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Nizhny Novgorod
Computable General Equilibrium in One Region with Barter and Arrears

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The authors construct a computable general equilibrium (CGE) model of a Nizhny Novgorod regional economy – a typical large industrialised region of the Russian Federation. The model allows to capture some of the key features of the 'virtual economy', such as barter transactions and arrears, as well as region-specific market characteristics and provides a *dynamic* framework for analysing alternative policy measures aimed at cutting short the vicious circle of the virtual economy. Numerical simulations are based on statistical data for the period 1992–1997, which have been obtained from the statistics committee of the Nizhny Novgorod region.

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Keywords: Russia, regional economics, transition period, general equilibrium, barter, arrears, public welfare analysis.

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1. INTRODUCTION

Excessive centralisation, an attempt to establish production plans for each production unit in the economy, was an inherent weakness of the Soviet economy. Since the state could not completely regulate retail sales and labour supply, economic forecasting – the basic building block of the central planning system – was bound to be inaccurate. Planning authorities were forced to set ever higher production targets; firms engaged in false reporting and/or producing the prescribed quantities of low-quality goods. This system could not be sustained, and collapsed.

Nizhny Novgorod is a typical large industrialised region of the Russian Federation. It inherited an oversized military-industrial complex, a weak consumer goods industry and highly monopolised markets. Nizhny Novgorod is also quite special in many ways since it has been the first among Russian regions to step upon the path of radical economical reforms, serving as a pilot project (the so called "Nizhny Novgorod prologue") of economic liberalisation. Fast liberalisation helped eliminate consumer goods shortages during 1992–1994. However, as elsewhere in Russia, the introduction of private property, and the elimination of price controls did not stimulate growth in output.

After 1993, as shown in Fig. 1 below, industrial output shrank quite dramatically- to less than 45% of its pre-reform level. The phenomenon of transformational recession has been studied quite extensively, and most of the standard explanations apply to Nizhny Novgorod as well. Here, however, given the high concentration of military industry, the decline in government procurement (and subsidies) has had a particularly severe effect. Unable to finance investment, most enterprises in the military-industrial complex simply could not engage in costly restructuring or conversion.

To gain a better perspective over the outcome of the Nizhny Novgorod experiment, one can compare its performance with that of its immediate neighbour, Samara. Starting from very similar conditions in terms of economic structure, geographic location, size of territory and population, the two regions followed very different trajectories. The initial fall in output was more pronounced in Samara, however, in 1997 Samara reached a higher level of industrial output, and, even more importantly, was growing at a faster pace. In 1997, the average wage in the Samara region was almost twice higher than that in Nizhny Novgorod.

In 1997, judging by the purchasing power of its population, the Nizhny Novgorod region joined the club of the 'less developed' Russian regions: the average *per capita* income has dropped below twice the estimated minimum regional subsistence level. Even so, the region maintains a considerable potential for development due to the availability of qualified labour and large 'home market'. These are certainly factors which may help attract foreign investors. Moreover, the region is largely self-reliant, with the share of federal transfers in the regional budget falling below 5%.

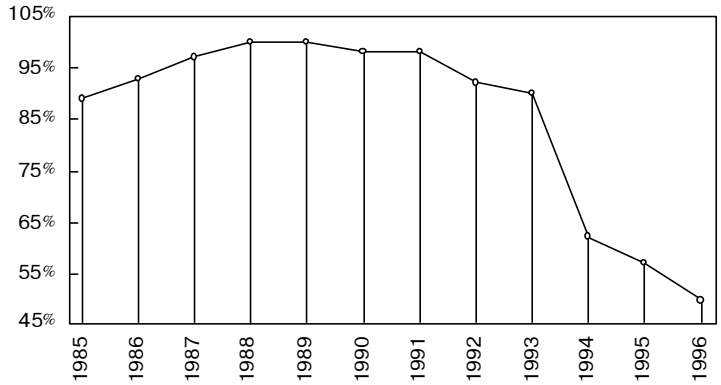

Figure 1. Dynamics of manufacturing volume in the Nizhny Novgorod region (1989 volume = 100%).

The different performance of two neighbouring – and very similar, regions calls for an explanation. Such an explanation must be rooted in an understanding of the so-called 'virtual' features of the Russian transition economy.

Liberalisation and privatisation have set in motion a long and painful process of transformation. The emerging institutional framework, while resembling that of developed market economies, is in many important ways carrying the birthmarks of the central planning period. A good case in point is the way transactions are conducted among enterprises, as well as among enterprises and the state. Barter, the volume of which has been increasing until very recently, is the key feature of the virtual economy. When a transaction is carried out through barter, prices are set at an artificially high level. The barter 'price' is a virtual price and it creates a virtual value added.

Barter – inefficient as it is in a normally functioning market economy - has become an integral part of the Russian economy. Cash sales are not sufficiently high to cover production costs for most large manufacturing firms. On the one hand, cutting costs is not easy given the burden of the so-called social 'assets' (schools, kindergartens, etc.), most industrial giants inherited from the socialist era. The poor quality of the manufactured goods, on the other hand, does not help increase sales in the domestic consumer market or export. Virtual 'profits', in turn, create 'virtual' tax liability and in-kind tax payments. The practice of 'virtual' tax payment, however, creates *real* budget deficits at all levels of government, accumulation of wage arrears in the public sector, non-payment for state orders and higher tax rates. A "vicious circle".

The system is stable also because the virtual economy is characterised by high rates of nominal employment, albeit at ridiculously low wage levels and huge wage arrears. Low unemployment translates into low social tension and lack of political protest.

Between 1994 and 1997, the Russian Federation has experienced at least two periods of relative price stability. Monthly inflation hovered around 3% and 1% in the middle of 1995 and 1997, respectively. The lower price 'equilibrium' in 1997 has been achieved at a considerably lower level of industrial output (see Fig. 2). A period of tighter of monetary policy, e.g. in 1997, when inflation rate approached zero, was associated with a continuous slowdown in production, perhaps supporting the view that moderate inflation, in fact, may help stabilise an economy based on barter.

In this paper, the authors attempt to construct a computable general equilibrium (CGE) model of a regional economy, which incorporates some of the virtual economy features and provides a *dynamic* framework for analysing alternative policy measures aimed at cutting short the vicious circle of the virtual economy.

The CGE modelling approach is particularly appropriate for modelling transition processes since it does not require long time-series data, the necessary prerequisite of econometric investigation. Rather, the model is based on a simple set of economic assumptions concerning the behaviour of key economic agents. By simulating the model, the authors arrive at a number of interesting qualitative results concerning the system's response to external shocks and changes in regional policy regimes.

In the paper, the authors consider a three-sector model of a regional economy, in which eighteen branches of the regional industry have been grouped together into three sectors:

- Sector I: producers of consumer goods
- Sector II: producers of intermediate consumption goods
- Sector III: producers of energy and raw materials.

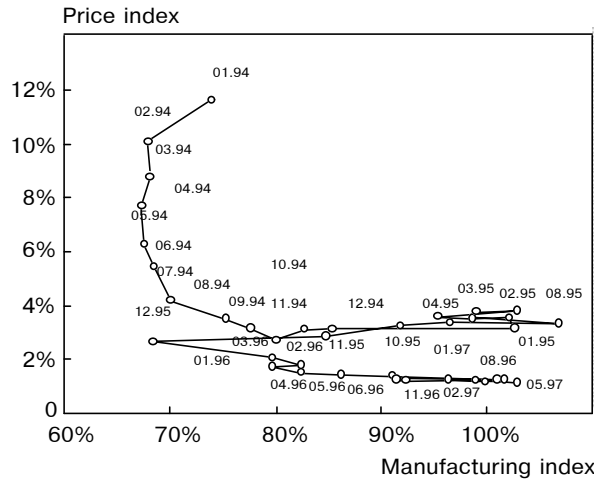

Figure 2. Adjusted output and price index.

The model incorporates the behaviour of households, the banking sector, regional and federal levels of government. Exchange rate is treated as exogenously given.

The model allows to capture some of the key features of the 'virtual economy', such as barter transactions and arrears, as well as region-specific market characteristics. Numerical simulations are based on statistical data for the period 1992–1997, which have been obtained from the statistics committee of the Nizhny Novgorod region.

The authors analysed a number of stages in the Nizhny Novgorod version of liberal market reforms. First, the period of 'shock therapy, which started with price liberalisation in January 1992. Second, the period of 'socialist privatisation' (began in the second half of 1992), which resulted in employee ownership over most enterprises. While exponential growth of wage arrears renders the economic system less sensitive to the traditional tools of economic policy, the model helps establish the optimal values for key macroeconomic policy parameters and analyse alternative policy scenarios.

2. HYPOTHESES

The period 1994–1995 saw the most drastic fall of production output in the Nizhny Novgorod region (see Fig. 2). The structure of aggregate demand underwent considerable changes and the number of consumer and investment goods decreased; however, the number of intermediate goods increased. Reductions in solvent demand have negatively influenced the functioning of enterprises.

The share of subsidies in GRP (Gross Regional Product), targeted to cover company losses and product price differences, has grown from 3.1% to 3.7%. The tax burden has grown too; the tax income/profit ratio increased from 1.21 in 1994 to 1.32 in 1995.

Table 1. Structure of aggregate demand in the Nizhny Novgorod region.

Factors forming aggregate demand	Demand structure	
	1994	1995
Aggregate demand	100.0%	100.0%
Intermediate consumption	43.5%	49.6%
Final consumption by the population	26.4%	27.7%
Final consumption by the government	8.3%	10.0%
Investment demand	21.8%	12.7%

Annual GRP (Gross Regional Product) in the Nizhny Novgorod region is less than $2000 *per capita*.

Income and expenditure *per capita* in the Nizhny Novgorod region are lower than the Russian average. Moreover, the considerable differences between expenditure and income are greater than the Russian average. This fact indicates an unsatisfactory structure of sales and postponed consumer demand.

State. State expenditures have exceeded tax income in 1994 and 1995 and the budget deficit has been financed by non-tax incomes (hard currency sales, privatisation, other duties, *etc.*).

Savings. Savings from enterprises have formed the lion's share of total regional savings. The share of imported goods in consumption has reached 7%, while the share of exports in the volume of sales has increased from 8 to 14%. Part of regional exports have been targeted towards foreign trade (66% of total export sales in 1994 and 74% in 1995). Extensive exports, however, have led to a reduction in interregional trade.

Table 2. Income and expenditure per capita in the Nizhny Novgorod region.

	Unit of measurement	1994	1995
Population	millions	3.7405	3.7463
GRP (Gross Regional Product)	bn. rubles	11575.6	32152.4
Population incomes (aggregate)	bn. rubles	7388.3	536.0
Population expenditure (aggregate)	bn. rubles	6296.4	14836.0
Income *per capita*	1000 rubles/month	164.6	381.7
Expenditure *per capita*	1000 rubles/month	140.2	330.0
Russia (average)			
Income *per capita*	1000 rubles/month	203.0	562.0
Expenditure *per capita*	1000 rubles/month	194.0	

Table 3. Structure of state expenditure.

	1994	1995
Aggregate state expenditure	100%	100%
Subsidies for enterprises	10.6%	11.3%
Final state consumption	42.3%	49.9%
Management costs	3.5%	3.0%
Social transfers	34.8%	32.1%
Investments	12.3%	6.7%
Share of state expenditure in GNP	29.4%	32.6%

Table 4. The structure of savings.

	1994	1995
Enterprises	55.6%	57.2%
Population	19.0%	20.8%
State (direct investments)	11.0%	10.6%
Foreign investments	14.4%	11.4%

Tax incomes have become dominant and have thus reduced the cost of labour and capital, both known to be the main factors of production.

The savings of the population of the Nizhny Novgorod region have been at the level of 19–23% as a proportion of their expenditure, corresponding to a stable economy. However, only 8–12% of savings participates in capital turnover. The remaining savings have been idle in the possession of the population and thus they appear to be economically inactive. In addition, the population of the region had 2000 bn Rubles (in 1995 prices) as a "money overhang".

The Social Accounting Matrix (SAM) of the Nizhny Novgorod region is based on the information obtained from the regional statistics committee (see Appendix B.) The amplitude of deviations from the equilibrium is insignificant and reaches no more than 15%, even during the most unstable years for the Nizhny Novgorod region.

Based on these facts, we will try to construct a dynamic model of the regional economy based on the theory of general equilibrium. Also, however, it is necessary to take into account a number of specific features of the Russian economic system, essentially distinguishing it from neo-classical, arrears-based and barter payment systems.

We could write the main inequalities of the theory of general equilibrium as:

$$Y \geq J + C, \quad rpY \leq pY \leq \Pi + sR .$$

Here

$$r = (1 + d(k - 1)), \ 0 \leq r \leq 1,$$

where J — intermediate consumption, C — final consumption, Y — manufactured product, p — price, Π — profit, k — share of cash payments made for production, d — the discount at which will be sold any illiquid assets. For simplicity, we consider that the costs of the enterprise are only the salaries for labour R.

The form of the Walrasian classical equations is not changed, although it now describes an economic system with two prices: money and barter.

3. REVIEW OF LITERATURE

The description of a similar economic system, where several systems of pricing co-exist and payments are carried out with a significant delay, fits the framework of the theory of general equilibrium (Atkinson and Stiglitz, 1980; Shoven and Wholly, 1985, 1986, 1992; Гуриев, 1994; Поспелов, 1994, 1995). Equilibrium in this system exists, yet not

efficiently, therefore the "welfare theorem" does work (Гуриев, 1994; Поспелов, 1994–1996).

Using preferential loans may increase the efficiency of a stable equilibrium. Гуриев (1994) and Поспелов (1994–1996) argue that the volumes of preferential loans must be carefully balanced. Surplus and deficit in preferential loans reduce the efficiency of the equilibrium. So, if a situation of arrears does not happen, then the system will coincide with the neoclassical one and can be described by the Harberger model.

Harberger (1962), who has applied a two-sector model of a Walrasian competitive equilibrium to study the effect of corporate taxes, has obtained important results in an analysis concerning state financial policy. Harberger's approach has been improved by Shoven and Wholly (1985, 1986, 1992), who have taken the ideas of the general theory of equilibrium as a basis. They have also constructed a model of the fiscal policy of the US, as well as a model of the world market. Siljak (1973) has investigated the stability of the Walras model using the Lyapunov vector function and comparative equations.

4. REGIONAL FEATURES

Russian economic reforms in the 90s provided intensive institutional transformations and the building of a three-level budget system. For simplicity, we consider a two-level system, neglecting the financial flows between the budget of the subject of the Federation and lower level budgets. It does not constrain the model because more than 80% of the districts of the Nizhny Novgorod region are subsidized.

The federal budget redistributed up to 10% of GNP in the period 1995–1998. We consider the four main forms of financial flow. These are: transfers of financial support; regionally-oriented expenditures; budget loans; and clearing.

The regionally-oriented expenditures take up the lion's share of federal budget outlays for education, agriculture, medical and other programmes for the subjects of the Federation.

The budget loans and clearing are a smaller part of the financial flows. Budget loans are short-term loans to the subject of the Federation, the main aim of which is to provide salaries for state employees.

Transfers are the smallest part of the federal budget, used for the vertical or horizontal equalisation of the various budgets.

We ignore transfers in our model.

The model is based on the following hypothesis. On the open market, the regional economy is mainly determined by the internal and external demand for domestic and imported goods and by the inter-sectoral price ratio.

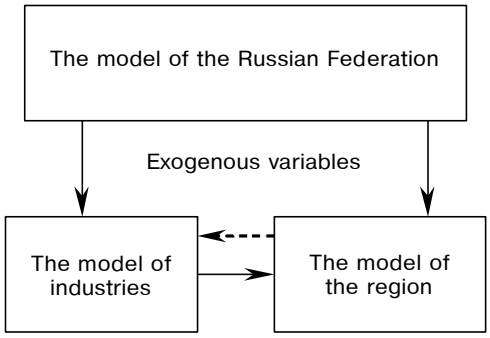

Figure 3. Hierarchy of the models.

The aggregated structure of the model is shown above. The models block interaction between the exogenous variables (*i.e.* for each block). Interactions directed downwards show that regional development may be induced by the Federation, but not in the opposite direction.

The regional regulators are the monetary, budget and fiscal norms and export-import tariffs. These are constrained by the regional executive.

Attempts at the direct monetary control of the economy during the period 1992–1993 operated at the regional level.

Following the aggregate structure, we describe the general approach to the modelling of the regional markets and consumer/manufacturer behaviour.

5. METHODOLOGY

Walras's law states that the value of market demands C_i is equal to the value of the economy's supply Y_i that is:

$$\sum_{i=1}^{N} p_i Y_i(p_i) = \sum_{i=1}^{N} p_i C_i . \qquad (1)$$

On the other hand, the value of excess demands in the market equals

zero at all prices:

$$\sum_{i=1}^{N} p_i(Y_i(p) - C_i) = 0. \quad (2)$$

A general equilibrium in this system is a set of prices p_i^*:

$$Y_i(p^*) - C_i \le 0 \quad (3)$$

with equality if $p_i^* > 0$. Equilibrium prices, therefore, clear the markets.

Manufacturers maximise their incomes, so inputs and outputs are derived from:

$$(Y(p), V(p)) = \arg\max (pY - pV). \quad (4)$$

We assume that the product set $c(p)$, which the customer population buys, determines a solution to the maximisation problem of the concave and monotonic utility function $U(c)$ for the budgets $\{c: pc \le \Psi(p)\}$, where $\Psi(p)$ is the desired planned consumption spending.

Then, prices identically determine the consumption volume $c(p)$:

$$c(p) = \arg\max U(c). \quad (5)$$

Each manufacturer produces a product set Y and consumes the product set V.

Walras's law provides:

$$\Psi(p) \le pY(p) - pV(p). \quad (6)$$

If $\Psi(p)$ is a continuous function, then equilibrium exists and it is unique, $c(p) > 0$, $p > 0$.

In equilibrium, the consumers' utility function $U(c)$ is maximised:

$$U(c) = \max U(Y - v). \quad (7)$$

This equilibrium identifies the output vectors.

If a real manufacturer's income x is not equal to the market price of the output, and $ps = pA$, then A is a non-negative matrix for which the equilibrium conditions are:

$$C(p) \le y(p, A) - v(p, A), \quad (8)$$

$$pc(p) = py(p, A) - pv(p, A). \quad (9)$$

If the economy is closed and manufacturers obtain all their income from output sales, then these equations describe the neoclassical model. If a

part of income goes to other economic agents, such as government, banks and others, then product prices are not equal to market prices and this model can be distinguished from the neoclassical model. This yields a model with several price systems.

As shown in Гуриев et Поспелов (1994), equilibrium in the model exists but it is not effective. It means that the manufacturer does not cover costs through the sale of output at equilibrium prices

$$U(cA) < U(c^*) = \max U(y - v). \tag{10}$$

Then $A \neq E$ and, if A is too far from E, the confluent case $cA = 0$ is possible.

5.1. Manufacturer's behaviour and arrears, and their demand for credit

It is assumed that $x(t)$ comes to the manufacturer with delay θ, and price $p(t)$ changes. If the manufacturer can get a loan $K(t)$, his current income is:

$$\Pi(t) = p(t - \theta)\, y(t - \theta) - p(t)\, v(t) + K(t). \tag{11}$$

The manufacturer maximises estimated discounted income:

$$\int_{t}^{t+\tau} e^{-\Delta\tau}\, \Pi(t)\, d\tau \Rightarrow \max. \tag{12}$$

The discounting factor is held to be Δ.

Income B is received subject to delays which may correlate with non-payments from other agents:

$$\frac{dB}{dt} = p(t)\, y(t) - p(t - \theta)\, y(t - \theta). \tag{13}$$

The flow of credit is accumulated as the debt L of the manufacturer:

$$\frac{dL}{dt} = r L + K, \tag{14}$$

where r is the interest rate.

Credit arrears in the banking system are:

$$L \leq \chi B. \tag{15}$$

Input and output volumes are determined from:

$$(y,v) = \arg \max_{(x,v)\in T} (kpy - pv), \tag{16}$$

where

$$k = 1 - (1 - e^{-\Delta\theta})(1 - \chi(1 - r/\Delta)). \tag{16'}$$

5.2. Manufacturer's strategy and barter

It is assumed that there is a simple technological chain, which consists of two industries and households:

- industry 1 produces raw material;
- industry 2 produces the final product.

Industry 2 receives money to the households and passes some of the final product to Industry 1. The payments to federal and local budgets are provided in money and in the final product. At the same time, a part of the Industry 2 output is sold on the open market.

Barter exchanges exist in the following conditions:

Industries mutually raise the so-called "budget" price, keeping a constant barter exchange ratio. Industry 1 sells the final product of Industry 2 with significant discounts to acquire money for employees' salary. So, there are several market prices for the final product.

Typically, this happens as follows. The producer issues a bill to acquire working capital and covers it with its product at a significant discount (up to 40%). In addition, there exist the so-called "budget" prices, *i.e.* the prices for tax contributions at different budgetary levels, and the so-called "offset" prices for barter arrangements.

Dealers usually distribute the product and so the discount rate is subject to negotiation.

Owing to the existing deficits in working capital, the producer (by increasing the discount) finally receives less than the competitive market price for its product, *i.e.* kp, $k < 1$

A similar situation occurs when the payment is delayed.

5.3. Industry production function

Johansen (1972) characterises production functions, constructed below, as "putty-clay".

It is assumed that industries are described by a continuous density function concerning the distribution of capacities, which is technology $m(\lambda, t)$, where λ is the norm of labour costs per unit of output product. The function $m(\lambda, t)$ changes due to the amortisation of old capacities and the construction of new ones. The new capacities $I(t)dt$, constructed in time period $[t, t + \Delta]$, uses technology with the lowest norm v of labour costs. The capacities constructed at the moment t, due to amortisation, will have at the moment τ ($\tau \geq t$) the technology with the lowest norm v of labour costs:

$$\lambda(\tau, t) = v e^{\mu(\tau - t)}, \quad m(v, \tau) = \frac{I(\tau)}{\mu v}, \tag{17}$$

where μ is the rate of capacity amortisation.

The total industry capacity is:

$$M(t) = \int_{v}^{+\infty} m(\lambda, t) d\lambda . \tag{18}$$

If the rate of construction of new capacities is γ, then

$$I(t) = M(\tau_0)(\gamma + \mu) e^{\gamma(t - \tau_0)}, \tag{19}$$

and

$$m(\lambda, t) = M(\tau_0) e^{\gamma(t - \tau_0)} \frac{\gamma + \mu}{\mu v} (v / \lambda)^{(\gamma + 2\mu)/\mu} . \tag{20}$$

If the distribution $m(\lambda, t)$ is normalised by the industry capacity $M(t)$, then the industry output is:

$$Y(t) = M(t) \int_{v(t)}^{\zeta} h(\lambda, t) \mathrm{d}\lambda , \tag{21}$$

where ζ is determined from the equation:

$$R(t) = M(t) \int_{v(t)}^{\zeta} \lambda \, h(\lambda, t) \mathrm{d}\lambda , \tag{22}$$

and where $R(t)$ is the number of employees and $h(\lambda, t) = m(\lambda, t) / M(t)$.

5.4. Consumers' behaviour and their money supply

Consumers maximise their discounted utility:

$$\int_{t}^{t+\tau} e^{-\delta t} U(c(t))\,d\tau \Rightarrow \max, \tag{23}$$

where δ is the discount factor of a future utility, $c(t)$ is a future consumption vector and $U(c(t))$ is the utility function. The consumer's income $\Phi(t)$ is spent on consumption $p(t)c(t)$, or is saved as the deposit D with an interest rate ρ:

$$\frac{dD}{dt} = \rho D + \Phi - pc. \tag{24}$$

The restriction for D is:

$$D \geq 0. \tag{25}$$

The consumers' demand function $c(p, \Phi, D)$ is determined from:

$$c(p,\Phi,D) = \arg \max_{pc \leq \Psi(\Phi, D)} U(c), \tag{26}$$

where $\Psi(\Phi, D)$ represents consumers' expenses.

Therefore, solving equation (26), the consumption level converges to

$$\Psi = \Phi\left(1 - \frac{1 - \delta/(\rho - i)}{\beta}\right) + D\left(\rho - i - \frac{\rho - i - \delta}{\beta}\right), \text{ if } \rho - i - \delta > 0;$$

$$\Psi = \Phi, \text{ if } \rho - i - \delta < 0.$$

By the end of the planned period, savings are zero. When $T \to \infty$, the flow of savings approaches a certain function which depends on the interest rate, inflation, and the discount.

The solution to the problem essentially depends on the real discounted rate. When the real interest rate is negative, then households are not willing to save.

5.5. Closing the model

The condition closing the system of money circulation is a banking system balance. The sum of assets must equal the sum of liabilities. The bank's assets are the loans to manufacturers L, while the liabilities (the sources of the loans) are the household deposits D and the settlement

accounts B:

$$\frac{dD}{dt} + \frac{dB}{dt} = \frac{dL}{dt} \tag{27}$$

Household consumption is formed from wages as a part of enterprise incomes Π less the deposit rates.

$$\Phi = \Pi + rL - \rho D = p(t-\theta)y(t-\theta) - pv + K(t) + rL - \rho D = \\ = -\frac{dB}{dt} + py - pv + \frac{dL}{dt} - \rho D. \tag{28}$$

The household incomes equation Φ depends on the level of arrears. There are two ways of payment defined by the Russian government:

Variant 1. First, enterprises pay wages. Then, as soon as possible, but with a significant delay, the manufacturers pay taxes to the several levels of the budget.

Variant 2. First, enterprises pay taxes. In this case, wages are paid with a significant delay.

It is shown in (Гуриев et Поспелов,1994) that the Walras law at any price level defines the demand functions.

In this way, if there are arrears and/or barter relations, then there will be a two-price model system. In the case of arrears, it is natural to consider a dynamic model. In the case of barter relations, a stationary model is possible. This model requires equations describing the changes in capacities, pricing, wage levels and stock formation.

A change in capacities happens at a much slower rate than a change in prices. Therefore, for a "quick" analysis, it is assumed that capacities are stationary. In conditions of stable prices, and for a consideration of longer intervals of time, the dynamics of the capacities are described by equations similar to those in the theory of growth.

5.6. Construction of the three-sector model of the regional economy

To construct a three-sector model of the regional economy, the basic economic agents describing the scenario, which take into account tax rates and tariffs, must be aggregated. In addition, it is assumed that the regional economy is open.

We propose that the behaviour of economic agents is similar at the federal and regional levels. The financial market is external to the regional

economy; the equations describing the dynamics of the financial market and the behaviour of exporters are exogenous for the region.

The first sector includes industries producing consumer goods: textiles and the food industry. These manufacturers face fierce competition from imports. Competition has led to light industry in the Nizhny Novgorod area practically ceasing to exist. The food industry, in contrast, has been transformed into the most dynamically developing sector, with the greatest share of the resources invested in innovation.

The second sector includes processing industries. Producers in the second sector, facing limited demands and a lack of working capital, do not invest the profit they receive. In the Nizhny Novgorod region, only the large company, the Gorky Automobile Plant (GAZ), is making investments. The share of exported production is not significant. The company imports equipment and materials.

The third sector includes raw materials, energy industries and others. Producers in the third sector are export-oriented. In the Nizhny Novgorod region, the biggest are the refinery, pulp and paper plants ("NORSI", "Caprolactam", "Corund", and "VOLGA").

The table below shows the 18-industry inter-sectoral balance developed by the Centre for Economic Co-ordination and Forecasting under the RF Government.

Table 5. The three industry sectors.

The first sector	Textiles and food industry
The second sector	Machinery, miscellaneous manufacturing, transportation, communications, and utilities
The third sector	Electroenergy, crude oil and gas, fuel, ferrous and non-ferrous metallurgy, chemical and refining industries, forestry, woodworking, pulp and paper industries, stone, clay and glass industries, agriculture.

The model like Петров, Поспелов, Шананин (1996) describes the behaviour of five types of economic agent:

- population (households);
- enterprises (manufacturers);
- importers and exporters;
- banks;
- Government (federal budget, regional budget, the Central Bank).

The following rules determine the relations between the economic agents.

Household incomes are determined by direct budget transfers and wages. Savings are made in deposit accounts and in hard currency cash.

Managers of enterprises are assumed not to invest but to increase consumption. Recession in manufacturing is reflected in the underutilisation of capacity. Innovation and investment occur only in the largest enterprises which have preferential loans. Here, bankruptcy is absent and unemployment is low. Working capital increases by means of barter. It is assumed that manufacturers maximise net discounted income.

Consumer goods are imported. The production of refineries and the chemical and glass industries is exported. Importers set prices in hard currency to maximise profit. The prices for the production of domestic manufacturers in the home market come close to the prices for imported products.

The main income of commercial banks is the differential between government credit rates and deposit rates. The banking system establishes the interest rate to maximise its discounted profit. The banks provide export-import operations. The importers receive short-term currency loans. Exporters provide the supply of currency. The Central Bank intervenes on the USD/RR market, trying to hold the exchange rate within the given range (at least, until August 1998).

Below, the industry market is described following the assumption that the second and third sectors are controlled by a hierarchy of oligopolies.

The first sector market. It is supposed that centralised imports are absent. Imported consumer electronics and the production of the textile industry occupy the major part of the consumer goods market.

The suppliers of durable goods are mainly representatives of large Moscow corporations and are assumed to have monopoly power *vis-a-vis* consumers. The suppliers of imported consumer goods also have monopoly power or are oligopolistic. Production in the domestic food processing industry (which can be considered as a monopoly) remains competitive by the stability of consumer preferences. Among the leaders, we have a Nash equilibrium.

The second sector market. Production of intermediate consumption in the second sector accounts for a minor share of manufacturing in the

Nizhny Novgorod area. The greatest share of the machine-building production of final consumption goods is held by the Gorky Automobile Plant (GAZ). Until August 17 1998, domestic car manufacturers faced fierce competition from importers. Now VAZ (Volzhsky Automobile plant) and GAZ supply the domestic car market. The Stakelberg model describes this market. GAZ and VAZ are assumed to determine their production for this market by a Stakelberg process. VAZ is the market leader.

The third sector market. Several companies in the Nizhny Novgorod region and in Tatarstan produce refinery products; in this case, both oligopolies and a Nash equilibrium exist. Fig. 4 shows the existing structure of the industries of the Nizhny Novgorod region by gross output and corresponding to our sectoral division.

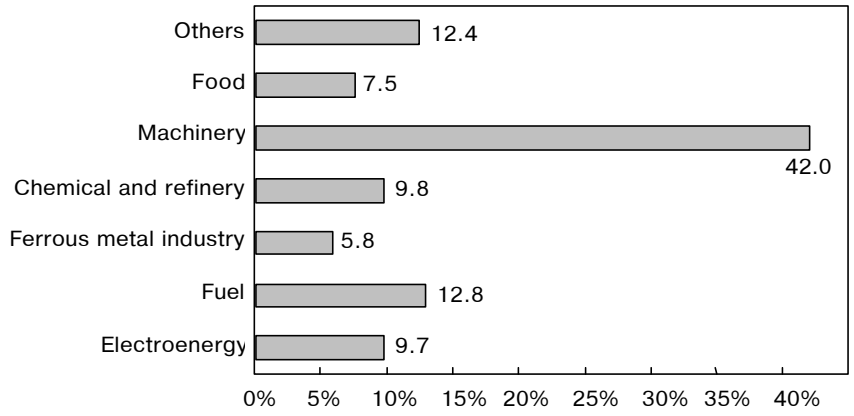

Figure 4. Industrial structure of the Nizhny Novgorod region.

The financial market. The industrial and credit-finance markets are weakly connected. In practice, the banks play the role of intermediaries for the Central Bank. It is supposed that the financial market is in equilibrium and the Nash and Stakelberg equilibriums for this financial market coincide.

5.7. Description of the basic model of the regional economy in an imperfectly competitive and non-equilibrium market

The i-th sector's output of a homogeneous product per unit of time is denoted as X_i and the industrial capabilities of the i-th sector are de-

scribed by the production function: $X_i = f_i(V^i)$, $i = 1, ..., N$. It is assumed that the vector $V^i = (V_1^i, ..., V_N^i)$ represents the industrial costs of the i-th sector.

The balance of production and distribution of the product of the i-th sector can be written as:

$$X_i \geq Z_i + Y_i + G_i, \quad i = 1, ..., 3, \tag{29}$$

where $X_i = f_i(V^i)$ is the output of the i-th product, Z_i is the consumption by the other sectors, Y_i is the consumption by the ultimate users (households and exporters) of the i-th product, and G_i is the state purchases of the i-th product.

The production function of the i-th sector is explicitly written as follows:

$$X_i = \frac{2V_j^i}{\bar{v}_i^j}\left(1 - \frac{V_i^j}{2\bar{v}_i^j M_i}\right), \quad 0 \leq V_i^j \leq \bar{v}_i^j M_i \tag{30}$$

where v_i^j is the average norm of the costs of the production factor per unit of output with a maximal load of capacity. It is convenient to estimate this parameter on the basis of inter-sectoral balance data.

The production function in this form allows an analytical solution of the problem of determining the producer's economic strategy (Петров, Поспелов et Шананин, 1996), depending on the level of relative prices, the amount of state purchases and the total amount of preferential loans. The solution is achieved by writing out the conditional extremes of the Lagrangian function. However, for a more thorough investigation, the elasticity of substitution, at least for the primary factors in the production function, must be taken into account.

The financial condition for the i-th sector is described by its settlement account N_i^P, the liabilities account L_i^P in the bank system and the accumulated debts of other sectors to the i-th sector B_i^A and of the i-th sector to the others.

The liabilities account of the sectoral changes is described by the equation:

$$\frac{dL_i^P}{dt} = K_i. \tag{31}$$

Where K_i is the flow of preferential loans, assuming that total sectoral debt equals zero.

The settlement account, to which money arrives with delay τ_Π, is described by:

$$\frac{dN_i^P}{dt} = [q_i G_i + p_i Y_i + s_i Z_i]_{t-\tau_n} + K_i - \sum_j s_j V_{ji} - \rho L_i^P - \Phi_i - U_i \,. \qquad (32)$$

(Where q_i, p_i, s_I are the so-called "budget", "market" and "barter" prices respectively, ρ is the interest rate for preferential loans, Φ_i is the pure earnings of the workers in the i-th sector, and U_i is the value added tax, calculated at the rate n_p.)

The mutual arrears are described by the equation:

$$\begin{aligned} \frac{dB_i^A}{dt} &= p_i Y_i + q_i G_i + q_i Z_i - [p_i Y_i + q_i G_i + s_i Z_i]_{t-\tau_n}, \\ \frac{dB_i^\Pi}{dt} &= \sum_j (q_j - s_j) V_j^i \,. \end{aligned} \qquad (33)$$

To carry out financial operations, sector i must have funds in its settlement account.

$$N_i^P \geq \theta_\Pi \left\{ \Phi_i + (1 - n_p) \sum_j s_j V_j^i \right\}. \qquad (34)$$

Liabilities are restricted by:

$$L_i^P \leq (1 - n_p)\left(\chi_A B_i^A + \chi_\Pi B_i^\Pi\right), \qquad (35)$$

where $(1 - n_p)\chi_A$ and $(1 - n_p)\chi_B$ are crediting norms.

A manufacturer maximises estimated discounted pure income:

$$\int_t^\infty e^{-\delta\tau} \Phi_i(t)\, d\tau \Rightarrow \max \,, \qquad (36)$$

δ is the discounting factor. The manufacturing control parameters are: $X_i^s(t)$, $V^{id}(t)$, $\Phi_i(t)$, K_i^d. They meet the conditions of equations (34) and (35).

Finding out the limits corresponding to the Lagrangian extremes and their factors solves equation (36). Equation (36) is used to define the

effective value added cost for a sector.

$$p_i^s f_i(V^i) - \sum_j p_j^d V_j^i \Rightarrow \max . \tag{37}$$

The solution of equation (37) gives the function of the effective value added cost for the sector:

$$\Pi_i(p_i^s, p^d) = \max_{for\ \forall V_j^i \geq 0} \left[p_i^s f_i(V^i) - \sum_j p_j^d V_j^i \right]. \tag{38}$$

After that, product supply X_i^s and demand for manufacturing factors V_j^{id} are calculated as follows:

$$X_i^s = \frac{\partial \Pi_i}{\partial p_i^s}, \quad V_j^d = -\frac{\partial \Pi_i}{\partial p_j^d} . \tag{39}$$

The behaviour of all the manufacturers in the sector is described by supply and demand functions which depend on market prices p_i and which correspond to the problem maximisation which has the solution:

$$\sum_i (q_i G_i + \Pi_i(p_i^s, p_i^d)) \Rightarrow \max , \tag{40}$$

under restriction

$$(1 - n_p)\chi_\Pi \sum_{i,\ j} \Delta p_j V_j^{id}(p_i^s, p_i^d) \leq K , \tag{41}$$

where K is the given amount of preferential loans.

The solution may be $\Delta p_j < 0$. In this case, loans are small enough and manufacturers provide a prepayment.

Income of the producers. The estimated incomes Φ_i of the production sectors are determined by equation (34): Φ_i can be excluded from equation (34) and inserted into equation (32). After integrating equation (32), this determines N_i^p, and Φ_i.

The households. Households are described as a homogeneous group which consumes goods for current consumption and durable goods in a fixed proportion according to the utility function $(C_1^L)^{(1-\alpha_2)}(C_2^L)^{\alpha_2}$, where

α_2 is a fixed parameter and C_1^L end C_2^L are the corresponding consumption patterns for goods 1 and 2. A household maximises its utility function under given budget restrictions.

The population is divided into two groups — employees of private enterprises and governmental employees.

The amount of money W held by the population is equal to the sum of the cash in circulation and the cash equivalent deposits of households:

$$\frac{dW}{dt} = (1 - n_L)\Phi - \Phi^L + r_2 W, \tag{42}$$

where r_2 is the interest rate on deposits, n_L is the rate of income tax and Φ^L is consumers' expenses. The incomes of households are defined by the equation:

$$\Phi = p_3 M \sum_i \overline{\Phi}_i^R + S, \tag{43}$$

where the sum is taken over the $\overline{\Phi}_i^R$ incomes of private enterprise employees, S is the total income of government employees, n_L is the rate of income tax and Φ^L is the consumption expenditure of households.

During a financial crisis, the population does not save and:

$$W = \theta_c p_2 C_2^L,$$

where θ_c — constant.

Inflation makes real wages r_2 negligibly small, and consumer behaviour is determined by:

$$\gamma \theta_c p_2 C_2^L = (1 - n_L)\Phi - \Phi^L, \tag{44}$$

$$\Phi^L = p_1 C_1^L + p_2 C_2^L, \tag{45}$$

$$p_1 C_1^L = \frac{1 - \alpha_2}{\alpha_2} p_2 C_2^L, \tag{46}$$

where γ is the rate of inflation.

Importers. Assume that importers are oriented towards the consumer market and are divided into two large groups. The first group specialises in durable goods and the second in consumer goods.

Both groups are monopolists as regards consumers, with the latter determining demand against established prices (Stakelberg equilibrium).

As regards each other, importers operate equitably and establish prices which maximise pure income as opposed to other prices which are fixed (Nash equilibrium).

When planning import volume Y_1^I, importers use information about consumer demand $C_1^L(p_1, p_2, \Phi^L)$ and the manufacturing levels of import substitutes Y_1:

$$Y_1^I = C_1^L(p_1, p_2, \Phi^L) - Y_1 .$$

The importer's demand for credit is determined by the needs of working capital for the importing of goods, taking into account the estimated rate of inflation. So, for the repayment of loans, the following should be provided:

$$C_1^L(p_1, p_2, \Phi^L) - Y_1 \geq 0 .$$

Equations describing importers' assets and liabilities are:

$$\begin{aligned} \frac{dN^I}{dt} &= p_1 Y_1^I + p_2 Y_2^I + K^k - H^k - rL^I - d^I, \\ \frac{dL^I}{dt} &= K^k - H^k, \\ \frac{dN_v^I}{dt} &= \frac{d^I}{k} - (1 + n^I)(\pi_1^I Y_1^I + \pi_2^I Y_2^I). \end{aligned} \tag{47}$$

Where N^I are the funds on ruble accounts, N_v^I are the funds on currency accounts, L^I is the total liability, H^k represents the interest rates, d^I is the ruble offer, π_i^I is the average "world price" for imported goods, n^I is the customs tariff and k is the currency exchange rate.

Banking system and exporters. The banking system establishes interest rates for commercial loans based on demand, and in order to maximise profits.

$$(e^{-\delta\theta_I} - e^{-r\theta_I})\beta_m \overline{\Phi}_L \overline{k}^k \left(\frac{k\beta}{\overline{\Phi}^L}, \bar{y}_1, \bar{y}_2\right) p_3 M_3 \Rightarrow \max_{r \geq 0} . \tag{48}$$

The function $\overline{k}^k$ is determined by the demand for loans made by importers. The problem solution determines the interest rate r, depending on exchange rate k, the inflation rate γ and the economy condition Y_1,

Y_2, Φ^L. After that, it determines the amount of loans and the average demand for foreign currency (and the ruble offer).

Banks provide deposit accounts D^B. The bank's income is made up of loans and interest repayments. The funds in account D^B change as in:

$$\frac{dD^B}{dt} = \rho(L_1 + L_2 + L_3) + r\,\theta_l\,K^k - d^B. \tag{49}$$

The bank's currency account N_v^B is described as

$$\frac{dN_v^B}{dt} = \frac{d^B}{k}. \tag{50}$$

The change in the bank's settlement accounts is described by:

$$\frac{dN^B}{dt} = \rho\,(L_1 + L_2 + L_3) + r\,\theta_l\,K^k - K - \theta_l\,\frac{dK^k}{dt} - \Phi^G - d^B + \varepsilon. \tag{51}$$

There are $K_1 = K_2 = K_3$ loans to manufacturers, importers and government respectively and the money supply is ε.

The dynamics of money in the settlement account N^0 carries arrears, given in the equation:

$$\frac{dN^0}{dt} = \sum_{i=1}^{3} \left([p_i(Z_i + Y_i) + q_i G_i] - [p_i(Z_i + Y_i) + q_i G_i]_{t-\tau_\Pi}\right). \tag{52}$$

The Central Bank intervenes in the USD/RR market, trying to hold the exchange rate within the given range (until August 1998). Exporters influence the exchange rate to maximise pure currency income given the world raw material prices, minimising home market costs.

The pure currency income of exporters depends on export sales and costs, taking into account the current exchange rate k.

Exporters maximise the next expression:

$$\left\{1 - \frac{k_3^3}{k}\right\} \bar{k}^k \left(\frac{k\beta}{\bar{\Phi}^L}, \bar{y}_1, \bar{y}_2\right) \Rightarrow \max_k. \tag{53}$$

The balance N^E of the exporter's settlement accounts is:

$$\frac{dN^E}{dt} = d^I + d^B - (1 + n^E)\,p_3\,Y_3^E. \tag{54}$$

The settlement account of the state budget N^G, the liabilities account of the internal state debt L^G and the currency account N_v^G describe the condition of the "government" as an economic agent. Changes of "government" accounts occur based on the revenues and expenditures of the corresponding budgets.

$$\frac{dN^G}{dt} = n_p \left\{ \sum_{i=1}^{3} p_i (Z_i + Y_i) + q_i G_i \right\}_{t-\tau_\Pi} + n_L \left\{ \sum_{i=1}^{3} \Phi_i + S \right\} + n^E p_3 Y_3^E -$$

$$- n_p \sum_{i=1}^{3} \sum_{j=1}^{3} p_j V_j^i - \sum_{i=1}^{3} q_i G_i - S + \Phi^G . \qquad (56)$$

The currency account changes as:

$$\frac{dN_v^G}{dt} = n^I (\pi_1^I Y_1^I + \pi_2^I Y_2^I) - d^G . \qquad (57)$$

The internal debt is:

$$\frac{dL^G}{dt} = \Phi^G . \qquad (58)$$

The government economic policy parameters G_i, S, Φ^G, K, ρ, n_ρ, n_L, n^I, n^E and "world prices" are exogenous and vary by several ways of development.

5.8. Analysis of the three-sector model of the regional economy

Fig. 2 showed that the real sectoral dynamics of the Nizhny Novgorod region have demonstrate an oscillating character, as a result of internal stabilising market processes and destructive environmental factors. It is very important to find stability within the regional economy. We estimated the stability area by using a simplified uni- and bi-sectoral model.

5.9. The static model (regional features)

As an analysis of the statistical data shows, the main problems of the Nizhny Novgorod region are arrears and the budget deficit. (As has been shown, barter relations could be reduced to arrears). The volume of arrears, taking into account the price index, grows exponentially, as the charts in Appendix A illustrate.

The charts also show that these problems are not simply the results of tax evasion. The growth in budget income at the end of 1997 did not change the situation. Our model could be answered by the consequences of the arrears in providing an imbalance in the development of the Nizhny Novgorod region, or some other common macroeconomic reason. We should notice that the model admits a solution which corresponds to the isolation of the banking system and manufacturing on the whole, without specifying the separate sectors.

From equations (31), (32), (42), (47), (49)–(52), (57) and (58) it follows that: The supply of the money aggregate M_1 changes and the sum of assets equals the sum of liabilities.

Delays in wages reduce consumption expenditure, *i.e.* households are forced to save (!), and provide credit to the Government; The Government loan is almost equal to the budget deficit.

From equation (49), the bank profit determines r_G as the average yield of T-bonds. If yield r_G is good enough, then banks could, but do not, give credit to manufacturing or trading enterprises ($L^P = L^T = L^F = 0$). In this case, M_1 may not rise if emission is absent and the growth of Government debt is compensated for by the savings (and wage arrears) of households. The main income banks receive comes from Government debt, as follows from equations (49)–(52), and not from loans to the real sector (Φ_K^r).

Let us investigate by using the comparative static method the sensitivity of the function k (16') to changes in the parameters of the model. The results of these investigations are shown in the table below:

Table 6. Influence of the parameters to the loans volume.

Derivative	θ	χ	$r > \Delta$	$r < \Delta$	$r = \Delta$
$\partial k/\partial\theta$	Not affected	Not affected	< 0	> 0	0
$\partial k/\partial\chi$	Not affected	Not affected	> 0	< 0	0
$\partial k/\partial r$	<0	<0	< 0	< 0	< 0
$\partial k/\partial\Delta$	$-\theta\, e^{-\Delta\theta}(1-(1-\frac{r}{\Delta})\chi)+(1-e^{-\Delta\theta})\frac{r\chi}{\Delta^2}$				

From the first order conditions by Kuhn–Takker, the problem of profit maximisation, taking into account barter and delayed payments to

manufacturers, differs from the classical by the component

$$(1-e^{-\Delta\theta})(1-(1-\frac{r}{\Delta})\chi)\,p\,x\,.$$

When k ≡ 1, problems are coincident.

We could formulate the main problem for authorities (at the regional and federal levels) as being to keep the control parameters (particularly r and Δ), where k is close to 1.

From the Table 6, it also follows that the effect on k of delayed payments, with inflation decreasing through a contraction in the money supply, is to provoke a new wave of delays (because of the money shortage) and the resulting inefficiency. This was the path of reform in Russia from 1992 to 1998.

As is known from Поспелов (1996), this model allows stable economic growth with an absence of restrictions on labour and natural raw resources.

In the case of a uni-sector economy, balanced growth exists at any wage rate. In the case of several sectors, the economic effect is proved in following the statement:

At any proportion of initial rates of wages in the different industries, one can choose the scale of the realisation of balanced growth at any given rate. When labour resources are restricted, some special solution existed — "inflation", with prices, wages and the money supply all growing. Real output in this case is constant.

The statement does not hold in the case of delayed payments. We use it for an analysis of the system dynamics. We should notice that the equations hold for the basic solutions for a system which has several sectors.

Qualitative methods indicate the existence of the solution $A = A_0\,e^{\lambda t}$ which corresponds to the exponential growth of delayed payments. It is very close to the statistical data (see Appendix A).

The equations determine the crucial proportions between interest rates and arrears.

$\rho - i - \delta = 0$, where ρ is the rate of deposit interest, i is the inflation and δ is the consumer discounted utility factor. $\chi^* = 1/(1-r/\Delta)$ is the credit norm and $\Delta = i + \delta$. r is the rate of interest. We should consider $\rho - i - \delta > 0$, then $\chi^* > 1$ because $r > \rho$. This means that loans are not

covered by expected gains and cannot absorb savings. Long-term investments could be a solution, but their absence makes long-term stability with positive real interest rates impossible. However, such a quasi-stable situation did exist from 1996 until August 1998. The Government offered GKO (Russian Government debt T-bills) to banks, their yield was provided by their own and borrowed reserves, and thus stability was provided to the financial and consumer markets. This effect has been statistically verified.

Table 7. Parameters of the money market before August'98.

Average GKO yield 1996–1998	Average ρ 1996–1998	Average inflation rate	Discounted utility*
60%	30%	10%	7.5%

* — estimated as the forecasted USD/RR exchange rate. The Government declared in 1997 a currency range with the ruble falling by up to 15% by 2000.

The stability crash (the August'98 crisis) is connected to the practical exhausting of Government reserves.

One of the consequences of the crisis was the sign changing in $\rho - i - \delta < 0$.

Table 8. Parameters of the money market after August'98.

Average ρ in September–October 1998	Average inflation rate*	Discounted utility*
40%	50%	25%

Estimating the average inflation rate, we do not take into account the shocking ruble plunge and the price of the consumer basket at the end of August–September, bearing in mind that it was a transition period. The discounted utility was estimated as the forecast USD/RR exchange rate in 1999 at 23–25 USD/RR.

When $\rho - i - \delta < 0$, households do not save. The bank balance looks like $\dot{B} = \dot{L}$, or $(\chi - 1)\dot{B} = 0$. When $\chi < 1$, $\dot{B} = \dot{L} = 0$ and inflation is absent.

This does not correspond either to the Russian economy as a whole or to the Nizhny Novgorod region in particular. We are considering $\chi = 1$. In this case, inflation and interest rates are positive: $r < i + \delta$. Actually, interest rates are now significantly higher: 90–120% in rubles and 19% in hard currency (EBRD sources).

Arrears affect a manufacturer's profit in the following way. He gets kpY, $k < 1$, $k = 1 - \left(1 - e^{-\Delta\theta}\right)\left(1 - \left(1 - \frac{r}{\Delta}\right)\chi\right)$ instead of pY. The discounts which are widely used in barter relations are easily connected to arrears (see Fig. 5).

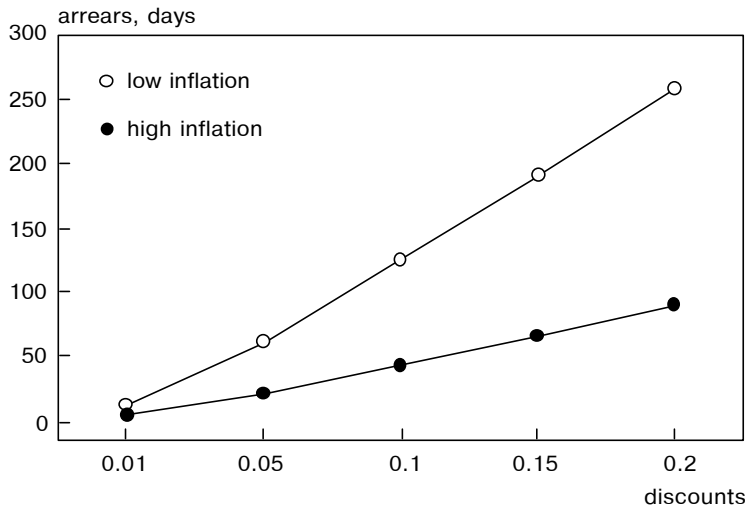

Figure 5. Discounts and arrears.

Therefore, inflation decreases liquid part of payment, resulting in arrears.

Figs 6 and 7 show that liquid part of payments is dependent on inflation in cases of the usual credit arrangements, *i.e.* $r > \Delta$. One can see that, in this case, inflation idecreases the liquid part of payments.

We may improve this situation using preferential crediting; if $r < \Delta$, one can keep the previous share of the liquidity in payments.

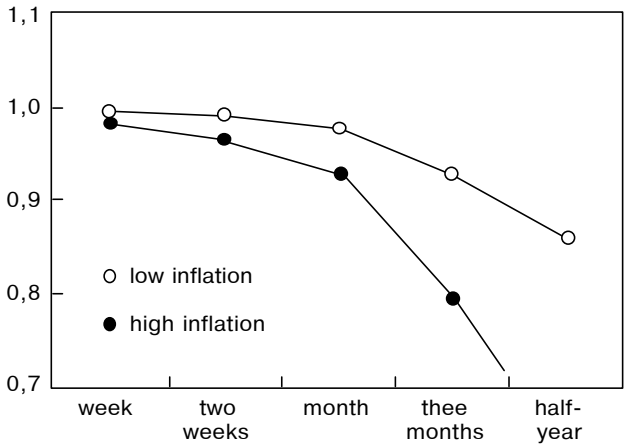

Figure 6. The liquid part of payments k and commercial credits.

The region has no effect on interest rates in the country as a whole, but profitable manufacturing may be provided for by preferential loan arrangements within the region.

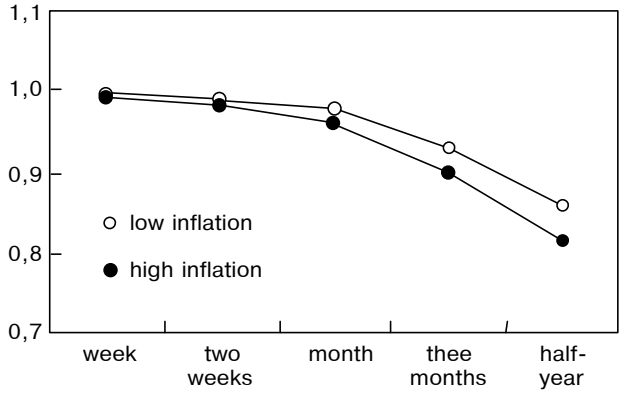

Figure 7. The liquid part of payments k and preferential credits.

6. RESULTS OF NUMERICAL EXPERIMENTS WITH THE THREE-SECTOR MODEL OF THE NIZHNY NOVGOROD REGION

6.1 Initial data and general assumptions

Statistical data shows (see Table 9) that regional budget revenues generally consist of income tax and Value Added Tax (VAT). This paper assumes that the regional budget receives a portion of these incomes, with the remaining portion going to the federal budget.

The "world prices" for crude oil (OPEC prices) are exogenous to the model, whereas internal oil prices are formed at the federal level.

Present inter-regional links are weak and this paper omits the share of inter-regional trade in the regional trade balance.

However, foreign trade is of utmost importance to the Nizhny Novgorod region. Table 10 shows that one of the key foreign partners for the Nizhny Novgorod region is Germany. In this respect, German market data is used to determine "world prices", *i.e.* the export-import prices for the production output of the first and second sectors, the data was obtained from http://www.economagic.com.

Table 9a. Annual budgets of the Nizhny Novgorod region (in bn. rubles and % GRP (Gross Regional Product)).

	1992		1993	
Total revenue	71 695.9	9.7%	761 606	10.78%
Corporation tax	26 248.9	3.5%	420 097	5.95%
VAT	14 245.2	1.9%	69 786	0.98%
Excise duty	3 524.9	0.48%	36 911	0.5%
Income tax	8 786.6	1.2%	102 403	1.45%
Privatisation	1 470.1	0.2%	11 631	0.16%
Property incomes	N/A	N/A	N/A	N/A
Regional taxes	N/A	N/A	N/A	N/A
Land tax	N/A	N/A	N/A	N/A
Regional bonds	N/A	N/A	N/A	N/A

Continued from p. 38

	1994		1995		1996	
Total revenue	2 061 420	10.1%	4 662.5		6 239.4	
Corporation tax	842 350	4.14%	1 700.1	36.4%	116.3	1.8%
VAT	231 701	1.1%	551.9	11.8%	1 011.8	16.2%
Excise duty	57 825	0.28%	137.8	0.3%	164.9	2.6%
Income tax	395 201	1.9%	700.6	15.0%	972.3	15.6%
Privatisation	16 578	0.1%	26.2	0.0%	52.9	1.0%
Property incomes	92 817	0.45%	332.1	7.1%	679.8	10.1%
Regional taxes	N/A	N/A	74.2	N/A	57.3	1.0%
Land tax	25 107	0.1%	N/A	N/A	78.3	1.2%
Regional bonds	26 723	0.1%	N/A	N/A	N/A	N/A

Table 9b. Annual budgets of the Nizhny Novgorod region (in bn. rubles and % GRP (Gross Regional Product)).

	1992		1993	
Total expenses	62 093.1	8.48%	907 121	12.8%
Manufacturing	21 474.8	2.9%	309 588	4.38%
Social expenses	18 864.9	2.5%	288 152	4.0%
Education	8 323.5	1.1%	132 006	1.87%
Culture	N/A	N/A	17 836	0.25%
Public health	N/A	N/A	117 772	1.7%
Public services	1 008.9	0.14%	26 917	0.38%
Law enforcement agencies	N/A	N/A	N/A	N/A
Others	4 251.9	0.58%	35 571	0.5%
Budget deficit	9 602.8	1.3%	−145 515	2.0%

Continued from p. 39

	1994		1995		1996	
Total expenses	2 139 546	10.5%	4 654.2	N/A	6372.9	N/A
Manufacturing	791 206	3.9%	1 540.5	33.1%	2318.3	36.4%
Social expenses	958 216	4.7%	N/A	N/A	N/A	N/A
Education	449 606	2.2%	938.8	20.2%	1365.0	21.4%
Culture	60 237	0.3%	114.9	2.5%	155.7	2.4%
Public health	400 466	1.9%	875.5	18.8%	1181.3	18.5%
Public services	103 554	0.5%	139.0	2.9%	210.0	3.3%
Law enforcement agencies	N/A	N/A	113.1	2.4%	220.9	3.5%
Others	10 557	0.05%	932.4	20.0%	921.7	14.5%
Budget deficit	−78 126	0.04%	8.3		−133.5	N/A

Table 10. Trade partners of the Nizhny Novgorod region.

Export		Import	
Countries	Share %	Countries	Share %
Ukraine	17.00	Kazakhstan	26.26
Latvia	12.98	Ukraine	24.25
Kazakhstan	6.94	Germany	12.46
Belgium	4.56	France	4.17
Finland	4.55	Austria	4.02
Switzerland	4.42	Italy	3.91
Germany	4.15	USA	2.54
Virgin islands	3.93	Finland	2.42
Others	41.47	Others	19.97

Source: *State customs committee of the Russian Federation 1994–1996*

6.2. Numerical results

The result of the calculations is shown below. The third sector (the oil industry) is the leader in price growth. This sector takes up the main share of preferential loans. Qualitatively, the dynamics of cross-liability growth correspond to the statistical data (see Appendix A: Indices of the socio-economic development of the Nizhny Novgorod region.)

In general, privatisation without appropriate investment leads to a decline in manufacturing and a growth in cross-liabilities. This problem is important for the Nizhny Novgorod region. A change of owner has caused several chemical enterprises to do nothing else except file for bankruptcy.

The model also demonstrates an imbalance in developments between the sectors. Following calculations, the model shows that cross-liability

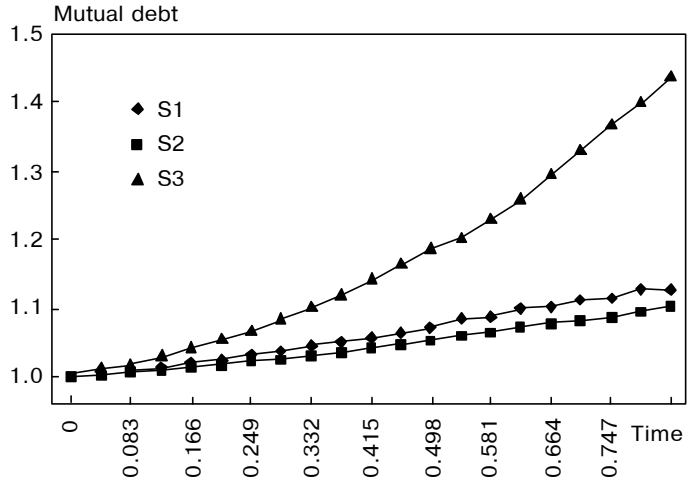

Figure 8. Dynamics of the cross-liabilities between the industrial sectors.

is absent and the debts of the third sector (oil and the raw material industry) grow faster than the debts of the other sectors.

Loans demanded for this sector significantly surpass other sectors.

It is noticeable that exporters of raw materials, as the main users of foreign loans, are interested in the growth of the ruble exchange ratio. On

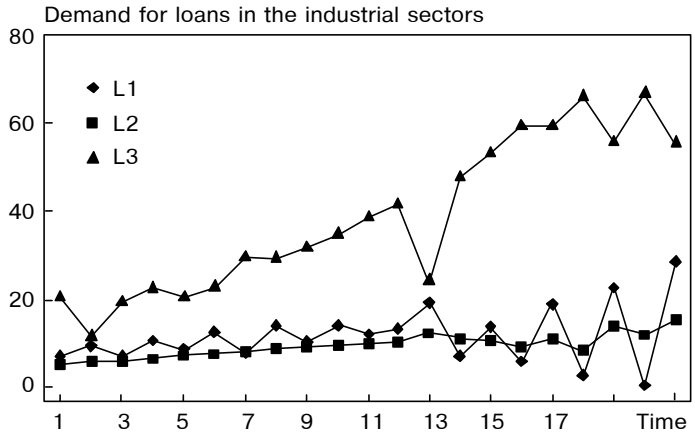

Figure 9. Dynamics of the demand for loans in the industrial sectors.

the other hand, ruble devaluation leads to their hard currency profit growing. This contradiction is emphasised by the instability of the ruble.

It is seen that this instability may results in spikes like that in October 1994 ("black Tuesday"). These facts prove that the model is vigorous and adequate for the Russian economy.

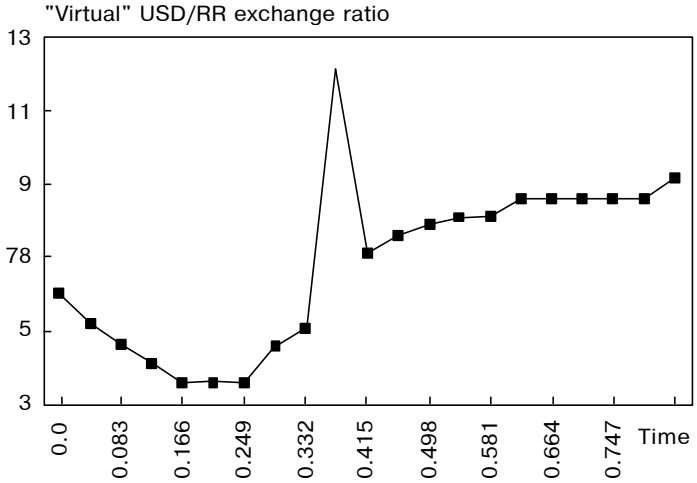

Figure 10. Dynamics of the "virtual" USD/RR exchange ratio.

7. CONCLUSIONS FOR ECONOMIC POLICY

Our investigations show that arrears and money substitutes become latent loans to the Government. Households do not receive funds from the budget and are actually forced to save. This situation keeps consumer prices from rising and pays the government endogenous and exogenous debts to compensate for tax evasion and the inefficiency of production.

Solutions which would provide economic growth by the monetary decrease of inflation (through contractions in the money supply and in working capital) are absent.

The results of the calculations are qualitatively close to the statistical data. However, it is necessary to identify variables for a better quantitative concurrence.

Our calculations and statistical observations prove that the government's monetary policy has to be executed without an exponential growth in the volume of delayed payments, which renders any tax policy absurd.

The Government provoked the last banking crisis. The situation created favourable conditions in which the banks could receive higher profits from the Government's debt without any investment, thus breaking the homogenous balance of "investment-savings". Legal restrictions, to regulate the profitability of Government T-bonds, should be made.

Analysing the behaviour of the model shows the inadequacy of the state's monetary policy as regards the economic conditions at the beginning of the reforms. Together with this, the model offers solutions when reforms continue in a situation of decreasing government debt and growth in the income of the population.

Chaotic privatisation without investment initiative leads to a decline and an increase in cross-liabilities. Our final calculations recommend the participation of the government in a redistribution of the revenues of the oil and gas industries. This participation could ease the imbalance between the development of the sectors.

APPENDICES

A. Indices of the socio-economic development of the Nizhny Novgorod Region

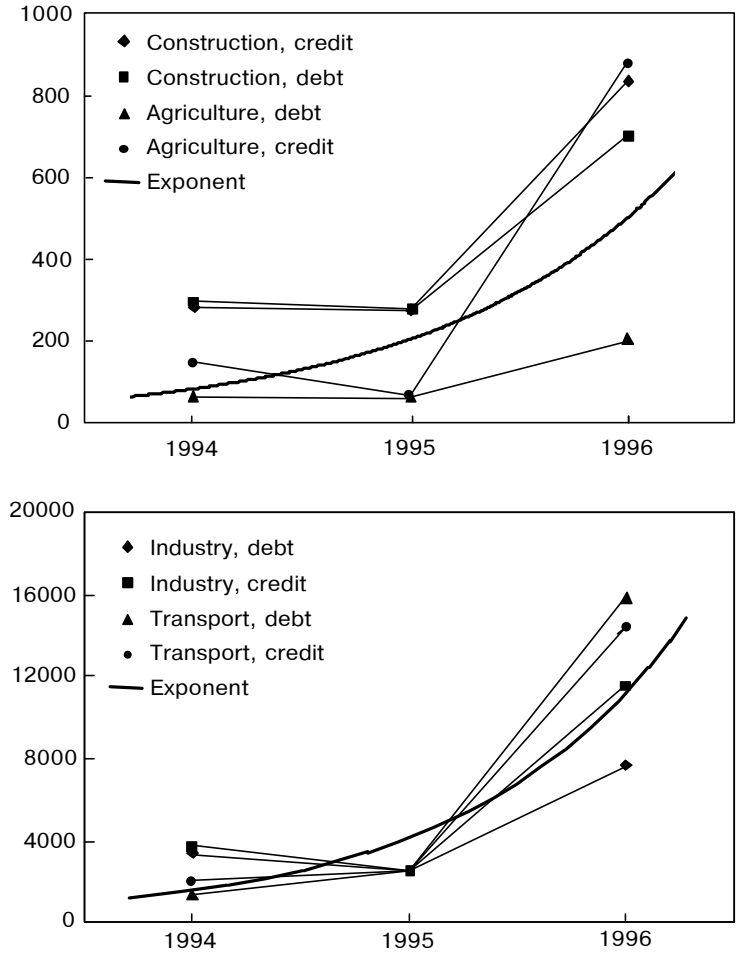

Figure A1. Growth in arrears among enterprises (bn. rubles).

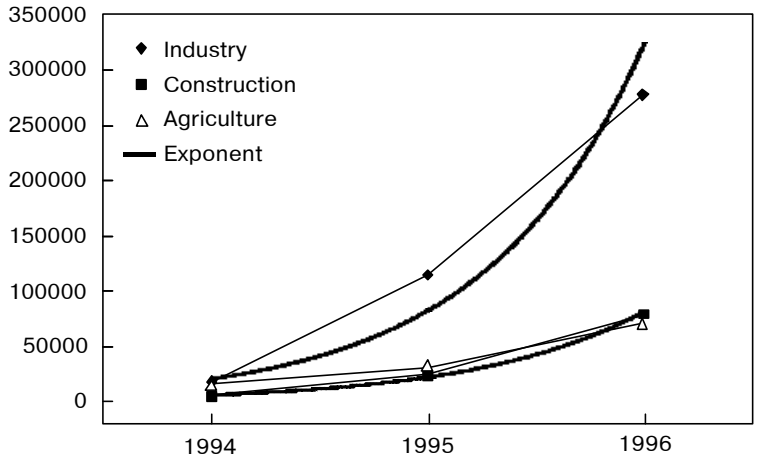

Figure A2. Growth in wage arrears (million rubles).

B. Social Accounting Matrix for the Nizhny Novgorod region (1994–1995)

Data of 1995 shown in brackets.

		Activities	Goods	Manuf. factors	
				L	K
Activities			Interim goods (65 700.0) 83 692.17		
Goods		Interim consum. (30 527.2) 40 326.6			
Manufacturing factors	L	Salaries, gross (8 082.3) 12 353.6			
	K	Gross revenue (2 259.9) 23 826.8			
Economic Agents	Enterprises			(6 542.3) 10 653.6	Profit (6 472.0) 6 917.4
	Population			Salaries (6 542.3) 10 653.6	
	State	Indirect taxes (5 262.5) 8 058.71		Tax (2 905.7) 5 572.8	Corp. tax (915) 1 233.3
Savings					
CIS			Import (422.1) 840.1		
Ext. world			Import (819.5) 2391.4		
TOTAL		Gross payments (66 471.0) 84 565.7	Gross. Consumption (68 831.1) 87 272.12		

Continued from p. 46

		Economic Agents			Savings
		Enterprises	Population	State	
Activities				Subsidies enterprises (771.6) 1 679.7	
Goods		Consump-tion (4 490.9) 4 386.2	Personal consum. (12 927.1) 15 552.2	State con-sumption (1 082.1) 2 227.0	Gross investment (14 801.4) 24 780.1
Manufacturing factors	L				
	K				
Economic Agents	Enterprises	(39 072.6) 62 730.3			
	Population			Social transfers (4 504.8) 5 433.6	
	State	Import (5 180) 7 297.2	Duties (956) 1 572.1		
Savings		Investments (3 343.4) 5 887.6	Savings 2 596.9) 4 499.1	Investments (8 861.1) 14 393.4	
CIS					
Ext. world					
TOTAL		Enterprises spending (52 086.9) 80 301.34	Population spending (16 480) 21 623.4	State Spending (15 219.6) 23 734.1	Gross saving (14 801.4) 24 780.1

Continued from p. 47

		CIS	Ext. world	Total
Activities		Export (1 834) 1 307	Export (5528.7) 4 385.0	Sales volume (73 834.3) 91 063.8
Goods				Average demand (68 831.1) 87 272.1
Manufacturing factors	L			
	K			
Economic Agents	Enterprises			Enterp. Incomes (52 086.9) 80 301.3
	Population			Personal incomes (18 800) 23 745.9.5
	State			State incomes (15 219.6) 23 734.15
Savings				Gross savings (14 801.4) 24 780.1
CIS				Import (840) 1 328
Ext. world				Import (2291.7) 2252.0
TOTAL				

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