenario under the basis combination of variants).

3.3.4 Shock reduction in production capacity

Internal perturbing factors, such as strikes also influence the economic situation. Simulations showed the consequences of a hypothetical strike in August 1993. We assume the basis combination of variants in the government macroeconomic policy.

If the workers of basic industries struck in August 1993 (recall that these are represented by the third sector in our analysis) so that the monthly capacity were decreased in 50%, this would have entirely different consequences for the economy, depending on the existing economic situation. Namely, if the economy have a sufficient inventory (not less

than for a month), then the strike in August would lead to 15--20% decrease of production in the first and second sectors in September. But if the economy had inventories less than for a month, it would fall into the hyperinflation, and the production would collapse.

Note. It should be noted again and again that the conclusions and forecasts are as valid as the assumed scenario of economic relations is. From this point of view, one should pay attention on the forecasts of USD exchange rate³. These are based essentially on the assumption that the Central Bank does not make any interventions on the domestic currency market, and the net currency incomes of exporters and importers do not return on this.

3.3.5 Crisis in the Currency Market on Oct 11, 1995

In the middle of September 1994 the USD exchange rate growth accelerated in domestic currency market, and on Tuesday, Oct 11, an exchange rate shock happened. The exchange rate remained high for few days and then fell back to the level before the shock Oct 11. The economy responded by increase in inflation rates. The shock has resulted in short-term qualitative change of the dynamics of the economy and that is why it was very interesting for evaluation of the model's adequacy.

Remember that our model has not been predicting correctly the exchange rate in domestic currency market in 1993 because the scenario assumed that the Central Bank did not make interventions in the currency exchange. In the end of 1993 the economic situation changed noticeably. The Central Bank had accumulated large currency reserves and conducted active policy in the currency exchange. Exporters and importers had been obliged to sell to the Central Bank part of their currency incomes at the current exchange rate. The households' demand for currency had increased. In order to match the new situation, the model was changed.

Firstly, we assumed that households saved some of their income in foreign currency to protect, at least partially, their wealth from inflation. Secondly, exporters sold the Central Bank some share of their currency income at the current market exchange rate. Importers paid import tariffs that was a fixed share of currency value of their gross income. Thirdly, the Central Bank intervened domestic currency market, selling certain share of the currency bought from exporters and importers.

As soon as we introduced these changes we obtained good accordance of modelled and observed time series as can be seen in the Figs. A27-A42.

Certainly, in the beginning of 1994 we could not predict the shock pitfall in October as we did not know anything about government's and the Central Bank's policies. But we predicted that in 1994 the exchange rate would be much higher without large

³ In Russian economic literature it is common to refer to ruble exchange rate as US\$ exchange rate in the domestic currency market. So in this document we will use "high exchange rate of dollar" instead of "low exchange rate of ruble" etc.

interventions of the Central Bank than it actually was, giving an estimate for the inflationary potential.

In November 1994 we made a new forecast of evolution of Russian economy that took into account the Central Bank's policy in the end of September and beginning of October of 1994. The October 11 "Black Tuesday" was modelled by the following policy shock: the Central Bank suddenly changed from selling to buying currency in domestic market and then began selling again. The consequences are shown in Fig. A32-A36 and A37-A41.

One can see in the graphs in Fig. A32-A36 that the model gives an adequate estimate of the economy's response to the policy shock of the Black Tuesday. E.g. in Fig. A34 exchange rate dynamics predicted by the model 1 coincides with the statistics 2. But the model is even more useful: it allows to compare the actual dynamics of the economic indices with the one that could take place if the policy shock did not happen. This helps to understand whose interest the Central Bank pursued (deliberately or not) on Black Tuesday.

Fig. A37-A42 show percentage change of economic indices due to the Black Tuesday (difference between dynamics in Fig. A27-A31 and the ones in Fig. A32-A36 divided by the ones in Fig. A27-A31). The analysis shows that the Black Tuesday was essentially to devalue ruble (Fig. A39) with the moment for such devaluation being selected very efficiently - on the very peak of inflation rate (Fig. A31) when it was easier to generate the speculative demand for dollars.

The devaluation did not have irreversible consequences for the economy but resulted in some shift of resource allocation. The basic industries (the third sector) have gained (both higher output and higher price Figs. A37-A38). The government has gained as well. Although Fig. A37 shows that the budget deficit increases, we also need to take into account significant increase in the Central Bank's profit. Fig. A42 depicts the change in budget deficit if Central Bank shares the profit (net increase in currency reserves) with government. In this case the increase in budget deficit is well made up for, so at the end of the day budget deficit is reduced by 30%.

As for other industries, additional decline in output (Fig. A37) was almost completely compensated by additional price growth (Fig. A38).

As a whole, the households loose - the real incomes fall and inflation rate increases (Fig. A40, A41). Net currency income of exporters do not fall and these are importers who really loose - their income falls (Fig. A39). But one should remember that model does not take into account the very unequal income distribution and therefore overestimates elasticity of consumer demand. Thus the actual CPI growth rate is higher than in the model and the households will actually loose more and importers will loose less.

3.3.6 A Model of Restoration of Savings

In all above we assumed that capital investments are suppressed in modern Russian economy. The initiation of investment process is one of the most important economic problems now in Russia. There are a number of solutions to this problem proposed by economists. As the problem of initiation of investment is very much interrelated with

other challenges in the economy, the system analysis of evolving economy should be applied for evaluation of these proposals.

One of the proposals is Prof. Bernstam's idea of restoration of savings destroyed by price liberalization in January, 1992 and making the restored savings main source of investment. A mathematical model has been built for study of consequences of restoration of savings [15]. Prof. Bernstam suggested that the destroyed savings should be converted into long-term government bonds that will be used for encouraging investors. In the mathematical model the idea is further developed and a closed system of economic relations between households, firms, commercial banks and government is constructed. Fig. A43 shows the financial circulation after restoration of savings.. The commercial banks are divided into savings and investment banks. Savings banks borrow money from households and lend to investment banks which then buy bonds from households that originally own the bonds. Then investment banks select investment projects proposed by firms and sell the bonds to government against the selected projects. The money received from government for the bonds must be spent only for investment loans to firms. The investment loans received by firms should be spent on the investment projects selected.

The model has proved that such pattern of restoration of savings may encourage investment and real economic growth and lower inflation if potential productivity in the economy is high enough and financial intermediaries are efficient. The idea is to provide restored savings to investors so that the increased money supply will be compensated by growth in real output so inflation will not increase. The low inflation is very important as money is not neutral in the model (the transaction costs are taken into account), so that higher inflation would destroy growth (see Fig. A44-A45).

This gives a condition on parameters of the economy that must hold for successful implementation of restoration of saving. These are two groups of parameters: the first one includes input-output coefficients, duration of production cycle etc. that determine the amount of financial resources which is required for the take-off of production. The other group includes parameters of efficiency of financial intermediation that determine how much of the households' savings become investments and how large the difference between interest rates on households' savings and loans to firms is. The model allows to calculate the resulting growth and inflation rates in the economy under given government policy (i.e. fiscal policy, speed of restoration of savings, whether to make the bonds interest-bearing or zero-coupon etc.). If this condition holds then the restoration will generate saving and investment without higher inflation and therefore promote growth of output and income which will give a positive feedback to saving and investment process.

Unfortunately, the calculations have shown that Russian economy does not satisfy the condition for launching long-term growth; using the restored saving for financing slow growth will lead to high inflation and therefore to even lower growth rate. However, the restored savings may also be used for investments in inventories and launching short-term growth up to volume of output at which existing production capacities are fully employed while there is no investment into new production. In this case, if financial intermediation were efficient, the restoration of savings would give rise to rapid economic growth with the inflation rate being even lower than before restoration of savings. Such fast recovery growth could not last for long but this would give rise to

increase in output and therefore national income which will allow to increase savings and open the way for longer-term investment projects. Unfortunately again, financial intermediaries in modern Russia are not efficient enough to satisfy the condition.

The influence of government policy on the growth rate and inflation rate is examined. Government can sacrifice growth for inflation and vice versa with the slope of trade-off depending upon parameters of efficiency of financial intermediation (Fig. A44-A45). As mentioned above under given inefficient economic structures the government's ability to influence the development of the economy is limited.

The conclusion is that there are no contradictions in Prof. Bernstam's proposal, and this pattern of restoration of savings could work well in an economy with a high potential of growth. As for Russian economy, this potential is not sufficient, so it makes sense to decrease input-output coefficients (e.g. by introduction of resource-saving technologies) and to improve financial intermediation first and only then restore savings according to this proposal.

3.3.7 Concluding remarks

- The main conclusion is that the macroeconomic policy of the government has rather restricted possibilities. The policy itself can only support the stability of existing economic structures or destroy this. Evolution of an unstable system cannot be predicted accurately. The mechanisms of self-organization are involved in this case; these reveal in millions of stochastic events and cannot be predicted. Therefore the macroeconomic policy should be added by a policy stimulating desired structure shifts in the economy
- The closest attention should be paid to the comprehensive character of government macroeconomic policy. It was said above that the variants of credit policy and policy of government purchases safe by themselves can be economically dangerous in some combinations
- The main problem is that the existing economic structures are not efficient. First of all, this reveals in taking out of the country the net currency incomes of exporters and importers. The main problem of transitional period is to restructure the economy. Substantial investment resources are necessary for this. Various schemes of industrialization and change of technological structure are known from the economic history. The internal sources form always at the sacrifice of population. The export of natural resources and resources accumulated during years of inefficient consumption of these could be a logical source of investment resources. The export of currency super incomes would exhaust essentially this source, and the sacrifices of population were not only in vain, but also economically dangerous
- The inefficiency of existing structures is characterized by the structure of domestic prices. Under all combinations of variants of the macroeconomic policy, the prices for manufactured goods grow faster than those of consumer goods or products of basis industries. Since, in general, our machinery cannot be competitive on the external market, the market for this production reduces and difficulties in product realization remain

4. Directions of Further Research

The results presented above seem to be promising. The model describes principal phenomena observed in the modern Russian economy. It can point out some boundaries of existing economic structure stability. It gives reasonable figures for the main economic indices. That is why we believe that our approach can form an appropriate language to discuss the prospects of Russian economic reform.

We are interested in a broader discussion of our results, assumptions and methodology and we are ready to present, explain and clarify them in any form for any audience. We hope that such a discussion will give a better understanding of Russian economic life and at the same time will open ways to further development of our method. From our point of view we see the following interrelated direction of researches:

- model investigation
- model development
- model extension
- model modifications

4.1 The tasks of model investigation

We are not able to observe the same economy under another economic policy. So we can't verify the model evaluation of different policies empirically. The only way to ascertain model reliability, to learn its strengths and weaknesses is to investigate thoroughly its internal properties. It is to find all possible modes of the model behavior, to distinguish typical ones, to search the way they depend on the model parameters and so on. Note that such investigation often allows us to simplify the model. The work has already begun and a new type of general economic equilibrium was found and examined, [16].

We have sufficient experience in mathematics and dispose a special technique for computer experiments with models, [17]. To complete investigations of the existing model and to be able to repeat them for further model versions, we need additional equipment and financial support for still scientific work for some time. Some additional statistical information should be probably paid for.

4.2 The tasks of model development

The development of the model consists in variations of model descriptions in the framework of principal scheme presented above. At least, it is necessary

- to revise the description of arrears
- to learn the function of inventories in trade and production in the modern Russian economy
- to take into account income differentiation between households

- to clarify the question of fixed costs of production

The latter question can be crucial since some data show that productivity falls with the reduction of output. This dangerous tendency may be caused by large fixed costs of production

In order to solve this group of problems in addition to regular research work we require some consultations with specialists. We have good contacts with our colleagues in research economic institutes and some federal analytical centers.

4.3 The problems of model extension

So far certain obviously important processes remain beyond the model descriptions. Some of these process seemed negligible a year ago when the model was developed, but became important now. Others were simply not included because of the lack of information. The problem is to take into account these processes..

Now we think of the following processes.

Private domestic wholesale trade. Half a year ago the wholesale trade concentrated mainly on imported goods and raw materials for export. Now it involves almost all commodities. Statistics on the wholesale trade is very poor, but this trade is known as abnormally profitable.

Real estate market. This did not exist legally half a year ago. Now it is highly developed. Realty seems to be the main object of internal private investments.

Stock market. This makes large noise during the last half a year. Its real role in the modern Russian economy is not clear.

Economic interactions within the former Soviet Union. This subject is important from the very beginning of the reforms. The reliable general information on this question is absent completely. Nobody seems to be able to outline the whole picture of relations between the former Soviet republics.

The list of problems to be considered may be specified during the discussions of modeling results and assumptions. In any case, to couple the question above we need broader contacts with experts and new sources of information especially on the modern private business activity.

A scientific question arises also. Our experience teaches that the formal expansion of the model is fruitless. A better way is to build a system of interconnected models. We have been developing methods and means to work with such a systems. These investigations require extension of our research group and need a special support.

4.4 The model modifications

In the model above we have taken some negative features of the modern Russian economic reality as given (absence of productive capital investments, permanent arrears etc.). When we discuss further reforms we should go beyond these assumptions. Some steps can be undertaken within the existing model, but a regular work with various reform scenarios requires that the model is modified. Now we plan to include the following issues in the scope of modeling

Capital investment problems. The long-term development of the economy requires capital investments, which are completely suppressed now. First of all it is necessary to know the causes of the compression. We hope that the modified model can help us to solve the following questions:

- does the privatization adsorb profits thus preventing the real investments?
- do real investments flow into banking and trade thus leading to undesirable structural changes in the economy?

Various projects are aimed at the investments regeneration. We have examined such a project in [15]. We also propose to examine the effectiveness of the following ones:

- direct budget financing of investment projects
- consumer loans with mortgage

Structural sources of inflation. It is quite evident that the inflation in Russia is not of pure monetary nature. We propose to examine the lack of resources as a possible cause of inflation by means of the model. Particularly, we intend to study the threat of energy crisis.

Arrears. Arrears may be considered as a sort of money. There are projects to convert arrears into IOUs. It seems very important and interesting to investigate the possibility and consequences of such a reform with the model. It is necessary to estimate social stability limits associated with delayed payments of wage.

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Appendix 1. Macroindices of Russian Economy in 1992-1993: Results of Computer Simulation.

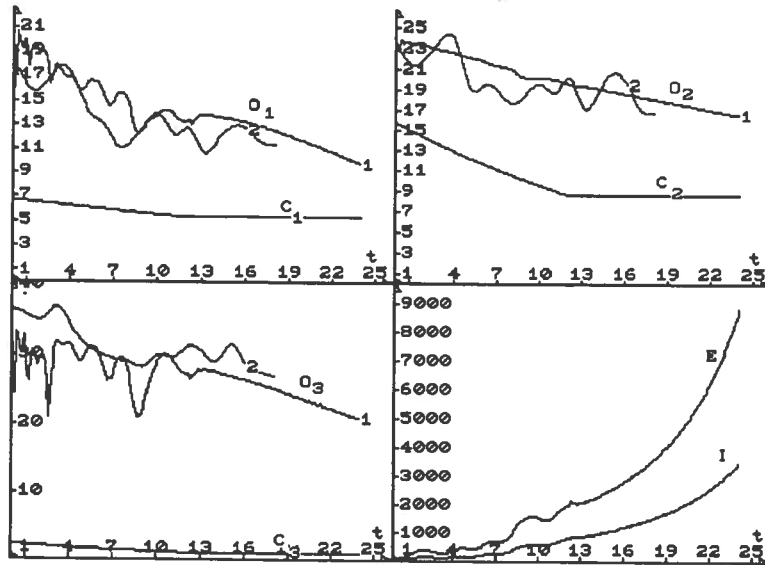


Fig. A1. Basis variant of scenario. Comparison of the simulation results with statistical data.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The simulation results (curves 1), the statistical data (curves 2).

O_1 , O_2 and O_3 [bil.rub. (1990) per month] are the outputs of the sectors 1, 2 and 3, respectively.

C_1 , C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month]

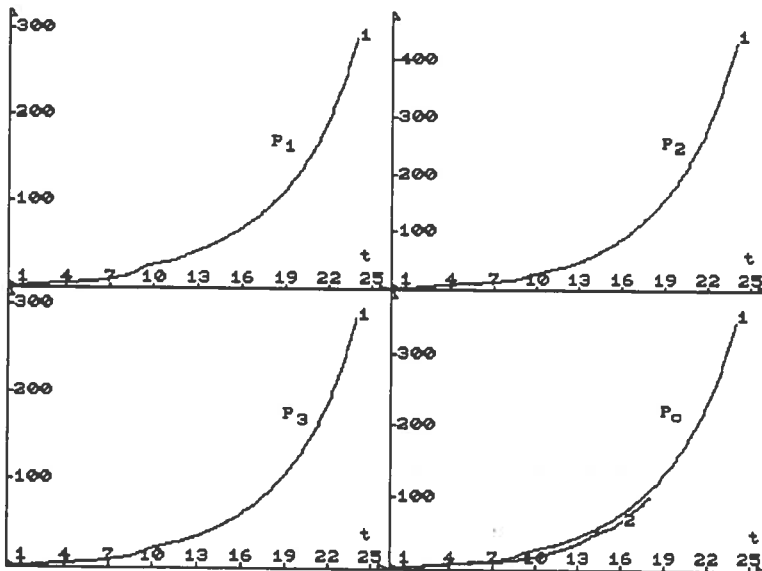


Fig. A2. Basis variant of scenario. Comparison of the simulation results with statistical data.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The model simulation (curves 1), the statistical data (curves 2).

P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index ($P_1=1$, $P_2=1$, $P_3=1$, $P_C=1$ in December 1991).

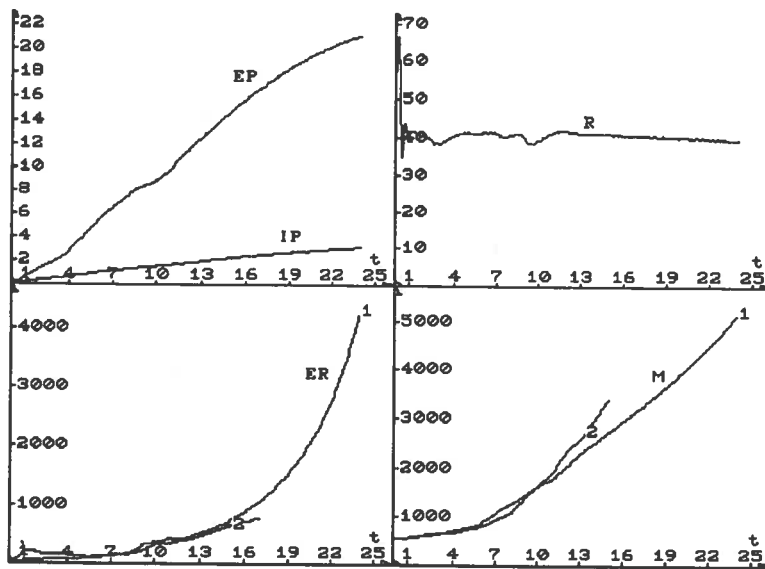


Fig. A3. Basis variant of scenario. Comparison of the simulation results with statistical data.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.
 The model simulation (curves 1), the statistical data (curves 2).
 EP is net income of exporters [\$ billions]; IP is net income of importers[\$ billions].
 IR is the interest rate for commercial loans [% per month].
 ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

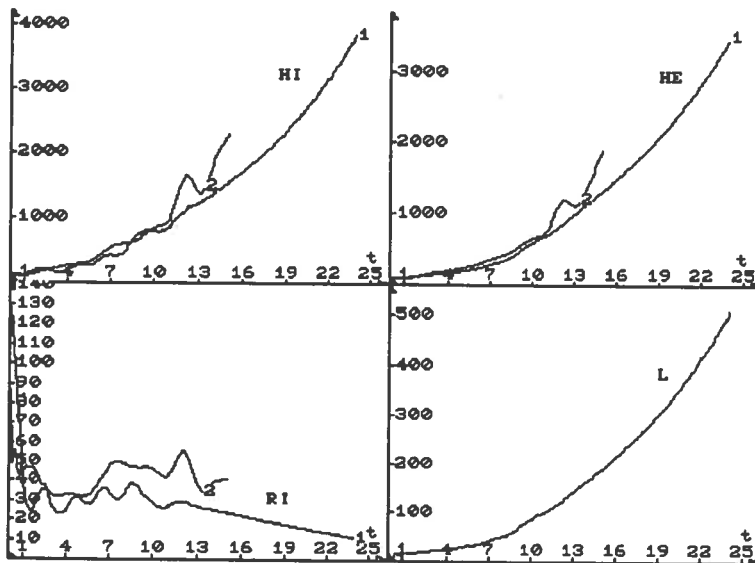


Fig. A4. Basis variant of scenario. Comparison of the simulation results with statistical data.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.
 The model simulation (curves 1), the statistical data (curves 2).
 HI are household incomes [bil.rub. per month];
 HE are household consumption expenditures [bil.rub. per month];
 RI are real household incomes [bil.rub. of December 1991 per month];
 L is the flow of commercial loans [bil.rub. per month].

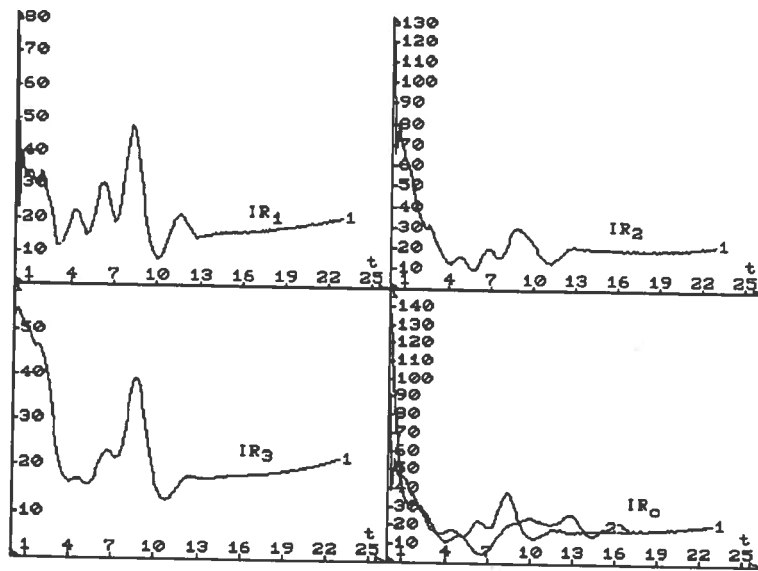


Fig. A5. Basis variant of scenario. Comparison of the simulation results with statistical data.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The model simulation (curves 1), the statistical data (curves 2).

IR_1, IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively [% per month]; IR_c is the growth rate of consumer prices [% per month].

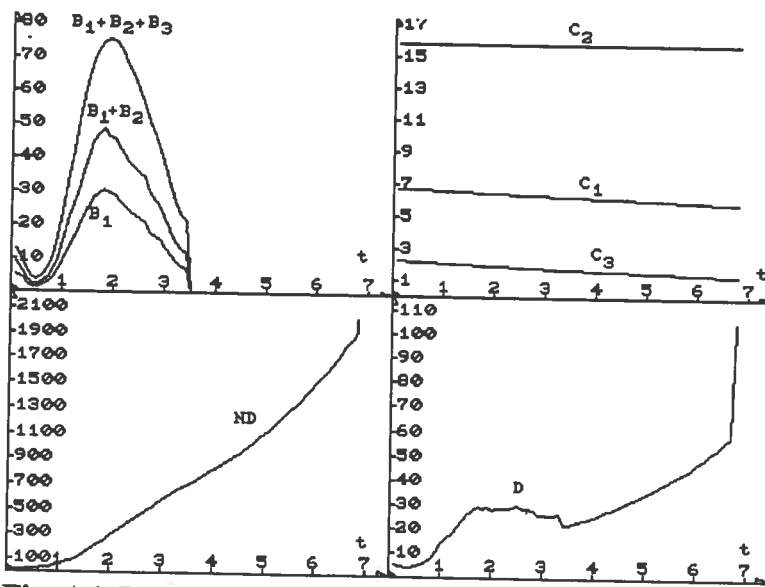


Fig. A6. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

B_1, B_2 and B_3 [bil.rub. (1990) per month] are the preferential loans to the sectors 1, 2 and 3, respectively.

C_1, C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

ND is internal national debt [bil.rub.].

D is budget deficit [bil.rub. per month]

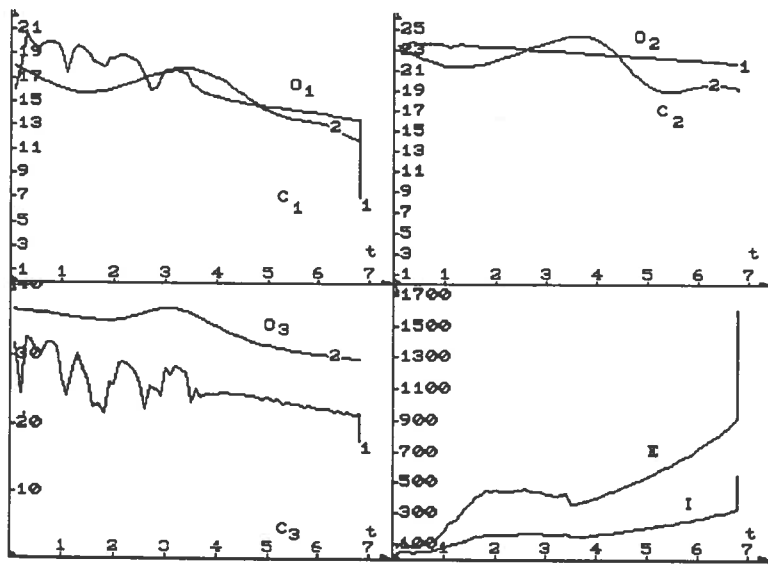


Fig. A7. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

O_1 , O_2 and O_3 [bil.rub. (1990) per month] are the outputs of the sectors 1, 2 and 3, respectively.

C_1 , C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month]

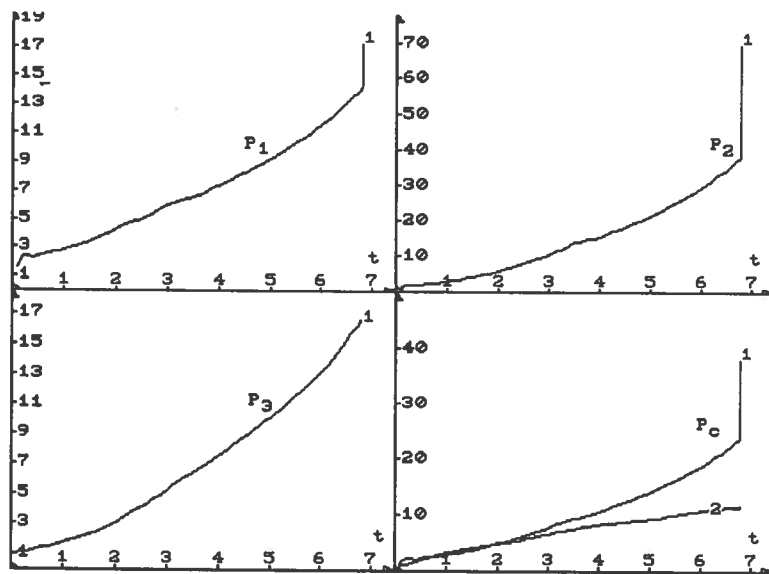


Fig. A8. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index ($P_1=1$, $P_2=1$, $P_3=1$, $P_C=1$ in December 1991).

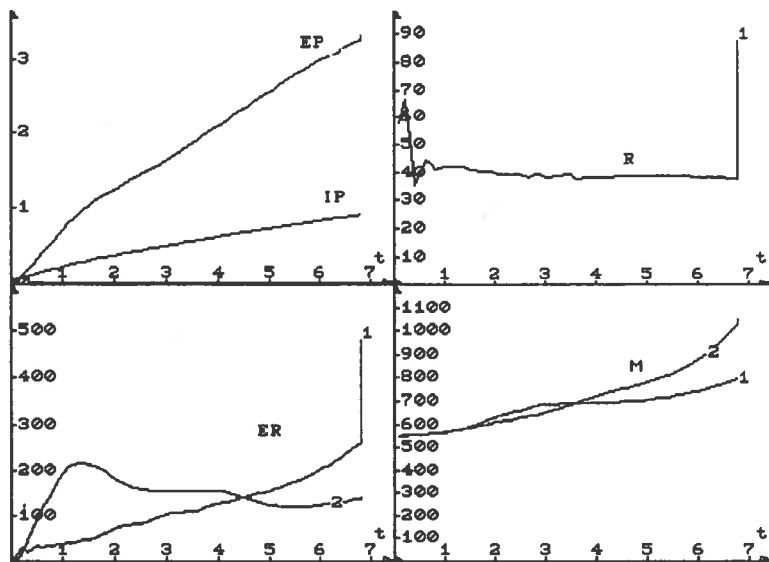


Fig. A9. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

EP is net income of exporters [\$ billions]; IP is net income of importers[\$ billions].

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

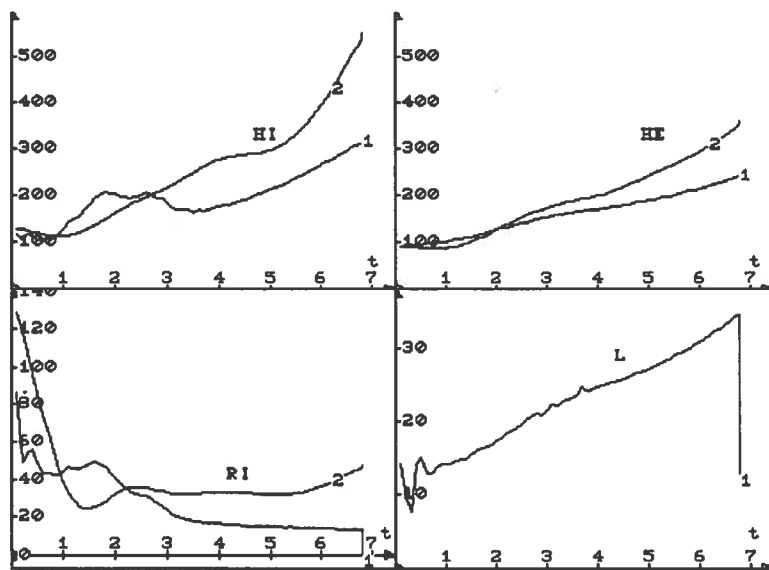


Fig. A10. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The model simulation (curves 1), the statistical data (curves 2).

HI are household incomes [bil.rub. per month];

HE are household consumption expenditures [bil.rub. per month];

RI are real household incomes [bil.rub. of December 1991 per month];

L is the flow of commercial loans [bil.rub. per month].

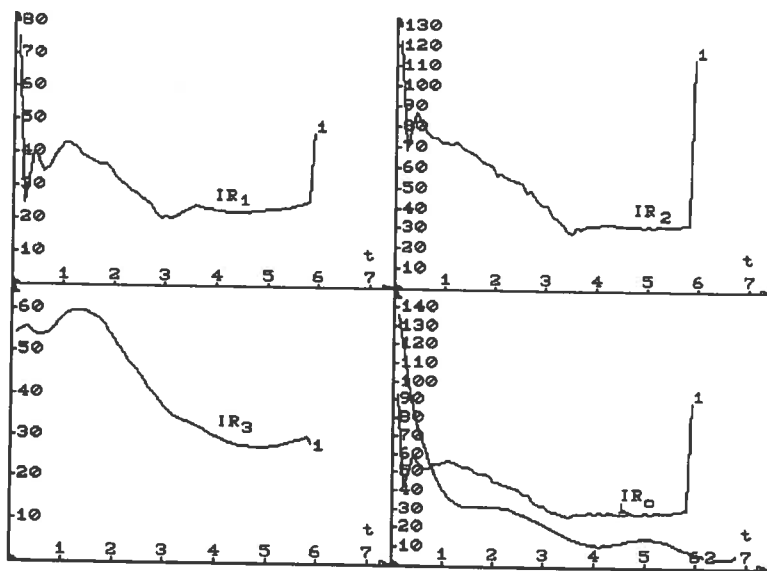


Fig. A11. Dangerous combination of tight credit policy and moderate reduction of government real purchases.

IR₁, IR₂ and IR₃ are the growth rates of prices in the sectors 1, 2 and 3, respectively [% per month]; Horizontal axis shows time in months; 1 corresponds to January 31, 1992. IR_c is the growth rate of consumer prices [% per month].

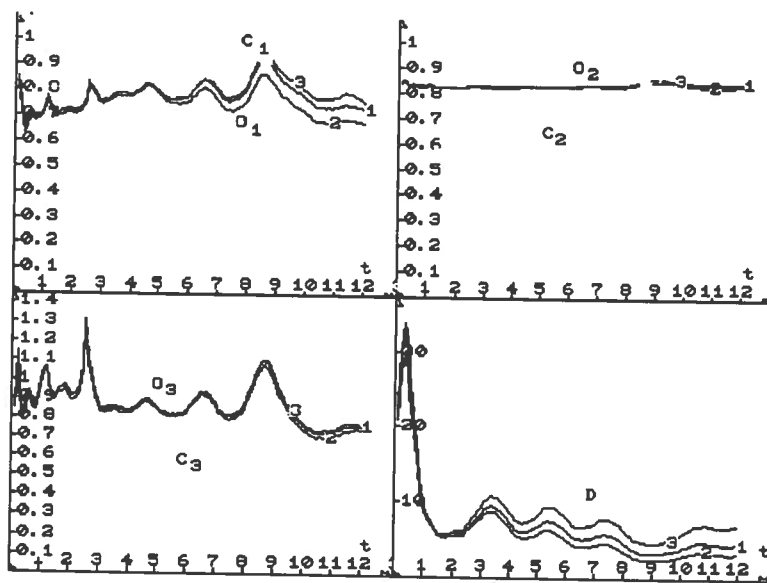


Fig. A12. Comparison of three variants of the credit policy in 1993 with respect to the corresponding month of 1992 (curves 1, 2 and 3, respectively).

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

O₁, O₂ and O₃ are the outputs of the sectors 1, 2 and 3, respectively.

C₁, C₂ and C₃ are the government real purchases of products of the sectors 1, 2 and 3, respectively.

D is budget deficit.

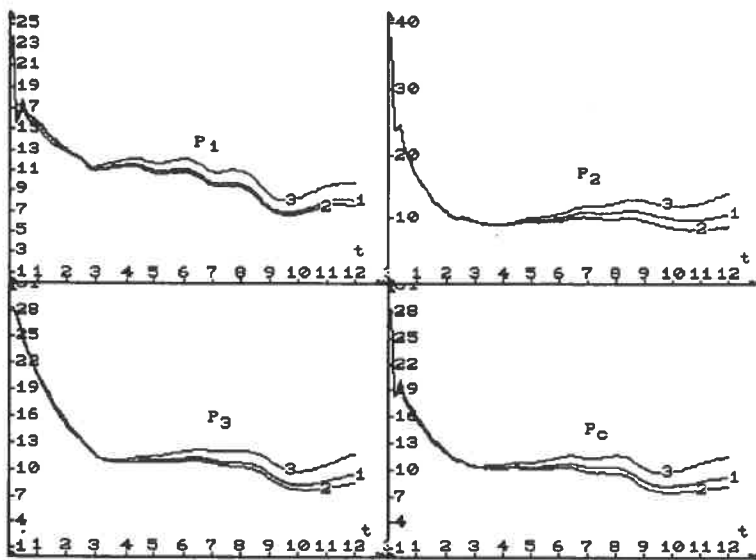


Fig. A13. Comparison of three variants of the credit policy in 1993 with respect to the corresponding month of 1992 (curves 1, 2 and 3, respectively).

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_c is consumer price index.

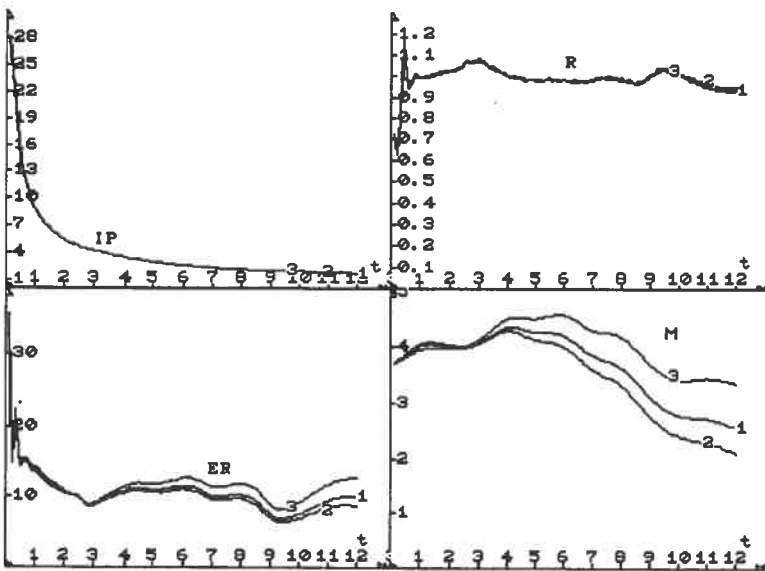


Fig. A14. Comparison of three variants of the credit policy in 1993 with respect to the corresponding month of 1992 (curves 1, 2 and 3, respectively).

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

IP is net relative income of importers.

IR is the relative interest rate for commercial loans.

ER is relative exchange rate. M is relative money demand.

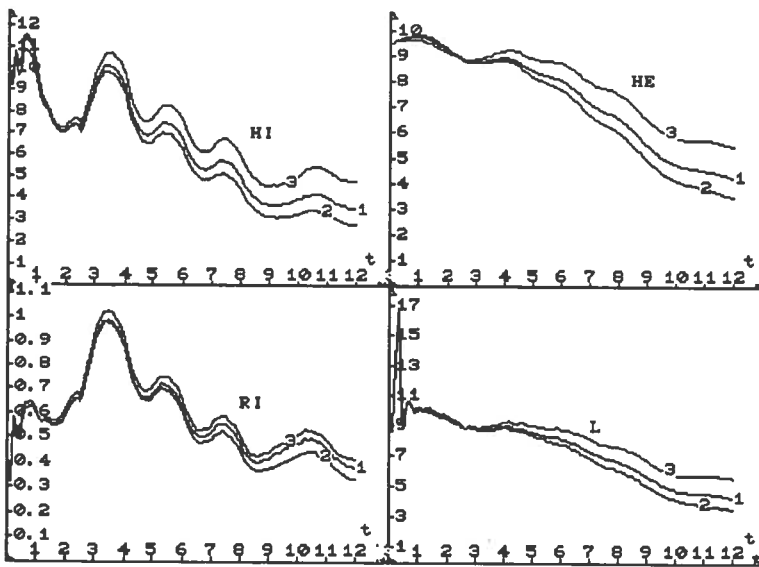


Fig. A15. Comparison of three variants of the credit policy in 1993 with respect to the corresponding month of 1992 (curves 1, 2 and 3, respectively).

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

HI are relative household incomes;

HE are relative household consumption expenditures;

RI are relative real household incomes;

L is the relative flow of commercial loans.

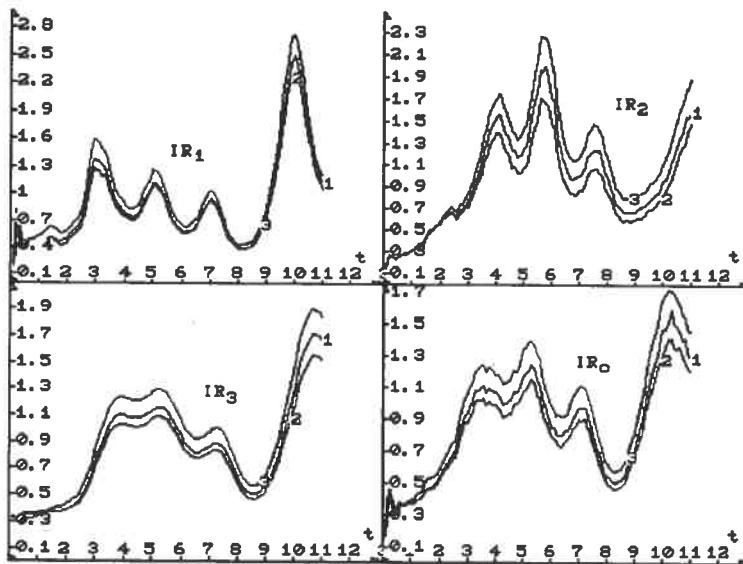


Fig. A16. Comparison of three variants of the credit policy in 1993 with respect to the corresponding month of 1992 (curves 1, 2 and 3, respectively).

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

IR_1 , IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively;

IR_c is the growth rate of consumer prices.

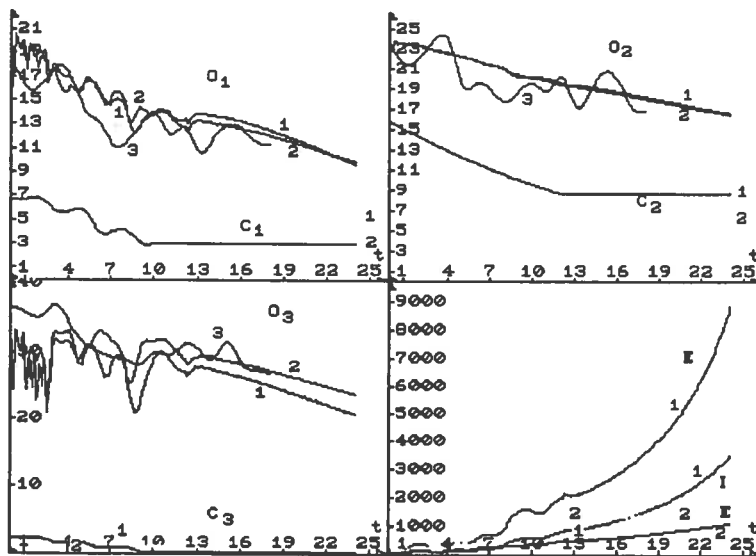


Fig. A17. Comparison of two variants of government real purchases policy in 1993.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The basis variant (curves 1) is compared with the variant of tough reduction of the government real purchases (curves 2), and with the statistical data (curves 3).

O1, O2 and O3 [bil.rub. (1990) per month] are the outputs of the sectors 1, 2 and 3, respectively.

C1, C2 and C3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month].

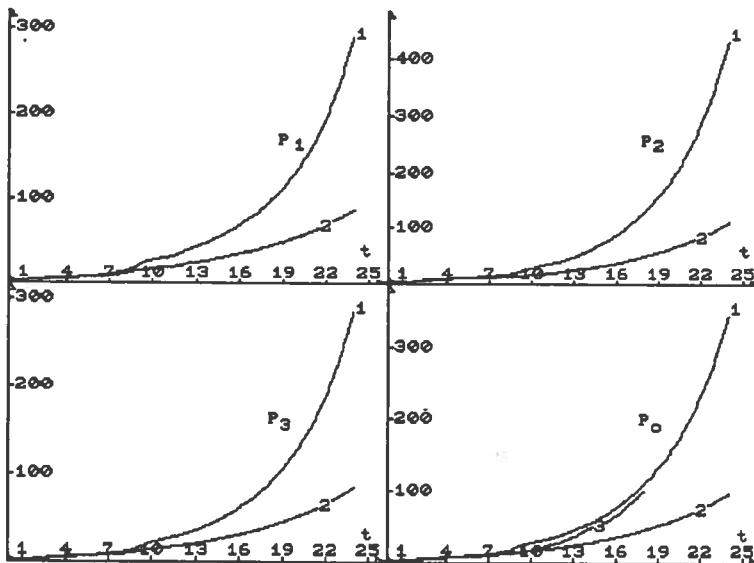


Fig. A18. Comparison of two variants of government real purchases policy in 1993.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1) is compared with the variant of tough reduction of the government real purchases (curves 2), and with the statistical data (curves 3).

P1, P2 and P3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index (P₁=1, P₂=1, P₃=1, P_C=1 in December 1991).

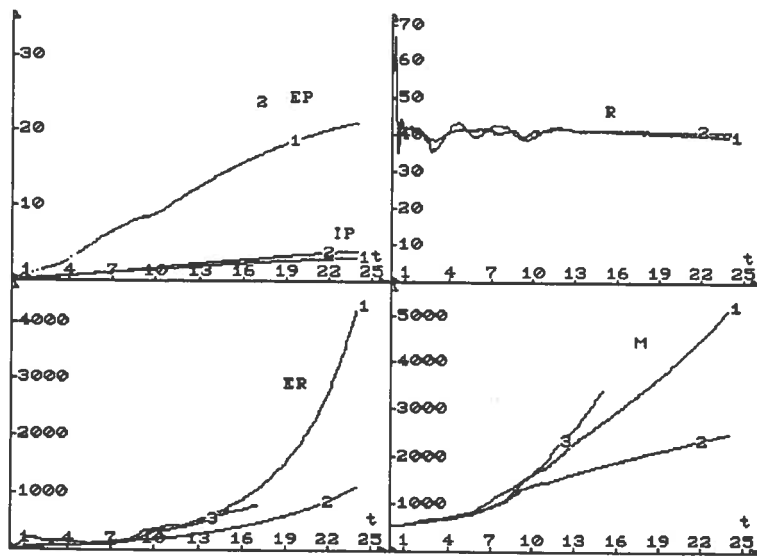


Fig. A19. Comparison of two variants of government real purchases policy in 1993.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1) is compared with the variant of tough reduction of the government real purchases (curves 2), and with the statistical data (curves 3).

EP is net income of exporters [\$ billions]; IP is net income of importers[\$ billions].

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

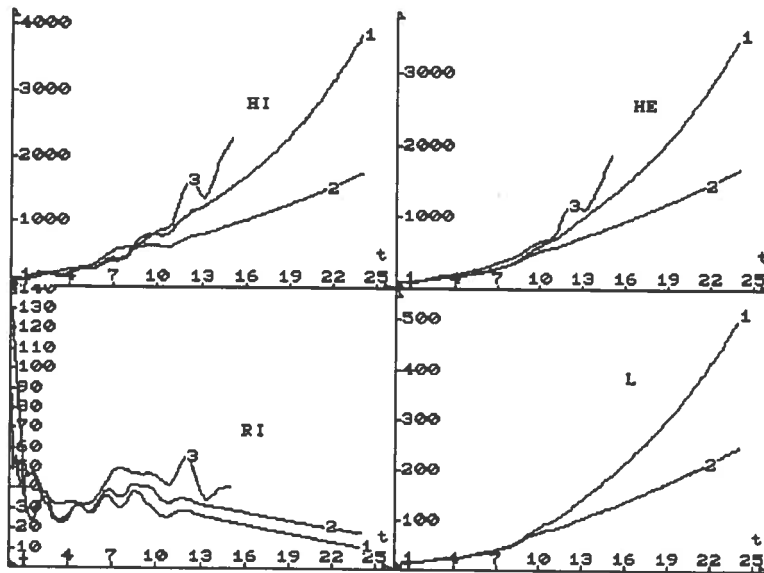


Fig. A20. Comparison of two variants of government real purchases policy in 1993.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1) is compared with the variant of tough reduction of the government real purchases (curves 2), and with the statistical data (curves 3).

HI are household incomes [bil.rub. per month];

HE are household consumption expenditures [bil.rub. per month];

RI are real household incomes [bil.rub. Dec 1991 per month];

L is the flow of commercial loans [bil.rub. per month].

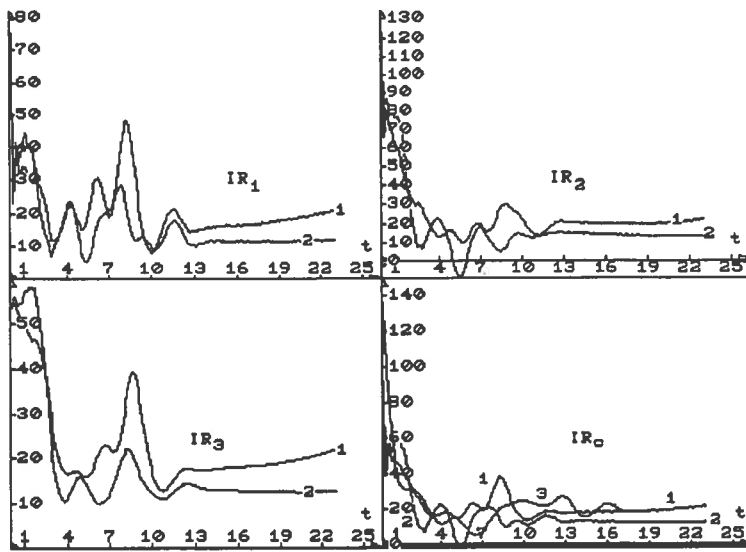


Fig. A21. Comparison of two variants of government real purchases policy in 1993.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1) is compared with the variant of tough reduction of the government real purchases (curves 2), and with the statistical data (curves 3).

IR_1 , IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively [% per month]; IR_C is the growth rate of consumer prices [% per month].

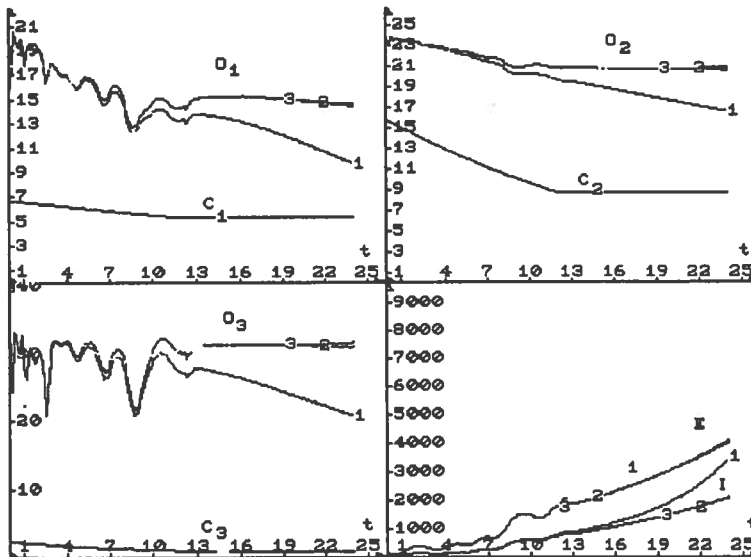


Fig. A22. Comparison of the pessimistic scenario with two similar variants of the optimistic scenario.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1), two variants of optimistic scenario (curves 2,3), the statistical data (curves 4).

O_1 , O_2 and O_3 [bil.rub. (1990) per month] are the outputs of the sectors 1, 2 and 3, respectively.

C_1 , C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month].

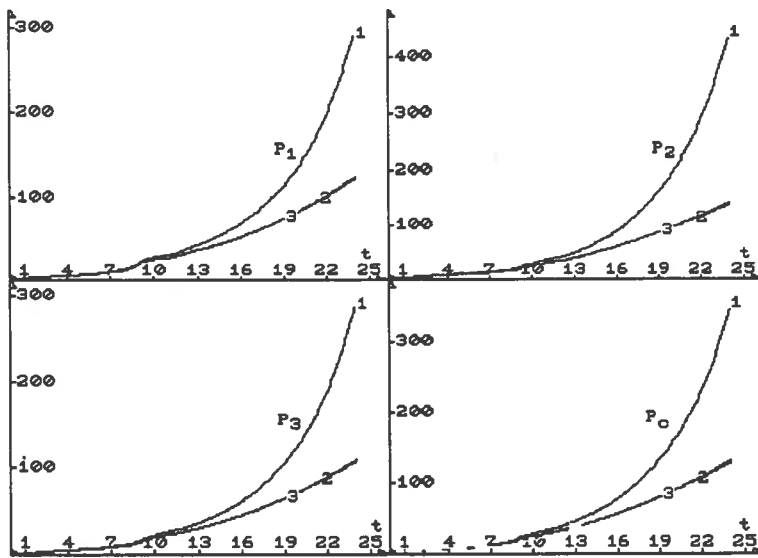


Fig. A23. Comparison of the pessimistic scenario with two similar variants of the optimistic scenario.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992.

The basis variant (curves 1), two variants of optimistic scenario (curves 2,3), the statistical data (curves 4).

P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index ($P_1=1$, $P_2=1$, $P_3=1$, $P_C=1$ in December 1991).

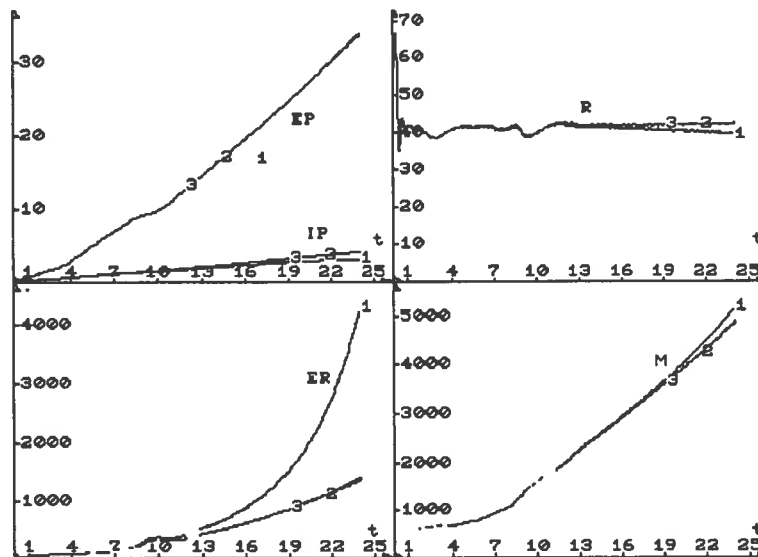


Fig. A24. Comparison of the pessimistic scenario with two similar variants of the optimistic scenario.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1), two variants of optimistic scenario (curves 2,3), the statistical data (curves 4).

EP is net income of exporters [\$ billions]; IP is net income of importers[\$ billions].

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

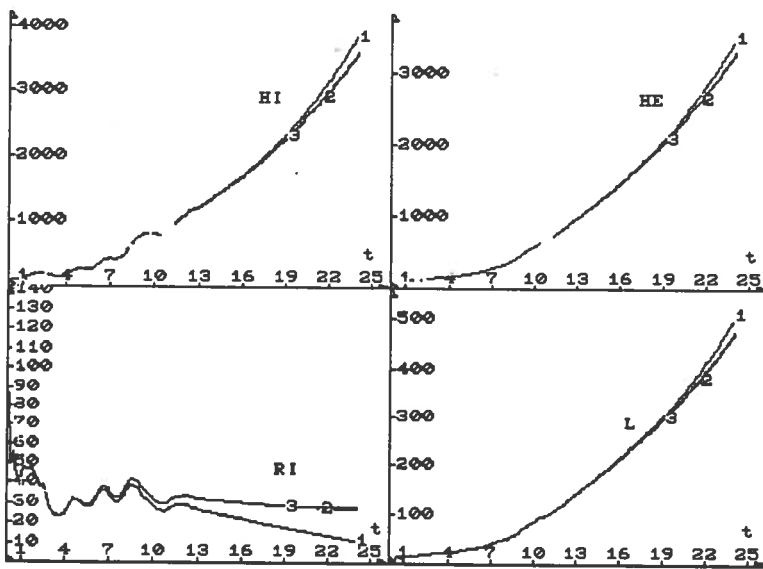


Fig. A25. Comparison of the pessimistic scenario with two similar variants of the optimistic scenario.

Horizontal axis shows time in months; 1 corresponds to January 31, 1992..

The basis variant (curves 1), two variants of optimistic scenario (curves 2,3), the statistical data (curves 4).

HI are household incomes [bil.rub. per month];

HE are household consumption expenditures [bil.rub. per month];

RI are real household incomes [bil.rub. Dec 1991 per month];

L is the flow of commercial loans [bil.rub. per month].

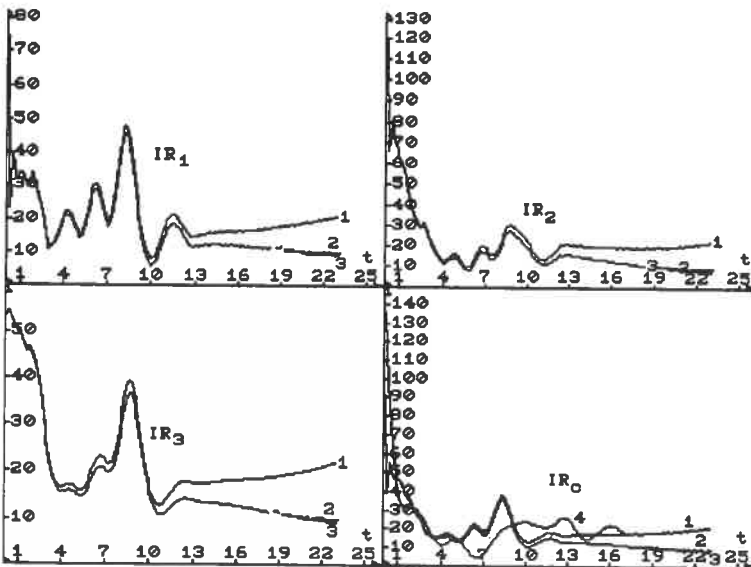


Fig. A26. Comparison of the pessimistic scenario with two similar variants of the optimistic scenario

Horizontal axis shows time in months; 1 corresponds to January 31, 1992...

The basis variant (curves 1), two variants of optimistic scenario (curves 2,3), the statistical data (curves 4).

IR_1 , IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively

IR_c is the growth rate of consumer prices.

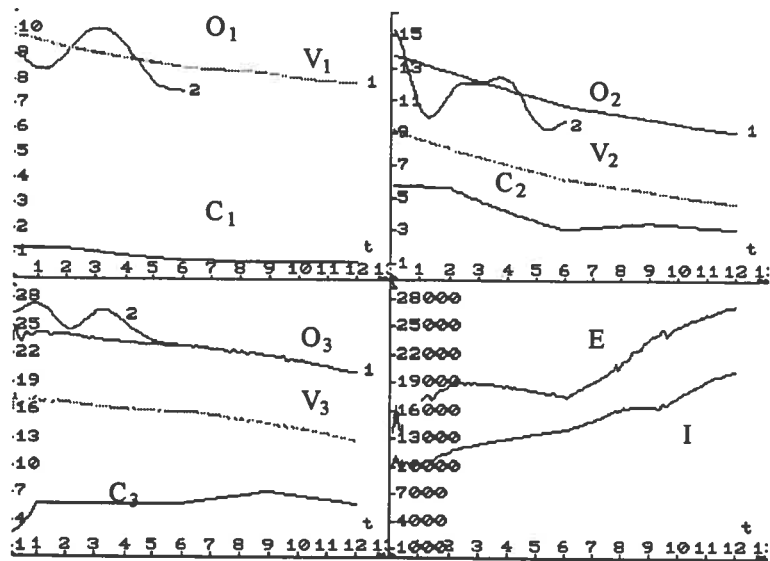


Fig. A27. Influence of the Central Bank's policy on the evolution of the economy. The scenario without policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The simulation results (curves 1), the statistical data (curves 2).

O_1 , O_2 and O_3 [bil.rub. (1990) per month] are outputs of the sectors 1, 2 and 3, respectively.

V_1 , V_2 and V_3 [bil.rub. (1990) per month] are the values added by the sectors 1, 2 and 3, respectively.

C_1 , C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month]

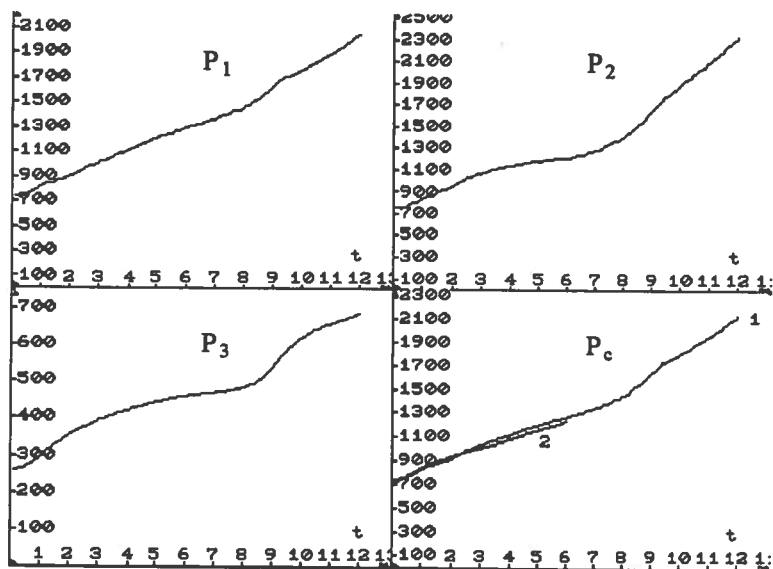


Fig. A28. Influence of the Central Bank's policy on the evolution of the economy. The scenario without policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_c is consumer price index ($P_1=1$, $P_2=1$, $P_3=1$, $P_c=1$ in December 1991).

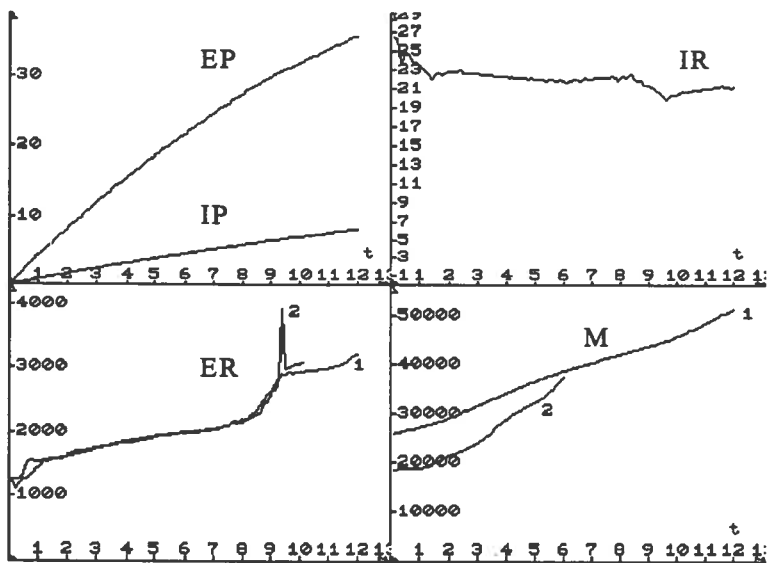


Fig. A29. Influence of the Central Bank's policy on the evolution of the economy. The scenario without policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

EP is net income of exporters [\$ billions]; IP is net income of importers [\$ billions].

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

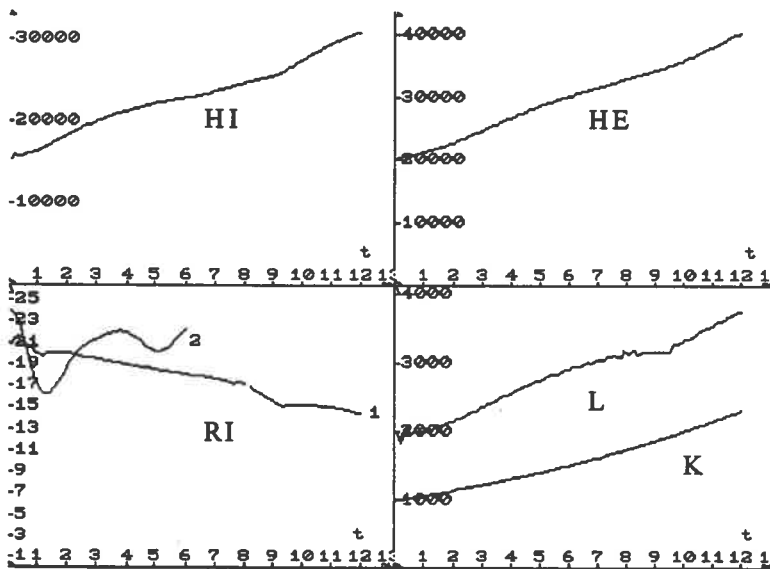


Fig. A30. Influence of the Central Bank's policy on the evolution of the economy. The scenario without policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

HI are household incomes [bil.rub. per month];

HE are household consumption expenditures [bil.rub. per month];

RI are real household incomes [bil.rub. of December 1991 per month];

L is the flow of commercial loans [bil.rub. per month],

K is the flow of Central Bank's loans [bil.rub. per month] (the credit policy).

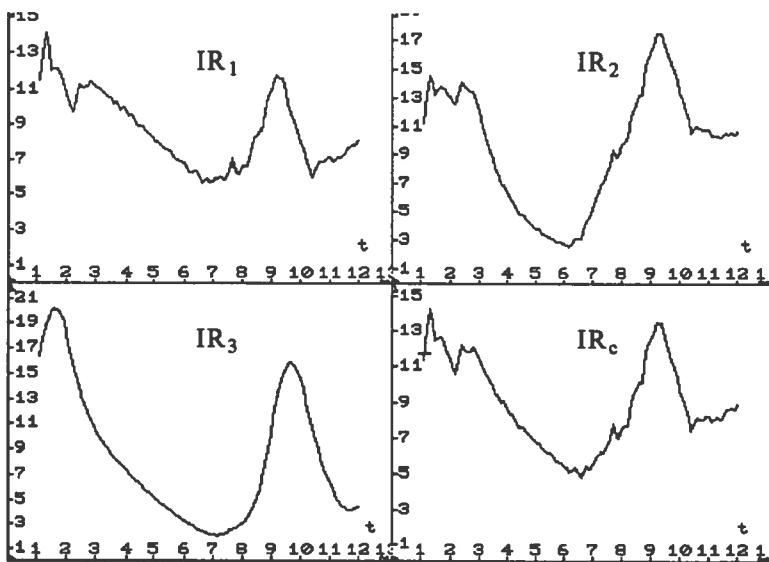


Fig. A31. Influence of the Central Bank's policy on the evolution of the economy. The scenario without policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

IR_1, IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively [% per month]; IR_c is the growth rate of consumer prices [% per month].

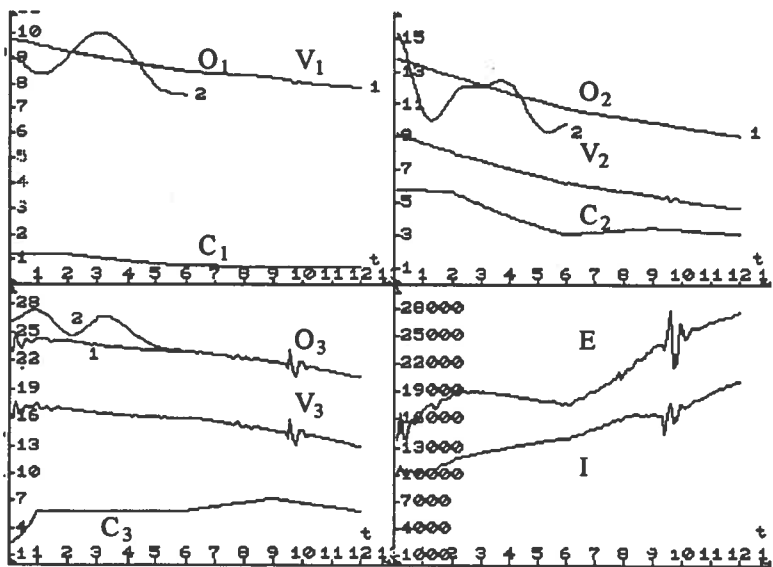


Fig. A32. Influence of the Central Bank's policy on the evolution of the economy. The scenario with policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The simulation results (curves 1), the statistical data (curves 2).

O_1, O_2 and O_3 [bil.rub. (1990) per month] are outputs of the sectors 1, 2 and 3, respectively.

V_1, V_2 and V_3 [bil.rub. (1990) per month] are the values added by the sectors 1, 2 and 3, respectively.

C_1, C_2 and C_3 [bil.rub. (1990) per month] are the government real purchases of products of the sectors 1, 2 and 3, respectively.

I is budget incomes [bil.rub. per month]. E is budget expenditures [bil.rub. per month]

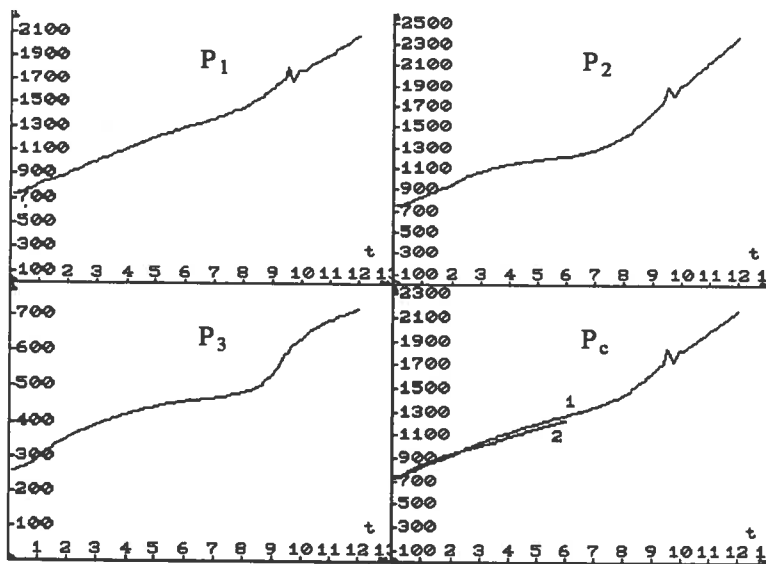


Fig. A33. Influence of the Central Bank's policy on the evolution of the economy. The scenario with policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

P_1, P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index ($P_1=1, P_2=1, P_3=1, P_C=1$ in December 1991).

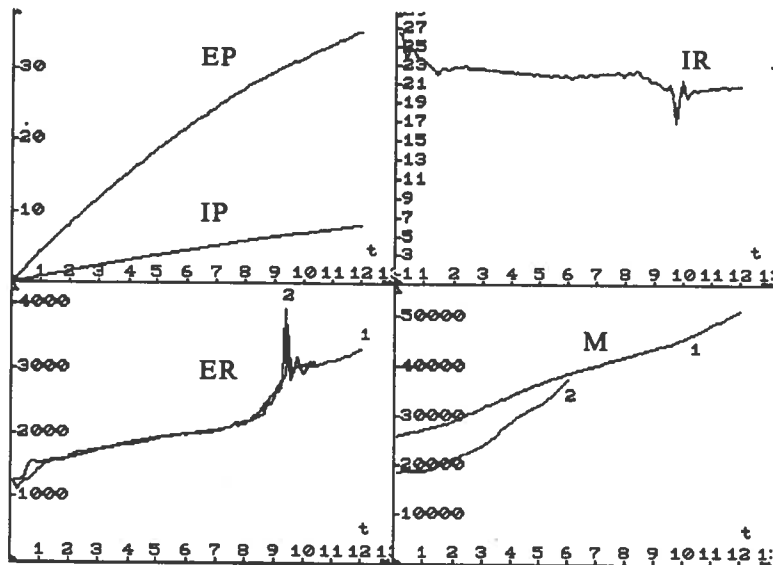


Fig. A34. Influence of the Central Bank's policy on the evolution of the economy. The scenario with policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

EP is net income of exporters [\$ billions]; IP is net income of importers[\$ billions].

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand [bil.rub.].

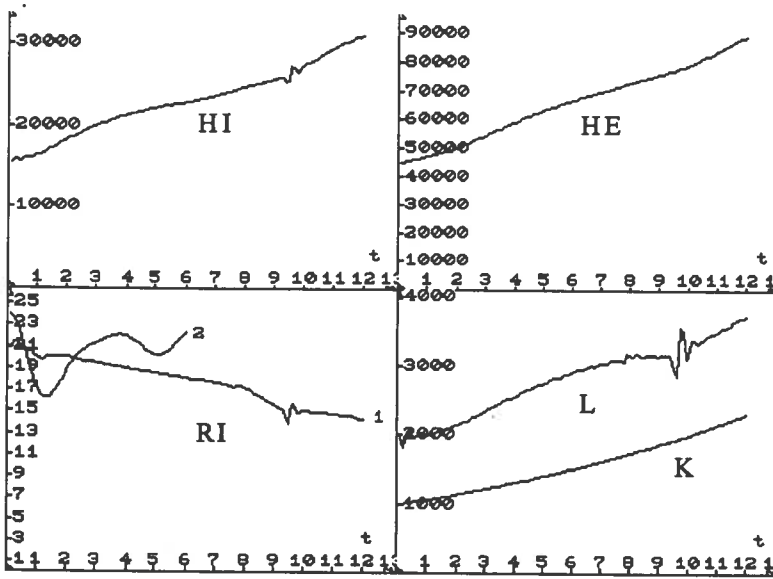


Fig. A35. Influence of the Central Bank's policy on the evolution of the economy. The scenario with policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

HI are household incomes [bil.rub. per month];

HE are household consumption expenditures [bil.rub. per month];

RI are real household incomes [bil.rub. of December 1991 per month];

L is the flow of commercial loans [bil.rub. per month],

K is the flow of Central Bank's loans [bil.rub. per month] (the credit policy).

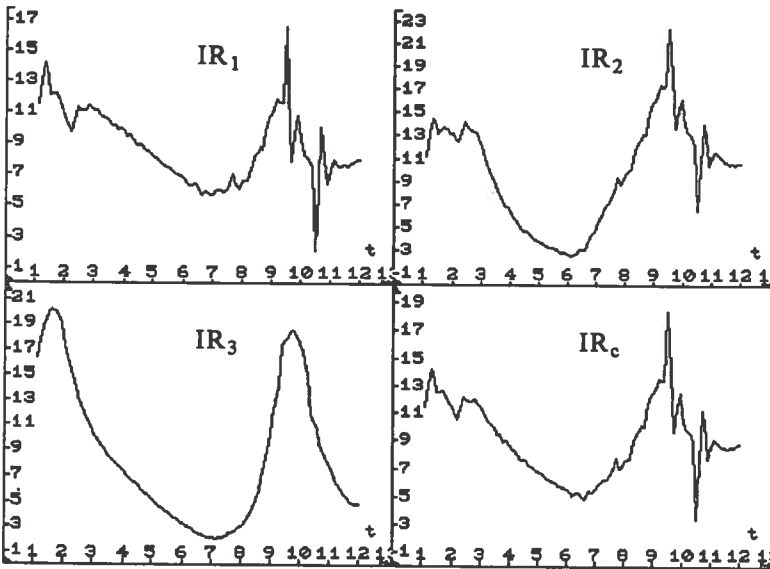


Fig. A36. Influence of the Central Bank's policy on the evolution of the economy. The scenario with policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

IR_1, IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively [% per month];

IR_c is the growth rate of consumer prices [% per month].

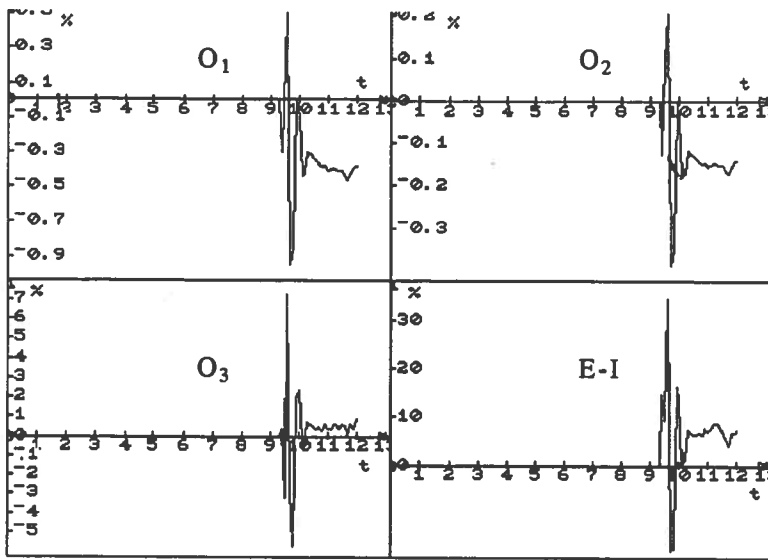


Fig. A37. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of economic variables in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31,1994.
 The simulation results (curves 1), the statistical data (curves 2).
 O_1 , O_2 and O_3 are outputs of the sectors 1, 2 and 3, respectively.
 I is budget incomes. E is budget expenditures

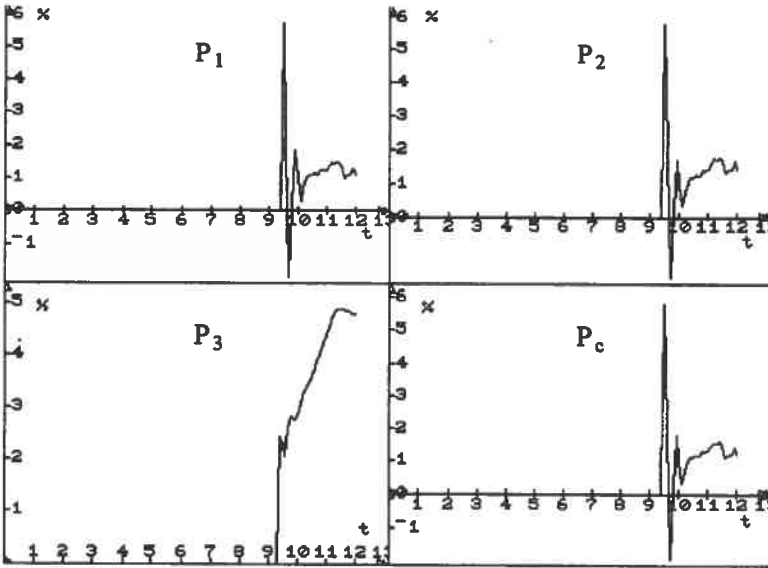


Fig. A38. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of economic variables in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31,1994.
 The model simulation (curves 1), the statistical data (curves 2).
 P_1 , P_2 and P_3 are the price indices of products of the sectors 1, 2 and 3, respectively; P_C is consumer price index ($P_1=1$, $P_2=1$, $P_3=1$, $P_C=1$ in December 1991).

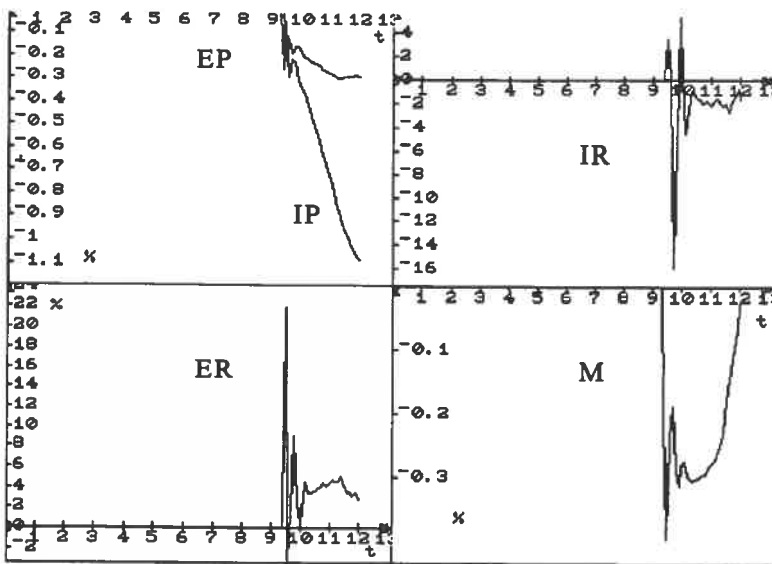


Fig. A39. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of economic variables in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

EP is net income of exporters in \$; IP is net income of importers in \$.

IR is the interest rate for commercial loans [% per month].

ER is exchange rate [rub./\$]. M is money demand .

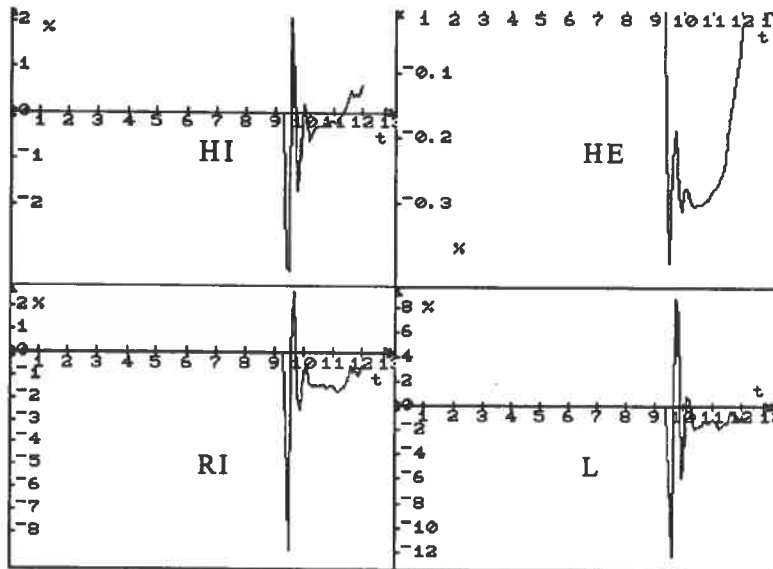


Fig. A40. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of economic variables in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

HI are household incomes;

HE are household consumption expenditures;

RI are real household incomes;

L is the flow of commercial loans.

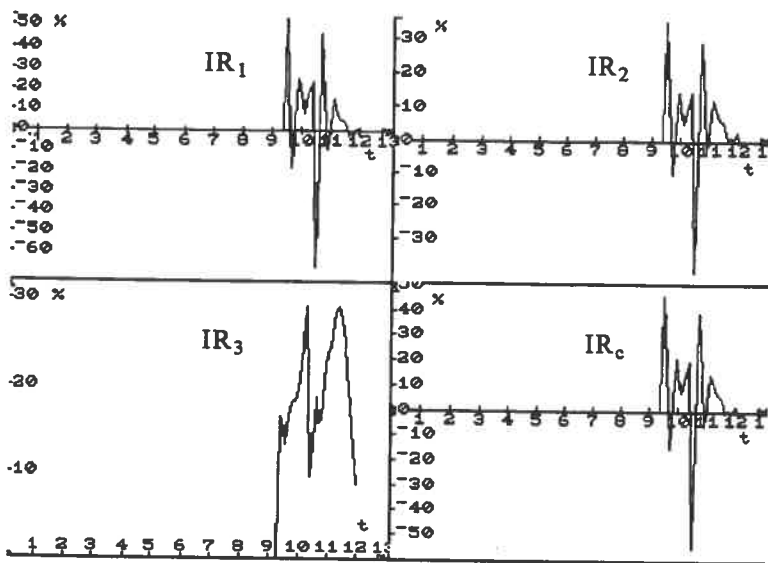


Fig. A41. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of economic variables in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

The model simulation (curves 1), the statistical data (curves 2).

IR_1, IR_2 and IR_3 are the growth rates of prices in the sectors 1, 2 and 3, respectively;

IR_c is the growth rate of consumer prices.

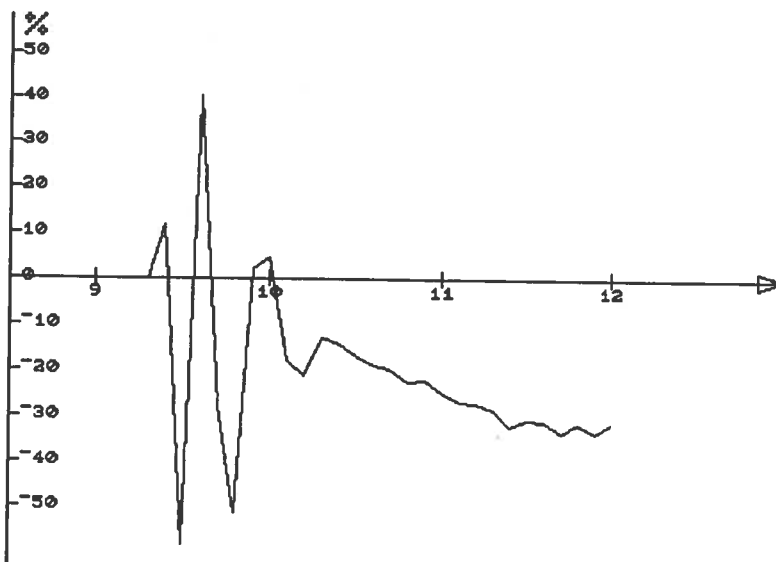


Fig. A42. Influence of the Central Bank's policy on the evolution of the economy. The percentage change of budget deficit including the increase in the Central Bank's reserves in response to policy shock on Oct 11, 1995.

Horizontal axis shows time in months; 1 corresponds to January 31, 1994.

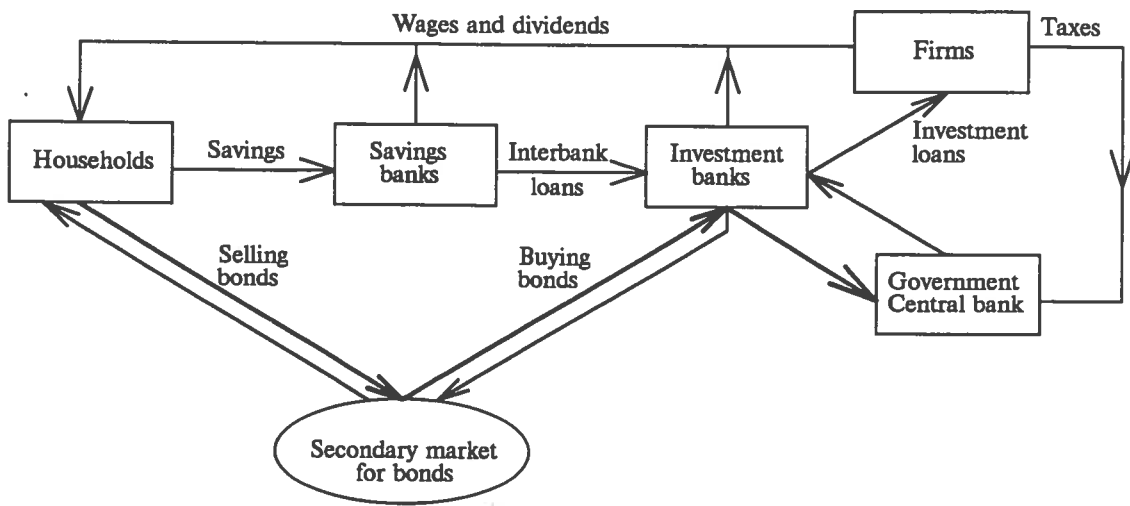


Fig. A43. Main financial flows in the economy after restoration of savings. Some conventional financial flows such as required reserves are not shown in the chart.

Inflation rate

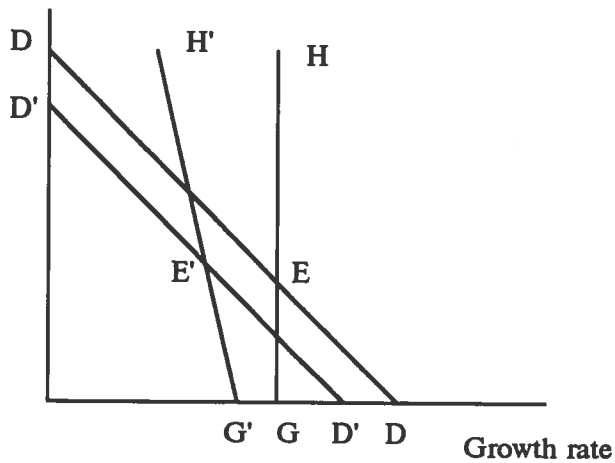


Fig. A44. The imperfection of financial intermediaries and the growth rate (a simplified model).

In the case of perfect financial intermediaries (when both reserve ratio ξ and the bankers' salary λ are zero) the equilibrium is reached at the point E as the intersection of GH and DD. The DD line is defined by the equation $i+g=D$ (i - inflation rate, g - growth rate, D - relative increase of money supply), GH line is vertical as the neutrality of money holds. E.g. if government wants to speed up the restoration of saving, and the flow of the bonds paid increases, then D increases which leads to higher inflation rate, but growth rate remains the same and equal to G which depends only on technology parameters ("real" economic variables).

However if financial intermediaries are not efficient ($\xi > 0$ and $\lambda > 0$) then DD shifts downward (the DD' is proportional to ξ), while GH not only moves leftward but also rotates. The angle of rotation (the non-neutrality) is proportional to ξ , and the shift to the left (the loss of efficiency) is proportional to λ . Thus if λ increases then the growth declines and inflation increases, while if ξ increases, the growth rate falls and the inflation rate may both increase or decrease regard to which effect is stronger - the one of rotation of GH or shift of DD. It can also be seen that increase in budget deficit (DD moving outward) will not only increase inflation but also suppress growth.

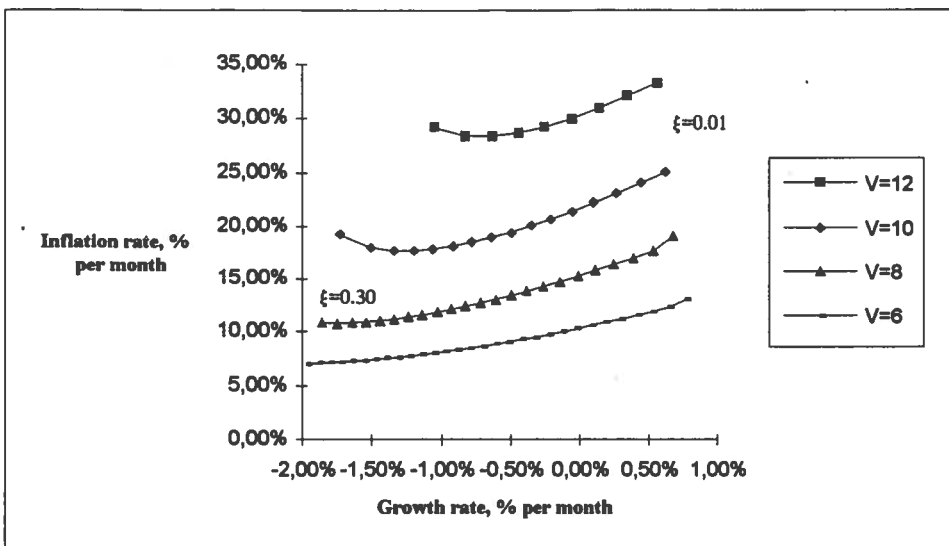


Fig. A45. Inflation and growth at different reserve requirement ratios ξ and different money velocity V .

Increasing required reserves (from right to left in each series) may help fight inflation at the expense of growth but sometimes (upper left part of the graph) the tight monetary policy will result in both high inflation and low growth, making restoration of savings a failure rather than a success.