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Janos Kornai: a non-mainstream pathway from economic planning to disequilibrium economics

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Abstract
This paper first positions Janos Kornai in the controversies about the feasibility of socialist planning (Lange, Hayek). Kornai has leant in favor of Hayek's thesis contending that, without an actual market price system for conveying information to those who can beneficially use it, a socialist economy is impracticable. The paradox is that Kornai worked at the Computer Centre of the Hungarian Academy of Sciences in relation with the Planning Institute of the National Planning Office and conceived an algorithm for decentralized two-level planning, *i.e.*, the best improvement ever brought into Lange's model of market socialism. This is due to Kornai being also involved in actual dysfunctions of central planning in Hungary (shortages) that he eventually theorized with disequilibrium modelling in his *Economics of shortage*. However, the latter departs from standard disequilibrium economics (Barro–Grossman) which has been joined by most former planometricians (such as Malinvaud for instance). Eventually Kornai adopted a more institutional approach for his recommendations as regards post-communist transformation into a market economy with a Hayekian flavor, in particular his support to an organic development of a privately-owned sector within a gradualist process instead of mainstream-supported overnight privatisation. His recent analysis of capitalism as a surplus economy shows the continuity of his non-mainstream view of disequilibrium over five decades. All this makes Kornai an original front-running researcher and breaking-through analyst, though somewhat paradoxical, and a quasi-heterodox economist, one foot in and one foot out of the mainstream.

Keywords Walras *tâtonnement* · Disequilibrium · Market socialism · Decentralized planning · Planometrics · Fixed prices · Shortage · Coordination mechanism · Infra-microeconomics

JEL Calssification B13 · B23 · B24 · C61 · D50 · D80 · O21 · P21

Kornai's approach to central planning is associated closely with the practical course of his life. He was employed at the Computer Centre of the Hungarian Academy of Sciences, where he had working relations with the Planning Institute of the National Planning Office.

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He should have been a fan of Lange's model of market socialism, but in the Hungarian context he had leaned toward Hayek's focus on the informational barriers to central planning. He co-authored the best algorithm for decentralized planning. The algorithm was not able to converge to the optimal plan in due time and eventually became useless when substantial economic reforms were introduced in Hungary. Then Kornai provided a theory explaining recurrent dysfunctions of Soviet-type planning and elaborated a model of economic disequilibrium at a time when it was demonstrated that general equilibrium (GE) theory relies on assumptions about demand functions that do not guarantee the attainment of Walrasian equilibrium, but he did not join mainstream disequilibrium economics. Kornai often took a heterodox approach that made him an original and pathbreaking, though sometimes paradoxical, economist.

1 Is centrally planned socialism practicable?

Kornai (1959)[1] first studied the dysfunctions[2] of the national plan in Hungarian textile industry. Working later in relation with co-workers at the Institute of Central Planning, he conceived one of the most famous mathematical models for decentralizing central plan elaboration. The former circumstance should have made him an admirer of Hayek advocating the impracticability of socialist planning while the latter was a follow-up to Lange's model of market socialism.

1.1 The neoclassical debate on the economic feasibility of socialism

Some neoclassical economists contended that a collective ownership economy organized by a central planner could reach an optimum identical to that of a market economy. Pareto (1906) stated that in a collectivist economy prices and interest rates may vanish as real entities, but will survive as accounting units without which the central planner will be blind and unable to organize production. Barone (1908) argued that without prices the planner can allocate national resources across producers after a trial and error calculation of equivalence ratios between the various resources and between the various products and between products and resources, i.e., the dual shadow price system of the production program. Such a planner behaves like a Walrasian auctioneer in solving the system of equations linking all resources and all products; it would be gigantic work but not impossible. All additional pro-socialist literature retained the idea that a centrally planned economy (CPE) is capable of reaching a welfare optimum and is rationally practicable.

The feasibility of a socialist economy came under severe fire, beginning with Mises's (1920) attack concluding that socialism is the abolition of a rational economy. However, Robbins (1934) admitted that Barone's optimum can be confirmed by solving a series of mathematical equations "on paper" but contended that the solution was unrealistic. Hayek (1935) echoed Mises's conclusions and added another: rational economic calculation is impracticable in such a system. In a society without consumer freedom and free choices

[1] Gregory (2020) summarizes this English translation of Kornai's Ph.D. dissertation in this special issue.

[2] Hungarian enterprises were not fulfilling their plan because of weak incentives and dysfunctional bureaucratic relationships with central planners. Plan uncertainty was sustained with repeated plan revisions; inconsistent planning quantitative indicators were drifting into input shortages.

of occupations, the allocation problem in principle can be solved on the assumption of complete knowledge of all relevant data, but that is "humanly impracticable and impossible" (Hayek 1935, p. 208). Finding a solution would require statistical enumeration of concrete information about millions of commodities and their technical properties, along with solving hundreds of thousands "simultaneous differential equations, a task which, with any means known at present, could not be carried out in a lifetime" (ibid., p. 212). Even if the central planner has access to all relevant information at time *t*, he has no information about future economic development over the central plan's time horizon. Price fixing on that basis, though conceivable, is utterly impracticable, Hayek concluded. The practical unfeasibility of central planning became the mainstream's warning about Soviet-type economies until the 1980 s with a few, though significant, exceptions such as Samuelson and Nordhaus (1989, p. 837) contending that "a socialist command economy can function and even thrive." Sometimes criticism went far beyond Hayek, including among non-mainstream commentators (Nove 1981).[3]

The Hayekian thesis was contested by Taylor (1929) on the basis of the iterative trial-and-error price formation process, and most brilliantly Lange (1936). A price has two different functions as a rate at which two goods are traded against each other and as an index guiding individual agents in their alternative choices. Only the second function of prices is crucial in determining a rational allocation of resources, no matter whether they are market prices or parametric indexes provided to individuals by a central agent. Lange underlined that in a perfectly competitive market prices are given as parameters (they cannot be influenced by individual actors) by the market to individual decision makers who integrate them in their daily calculations. Consequently, Barone's trial-and-error process is as rational as perfect competition.

From that starting point, Lange elaborated two models of a socialist economy. The most famous one, called "market socialism",[4] relied on the following assumptions:

- In a socialist economy a consumer good market is maintained wherein consumers have free choice;
- A labor market exists wherein workers are free to choose their jobs;
- A central planning board (CPB) is left only with asking producers to stick to two rules (that also are followed in a market economy): calculate their production programs by minimizing the unit cost of production and equating marginal cost to price, now a parameter sent by the CPB; they then send back their input demands to the latter; the CPB will allocate resources accordingly, given the absent market for producer goods.

Suffice to say that the CPB sticks to the Lange-Taylor decision rule and the optimal plan will be reached after a number of iterations (top-down and bottom-up information transmissions) between producers and the CPB. The operative rule commands that if excess demand arises for a product or resource *j*, the CPB has to raise the planned price p_j; in the

[3] Kiev mathematicians had calculated in 1965 that it would take 10 million years of the world population's work to build up the annual precise and detailed supply plan for the Republic of Ukraine only (Antonov 1965, p. 23).

[4] Another interpretation of market socialism, often criticized by Kornai, considers it as "a combination of socialism and capitalism"—see Vahabi (2020) in this issue; such a combination cannot be found, even with an in-depth reading of Lange (1936, p. 135) who writes that "the capitalist economy cannot function under a socialist government" (p. 135), a statement that Kornai would not deny.

case of excess supply, the CPB reduces the parametric price p_j. If the iterative process converges, then perfect planning is identical to perfect competition. The Robins-Hayek argument about millions of equations is irrelevant.

Lange also demonstrated that the same iterative process reaches typical neoclassical equilibrium in a second model named "bureaucratic socialism" wherein the first two assumptions above are relaxed. Consumer goods and workers are allocated by CPB bureaucrats on the basis of the latter's preferences imposed on individuals. It still is economically rational![5] However, following Lerner (1934), Lange eliminated the model on political grounds as undemocratic and incompatible with the ideals of the socialist movement.

Unnoticed by Lange, an underlying implicit assumption is that the optimal plan is reached in a finite number of iterations, a conclusion that cannot be taken for granted; this is the convergence issue. In particular, if the iterative process converges only at the infinity, the practical issue of the plan's time horizon arises, at least in a pre-computer era without big data and the Internet. The latter emerged too late, after the collapse of the Soviet system.

Moreover, would decentralized enterprises have any incentive for delivering to the CPB the accurate quantities they had calculated according to the two aforementioned rules? If enterprises transmitted false or biased information, based on creative accounting methods to mislead central planners, they would distort the whole centrally planned economy, causing a misallocation of resources, which was the actual story of Soviet planning for decades (Andreff 1993). That is the issue of transparency in information circulation,[6] opening a backdoor to the most convincing argument raised by Hayek (1945, p. 5) against central planning. He considered that the economic problem faced by society is not merely a matter of economic calculation. Such was the starting point of his response to Lange and his opposition to the use of mathematics. The problem is the utilization of knowledge that is not given to anyone in its totality rather than one of allocating given resources. Obviously an economic system is more efficient when fuller use is made of existing knowledge (information) dispersed among many different individuals. Thus, planning has to be based on knowledge that is not given to the planner but to somebody else, which somehow will have to be conveyed to the planner. Though practically every individual has some advantage over all others because he possesses unique information to which beneficial use might be made, namely, information about the special circumstances of time and place that cannot be reduced to numbers and transmitted to the CPB in statistical form.

Hayek contended that decentralization is needed to resolve the issue of accurately using and communicating information and, moreover, that a market price system is required to do the job. The indispensability of a price system for rational calculation in a complex society makes Mises convincing even to the pro-planners Trotsky, Lange and Lerner.[7] Since the knowledge of relevant facts is dispersed among many individuals and firms, only market

[5] Malinvaud (1968) modeled such a hyper-centralized economy with central planning of consumer goods' distribution, in addition to production planning when labor is one input.

[6] Even after serving at Poland's CPB, Lange (1967) taught how to program the plan's optimal decisions without a word about enterprises' informational 'cheating' by transmitting fake data about their plan's fulfillment in view of being rewarded (bonuses) and supplied with scarce inputs.

[7] "When we find Leon Trotzky arguing that 'economic accounting is unthinkable without market relations'; when Professor Oskar Lange promises Professor von Mises a statue in the marble halls of the future Central Planning Board; and when Professor Abba Lerner rediscovers Adam Smith and emphasizes that the essential utility of the price system consists in including the individual, while seeking his own interest, to do what is in the general interest" (Hayek 1945, p. 16).

prices can coordinate the separate actions of different people. That is a third function of prices (conveyor of relevant information to all and consequently as coordination mechanism),[8] a function unheeded in the previous debate. The mere fact that one market price prevails for any commodity at one time and in one place brings about the solution to the social problem of passing the most essential information on only to those concerned, and of extending the span of out utilization of resources beyond the span of control of any one mind (including the central planner's). Equilibrium economics and mathematics do not deal with that crucial social process.

Compared to a market price coordination system, without an omniscient dictator, central planning is a primitive, crude, and limited tool (Hayek 1944). A planned society, wherein a CPB misses accurate information, would resort to rationing and regulation of individual consumption choices by exercising control over production that would require central allocation of labor and wage fixing. But here is reached the end of individual freedom and the road to serfdom, which disqualifies socialism politically from a Hayekian liberal standpoint.

1.2 Kornai opted for Hayek against Lange

Where did Kornai stand in the midst of such controversies? In his first attempt at building a theory of economic systems, Kornai (1971) criticized the Barone-Lange model as being embedded in general equilibrium (GE) theory: firms are profit-maximizing, equilibrium is a requirement, and price is the exclusive vehicle of information transmission (the last criticism can be addressed to Hayek too!). Kornai added that GE theory may serve the ideology of a strictly centralized socialist economy. Practically, Lange never recommended implementing his model as a control system in Poland's post-war planned economy. Underlining that CPB regulates prices in accordance with Walrasian *tâtonnement* in Lange's model, the latter cannot be reformulated into a simulation exercise—Kornai attempted such a simulation experiment with the Planning Institute—because it misses interpretative rules for dealing with unsold products and unsatisfied needs (i.e., disequilibria). Which organizations bear the consequences of disequilibria and to what extent? Lange neither raised nor answered such a question. Since Kornai's 1971 book is a fundamental criticism of GE theory, at the end of the day Lange's model is rejected as belonging to the mainstream GE school. Consequently, in *Economics of Shortage*, which is a theory of disequilibria, no reference to Lange is found any longer (Kornai 1980).

In 1971, Kornai did not mention Mises and his only reference to Hayek was about solving millions of equations. Kornai (1980) mentioned Hayek (1944) only once as having adopted the intuition of soft budget constraints (SBCs) which is quite significant in the context of dealing with a shortage (excess demand) economy but, in a sense, is at odds with Hayekian beliefs in the spontaneous equilibrating power of prices. Nevertheless, SBCs translated into the socialist state pouring easy money (subsidies, soft credit) into any enterprise in the red owing to governmental full employment policies and recurrent excess demand on consumption and labor markets—everyday life in Hungary and other centrally planned economies (CPEs)—thus propagating the effects of distorted planned allocations of resources to enterprises. That is a situation wherein biased information transmitted to

[8] Any attempt at controlling prices deprives competition of its power of efficiently coordinating individual efforts; controlled prices cannot guide individual decisions correctly (Hayek 1944).

CPBs and distorted incentives were closer to Hayek's than to Lange's intuitions about planning.

In a more policy-oriented book about post-socialist economic reforms in Hungary, Kornai (1990) briefly referred to Barone, Mises, Taylor, Hayek and Lange and their controversial debate before concluding that market socialism simply is a dead end illustrated by the then ongoing collapse of former Soviet-type economies. The experience of combining state ownership and market coordination, seen in Hungarian economic reforms since 1968, has failed. In Yugoslavia, Poland, China and the Soviet Union, market socialism, understood as 'state ownership + market coordination', likewise has reached a dead end, and must be forgotten once and for all in perspective of the 1990s' economic transformation. The title itself, *The Road to a Free Economy*, is a tribute to Hayek (1944) and in the preface Kornai explains that his 1990 book is about taking the Hayekian road to serfdom the other way around.

In his theoretical synthesis, Kornai (1992) focused on information as the crucial issue in any economic system, which requires market coordination and typical capitalist institutions, in a tribute to Hayek again. In a CPE, all plan directives could not be given in physical units of measurement because aggregation is inevitable in order to reduce the informational burden. Hayek had understood that socialism's real problem was not to set equilibrium prices, but what incentives a CPB could use to gather and assemble the dispersed information concealed in many different places.

Kornai then stressed that administered producer and consumer prices were not and could not be market clearing prices, either in Lange's model or in CPB calculations, because of information scarcity. As such, CPEs were plagued by—and collapsed owing to—both an inefficient bureaucratic coordination mechanism and disequilibria (excess demands). "How could one [the CPB] observe the differences between supply and demand for millions of products?" became Kornai's (1992, p. 523) substitute for Hayek's millions of equations. And his response was that the market is an effective coordination mechanism because its decentralized processes do the job automatically. Even though Kornai (1971, p. 476) recognized that Lange introduced many concepts for market socialism—the autonomy of firms with an interest in increasing profits and reducing costs, the fundamental role of price signals, and the specific linkage between centralization and decentralization—his last word was: "one can conclude that Hayek was right on every point in the debate".

Following Hayek, Kornai finally opted to oppose a man-made constructivist order and to favor a spontaneous, evolutionist one. He went further by signifying close affinity between private ownership and market coordination referring it to Mises (1920): "A natural advance by the market mechanism is inseparable from the expansion of the private sector" (Kornai 1971, p. 448). Should we stop writing the article at this point? Kornai's evolving thought is more complex because he has been involved himself in the practical process of central planning.

2 Kornai's contribution to planometrics

An entire generation of mathematical economists was committed to socialist planning, about five decades ago, evident by their elaborating on central planning procedures for either mandatory taut planning in bureaucratic systems or "indicative" planning in market economies. The standard highway to optimal planning consisted, first, in paying tribute to Lange's market socialism and then building up a model (algorithm) of decentralized

planning. Let us remind ourselves of the state of art in planometrics in the 1960 s before assessing the value Kornai added.

2.1 The context of mathematical economics for planning

Kantorovich (1965)—published in Russian in 1959—presented a model of plan elaboration proceeding by iterative revisions of shadow prices inspired by Walrasian *tâtonnement*, the only relevant starting point for finding a solution for the planning process according to Malinvaud (1967). In the context of preparing economic reforms in the 1965 USSR, a group of economic reformers and mathematicians[9] followed Kantorovich with a project of optimal planning relying on the computation of shadow prices under scarce resource constraints with linear programming. Kantorovich advocated centralization of all computerized plan calculations into the Siberian branch of the Soviet Academy of Sciences working with the *Gosplan*. Once reached through calculation, the optimum must be used to guide decentralized enterprises in complying with a mandatory optimal plan. A plethora of decentralized planning models emerged in the USSR (Ellman 1968) to apply mathematics and computers to serve socialism in building an automaton of the Soviet economy driven by data supplied to the *Gosplan* by industrial ministries and big enterprises.

Running an economy of the USSR's size and complexity with just a single central computer could not be envisaged.[10] A number of computerized planning models resorted to the Dantzig–Wolfe (1961) decomposition principle to connect a central computer running a principal program (PP) with peripheral computers running sectoral programs (SPs).

The Dantzig–Wolfe algorithm decomposes a linear program specified for an economy with n products and factors of production ($i=1, \ldots, n$) and m sectors ($k=1, \ldots, m$) into one PP and m SPs, for which a common and interlinked optimum is calculated by the simplex method. One solution to the PP defines objective functions for the m SPs. Solutions for all SPs under sectoral-specific (technological) constraints deliver a new PP solution, and so on and so forth. Computations are reiterated until an optimum is reached. Called a decentralized plan elaboration owing to the participation of numerous sectors in the computation, when the optimum is found the plan is implemented as mandatory for all sectors under CPB supervision, and in practical terms under the control of the Soviet central administration (Andreff 1976). A generalization of the Dantzig–Wolfe algorithm was demonstrated by Malinvaud (1967) in a Leontief–Samuelson type of economy.

Without surprise, the aforementioned works were appealing to Soviet planners and mathematical economists. Volkonsky (1964) conceived a planning procedure using the Dantzig–Wolfe decomposition algorithm for a PP wherein the production volume of a given assortment of products is maximized while enterprises' SPs maximize their profits at prices obtained from the PP's iterative solutions. However the Dantzig–Wolfe algorithm was criticized by Soviet economists as not practicable in the context of the Soviet economy. Aganbeguian et al. (1972) showed that the optimal prices computed by the PP generally cannot generate a nationally optimal plan (in quantities) when enterprises simply are asked to solve their own SPs. Moreover, although the Dantzig–Wolfe algorithm converges after a finite number of iterations, albeit a large number, Soviet planners still were facing the issue of the plan's time horizon.

[9] They absolutely opposed other reformers such as Liberman willing to introduce market-type mechanisms.

[10] Owing mainly to the small capacities of computers available in 1965.

If one considers that a genuine decentralized economy is characterized by direct information transmission and trade (called "direct links" in 1965's Liberman reforms in the USSR) between enterprises, and between the latter and consumers, obviously Dantzig–Wolfe as well as Soviet computerized planning procedures are decentralizing only a part of a plan's computation. It is not real economic decentralization, which would imply dense horizontal interrelationships between economic agents, including multilateral communication of information (and Hayek is back again) as, for instance, with the New Economic Mechanism (NEM) introduced in Hungary in 1968.

Malinvaud pointed to the difficult problem of information transmission which is not resolved in his model but he nevertheless was rather optimistic about his model's implementation[11] in a market economy with indicative planning though rather sceptical about market prices' abilities to convey all useful information[12]—quite opposite to Hayek. He added that the central planner must request only a limited amount of statistical information from decentralized agents if it wants to get exact and useful responses. Too many questions were asked of Soviet enterprises by the *Gosplan*, so many that the data gathered were biased, fake, incomplete or fraudulent. 'Cheating' in the sense of transmitting biased information was a managerial practice systemic at the enterprise level in Soviet planning (Andreff 1993).

The scholars who conceived decentralized planning models neglected the reality that genuine decentralization required information redistribution and consequently power redistribution across the different administrative layers of Soviet-type CPEs. But information and power redistribution may not be accepted by organizations in charge of implementing the plan, i.e., industrial ministries and state-owned enterprises (SOEs). Therefore an institutional dimension was missing in decentralized planning procedures when it came to moving from computerized plan elaboration down to practical plan implementation as pointed out by Walbroeck (1964, p. 23) from the standpoint of information cost and decision making rules: "from this perspective a fundamental problem of mathematical economics becomes one of defining the most efficient institutions".

The institutional issue of computerized central planning curiously was tackled in the context of French indicative rather than Soviet mandatory planning. When writing a mathematical decentralization program, a question always remain of partitioning it into a PP and a number of clearly delineated SPs. Answering that question poses both a mathematical problem and a practical institutional issue to be solved. For instance, a possible inconsistency between local SP optima and the global PP optimum arises with the Dantzig–Wolfe algorithm: the planned economy cannot be assumed to be institutionally partitioned in an optimal way, that is, to minimize the cost of collecting and utilizing information in light of the goal of reaching the optimum (Bessière 1967).

According to Bessière, a plan decomposition is optimal if it adopts a (sectoral) partition of the computerized program that minimizes the cost of collecting information by reducing to a minimum the number of iterations required to reach the optimum; that minimum

[11] "I may venture that the discussion given below has direct relevance for the exchange of information that occurs in France between the *Commissariat Général du Plan* and the large public enterprises when the former prepares the national plan and the latter determine their long-term programs. I also hope that the same discussion will find application in the future when a more systematic exchange of information will be organized between the *Commissariat* and the *commissions de modernisation* which represent the various industries" (Malinvaud 1967, p. 171).

[12] "No serious businessman, no serious government official believes that markets convey all the information required for good decisions with long- or medium-term implications" (Malinvaud 1992, p. 22).

contemplates a single iteration. A linear program satisfying that prerequisite is defined as a separable program (Bessière and Sauter 1968). If a program is not separable mathematically, the separation into different sectors is faulty and does not minimize the number of or cost of computations. The program must be partitioned again and again until its optimal separation is found. Such an optimal partition always can be found from a mathematical standpoint. But from an institutional point of view, the actual sectors (industrial ministries) must be restructured to coincide with the mathematically found optimal partition. Such restructuring never was attempted in the Soviet economy until Gorbachev's *perestroika*.

2.2 The Kornai–Liptak breakthrough failed in planning practice

Coming back to Kornai, after 1959 his research program was about applying mathematics to economics, and using linear programming for planning with a team of mathematicians and engineers at the Computing Centre of the Academy of Sciences (Kornai 2006). When working with the Institute of Central Planning he was involved in operationalizing a system of models—one central model (PP) and 18 sectoral models (SPs)—decomposed into three levels: a Centre, seven major industries, and 46 sub-industry sectors with 491 product groups (Kornai 1969). That system was run using the Dantzig–Wolfe algorithm and an original decentralized procedure (Kornai and Liptak 1965). Kornai organized and supervised data collection and the computation of different plan variants. He had to face the practical issues involved in elaborating the central plan that underpinned the five-year plan's social choices and policies. He dirtied his hands in the concrete tasks of the computerized programming experimented with in Hungarian central planning in the 1960s. He became acquainted with the mathematical school of economic planning that was developing in the Soviet Union and in other Soviet-type economies which eventually was called planometrics (Zauberman 1967).

The paradox is that a few years later he considered Lange's model of socialism controlled with shadow prices as creating a utopia, though in Kornai (1971) he contended correctly that Kantorovich basically retained the fundamentals of Lange's original model. The difference between Lange's and Kantorovich's models was that the CPB no longer needed to "feel out" the equilibrium price; rather the latter can be computed as the dual solution of a linear program that is optimal in shadow prices. Then, as to Kantorovich, shadow prices must be used compulsorily as actual prices in the financial accounts of the *Gosplan* and SOEs. However, two big issues emerged with the Hungarian system of planning models.

A first practical problem that Kornai and Liptak were not able to solve with the computers at their disposal at that time was that their 1965 algorithm was converging to the optimum very slowly given the mass of calculations to be done. The algorithm thus was replaced by crude procedures to find a proxy for the optimum. We do not know exactly whether the Hungarian National Planning Office and industrial ministries ever took such calculations into account (Andreff 2014a). Later Kornai (2006) confessed his feeling that mathematical planning was an alien component in traditional bureaucratic planning. By 1969, he definitely lost his faith in the ideas that central planning could play any positive role in efficient resource allocation all the more so because Hungary started its NEM and reduced the importance of planning.

Kornai many time raised doubts about the capacities of market socialism (see footnote 4) to solve the most crucial issues of the Hungarian economy, first of all, its recurrent shortages. He thus advocated more radical economic reforms in Hungary at that time. Moreover, if used, mathematical models would have constrained planners and political decision

makers to implementing calculated optimal solutions to which they were not prepared to submit. Such models became increasingly old-fashioned with the NEM.

Second, in a chapter that Malinvaud offered to Kornai (1967), Kornaï stressed the differences and difficult relationships between mathematical programming and traditional methods of taut planning at work in Hungary. Faith in mathematics was no longer there. Kornai (2006) declared later that—contrarily to Kantorovich and Soviet planometricians—he had not imagined even briefly applying linear programming to operational planning of the economy. That surely is a realistic statement ex post, but does it correctly reflect what Kornai actually was thinking by 1965 when he was collaborating with Liptak on the most advanced research frontier in planometrics?

A second paper Kornai co-authored with Liptak (Kornai and Liptak 1965)[13] is the most sophisticated decentralized planning algoritm ever conceived in line with Lange's model. Malinvaud had to assess that paper before publication as a member of *Econometrica*'s editorial board. And he confessed his regrets (Malinvaud 1967, p. 180) at having received the paper after finalizing and submitting his own 1967 model for publication. A genius idea—that Kornai recognized being Liptak's—consisted in reformulating the planning linear program into a game theory model.

Technically speaking, Kornai–Liptak reversed the Lange–Malinvaud procedure. Now the central PP first sends an allocation of inputs and quantitative output objectives to all SPs that then compute their optimal sectoral plans and send back their computed shadow prices to the PP, that is, the prices that they affect for each input they request and each output required by the Centre. The latter computes again a new resource allocation and a new set of output objectives that equalize marginal returns; the iterations continue until a neoclassical optimal allocation of resources and objectives is attained at which all marginal returns equalize with shadow prices. Instead of having decentralization through prices à la Lange–Malinvaud, Kornai–Liptak pushed forward decentralization through quantities, a procedure that was more in tune with Soviet-type planning practices in the 1960s (Andreff 1976). With the Kornai–Liptak algorithm, quantitative information moves top-down while price information moves bottom-up, an information circulation that neither Lange nor Hayek could have imagined! Otherwise, the Kornai–Liptak model remains one of perfect planning and does not assume that sectors (industrial ministries or SOEs) 'cheated' on the information they transmitted to CPB in Hungary. Possibly that is why Kornai–Liptak (1965, p. 184) wrote: "It is impossible that central planning functions perfectly".

In fact, Liptak's major innovation was something else. The two-level linear program (PP is one level, SPs are the second one) is treated as a polyhedric game wherein the player on one side is the CPB, and on the other side the team of sectors, all sectors being assumed to optimize jointly a single common objective function. The common gain function sums all dual sectoral functions. The polyhedric game is solved by means of the Brown-Robinson procedure which is interpreted as a consecutive series of 'throws-in' during a virtual game in which each sector separately assesses resource allocation and output objectives sent by the CPB; it then returns to the latter shadow prices and recommendations regarding revised resource allocation and output objectives at the next iteration. The CPB revises resource allocation and output objectives accordingly, and so and so forth. The optimum is reached at the saddle point of the game which boils down to a minimax procedure once the objective function of the sectoral problem is assumed to be one of maximizing the value

[13] Their first paper (Kornai and Liptak 1962) submitted to *Econometrica* was supported warmly within the editorial board by Malinvaud.

of outputs sold overall, while the central dual problem consists of minimizing the value of sectoral constraints, both values being equal at the saddle point (duality theorem).

With the Kornai–Liptak method, decentralized sectors are involved more actively in finding the PP's optimum, by sending their revision recommendations and shadow prices, than with Lange–Malinvaud price decentralization. Even considered as the first best solution ever conceived in the train of thought initiated by Lange, the Kornai–Liptak algorithm was too slow and too much data-demanding for reaching an acceptable, timely proxy for the optimal plan, thus pointing again to a trade-off between circulating a mass of information with many iterations and living with a mass of disequilibria (shortages) definitely not cleared by the plan's elaboration.

2.3 Information transmission and non-convergence buried central planning

Kornai never commented in his writings openly about why the experience with mathematical planning went to the grave in the Soviet Union—the only credible alternative to Kornai–Liptak (1965) was to build an automaton of the economy. That failure must have convinced him that planometrics was a dead end for non-mathematical reasons and reinforced his U-turn in favor of a non-socialist market economy.

The USSR of 1966 launched an automatized (computerized) system of data collection and utilization for national planning by a network of computing centers integrated into a so-called automatized planning system (ASPR in Russian). Implemented slowly owing to a lack of computing powers, it began working when all Soviet mathematical planning models were synthetized into the system of optimal functioning of the national economy (SOFE) pushed forward by Fedorenko (1972). SOFE, with the help of ASPR's computing network, was supposed to become an automatic regulator (automaton) of the Soviet planned economy overall, transforming it into a kind of cyber-planned economy. Because of the large number of required iterations, SOFE was looking for a proxy of the optimal plan by computing several alternative variants. The *Gosplan*, industrial ministries and 200 major SOEs eventually were equipped with computers networked through the ASPR in 1972.

As long as the ministries and SOEs were asked to provide information about prices, quantities and their technologies to train themselves with SOFE and using computers, they delivered the requested (more or less unbiased) information to the automatized planning system. But when it came to provision of the information a tually needed for elaborating on the next genuine variant of 1976–1990 long-term plan, the ministries and SOEs blocked the system by refusing to communicate the data requested. Information retention by ministries and SOEs continued when they were asked to participate in the elaboration of annual and five-year plans; they purposedly sent biased information to the planning system. It appeared that they were 'cheating' insofar as they were still animated, assessed and rewarded by central authorities according to the percentages of their plans they fulfilled (Andreff 1993). SOFE was abandoned in the late 1970 s since no one ministry or SOE was willing to be transparent in terms of the information transmitted to the *Gosplan*, i.e., to communicate to CPB the kinds of information that would be better used by the ministry or SOE on its own. Such an outcome illustrates to the extreme an incentive-incompatibility (Hurwicz 1973) wherein conflicts amongst goals were not resolved; the participants not only refused to modify their initial endowments (the "no trade option"), but also to reveal relevant information. And Hayek's point mattered again.

Central indicative planning, which was a mid-term macroeconomic forecast rather than imposing a mandatory plan, also was abandoned. In France that happened in 1992 because

of increasing ineffectiveness of indicative plans in a context of economic globalization when French policy makers had lost control of many crucial variables such as (globally determined) prices, interest rates, exchange rates and so on. Malinvaud's aforementioned model definitely became old-fashioned.

Moreover, it must be stressed that all models relying on Walrasian *tâtonnement* were devalued considerably by a theoretical shock which could not go unheeded by the proponents of all of the models of decentralized planning discussed above, including Kornai and Malinvaud. The point is that it was found that convergence to equilibrium never is guaranteed even in theory.

Sonnenschein (1973), Debreu (1974) and Mantel (1974) have demonstrated independently that household demand functions in an Arrow–Debreu (1954) model may have any shape and so may net demand curves as well. But the convergence of Walrasian *tâtonnement* towards equilibrium, established by Arrow-Debreu, absolutely requires that net demand curves must have an appropriate shape (identical and continuous) in order always to respond to price variations so as to narrow the gap with the equilibrium point. If the curve may have any kind of shape, for some goods the net demand will fall with price reductions and for some other goods the net demand will rise with a price decline. Therefore, except when the net demand curve has an appropriate shape (a specific, not a general case), neither logical nor theoretical reason can be found for the Walrasian system of prices and quantities to converge towards equilibrium. The *tâtonnement* process may well be unstable and non-convergent.

Sonnenschein's theorem implies, from a theoretical standpoint, that iterations à la Walras-Lange do not necessarily drive to equilibrium (optimum) but, instead, may end up with excess supply, excess demand, or both solutions. In other words, 'general equilibrium' is a whole set of equilibria and disequilibria on disaggregated markets for different goods in the general case. Besides, if one relaxes the Walrasian model's assumption of infinitely flexible prices and admits that prices are rigid or sticky, then quantities will not react in the required proportion, or will not react at all to price variations (Varian 1975). Sonnenschein's theorem actually is disastrous for applying Walrasian *tâtonnement* models in the practical course of economic planning when we do not know whether it will converge at all. Since the 1970s, neither Kornai nor Malinvaud mentioned that theorem as an excuse for switching their research program to non-Walrasian fixed price equilibria or disequilibria, but they converged on the same avenue for further research. That convergence was joined by a number of economists who had focused previously on CPEs and planometrics: papers collected in Davis and Charemza (1989) are representative of such U-turn in the research programs of the former planometricians.

3 From theorizing plan disequilibria to disequilibrium economics: Kornai's heterodoxy

Planometricians confronted empirical evidence that demonstrated the increasingly obvious shortcomings and mistakes of central planning in the 1970s despite some economic reforms, in particular the shortages generated by mandatory plans. While market economies with indicative planning did not avoid being plagued by rising unemployment, indicative plans were overwhelmed by globalizing markets. Not surprisingly, the former planometricians switched their focuses toward analyzing the observed disequilibria, such as a

shortage economy (Kornai 1980) and permanent excess supply labor markets (Malinvaud 1977).

3.1 Kornai and Malinvaud: parallel ideas on disequilibrium

Most former planometricians joined the 'school' initiated by Barro–Grossman's (1971) general disequilibrium model, in the wake of Clower's (1965) breakthroughs such as, for example, analyzing disequilibrium on consumer goods markets in CPEs (Portes and Winter 1980). The reason was obvious: they were witnessing daily, monthly and annually disequilibria in their empirical works on Soviet-type economies. Kornai's (1980) masterpiece appeared in such an environment as an attempt to theorize the failure of central planning. Despite Kornai's disequilibrium heterodoxy, a parallel may be drawn to Malinvaud, involved in French indicative planning, who became disappointed with the downsizing and then final drawback of central planning experience in France.[14]

The standard approach to theorizing about economic disequilibrium, as eventually synthetized by Benassy (1982),[15] was joined by Malinvaud, who observed that, in spite of indicative planning and regulation, the French economy was suffering recurrent unemployment, i.e., lasting labor market excess supply. Malinvaud's (1977) book as well as a later journal article (Malinvaud 1982) align directly with the earlier Barro–Grossman model. The new disequilibrium mainstream called itself 'the general theory of fixed price equilibrium' in order to maintain a sort of post-Walrasian flavor. In Krueger (2003, p. 191), Malinvaud reminds us that: "When I saw the work that was done on fixed price general equilibrium by people like Barro, Benassy, Grandmont, Grossman, Laroque and Younès, I realized that it provided precisely what I was up to, namely a model to explain the respective roles of wage push shocks and aggregate demand shocks on changes in employment. This is what I tried to explain in my 1977 monograph … The main object of this monograph was to characterize the comparative statics results about temporary fixed price equilibria in an aggregate economy with two markets where goods and labor services were respectively exchanged against money".

Standard disequilibrium economics assumed that on each of two markets (for labor and goods) the shorter side (supply or demand) determines the number of observed transactions. Malinvaud (1977) stressed that disequilibrium economics is not about analyzing partial disequilibria within each market but general disequilibrium, that is simultaneous and interdependent disequilibria that can emerge and cumulate into an aggregated excess supply or an aggregated excess demand in the labor market, on the one hand and, on the

[14] While Kornai (2014) still trusts medium and long-term planning to alleviate the detrimental effects of the surplus economy (capitalism) "but updated forms of indicative planning on the lines of those once used in France".

[15] The axiom of non-manipulability of demand adopted by Benassy rules out stock-hoarding demand, while the latter has been a critical phenomenon in the Soviet experience of a shortage economy. Later, Weitzman (1991) elaborated a model of shortage equilibrium taking on board prices that are not necessarily market-clearing and consumer behavior with search and waiting costs that trigger an inventory policy. In his criticism of the standard disequilibrium approach (see below), Kornai never referred to the limits introduced by the aforementioned axiom. Note that if shortage boils down to a consumer buying only small units at a time and then being compelled to wait in line anew for each small purchase, then Weitzman's (1991, p. 401) model adopts in turn a preferred limiting assumption: "after waiting in line for a sufficiently long time, or happening upon the good, the customer can effectively buy as much as he wants". Thus, he argues as if shortage had vanished in the meantime in a shortage economy.

other hand, in the market for consumer goods under the assumption that prices[16] are fixed and short-term adjustments then proceed in quantities. Quantitative adjustments are more apparent and determinant in the short term than price adjustments. In disequilibrium markets, the purchase (or sale) is the quantity actually traded while demand (or supply) refers to the quantity that an individual would like to trade.[17] "In Walras equilibrium where price adjustment is assumed to occur, demand is equal to purchase, and supply to sale. But in a fixed price equilibrium and quantitative adjustments, the equality does not hold any more" (Malinvaud 1977, p. 50).

Thus, Malinvaud (ibid., p. 49) followed Barro-Grossman in adopting the shorter side (or minimum) rule: "on each market, it is the short side which decides the amount of the transaction, and the long side which is rationed". Consequently, "if there is one rationed purchaser in the market, there cannot be one rationed seller on the same market, and vice versa" (ibid., p. 52). Malinvaud then analyzed sellers' markets (at least one rationed purchaser) and buyers' markets (at least one rationed seller), and developed the famous distinction between three economic regimes, respectively one wherein all markets are in excess demand (repressed inflation), another wherein all markets are in excess supply (Keynesian unemployment), and the last one wherein the market for goods is in excess demand, while the labor market is in excess supply (classical unemployment). He focused on the difference between Keynesian and classical unemployment in the French context, whereas the repressed inflation regime might have been of interest from Kornai's standpoint, whose shortage economy is a regime of excess demand in all markets. However Kornai adopted an approach splitting with the disequilibrium mainstream.

In his later preface, Malinvaud (1977, p. 17) mentioned two limitations of his fixed price equilibrium model: "When some supplies or some demands become rather high, the model's assumptions may be put in the wrong…. On the other hand, some second hand markets may emerge with different prices and different trading methods. The 'underground economy' or 'informal economy' may develop with its black markets, its black-market labor, its enterprises circumventing established practices and rules". Such references to potential shadow economy brings Malinvaud close to the economic environment in which Kornai elaborated his alternative disequilibrium model of a shortage economy.

Departing from the mainstream summarized above, Kornai suggested a different approach to disequilibrium modeling in which planned socialism and capitalist market economies were two sides of a same coin, the former being the realm of excess demands, while the latter was a world of excess supplies. Contrarily to Malinvaud, Kornai disagreed with some of the assumptions of standard disequilibrium economics. Despite Kornai's disequilibrium heterodoxy, a parallel still may be drawn to Malinvaud.

Kornai (1980) based his disequilibrium approach on the practical experiences of shortages in producer and consumer goods markets and the slack revealed in the overmanning of enterprises' workforces in CPEs. He thus contested the shorter side rule, i.e., aggregating all shortages into macroeconomic excess demand. He accepted neither Barro-Grossman's nor Portes–Winter's models because they analyzed the consumer good market as a macroeconomic aggregate and consequently asked whether excess demand or excess

[16] This assumption of fixed prices was criticized when it was formulated because no justification for it was provided. In the preface to the French edition of his book Malinvaud (1977/1980, p. 13) replied that the alternative assumption of enough flexible prices to guarantee permanent equalization of supplies and demands was even less justified, meaning the existence of auctioneers in all existing markets.

[17] That is Clower's notional demand (or supply).

supply emerged overall in such a market. In their models, excess demand and excess supply cannot coexist simultaneously on the same market. Kornai considered that shortages and excess supplies must be accounted for separately at microeconomic level. *Economics of Shortage* therefore presented a disaggregated approach to disequilibria because shortages in CPEs could not be captured correctly with aggregate indexes. Socialist CPEs were characterized by being plagued simultaneously with shortages of various consumer goods and with excess supplies of other goods, especially those ranked highly in the planners' pecking order; stockpiling excess (unsold) goods and unused production capacities were continuous sources of waste.

Thus, Kornai rejected the shorter side rule that commensurates aggregated instantaneous purchases (effective demand) with aggregated instantaneous sales (effective supply) on a given market. "Practical experience also justifies that at an infra-microeconomic level the 'short side rule' is generally verified. … When describing the microeconomic level, empirical observations suggest that the short side rule only exceptionally shows itself; most often it does not. A purchaser will be able to purchase more substitutive products than his initial demand when he accepts forced substitution" (Kornai 1980, p. 142).

Moreover, the Portes–Winter model analyzed only the consumer good market, while major sources of disequilibria in socialist CPEs were emerging in the investment sphere (owing to non-market allocation capital and producer goods) which is the hard analytical core of *Economics of Shortage*. Kornai identified correctly that the origins of shortages were not to be found in the consumer good market, but were generated upwards in input 'markets' of centrally planned inter-enterprise supplies and deliveries—a non-existing market in standard disequilibrium models. The idea of such a third 'market' potentially was present in Kornai (1980), although it was offered as such later (Andreff 1993). Therefore, from the very beginning that sharp difference had distanced Kornai's heterodox approach from mainstream disequilibrium economics. Consequently, Kornai did not exactly model a repressed inflation regime à la Malinvaud–Benassy because the hard core of his model consists in disequilibria in the market for inputs that are key determinants of the whole shortage economy regime.

Kornai's analysis of disequilibria also proceeds from a different rationale. While mainstream disequilibrium economics was looking for the microeconomic foundations (at the level of individual agent's behavior) of macroeconomic disequilibrium, Kornai rooted shortages in infra-microeconomic foundations at the level of each specific decision made by each individual at each time t (Andreff 1986). That point is related to and consistent with disaggregating the analysis of demand and supply down to each good and to the practical instantaneous decisions made by individual agents. In Kornai (1980), the theoretical unit of disaggregation is not the individual agent but each of his/her instantaneous, and sometimes simultaneous, decisions as a buyer, as a producer, and as a seller adjusting him/herself to current shortages at any moment. Each individual agent is "disaggregated" according to his/her different buying, producing, and selling functions and decisions. Therefore, Kornai's approach is much more microeconomic in *Economics of Shortage* than in all of the disequilibrium models published up to that time, which Kornai (1980, p. 143) has justified as follows: "Debreu's description can be considered as strictly located at an infra-microeconomic level, since prices are separately marked according to the date and place of a given good".

Here, Kornai has gone far from his earlier criticism of neoclassical GE microeconomics. In integrating an infra-microeconomic dimension, Kornai's analysis is both mainstream, in that Debreu's book (1959) is the pillar of axiomatic neoclassical theory, and heterodox, in that it goes beyond the aggregation postulate (and shorter side rule) of mainstream

disequilibrium models such as Clower's, Barro–Grossman's and Malinvaud's. One clear aspect of Kornai's disagreement with Clower is that the latter adopts an algorithm with only two iterations: the purchaser (seller) can change his/her notional demand (supply) just once while in *Economics of Shortage* the purchaser on the longer side of the market can switch his/her notional demand to actual demand through a number n of iterations and forced substitutions.

Kornai also addressed a general criticism to all such models wherein no frictions apply, first, to GE theory, then to all decentralized planning models—including Kornai–Liptak (1965)—and mainstream disequilibrium economics. As a consequence of frictions, shortages as well as excess supply can exist simultaneously on the same product market in different shops, stores and warehouses (Kornai 1980, p. 142), especially in the 'market' for the same input in CPEs. In his preface, Malinvaud (1977/1980, pp. 22–23) retains the same argument, but without disaggregating supply and demand in each of his model's market: "Despite the existence of more or less serious unemployment on various labor markets, there exists in some places, for certain skills and certain jobs, supplies that remain unsatisfied. While producers of certain goods would be able to instantaneously increase the pace of their manufacturing activity if they received more orders, other producers would operate on the frontier of their production capacity and impose waiting to their clientele".

In *Economics of Shortage*, Kornai contends that price is not the only vehicle that circulates information across decentralized units of an economic system.[18] He states that other data are required as coordination mechanisms such as quantitative information about unsold goods and order books in capitalist markets and, in CPEs, about the lengths of waiting lists and queues in front of state-owned shops, how asymmetric are disequilibria between supply and demand sides and the fact that market activity always is in flux (never in a state of equilibrium). Therefrom was the notion of priceless regulation conceived (Kornai and Martos 1981), i.e., one relying on norms, which, once established norms, becomes overt, although they do not satisfy any optimality criterion. For example, the materialization of physical streams of products between pairs of buyers-sellers provides (contractually normed) information as well as business to business non-price communication that circulates information horizontally; a large part of decentralized regulation was quantitative, based on non-price signals, in CPEs that Kornai (1980) sometimes compared to their nervous system.

Kornai conceptualized the shortage economy as a generalization of daily life experiences in Soviet-type CPEs of which shortage represents a normal and stable state. Forced substitutions caused by shortages, disrupted and incomplete deliveries, slack and dysfunctions in production, sellers' markets, and the resulting enterprise's soft budget constraints are endogenous to a planned economy, while in mainstream disequilibrium economics, excess supply is partly exogenous as a consequence of some specific market form (oligopoly or monopoly) or fully exogenous when the state interferes with the market mechanism through price or wage fixing.

[18] In that respect, Kornai departs from Hayek's (1945) faith in the price system as a unique and very simple system for "coordinat[ing] the separate actions of different people" among which relevant knowledge (information) is idiosyncratic and dispersed, and as "a mechanism for communicating information" when prices are not rigid; Hayek contends that the price system operates as an economy of knowledge reduced to "how little individual participants need to know in order to be able to take the right action", so "that the dispute about the indispensability of the price system for any rational calculation in a complex society is now no longer conducted".

3.2 Was disequilibrium economics a useless detour?

Both mainstream and Kornai's disequilibrium models, after being under the spotlight during the 1980 s, disappeared from the scene for practical and theoretical reasons. Kornai's 1980 book was famous for one decade, sometimes considered to be the best economic analysis of the dysfunctions in CPEs; it fell from fashion, and nearly was forgotten, with the collapse of communist regimes in 1989-1990 and their attempted transformation into fully fledged market economies. The latter events reinvigorated the neoclassical mainstream with the emergence of the so-called Washington consensus and its implementation in post-communist economies. Any room for disequilibrium theorizing definitely had vanished. At the dawn of the post-communist transformation, Kornai (2006, p. 322) criticized "those American advisers who, the day after the collapse of communist regimes, knew what was to be done and suggested the same solutions everywhere" with naivety and underestimation of how complex transition would be. In August 1989, Kornai was invited to lecture on the economic tasks Hungary was facing on the brink of its transition process; it became his 1990 book, a clear return to Hayek, halting temporarily his interest in disequilibrium economics.

Kornai's recommendations regarding post-communist transformations into market economies carry Hayekian colors: what is required is organic development of a privately owned economic sector as a gradualist process rather than the IMF's and World Bank's preferred 'shock therapy' characterized by overnight mass privatizations of existing SOEs. He later criticized the process and result of the 'privatization overnight by any means' carried out by means of the free distribution of state-owned assets to the population, recommended by the World Bank. He stressed that eventually his recommendations were shared only by a minority of economists,[19] in contrast to the self-defined Western experts in 'transitology', whose advices had led to corruption and asset grabbing by incumbent (i.e., former communist) managers.

In 2003, Malinvaud concluded that disequilibrium economics had "proved to be little rewarding for these colleagues. … My own conclusion is that the research in question enlightened our understanding of macroeconomic disequilibria, thanks to both the treatment of new theoretical models and the macro-econometric applications which were made. But further progress at the same overall level is very, very difficult to achieve. I had recently to comment for a journal on a paper which asked why this disequilibrium theory had failed. And I said that I wasn't really a proper referee for this paper. In the first place, I didn't believe the theory in question failed" (quoted in Krueger 2003, pp. 192-193). Kornai and Malinvaud gave up their research work on decentralized planning procedures nearly simultaneously in the early 1970 s and then on disequilibrium economics in the late 1980 s. Neither Kornai nor Malinvaud explained, or even mentioned, that they moved away from disequilibrium economics owing to "a change in [the mainstream] research strategy" (Blanchard and Fischer, 1989, p. 373).[20]

[19] At least until the publication of a World Bank (2002) report that gave up on the overnight privatization strategy recommended since 1989. One may assume that Kornai (2003) and a minority of non-mainstream 'transition' economists, including the present article's author, had little influence on the World Bank's policy U-turn.

[20] Blanchard–Fischer (1989, p. 373) contend that the disequilibrium approach to studying the implications of sticky prices and wages has run out of stream because it "had reached a dead end: the assumption of given prices, which had appeared initially to be a useful shortcut, turned out to be a misleading one. Further, in the absence of microfoundations that accounted for the price stickiness, it was difficult to make pro-

As to Kornai, concerns with ongoing changes in the post-communist economy drove him increasingly on a path to institutional economics, even though he never lost interest in disequilibrium economics. In *The Socialist System* (Kornai 1992), about 30% of the content, according to him, still takes on board the disequilibrium analysis elaborated in *Economics of Shortage*, although a major part of the book is devoted to the political structure and ideology of that system. Later Kornai (2014) wrote a book applying his disequilibrium approach to capitalism analyzed as a surplus economy, i.e., a dynamic economy of chronic excess supply on both markets for goods and for labor, with sticky prices, wherein household and business spending are limited by hard budget constraints. He assesses Hungary as having transformed from a shortage economy into a surplus economy between 1989 and 1991. In that book, Kornai claims to be on the same wavelength as Malinvaud, Portes-Winter and Benassy, despite some aforementioned methodological disagreements. The 2014 book exhibits his deep continuity with non-mainstream disequilibrium analysis over the five decades since his Ph.D dissertation. However, in the surplus economy instances of shortage may arise, isolated to some specific industries or places in which Kornai remains interested. A revival of disequilibrium modeling inspired by Kornai's views about excess demand and soft budget constraint emerged in sports economics when analyzing professional team sports leagues.[21] Kornai endorsed a book on that topic (Andreff, 2015) as "a new momentum to the wide research program on disequilibrium and the soft budget constraint".

4 Conclusion

Beyond concluding that Kornai truly is an original, paradoxical thinker and quasi-heterodox economist, what can we retain from his walk on the pathway through economic planning and disequilibrium economics?

First, Kornai conceived with Liptak the last and best algorithm attempting to operationalize Lange's model of decentralized planning. Failure to implement the algorithm in the Hungary of the 1960's led him to criticize not only central planning, but also Lange's market socialism from a Hayekian standpoint.

Second, Kornai's criticisms of mainstream general equilibrium theory in the 1970's and 1980's were derived from practical issues observed both in the planning system and everyday life in the Hungarian economy (shortages, disequilibria) and not from further theoretical demonstration of non-convergence toward equilibrium as, for instance, by Sonnenschein-Debreu-Mantel.

Third, his critical stand enabled Kornai to elaborate on a specific disequilibrium model of a shortage economy while rejecting the disequilibrium train of thought developed theoretically in the 1970's and 1980's by the most clear-sighted mainstream neoclassical economists. That likely explains why he did not notice or comment economists bypassing of disequilibrium breakthroughs of the 1990's. He nevertheless applied his disequilibrium

Footnote 20 (continued)

gress on several ambiguities that emerged from the framework". The last sentence might be inappropriate as regards infra-microeconomic roots of Kornai's SBC analysis.

[21] In the team sports league's business mid- and long-term supply of capital (stadiums) is fixed ex ante and prices are partly regulated (thus sticky) while teams operate under a soft budget constraint (Andreff 2014b).

approach to a surplus economy—capitalism—in 2014 because the broad relevance of his model of the socialist system, which in th meantime had vanished.

Fourth, Kornai was for a long time an opponent of so-called market socialism, in any sense of that concept, and a fan of the more radical systemic reforms in Hungary. But since the mid-1990s he had become critical of Washington-geared programs of transition to fully fledged market economies, in particular overnight privatizations, to which he would have preferred organic developments of privately owned enterprises within new institutional frameworks. His affinities to Hayek's thought surfaced here again.

At the end of the day, Kornai never immersed his train of thought fully in any kind of mainstream approach. He self-defined himself as having "one foot in and one foot out of the mainstream" (Kornaï 2006, p. 195). That is the clue to understanding the originality and paradoxical continuity of his thought.

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