Nickolay A.Pecherskykh

Political Economy Interests in The Kern of Input-Output Analysis

Discussion about methods of planning take place through 1927 in Soviet economy literature. S.G.Strumilin, V.P.Milyutin, I.T.Smilga and other 'marxists' insist on method of “inter-sectoral balance” (predecessor of input-output analysis). N.D.Kondratiev, N.P.Makarov and A.V.Chayanov insist on distinction between plan-forecasting and plan-directive as 'system of measures and tools of state influence on elemental development'. Matter of 'balance method' is structure of economy, – they said, – how much will produce every sector in order that all inter-sectoral structure would be balanced in equilibrium, all the production has supply with resources, and economy in total give planned final product. 'Forecasting' here is not 'time-series' or 'trend'. It is out of the time, it is 'control index'. Once, some day economy may get the structure of 'control index', but one would be too self-confident to say that about defined moment. Balance method being quite adequate for plan-forecasting became inadequate for plan-directive, because of economy dynamics depends on 'transitory coefficients' (magnitudes of inter-sector flows). One can't calculate 'transitory coefficients' *a priori*[1]. Even now, problem of 'transitory coefficients' have only technical decision[2]. As a result, economy dynamics is not reliable element of organizing of economy life or social management.

Let Y be vector of final product: $Y = O - I$. It is divided into personal consumption, public consumption and investment of all sectors of economy:

$$Y \to \begin{pmatrix} \textit{private consmption } C \\ \textit{public consmption } G \\ \textit{investition as structure } Inv \end{pmatrix} = \begin{pmatrix} y_{c1} & y_{c2} & \cdots & y_{cn} \\ y_{g1} & y_{g2} & \cdots & y_{gn} \\ y_{11} & y_{12} & \cdots & y_{1n} \\ \vdots & & & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{pmatrix} = \begin{pmatrix} k_{c1} y_1 & k_{c2} y_2 & \cdots & k_{cn} y_n \\ k_{g1} y_1 & k_{g2} y_2 & \cdots & k_{gn} y_n \\ k_{11} y_1 & k_{12} y_2 & \cdots & k_{1n} y_n \\ \vdots & & & \vdots \\ k_{m1} y_1 & k_{m2} y_2 & \cdots & k_{mn} y_n \end{pmatrix}$$

Here y_{ij} is 'consumption' of product *j* in sector *i* (productive sectors 1...m and 'joint' sectors of public and private consumption); y_i is stock of product *i* in the final product; k_{ij} is share of product *j* which come to sector *i* (transitory coefficient), $\sum_{i=c}^{i=m} k_{ij} = 1$ for every product *j*.

It is obviously, that *dynamics* of economy depends on distribution structure $\boldsymbol{K} = \{k_{ij}\}$ (transitory coefficients matrix), but it is not stable. Today we have two ways of predicting dynamics, both normative. Von Neumann method shows maximal rate of growth[3] (and $\boldsymbol{K}$ which correspond to that rate), but only presupposition that structure of economy is constant and external limitations absent.

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1 Кондратьев Н.Д. План и предвидение (К вопросу о методах составления перспективных планов развития народного хозяйства и сельского хозяйства в частности). // Пути сельского хозяйства, 1927, № 2 (20), с.3-36; Макаров Н.П. Некоторые очередные вопросы методологии составления перспективных планов по сельскому хозяйству). // Пути сельского хозяйства, 1927, № 2 (20), с.37-44; Челинцев А.Н. К вопросу о методах и принципах составления перспективных планов по сельскому хозяйству. // Пути сельского хозяйства, 1927, № 2 (20), с.45-82.

2 The future of the world economy: A United Nations study : Wassily Leontref et al. New York: Oxford University Press, 1977. vii + 110 pagesю

3 Morgenstern O., Thompson G.L. (1976). *Mathematical theory of expanding and contracting economies*. Lexington Books. Lexington, Massachusetts: D. C. Heath and Company. pp. xviii+277.

Both conditions wittingly do not fulfilled. In “The future of the world economy” Wassily Leontref et al. introduce $\boldsymbol{K}$ matrix evidently and show which it should be in order to get such a development when rich countries structure of economy is the future for the structure of poor countries. Both case, $\boldsymbol{K}$ is to be calculated which it should be in order to (get some form of growth).

of These paper put forward a hypothesis that one can predict $\boldsymbol{K}$ in the next way. Let $\boldsymbol{K_0}$ be $\boldsymbol{K}$-matrix at some fixed period of time (or at moment of time). Then change of $\boldsymbol{K}$ at the next moment (or period) $\nabla \boldsymbol{K} = \begin{vmatrix} \frac{\partial k_{11}}{\partial t} & \cdots & \frac{\partial k_{1n}}{\partial t} \\ \vdots & & \vdots \\ \frac{\partial k_{m1}}{\partial t} & \cdots & \frac{\partial k_{mn}}{\partial t} \end{vmatrix}$ depends on interest of subject of economy. If subjects of economy have 'propensity for investment' into a sector of economy *i*, than respective k_{ij} will increase in proportion reverse to 'resistance of adaptation'.

Lets have an excursus into interest of subject of economy.

Firm as well as household 'have needs', and it's holder is the subject of the needs. He thinks himself in some way as having these system of needs. Holder bear care of his economic entity.

Concept of 'need' consists of two attributes: magnitude of consumption and tension of need. Magnitude of consumption is a consequence of economic activity, as well as magnitude of production is. One can easy calculate it from input-output model of economic activity. Tension of needs, in its turn, manifests itself as evaluation of activity (productive and consumptive simultaneously). So, it is consequence of economic activity and in the same time of system of value of subject. Economical subject (*homo economicus*) did not seek for maximum property[4]. He decide: which species of activity to intensify, and which to cut down? To which species of activity dedicate limited recources? For which species of activity attract resources, from which extract resources? And doing so he compares measure of values both production and consumption. Hegel said that assumption possession has three forms: production of thing, consumption of thing and 'symbolic manifestation' of possession. Significant, that 'symbolic manifestation' have place only out-of-the-way.

Consequence of the 'limited rationality' do not consist in some irrationalities, but in dynamics. At given moment subject may be not in equilibrium. His interest may be not in maximum. The problem is not to be taken off by taking on average. One subject take more than equilibrium asks, another take less. So both have rate of interest lower than in equilibrium state. Representative subject should have means in equilibrium and rate of interest in maximum. Average subject will have means in equilibrium and rate of interest lower than maximum. Real subject will sensate if not understand his deviation from equilibrium as external force which constrain him to change business state. Here should be mentioned that J.M.Keynys in “General Theory” introduces together risks with propensities – to consume, to save and to invest, as well as 'frictions', but only frictions on labor market.

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[4] Maximum property magnitude is an *evaluation* of possessed things.

Let F be vector of production program, with m components, each represents one form of activity. Let $O=\boldsymbol{C}F$ and $I=\boldsymbol{A}F$ be vectors of output (production) and input (consumption) respectively, with n components representing species of resources (measured in natural indexes). Matrix of production $\boldsymbol{C}$ and of consumption $\boldsymbol{A}$ would be of $n\times m$ dimension. Final product would be $Y=\boldsymbol{O}-\boldsymbol{I}=\boldsymbol{C}F-\boldsymbol{A}F=(\boldsymbol{C}-\boldsymbol{A})F$.

Interest of capitalist enterprise[5] is profit m, which is to be calculated as total income minus sum of costs:

$$m=Y*P=\sum_{i=1}^{n} y_i p_i=\boldsymbol{O}*P-\boldsymbol{A}*P=(\boldsymbol{C}F-\boldsymbol{A}F)*P=((\boldsymbol{C}-\boldsymbol{A})F)*P$$

Here m is profit, P is price vector, p_i is the price of i resource, * is the sign of scalar product.

Chayanov said interest of labor farmer to be of another type. Making more output laborer in his own farm spend more labor (or his own working power) and get 'increasing bear of labor'. Trading his final product he get income but evaluate that income by it's utility (for consumption), by it's capacity to enjoy his needs and needs of his family. Equilibrium will be at point when marginal bear of ladour balance marginal utility of income[6] Could we co-measure 'bear of labor' and 'utility of income' in such a way really? Yes. 'Bear of labor' is increasing tension of needs in it's matter. 'Utility of income' is decreasing tension of needs: marginal utility of income is the utility of goods which subject can bye by it, and the last is rate of decreasing of tension of needs.

Sufficiently, that costs, income and profit (in money) have no independent value for subject of that type. Money have value only in relation to 'bear of labor' and 'utility of income'. Labor subject can co-measure them even if money and trade have no place.

J.Kornai described third type of economical subject[7]. Interest of factory in centralized economy system of Soviet type determined as total sum of 'wal' $w=O*P=\sum_i o_i p_i, w\to max$ where output O is restricted only by deficit Z (P is here price vector). This type of interest construct and contain it's own contradiction: on one hand more program – more output and more 'wal', on the other hand more program – more louses (not only costs!) because of deficit (first of all deficit in machinery). Kornai does non formulate respective 'limit theorem', but it is possible. But as well as in previous case, form of interest differs from capitalist, which 'neoclassical mainstream' pre-assume only. In particular, inputs and costs have no meaning for that type subject[8].

'Limited rationality' of economical subjects mean and presuppose that at given moment of time every subject haves state different from optimal (equilibrium). In general, for every type of economical subject interest is function of output O, input I, program F, technologies $\boldsymbol{A}$ and $\boldsymbol{C}$, prices P, stocks R, deficit Z and χ as of parameters of economical state: $h=h(O,I,F,\boldsymbol{A},\boldsymbol{C},R,P,Z,\chi)$. Some of that

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[5] And so is interest of capitalist as individual personifying interest of enterprise.

[6] Чаянов А.В. Крестьянское хозяйство. – М., 1989.

[7] Корнаи Я. Дефицит. – М., 1990; Kornai J. Anti-Equilibrium. – Budapest, 1971; и др..

[8] Inputs and costs for Soviet type factory, as well as income for labor farmer have only intermediate meaning. Those meanings consists in determining relation to other variables, meaningful immediate. One may exclude variables of inputs and costs (income, respectively) out of formula of interest.

parameters subject controls immediately (program, input, output), other controls relatively (technology coefficients – through input or output substitution), third (prices and deficit) – subject take or affect only as market categories. 'Global rationality' presuppose that subject choose such values of controlled parameters, which maximize *h.* Let it be (for competition market case) $h_{max}=h(O_{0,}I_{0,}F_{0,}\boldsymbol{A_0},\boldsymbol{C_0},R_{0,}P(t),Z_{0,}\chi(t))$ (here $O_{0,}I_{0,}F_{0,}\boldsymbol{A_0},\boldsymbol{C_0},R_{0,}Z_0$ is 'optimal values' of parameters under direct or relative control of subject, and $P(t),\chi(t)$ is parameters of market). 'Limited rational' subject's state at every moment of time differs from optimum: $\Delta O=O(t)-O_{0,}\Delta I=I(t)-I_{0,}\Delta F=F(t)-F_0$, etc. 'Limited rationality' means, that mathematical expectation of $\Delta O=0,\Delta I=0,\Delta F=0$ for total distribution of subjects in average, and 'rational expectation' means that difference is dependent on previous state: subject choose parameters optimal to state to some previous moment or to previous dynamics. In both case, 'average subject' have interest rate deliberately lesser than for 'representative subject':

$$h_t=h(O(t),I(t),F(t),\boldsymbol{A}(t),\boldsymbol{C}(t),R(t),P(t),Z(t),\chi(t))<h_{max}=h(,O_{0,}I_{0,}F_{0,}\boldsymbol{A_0},\boldsymbol{C_0},R_{0,}P(t),Z_{0,}\chi(t))$$

Subject have 'mistake right' not in sense of transcendental irrationality, but in sense of relativity of truth. Economical decision procedure is trancended by information about economical situation in quantity, but not in essence. 'Representative subject' (parameters are average) coincide with optimum in case of 'limited rationality' or lag in case of 'rational expectation'. If one integer his state by the time, 'representative subject' turns out as optimal. But 'average subject' (rate of interest is average) have interest rate lesser that it would have place with 'representative subject'.

Individual economical subject may be at given moment of time *not in equilibrium.* His interest may have lesser rate than maximal. Distribution integrating does not solve these problem: individual variations do not mutually compensates when we construct 'representative subject'. Every individual subject will fill (or may be – understand) his variation from equilibrium as force, which enforce him to change situation, or as 'propensity' to some economical action.

Hamilton operator of interest function gives optimal direction of economical adaptation (for individual subject):

$$Mh(t)=\nabla h(t)=Mh(F(t))=\left(\frac{\partial h}{\partial(f_1)},\frac{\partial h}{\partial(f_2)}\ldots,\frac{\partial h}{\partial(f_n)}\right)$$

Here differentiation is by components of program (other parameters of state depend on program). Marginal operator *Mh(t)* give optimization gradient, vector (direction) of optimal adaptation for activity of individual subject in given economical situation. Laplace operator of interest function gives magnitude of increment of interest rate, if subject decide to change activity in optimal direction:

$$\Delta h(t)=\Delta h(F(t))=\left(\frac{\partial^2 h}{\partial(f_1)^2}+\frac{\partial^2 h}{\partial(f_2)^2}+\ldots+\frac{\partial^2 h}{\partial(f_n)^2}\right)$$

Subject make decision to act, if he feel intuitively or understand rationally that he can get sufficient increment of *h*, or do nothing, if gradient display invisible.

These two operators together determines (in quality and in quantity) economical subject propensity for adaptation – term, which is elaborated too weak by economists. In quality (not in quantity) economy treat macro-economical

propensities to save, to consume, to invest, liquidity preference, inflation expectations, etc. Economists ordinary presuppose every that macro-parameter to be an aggregate of micro-parameters of individual actors, but ordinary as well, Keyns began, one reserve that micro-parameters are not observable most likely.

Propensity for adaptation is motive and intension of economical subject. It is, of course, only marginal value, only utility of changing of program. But it is quite enough for ordinal calculating values without 'constant needs and preferences' (i.e., that is the way for integrating into theory consumer's preferences and tastes as results of consumer's previous activity).

Such an approach should reverse up down use of well known concepts. For instance, propensity of firm - price-taker (capitalist) for production growth should depend on difference between price and limit cost; propensity for extending use factor should depend on difference between limit efficiency and factor price (both are inter-dependent with propensity of changing program). Naturally, that limit cost or limit efficiency are equal to prices in case of optimal equilibrium, and then no propensity exists. *But that is the very thing which has no meaning from the point of micro-economy dynamics.* What is meaningful that the equilibrium have place not for every subject; meaningful that almost every subject 'have propensities', though, may be, in average of subjects mass this propensities annihilate.

As well as, analysis of 'term of machine employ' [9] is in its matter limit model of 'propensity for investment'. Machinery and Labor substitute each other. Capitalist subject have 'term of machine employ' in such output magnitude when cost of product unity (taking in view quality of product and interest per capital) became equal to cost of hand-made. Consequently, capitalist subject's 'propensity for investment' depends on market volume nonlinear, with threshold. Term of machine employ corresponds to equilibrium; obviously, propensity for employ machine is so large, so situation is far from equilibrium.

Macro-economy propensity of adaptation is aggregate of individual propensities of all subjects. Methodology of such aggregation have it's own problems – in particular, macro-economy propensity is not mere sum of individual propensities. Economical mechanism or order (subject as well as market) is to be taken in account. Here order of market may have more meaning, than market itself. One can't reduce information flow between subjects of market to 'factors' of cost or production.

In individual situation Laplacian of interest shows the 'force' of propensity. Subject feel or understand this 'force' as enforcement by his interest for economical adaptation. But how accurate will he choose direction of that adaptation and how energetic will he fulfill measures of the adaptation? That depends not only on 'force' of subject intension, but else on 'friction in process of adaptation' (Kornai term). Economical mechanism of market and of subject himself is not ideal. Effect of machine for capitalist enterprise, rent per capital, may have 10% or 100% size, effect of production some good in family household (increase of degree in needs enjoy) may have the same 10% or 100% size, but subject still should organize and fulfill

[9] It is standard for Marxism and post-Marxism: Маркс К. Капитал. Т. 1. - М., 1978, с. 398-406; Чаянов А.В. Очерки по экономике сельского хозяйства. - М., 1923, с. 69-75; Политическая экономия. Т.1. / Под ред. Румянцева А.М. и др. - М., 1977, с. 148-149; A.Marshall have analogous proposition in long-term equilibrium theory (with other name); I.Schumpeter have it in theory of innovation efficiency.

respective measures in action. Subject should not feel only, but understand need for adaptation, should make a decision about measures of adaptation, should get resources and fulfill measures. All that take time, which costs 'more than money', i.e. one can't evaluate it in no one system of values.

Analyzing stock of resources and deficit at the product market, J.Kornai named as factors of 'friction' supplier's mistakes in demand forecasting, demand variations, misinformation of customer, supplier's adaptation lag and rigidity. He shows that in consequence of all these factors market has in the same time both reserves (surplus) and deficits of resources[10]. Walras equilibrium with zero volume of reserves (surplus) and deficits would be possible or in free market equilibrium or in ideal planned system. “But in actual reality there is not a system, in which adaptation take place fully without friction. Friction is market mechanisms, as well as in centralized systems of state planning and management. True, matter and nature of friction in that systems highly differs. Every type need to be studied separately. But no one is prefect by the point of achievement of situation when $w^*=0$"[11] (w^* - "normal" friction, as Kornai write – N.P.) Say formally, to calculate dynamics (velocities of adaptation) $\frac{df_j}{dt}$, one should $\Delta h(t)$ “divide” on W^* (vector of friction parameters), correspond gradient of interest to friction parameters of adaptation mechanism.

Such “the adaptation friction” necessary differs by essence from ordinary concept of “transaction costs” and should be opposed to it. Last is always an 'ad hoc' hypothesis mobilized to save theory in a field when it is not applicable. Concept “transaction costs” presuppose 'friction' to be evaluated adequately, for instance, in some sum of money. Consequently, one may again think about economy behavior as 'equilibrium': 'agent tends to global optimization' which include 'as well' transaction costs. In opposite, 'adaptation friction' concept means that 'limited rational' subject tends to local optimization, and moves in that direction with some velocity, probably never get an equilibrium.

Undoubtedly, 'bars' of different nature are real in economy, and they split market into local segments and prevent general equilibrium. Money and natural costs of transport, formal and informal borders of local communities really exists and act in economy. But relaxation process are real as well, subjects of economy are adapting to changing conditions.

'Market frictions' in the sense 'transactional costs' is a settled use of words. Aim is statical – to analyze equilibrium on connected markets. Aim determines method, method determines absence of dynamics and relaxations in a model. One describe 'market friction' as 'height of bars', naturally that 'levels in basins' depends on 'height of bars'.

E.Fehr and J.-R.Tyran use term 'frictions' just in the same way[12]. But as they explore effect of lasting in time inertia of nominal price after 'monetary shock', and that effect is of dynamic and relaxation, their results put us in front of model 'propensity – adaptation friction'. May be, to distinguish 'adaptation friction' from

[10] Корнаи Я. Дефицит. - М., 1990, с. 173-197 (Kornai J. Deficit – in Russian)

[11] Ibid., p. 197.

[12] Fehr E., Tyran J.-R. Does Money Illusion Matter? // The American Economic Review, Dec. 2001, V. 91, № 5, p. 1239-1262; Fehr E., Tyran J.-R. Limited rationality and strategic interaction: the impact of the strategic environment on nominal inertia . //Econometrica, vol. 76, no. 2 (march, 2008), p. 353–394 .

'market friction', the first would be named in another way, for instance, 'resistance', on the base of analogy to electrical chains, which is to be interpreted below.

Fehr and Tyran modeled monetary shock in price-setting games. Purpose of all experimental study was to isolate 'money illusion' (in second study – 'money illusion' and 'anchoring'). "In our context, – write Fehr and Tyran, – money illusion means that subjects take nominal incomes as a proxy for real incomes, implying that they prefer price vectors that yield high nominal incomes. Subjects with money illusion thus tend to resist a general reduction in prices because it is associated with lower nominal incomes. Anchoring means that subjects start adjusting their behavior toward an optimal or correct solution from a salient reference point, or anchor."[13] In first paper they conclude: "In particular, we show that after a fully anticipated negative nominal shock, long-lasting nominal inertia prevails, even if informational frictions, costs of price adjustment and staggering are absent. Our results indicate that the direct and indirect effects of money illusion are the major determinants of this long-lasting nominal inertia. We show, in addition, that money illusion causes much less nominal inertia after a fully anticipated positive nominal shock. This result is reminiscent of the Keynesian proposition that downward wage rigidity causes asymmetric responses to monetary shocks"[14]. In second study, strategic complementarity and substitution was tested in addition, and conclusion was: "Our results show that the strategic environment indeed plays a decisive role. Under strategic complementarity, long-lasting nominal inertia prevails after the monetary shock. This result contrasts sharply with behavior under strategic substitutability where adjustment is extremely rapid. In fact, we cannot reject the hypothesis in the substitutes treatment that nominal prices are instantaneously in equilibrium after the shock, while the hypothesis of equilibrium play can be rejected for 8 periods in the complements treatment. We can also show that these treatment differences are driven by the fact that price expectations are very flexible in the substitutes treatment and very sticky in the complements treatment. These results suggest that the distinction between complementarity and substitutability is critical for understanding the nature and the extent of nominal inertia"[15].

Volume of money in currency change, purchasing power change in reverse direction, and nominal prices is to change with volume of money. But even in game, when subjects have fool anticipation of the shock, - 'correction', 'adjustment' (adaptation) to new level of purchasing power is a *lasting-in-time process* with relax form, as one may see in pictures from Fehr and Tyiran papers: nominal prices asymptotically relax to 'real' level in post-shock situation. Remarkable, that velocity of adjustment is directly proportional to difference between 'nominal' and 'real' prices (which act as propensity for adaptation at given moment of time). It should be also in reverse proportion to constant measure of 'friction' or 'resistance' in process of adaptation.

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[13] Fehr E., Tyran J.-R. Limited rationality and strategic interaction: the impact of the strategic environment on nominal inertia . //Econometrica, vol. 76, no. 2 (march, 2008), p.355-356

[14] Fehr E., Tyran J.-R. Does Money Illusion Matter? , p. 1239.

[15] Fehr E., Tyran J.-R. Limited rationality..., p. 356.

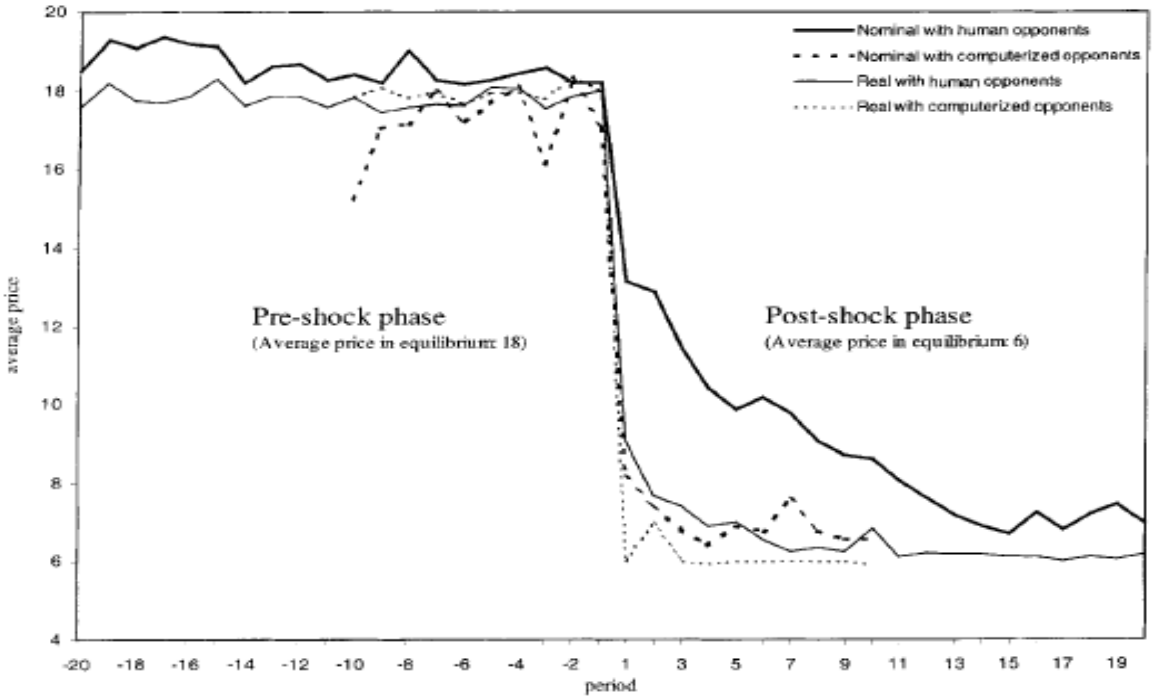

FIGURE 1. “EVOLUTION OF AVERAGE PRICES” from Fehr E., Tyran J.-R. Does Money Illusion Matter? // The American Economic Review, Dec. 2001, V. 91, № 5, p. 1251. Horizontal axis shows time steps. Equilibrium price before shock is 18, after shock become 6. Form of curves is character decreasing exponent. Velocity of decreasing differ as condition of adaptation differ.

'Resistance' sufficiently differ in situations of 'negative shock' demanding cut prices and 'positive shock' demanding price growth. It is meaningfully large in first situation. Form of relax curve is similar to electrical relaxation in electrical CR chain: condenser C charge to some tension and than relax through resistor R. Tension and current in chain decrease by exponent.

These 'resistance' or 'friction in adaptation process' have nature of economy (organization and behavior), not of technique and stuff[16]. Resistance arise from market mechanism, from way of decision making, and nor from production function, technology or costs, even of transaction costs. As Fehr and Tyran write: “However, there is a strong a priori argument that money illusion is likely to affect the adjustment process of an economy after a fully anticipated monetary shock. This argument is based on the simple fact that in an interactive situation the failure of some agents to fully adjust to the nominal shock will, in general, provide incentives for other agents to not fully adjust to the shock, either. Thus, there may be a snowball effect that causes less than full adjustment for a prolonged period of time"[17]. Adaptation of activity to negative monetary shock means to cut prices. Cut

[16] Technique and stuff aspects of the friction consist, in particular, in working process time and time of machinery exploitation. To increase some form of activity, stock of resources need to be collected. Factory need to montage equipment, collect stock of materials, train personnel. All that need time – days, month' or years. Reverse instant is disinvestment. Sector having capital over-accumulation, too large machinery and equipment, conjuncture would non improve with bankruptcy of some enterprises. Sailing enterprise with price little as it would be, machinery and equipment still make bad conjuncture. Wear and tear of equipment or dismantle are in need, and these process' obviously are in-time.

[17] Fehr E., Tyran J.-R. Does Money Illusion Matter? // The American Economic Review, Dec. 2001, V. 91, № 5, p. 1241.

is rational behavior – one not cut prices, one loose market at the end. Competitors will win him. But one cut price first, probably, win nothing if other cut price at the end. He would loose by sum of sale. Maximal benefit wold be strategy to cut prices with other. J.Haltiwanger and M.Waldman named 'nonrational' the subjects who lag with adjustment, named 'strategical complementarity' the situation, when every subject have intention to (interest in) follow other, and write that small part of nonrational subjects may have a grate impact for adjustment to equilibrium[18].

Meaningfool, that inflation monetary shock does not cause such lags, because of long-term rationality to adjust 'at the end' and short-time 'intension' to have higher price before competitors act in the same direction. 'Adaptation friction' appears lesser, adaptation occur quickly, but have the same relax form of curve. In addition, Fehr and Tyran papers show difference between situations when players are only real people and when real human play against computer 'opponents' (completely rational). In last case adjustment occur quickly (resistance to adaptation is lesser).

Data from the first paper of Fehr and Tyran[19] are sufficient to calculate adaptation resistance on average by games type. In the FIG.1 above, difference between pre-sock and post-shock phase is 12; it should be taken as tension of propensity. Velocity of price decreasing proximate with exponent $y_t = y_0 m^t$ (m is parameter relative decrease velocity). m is connected with resistance by relation $m = 1 - \frac{1}{w}$. Curve RC from FIG.1 (real price information, computerized opponents) corresponds to resistance w from 1 to 1,05 (computation procedure is sensitive to little difference from zero; Fehr and Tyran data series have one number exactly 6,0; zero difference make the result do not reliable). Adjustment take 1 step properly. Curve NC (nominal price information, computerized opponents) correspond w=5,77; curve RH (real information, human opponents) correspond w=4,84; curve NH (nominal information, human opponents) correspond w=8,84 and slowest adjustment. Obviously resistance of adaptation depends on completeness of information and way it is presented.

Experimental design of Fehr and Tyran study allows to show more effects. Contradiction between propensity for and resistance to adaptation generate relax process. The same contradiction in situation of uncertainty should generate relax process with damping oscillation. Formally such a process have w of a complex magnitude: real part corresponds to relaxation and dumping, imagine part correspond to oscillation. It is easy ti introduce uncertainty: subject would recognize magnitude and direction of the propensity only by results of his action. Experimenter may tell players only moment of changing money volume and let them calculate themselves direction and volume of change. Degree of oscillation and imagine part w should increase with uncertainty. It should be minimum if players are given with moment, direction and magnitude of changes; some more, if moment and direction is given, but not magnitude; big, if only moment is given; maximal, if players have to determine moment itself. Some uncertainty present in situation of full anticipate information: every player do not know way of adjustment of other players. These

[18] Haltiwanger J., Waldman M. Rational Expectations and the Limits of Rationality // American Economic Rewiew, 1985, June, V. 75 (3) pp. 326-340.

[19] Fehr E., Tyran J.-R. Does Money Illusion Matter?, pp. 1250, 1256.

uncertainty increase if players are 'limited rational'. In first paper Fehr and Tyran average results in such a way, that oscillation hidden. In second paper oscillation occurs in one computational simulation.

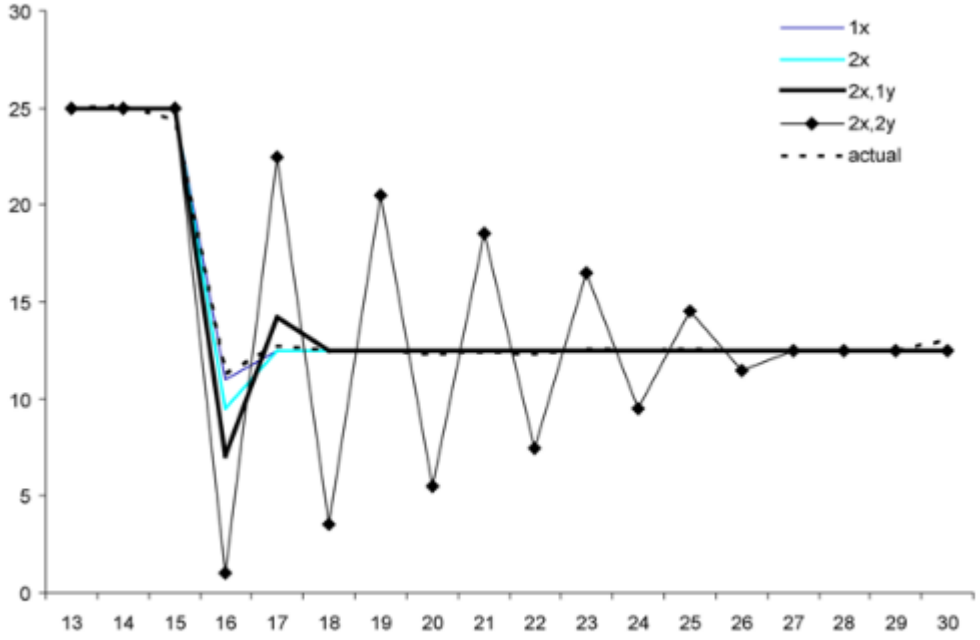

FIGURE 7A.—Simulations of price adjustment with varying numbers of adaptive players in the substitutes treatment (ST).

Figure 7A from: Fehr and Tyran, Rationality and strategic interaction, p. 380.

“Figures show simulations of price adjustment in the context of the two main treatments of our price-setting game. The simulations are based on the parameters of the post-shock phase and the assumption that equilibrium has been reached in the pre-shock phase. We simulated post-shock price adjustment for different assumptions about the shares of rational and adaptive players. For simplicity, the simulations assume that the adaptive players have fully adaptive expectations, that is, they expect the last period’s average price to prevail in this period as well. Either money illusion or anchoring could easily cause adaptive expectations because money illusion tends to inhibit the adjustment of expectations after a negative monetary shock and anchoring is naturally associated with sticky, backward-looking expectations. In the simulations, the rational players are also assumed to know the share of adaptive players and they also correctly anticipate the adaptive players’ price choices. In Figure 7A, for instance, the graph associated with (2x 2y) is based on the assumption that both x types and both y types in the group exhibit fully adaptive expectations in the ST. The graph shows that we should observe a cyclical adjustment pattern with large amplitudes, and full adjustment would only be reached in period 27”. (p. 379-381). Another sets of players in simulations does not show oscillations or 'cyclical adjustment'.

If games will show complex resistance, it would be verification of 'propensity – resistance' model of dynamic. Real dynamics shows many 'waves' and 'dumping oscillations', but at that moment we have no method to predict and differ both propensity and resistance.

E-mail: petcher@list.ru