The European Journal of Comparative Economics
Vol. 22, no. 2, pp. 287-318
ISSN 1824-2979

Edmond Malinvaud

and the theory of decentralised planning

Wladimir Andreff [*]

Abstract

The article sketches the context in which economic planning has drawn Malinvaud's attention. His modelling of decentralised planning takes place in the wake of Oskar Lange's model of market socialism and all the research in optimal planning based on the Walrasian *tâtonnement*. Malinvaud published two models of decentralised planning, one for production planning, the other one for planning the distribution of goods and services. Being theoretical models, they have not influenced either the French planning process or economic reforms of the planning system in the USSR and Eastern Europe. The article ends up with drawing a parallel between Malinvaud and Janos Kornai, both disappointed with the collapse of planning in their countries. The two authors have simultaneously given up their research on planning for dwelling upon two variants of disequilibrium economics.

JEL classification: B21, B31, C61, D50, P11

Keywords: Walrasian tâtonnement, Decentralisation, French planning, Soviet economic reforms, Disequilibrium economics.

1. Introduction

Edmond Malinvaud (1923-2015) was one of the most famous French economists in his generation. His international fame relies on research in input-output analysis (Malinvaud, 1954), national accounting (Malinvaud, 1957), statistics and econometrics (Malinvaud, 1969a, 1970a, 1978), micro- and macroeconomics (Malinvaud, 1969b, 1981, 1991a), unemployment (Malinvaud, 1980, 1983, 1991b, 1994), and eventually disequilibrium economics (Malinvaud, 1977, 1982). Malinvaud was appointed head of the forecasting department at the French Ministry for the Economy and Finance, then director of INSEE (National Institute for Statistics), and professor at the prestigious *Collège de France*. He served for years in the editorial board of *Econometrica*. It is less known that Malinvaud was a fan of economic planning and that he formalised a model of decentralised planning.

Malinvaud believed in the virtues of planning in a market economy (section 1) following up a neoclassical train of thought starting from Walras-Pareto to come up with the Barone-Lange theorisation. In the wake of Oskar Lange's breakthrough, it was demonstrated that an optimal plan, if accurately decentralised and properly computed, is

[*] Honorary Professor at the Université Paris 1 Panthéon-Sorbonne.

http://dx.doi.org/10.25428/1824-2979/044
First published online: 27/02/2026

mathematically identical to a Pareto-optimal market economy (section 2). Malinvaud's plea for decentralised planning is based on a theoretical model which two variants have been published in 1967 and 1968 (section 3). However, the model actually had no impact on either French indicative planning or Soviet-type mandatory planning at a time when both were reformed, increasingly criticised and finally abandoned (section 4). As most theoretical research on planning, Malinvaud's model was forgotten with de-planning and globalisation in market economies and the break-up of the former Soviet economic system. To some extent Malinvaud was disappointed with the collapse of planning, just like Janos Kornai; they both joined another avenue for further research, i.e. disequilibrium economics (section 5).

2. Edmond Malinvaud's support to economic planning

When and where did Malinvaud's interest for planning come from? Interviewed by Alan Krueger (2003), Malinvaud referred to his father socialist political background and – when being a child – to witnessing the collapse of porcelain and shoe industries in Limoges, the city where he was born, a bankrupt triggered by the financial crisis of the 1930s (Dostaler, 2007). The depth of capitalism crisis together with socialist feelings fuelled sympathetic beliefs toward planning in market economies; beliefs that materialised in post-war France. Then, Malinvaud had the opportunity of staying in the US in 1950-1951. He was hosted to work at the Cowles Commission where he met economists interested in planning, Thomas Marschak and Tjalling Koopmans, as well as Gérard Debreu with whom he was already acquainted after participating to a seminar convened by Maurice Allais[1] in Paris. Malinvaud was sharing with Debreu a deep faith in economic optimisation. He presented his 1967 article as a renewal of the Walrasian *tâtonnement* completed and improved with adding to it the theory of optimal resource allocation (Koopmans, 1957). At the Cowles Commission, Malinvaud made acquaintance with famous economists including John Chipman, Lawrence Klein, Jimmy Savage, Milton Friedman, Lloyd Metzler, and was very much impressed by Kenneth Arrow and Leonid Hurwicz.

Malinvaud came back twice to the US, at the University of Berkeley in 1961 and 1967. Then he was eager to communicate and work with Marschak who had recently

[1] Later on, both Allais and Debreu were awarded the so-called Nobel Prize in economics.

published two books (Marschak, 1959 & 1960) very attractive to Malinvaud; one was about theoretical modelling of either a centralised or decentralised economy, the other one was an assessment of pricing and capital budgeting in the French nationalised (state-owned) industries. He also shared his views with Roy Radner who was cooperating with Marschak in devising the economic theory of teams (Marschak & Radner, 1972). The latter book was influential on Malinvaud and his companions in French planning. In July 1967, he attended an important Berkeley seminar on mathematical techniques implemented for comparing economic systems. Malinvaud mentioned that Marschak, Koopmans and Radner as well as Chris Almon – who was working on the Dantzig-Wolfe algorithm (1961) - have read and commented his 1967 article.

Malinvaud's thoughts about economic planning were also influenced by his participation to the French planning system when it reached its peak. He answers to Krueger: "*I was involved in the 1960s very often in the activities of, let's say, French planning, which was essentially a way of deciding on the medium- and the long-run economic policies. And that influenced certainly my research, part of my research*" (Krueger, 2003, p. 197). Indeed, Malinvaud collaborated with Pierre Massé, head of the *Commissariat Général du Plan* (CGP – French Central Planning Agency), Claude Gruson, head of INSEE, and Marcel Boiteux, chief-economist with EDF (*Electricité de France*), the state-owned monopoly over electricity production and distribution, a company which was mathematically optimising its investment decision-making and pricing.

A major part of Malinvaud's model (1967) was first presented in 1960 at a CGP meeting examining which accurate information should be sent to state-owned enterprises and which information should be obtained from them by the CGP. Some years later, being head of the *Direction de la Prévision* (forecasting department) at the Ministry for the Economy and Finance (1972-1974), then head of INSEE (1974-1987), Malinvaud kept in touch with the CGP and those ministries most involved in French planning. Consequently, the 1967 article was written with the firm conviction and hope that it would be useful to the CGP: "*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 programmes. 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).

In the 1960s and 1970s, economic planning was felt to be able to cure market failures[2]; this belief was widespread among mathematical economists, statisticians and engineers involved in advising public authorities and state-owned enterprises in France. They were in tune with an international intellectual trend focused on planning techniques, for instance, with Henri Theil, Petrus Johannes Verdoorn, Peter de Wolff, Wilhelm Krelle, Jean Walbroeck, Luigi Spaventa, Michaël Bruno, Witold Trzeciakowski and four forthcoming Nobel Prize winners: Jan Tinbergen, Wassily Leontief, Ragnar Frisch and Leonid Kantorovich. Malinvaud has met some of them and quoted nearly all of them. Therefore, his articles were written in a mood supportive to modelling a national plan for the domestic economy. Malinvaud expressed his firm conviction in favour of economic planning as follows: « *One of the main aims of long-term plans which are drawn up in many countries, is to facilitate the formation of a productive system which will be adapted to the needs of future growth. To attain this objective, one must find the best solution to the multiple technical options which arise in different branches of activity. The plan should incorporate the best grouping of productive operations which can be implemented, given the country's resources and technological possibilities*» (Malinvaud, 1967, p. 170).

Finally, let us remind that, in 1950, when Malinvaud had just turned 27, he was recruited by INSEE to work on sampling and questioning households with regards to their consumption. One may wonder whether this first experience has inspired his 1968 model where, not only production, but also the distribution of consumer goods is planned. Even Soviet planners never went that far. The Soviet plan never forecast the distribution of consumer goods across the consumers but was used to rationing their supply - the shortage economy (Kornai, 1980).

Malinvaud kept his pro-planning convictions until the collapse of French planning[3], and probably later. According to him (Malinvaud, 1992, p. 22), in a market economy, planning has three functions: "*it must look into the future and announce its likely*

---

[2] A reviewer has pointed up that many economists, namely those involved in comparative economic studies, were believing in the comparative benefits of planning at that time.

[3] The collapse of French planning started with the IXth Plan (1984-1988) which was one-year shortened, and eventually ended up with the Xth Plan (1989-1992). The last year, 1992, coincides with the enforcement of European single market rules.

features; it must define strategies; it must evaluate public projects and control their realisation (…) No serious businessman, no serious government official believes that markets convey all the information required for good decisions with long- or medium-term implications. The need for prospective studies is widely recognized (…). "Indicative planning" was conceived as an efficient means for the diffusion of the results of such studies (…). But planning is not only indicative. It also contributes to the definition of strategies, which have to be adopted at various levels. There is not only the overall development strategy, but also programmes for particular sectors of the economy (agriculture, energy, transports) or for investments requiring special attention (education, research and development)".

3. From market socialism to the theory of optimal planning

Although his model is in line with the theory of optimal resource allocation in decentralised programming (Arrow & Hurwicz, 1960), Malinvaud first recalls the history of the Walrasian *tâtonnement* and how it is used in the theory of economic planning (Malinvaud, 1967, p. 179-180; 1968, p. 16-22). He stresses that the plan is optimal when it has exactly converged to the same marginal equalities as those defining the equilibrium in a pure and perfect competitive market, as suggested in Pareto (1906, p. 363). A same convergence is assumed and formalised in Barone (1908) and Lerner (1946)[4]. In a footnote (Malinvaud, 1967, p. 179), he points out that some economists have contended that the neoclassical equilibrium theory of a pure and perfect competitive market is less a correct theorisation of a fully-fledged market economy than a correct modelling of a centrally planned economy.

Then Malinvaud adds (1968, p. 17-18): «nowadays the study of planning procedures must facilitate understanding the process through which an equilibrium is determined in market economy, a process that current theories inadequately represent». Those computations allowing to find a planned optimum identical to the one spontaneously reached in a market economy have been less analysed than a precise characterisation of the optimal plan, after twenty years of research in the theory of resource allocation that started with Koopmans (1957). Malinvaud argues that Lange (1936) is the only one who proposed a clear view of a planning procedure relying on the

[4] One has also to mention Lerner's (1934) contribution to the debate among neoclassical economists launched by Von Mises and Von Hayek who attempted to invalidate Barone's positive conclusion about the feasibility of an actually existing rational collectivist (centrally planned) economy. The debate was closed for a while thanks to Oskar Lange's (1936) magistral article. More details about this debate in Andreff (1993).

Walrasian tâtonnement; afterwards, the foundations of the latter mechanism were conceptualised in depth by Arrow and Hurwicz (1960). Malinvaud (1967) underlines that his own formalised procedure is, under some conditions, identical to the one demonstrated in Taylor (1929) – sometimes coined the Lange-Taylor rule of price revision (Andreff, 1993) – where tâtonnement has a decisive role in price determination; with just one difference: Taylor's tâtonnement proceeds only with the prices of primary resources while in Malinvaud's model it pertains to all prices. Malinvaud also mentions Kantorovich (1959) for his planning procedure where price adjustments are based on a kind of Walrasian tâtonnement. The latter is taken on board by all those economists who have accurately considered the issue of planning procedures, in particular Kornaï and Liptak (1965)[5].

It is rather surprising that Malinvaud did not distinguish in Lange's (1936) article two different institutional contexts. In a first one, known as market socialism, Lange assumes that a Central Planning Board (CPB) is confined to applying the Walrasian *tâtonnement* only in allocating producer goods across socialist enterprises while two actual markets respectively allocate labour and consumer goods. In a second institutional variant, Lange presents a fully-fledged bureaucratic economy that differentiates from market socialism in relying on two assumptions[6]:

. there is no free consumer choice between different consumer goods (therefore no free market for consumers' demand);

. there is no free choice of occupation and working place (therefore no free labour market).

Then Lange (1936) writes: "In such a system the CPB decides which commodities are to be produced and in what quantities, the consumers' goods produced being distributed to the citizens by rationing and the various occupations being filled by assignment. In such a system rational economic accounting is also possible, only that the accounting reflects the preferences of the bureaucrats in CPB, instead of those of the consumers. The CPB has to fix a scale of preferences which serves as the basis of valuation of consumers' goods".

[5] Malinvaud has read and assessed the first draft of this article when participating to the *Econometrica*'s editorial board.

[6] With these two assumptions, the bureaucratic economy looks like the actual Soviet-type economy in the 1950s.

In the bureaucratic economy, all prices are parametric[7], including the wage rate. There are no variable market prices in the second Lange's model. However, the Walrasian *tâtonnement* converges towards an optimal plan of the bureaucratic economy once the CPB preferences are known. Lange concludes: "*By demonstrating the economic consistency and workability of a socialist economy with free choice neither in consumption nor in occupation, but directed by a preference scale imposed by the bureaucrats in the CPB, we do not mean, of course, to recommend such a system. Mr. Lerner* (1934) *has sufficiently shown the undemocratic character of such a system and its incompatibility with the ideals of the socialist movement*". The second Lange's model is disqualified on political grounds, and not because it would be economically irrational. Probably, Malinvaud would have accepted such a political conclusion; nevertheless, in his 1968 article, he defines a procedure for planning the allocation of consumer goods. But, no doubt, it is on behalf of another criterion that Malinvaud (1967) prefers market socialism: because it is a *decentralised* economy where the CPB does not interfere in the choices and behaviours of individual agents. While the bureaucratic economy is entirely centralised from this standpoint.

Malinvaud's assessment (1968, p. 17) is that, in practice, economic planning has not yet benefited from Lange and Taylor optimal planning procedures, "*neither microeconomic taut planning in Eastern Europe nor macroeconomic indicative planning in Western countries*". At best, planning practices have secured a minimal consistency between supply and demand for some highly-ranked commodities in the plan pecking order (in the East) or a macroeconomic consistency between some national accounting aggregates (in the West). Malinvaud wishes that the gap between the theory of planning and the practice of planning would disappear in the future.

Knowledge in the theory of economic planning as of 1968 is the outcome, as to Malinvaud, of three avenues for research. First, the research elaborating on the Walrasian *tâtonnement* has been completed through demonstrating that such procedure converges towards the optimum. Second, progress in mathematical programming has

[7] Here Lange (1936) follows Wicksteed (1910) who distinguishes two functions of a price: on the one hand, the function of a (relative) price consists in determining a rate of exchange between two commodities; on the other hand, the price is an index for alternative choices that guides economic agents in their decision-making. As to Lange, only the second function is required for resolving the issue of rational resource allocation. As indexes for choice, prices are parameters taken into consideration by all agents in their economic calculation. Since prices in a pure and perfect competitive market cannot be influenced by economic agents, they are fixed parameters sent by the market to the agents (just like those prices sent to them by the CPB in a planned economy).

found algorithms that can fit with economic planning, including the decomposition algorithm (Dantzig & Wolfe, 1961) that allows a simultaneous computation and data mining at the levels of both the CPB and decentralised entities of a domestic economy. A last theoretical input is the theory of organisations (Marschak, 1959) that compares the cost and efficiency of various decision-making procedures in situations where different individuals have separate access to complementary information required for pursuing a mutual objective; in such circumstances, there is a choice between different forms of organisation, more or less centralised[8].

Malinvaud is critical about most researches in the theory of economic planning because they are not aware of the important role assigned to production objectives when they focus on the *tâtonnement* achieved through price revisions on the one hand; on the other hand, researchers who work on the decomposition algorithms of linear programmes do not handle seriously the issues related to how communicate information in programming procedures. A better research orientation must accept that:

. Planning is a numerical computation which is supposed to optimise all and any possible programmes through *tâtonnement* procedures that rely on the general gradient method (Arrow & Hurwicz, 1960), but the latter converges very slowly towards the optimum; this requires the substitution of faster converging methods to the gradient (4 *infra*).

. Planning procedures assume that communicating information between the CPB and decentralised agents is an easy task whereas it is tremendously difficult in reality. If a planner would like to obtain accurate responses from decentralised entities, he must have a limited demand for information. The implication is that the only conceivable procedures must not last too long, no more than a few iterations during which any individual or entity has to communicate a limited number of numerical data. When the Soviet central planner was sending heavy questionnaires to decentralised enterprises, the number of realistically possible iterations was much lower than what would have been required for reaching plan consistency. A too heavy procedure will trigger the communication of fake data – i.e. cheating against the plan on the side of bureaucrats

[8] This approach is so complex that "*it may hinder the findings of any practically applicable result*" (Malinvaud, 1968, p. 19). Malinvaud is right in that the theory of teams (Marschak & Radner,1972), though very promising, was never applied in any practical system of planning a domestic economy.

and administrators of state-owned enterprises -, or even unplanned more or less fraudulent activity in the black market.

. Planning takes place in a particular economic context. It is often assumed that the CPB knows consumers' preferences as well as the stock of primary resources to be allocated across the enterprises, but it does not know either the quantity of resources held by the enterprises or their technology.

4. Malinvaud's model of decentralised planning

First, Malinvaud (1967) conceived a model of decentralised production planning; then he completed it with a model of decentralised distribution of commodities in quantities to consumers (Malinvaud,1968).

A model of production planning

The model analyses an economy with m + 1 agents, m enterprises (k = 1, … , m) and one CPB, n commodities (i = 1, …, n), where the production of commodity i is yi (yi > 0 if i is an output, yi < 0 if it is an input) while the final consumption of commodity i is xi. The net demand for commodity i by consumers and enterprises is:

$z_i = x_i - \sum_{k=1}^{m} y_{ik}$ (1).

A programme P for this economy is defined by the values taken by the (m+2)n numbers for xi, zi and y_ik. If the different xi are components of a vector x (the same applies to yi), (1) can be written in vectorial terms:

$z = x - \sum_{k=1}^{m} y_k$ (2).

If initially available resources in commodity i are wi, then the programme P is submitted to the constraint:

$z \leq w$ (3).

If there is a utility function u(x1, x2, …, xn), under the mathematical conditions for P to be feasible, the optimal programme is Ps such as u(xs) > u(xh) for ∀ j, j = 1, …, h, …, s, j standing for the ranking order of successive iterations.

In such an economy, the CPB has the task of: max u(x) under the (2) and (3) constraints.

Now assume that the CPB *a priori* knows the set of all acceptable final consumptions *X*, the vector of available resources *w*, and the utility function *u(x)*, but it does not *a priori* know the production capacities Y_k of the enterprises. While each enterprise *k* is assumed to know its own technical capacity of production (its technology) but does not know *X*, *w* and the utility function *u(x)*. Then, the CPB must communicate information downwards to the enterprises, and enterprises must communicate information upwards to the CPB through a number of successive iterations. During this procedure of plan elaboration, the CPB must send "prospective indexes" (figures) *B* to the enterprises, and the latter must transmit to the CPB their production and requested inputs *F* (thus revealing their technology to the CPB) that either maximise their profit or minimise their cost. The procedure must go on until, after *s* iterations, the optimal plan P_s is found (computed), so that:

B1 -> F1-> ⋯ Bj -> Fj -> ⋯ Bs-1 -> Fs-1 -> Ps

Malinvaud upholds that, in the above model, the procedure of plan elaboration is *decentralised*. To be effective, the procedure must have precise mathematical properties (Malinvaud, 1967, p. 182-185) that imply restrictive assumptions about the set of Y_k (it must be convex, meaning that decreasing returns prevail) and about X and the utility function $u(x)$. The procedure must be well-defined, monotonous, converging and finite (warranting that after a finite number of iterations P_s will be optimal) if the optimal programme is to be reached in quantities and dual prices are to converge toward optimal prices. However, Malinvaud neglects two other dimensions of the plan elaboration procedure: how quickly does it converge towards P_s and at which cost. In a modelling inspired from Arrow and Hurwicz (1960):

– The prospective indexes are prices p_i^s given by the CPB to each commodity i at each iteration, that is a p^s vector for n commodities ($i = 1, \ldots, n$). Each enterprise proposal of net production quantities is y_{ik}^s, thus a vector y_k^s for all enterprises. The procedure starts up when the CPB announces (like the Walrasian auctioneer) an initial price vector p^1.

– At each iteration, all enterprises select their net production proposal and send it to the CPB in such a way as to maximise their profit with using p_i^s prices, thus: $\max p^s y_k = \sum_{k=1}^{m} p_i^s y_{ik}$.

– After each iteration s, the CPB has to revise prospective indexes to be used in the next iteration, up to the $(s\text{-}1)^{\text{th}}$ one, as follows: increase the price of a commodity when demand exceeds available resources (net excess demand), and lower the price when available resources exceed demand (net excess supply). Thus, following Arrow and Hurwicz (1960):

$$p_i^s \;= \cdots \max\{0\ ,\ p_i^{s-1} + \rho(z_i^{s-1} - w_i)\} \quad (4)$$

where a zero price is given to any commodity for which computation comes out with a negative price p_i^s, and where ϱ is a fix proportionality coefficient (a discrete positive number) used to revise prices, upwards or downwards[9], by the CPB.

– At the last iteration, the vector x^s must maximise $u(x)$ under the condition:

[9] Like in the converging process of successive iterations formalised in Uzawa (1958).

$$x \leq w + \sum_{k=1}^{m} y_k^s \quad (5).$$

Malinvaud ends up his article with a few additional comments. In 1967, practical planning methods do not resort to the Walrasian *tâtonnement* first because its convergence toward the optimum requires restrictive (unrealistic) assumptions. The choice of a number for the proportionality coefficient ϱ required for Uzawa's discrete convergence is a real issue all the more that this choice is preconditioned by the number of iterations (price revisions) and by the speed of convergence of the planning procedure, i.e. an issue that tremendously matters for a real CPB. Planners often focus more on plan consistency than on computing the optimum. Supply-demand equilibrium is less of paramount importance than the path to reach it. In practice, after each iteration, the CPB takes into account all interindustry supplies and demands to build up a more comprehensive plan variant. Running such computation with a Leontief interindustry matrix, and its inversion, accompanied with price previsions and consistency tests were at the crux of French planning in the 1960s (Babeau & Derycke, 1967).

Taylor (1929) suggested an iterative method where the enterprises get from the CPB all the prices for all commodities and send back to the CPB information about their cost-minimising production techniques. Malinvaud (1967) models a same iterative procedure in an economy endowed with a Leontief-Samuelson technology (Samuelson, 1951) that is with just one scarce factor of production, i.e. labour. Each enterprise supplies just one single commodity, but can use different production techniques, with constant returns. In a Leontief model, technical coefficients are fixed for each industry (enterprise) whereas, in Samuelson's more general modelling, for each industry (enterprise) technical coefficients can take different values, allowing a substitution between different techniques of production. Assuming that the vector x of final consumption comprises of non-negative components, $u(x)$ is a continuous function known to the CPB, the matrix of interindustry coefficients has no negative component, and the CPB knows m vectors before launching the first iteration, Malinvaud provides a new formalisation of the Taylor procedure[10].

[10] For mathematical preconditions that guarantee convergence after a finite number of iterations, see Malinvaud (1967, p. 190-197).

At each iteration, the CPB must resolve an open Leontief model (open to final demand variations) which interindustry coefficients are those received from all enterprises at the previous iteration. Such procedure is coined plan decentralisation by means of prices – or *price decentralisation* - when prospective indexes sent by the CPB are to be used like prices by the enterprises for calculating their production programmes. The same Malinvaud's procedure can operate identically if the communication of information between the CPB and enterprises is reverted. It is so if at each iteration the CPB sends to each enterprise, as its prospective index, a project of its production plan (in quantities) and if, after calculation, all the enterprises send back to the CPB their cost-minimising prices for inputs. The procedure converges to the optimum when, with all data sent back by the enterprises, each price reaches a same numerical value for all enterprises, as a component of the p^s vector that maximises $u(x^s)$. This is called *quantity decentralisation* and resembles the actual practice of information communication witnessed in Soviet planning. Malinvaud notes that, in all Western countries which elaborate a mid-term plan, production objectives are calculated with an open Leontief model. In Soviet-type economies, the focus was on input-output relations in quantities. Montias (1959) demonstrated that the Soviet practice of plan elaboration with material balances is not different from using a Leontief model.

Malinvaud concludes his 1967 article with two serious reservations:

a/ When responding to the CPB, the enterprises may declare values for their technical coefficients that are the most beneficial to them rather than coefficients reflecting precisely their genuine technology - such "cheating" behaviour was widespread among Soviet-type enterprises (Bain et al., 1987; Andreff, 1993).

b/ The model is too much restrictive due to its assumptions: there is only one primary resource, i.e. labour; a scarce initial equipment of the economy or limited volumes of imports are also kind of primary resources.

The 1967 article stresses that the iterative procedure could be used in a mathematical programme computed at the planning centre. Then the CPB would not only take into account the last flow of information transmitted by the enterprises, but it would also compile and accumulate information, iteration after iteration, in view to acquiring a more precise knowledge of each enterprise's technology. Contrarily to a Leontief-Samuelson technology, techniques of production are no longer assumed to be complementary; they are substitutable. The CPB can retain the prices that are proportional to the marginal rates of substitution computed in the mathematical programme. Consequently, the CPB asks the enterprises to specify their production vectors y_k which, at centrally-transmitted prices, maximise the net value of their production. Such procedure is similar to the decomposition of a linear programme (Dantzig & Wolfe, 1961) of which Malinvaud's model provides a generalisation[11]. At each iteration, the CPB must resolve a programme such as:

$$\{ \max u(x)$$

$$\{ z = x - \sum_k y_k \leq w \quad (6)$$

with modified numerical values for variables that happen to have changed with the newly accumulated information compared to the previous iteration. If at the s^{th} iteration all enterprises provide the same numerical values for their net production as those computed in the P^s programme, this means that the programme has converged to its optimum.

In conclusion, Malinvaud himself underlines some shortcomings of his model:

- The model is static, there is no time-indexed variable.
- The described procedure does not allow any aggregation/disaggregation of commodities and industries; only a very detailed classification of commodities could fit with the model requirement[12].
- In the model, prospective indexes transmitted by the CPB to the enterprises are proxies for prices. In actual planning practice of most countries, the CPB also sends quantitative production objectives to the enterprises. The latter are supposed to make their economic calculation in prices fixed by the CPB, but it should not be envisaged to let them give up quantitative production objectives.

[11] For the mathematical demonstration, see Malinvaud (1967, p. 201-204).
[12] The most detailed input-output table used in Soviet planning was 110 industries x 110 commodities (Andreff, 1978), but the number of industries planned in detail was much lower. Implementing Malinvaud's model would require an even more detailed disaggregation.

- The law of diminishing returns assumed to pertain to Y_k has no practical justification for planning which, on the contrary, attempts at triggering increasing returns.

Centralised distribution of commodities to consumers raises both ethical and optimality issues. Malinvaud (1968) assumes that all ethical issues are resolved upstream of the planning process and he only sticks to two procedures that look for finding an optimal distribution of commodities[13].

A model of distribution planning

Individual consumers, without suffering any loss, can marginally substitute a quantity of a commodity distributed by the CPB to a fixed quantity of any other commodity distributed by the CPB.

Let w_h stand for available quantities of l ($h = 1, \ldots, l$) different commodities, and these quantities are known to the CPB; x_{ih} is the quantity of h allocated to consumer i, x_i is a vector comprising of l components x_{ih} ($i = 1, \ldots, m$). Consumer i has a utility function $u_i(x_i)$ with decreasing marginal utilities. The CPB does not know the u_i functions and is committed to distribute revenues as follows. When prices p_h are given for all commodities h and x_i is the consumption vector of all the commodities allocated to consumer i, the value of allocated commodities $\sum_{h=1}^{l} p_h \ x_{ih} = px_i$ must be a given proportion R_i of pw, the value of total quantities of commodities available. Moreover, the price vector p must encompass different prices in such a way as to coincide, when the optimum is found, with dual prices corresponding to that optimum. The definition of R_i implies:

$$\sum_{i=1}^{m} R_i = 1 \quad (7).$$

The CPB collects information from consumers after sending to them prospective indexes which are p^s prices during s successive iterations ($j = 1,\ldots, s$). At each iteration, consumer i responds to the CPB with transmitting a x_i^s vector that maximises $u_i(x_i)$ under the constraint that its value is equal to revenue R_i. To start up the procedure, the CPB chooses an arbitrary price vector p^1 under the condition that the value p^1w of all available

[13] The corresponding part of Malinvaud (1968) is titled "distribution planning" and tackles the theoretical issue of a central plan allocating commodities to consumers, even though Malinvaud states that "*a direct planning of individual consumptions is meaningless in practice*" (Malinvaud, 1968, p. 23).

commodities is equal to total revenues, that is 1 (according to equation 7). Among all potential formula for price revision, Malinvaud opts for:

$$\frac{p_h^s}{p_h^{s-1}} - 1 = a\left[\frac{\sum_{i=1}^{m} x_{ih}^{s-1}}{w_h} - 1\right] \quad (8)$$

a being an a priori chosen positive number.

The CPB increases or decreases the price of commodity h depending on the fact that its total demand is higher or lower than total supply $\sum_i x_{ih}$: *price decentralisation.*

In a second procedure, the CPB forwards the quantitative consumption programme allocated to each consumer. The individual consumer feedback consists in revealing and communicating his/her marginal rates of substitution between commodities that appear in his/her consumption programme. The rule for revising the quantitative consumption programme is as follows: if the marginal rate of substitution of commodity *b* to commodity *c* is higher for consumer *i* than for consumer *m*, the CPB allocates to consumer *i* a little bit more of commodity *b* and a little bit less of *c;* and a reverse revision applies to consumer *m*'s programme. Assume that x_i^s is the prospective index sent by the CPB to consumer *i*, and that commodity *l* has a positive marginal utility for all consumers, and that commodity *l* is chosen as the numerary. Consumer *i* informs the CPB of his/her marginal rates of substitution between *l* and each of the *l-1* commodities:

$$\pi_{ih}^s = \frac{U'_{ih}(x_i^s)}{U'_{il}\ (x_i^s)} \quad \text{(9) for h = 1,2,}\cdots\text{, l-1 (9)}$$

U'_{ih} being the U_i partial derivative of x_{ih}.

The initial distribution (before any iteration) of commodities among consumers is arbitrarily defined by the CPB though Malinvaud assumes that an *a priori* most reasonable distribution is

$x_{ih}^1 = R_i\, w_h$. At the *s*th iteration, the CPB must compute all the marginal rates of substitution resulting from consumers' programmes collected at the (*s*-1)th iteration where the marginal rate of substitution for commodity *h* is computed as:

$$\pi_h^{s-1} = \sum_{i=1}^{m} R_i\ \ \pi_{ih}^{s-1} \quad \text{(10)} \quad \text{h = 1,2,…, l-1 (10).}$$

The allocation of commodity *h* to consumer *i* is increased or decreased according to π_{ih}^{s-1} being higher or lower than $\pi_{.h}^{s-1}$. For all commodities except the numerary, the CPB retains the following rule for revising consumers' programmes:

$x_{ih}^{s} - x_{ih}^{s-1} = \alpha R_i (\pi_{ih}^{s-1} - \pi_{.h}^{s-1})$ (11) h = 1,2,⋯, l-1 (11)

where α is an *a priori* positive coefficient.

Given the (7) and (10) equations, summing up the right-hand side of equation (11) comes out with zero so that x_{ih}^{s} is a distribution of all w_h if x_{ih}^{s-1} already was such a distribution, which is the case by recurrence from x_{ih}^{1}.

In view to definitively moving from iteration *s-1* to iteration *s* (from x_i^{s-1} to x_i^{s}), it remains to allocate the numerary *l*. The best rule, according to Malinvaud, is:

$$x_{il}^{s} - x_{il}^{s-1} = -\sum_{h=1}^{l-1} \pi_{.h}^{s-1} (x_{ih}^{s} - x_{ih}^{s-1}) - \vartheta \sum_{h=1}^{l} \pi_{.h}^{s-1} (x_{ih}^{s-1}) - R_i w_h)$$
(12)

where ϑ is a fixed positive coefficient equal to 1 that garantees a convergence toward the value of R_i *w*. This second procedure corresponds to quantity decentralisation. The two procedures are symmetrical.

Malinvaud (1968, p. 26) contends that the first distribution procedure is not an 'idealisation' of the market mechanism, as it is sometimes assumed, because the CPB revises prices only after witnessing net excess supplies and net excess demands. As regards the second procedure, it represents a centrally planned economy where the planners *de facto* impose their consumption programmes to consumers[14]. In principle, both procedures can be implemented in elaborating the plan whatever the latter is imposed in an authoritarian way[15] or conceived just as a publicised forecast. Both suppose a certain degree of decentralisation meaning that planning tasks are based on a systematic circulation of information between individual agents and central planners.

Finally, the cost of the second procedure is higher because it implies more computational work to be done by the CPB than the first one since quantitative

[14] Malinvaud certainly was aware that the Gosplan was not centrally distributing commodities to consumers; instead, central planners were leaving disequilibria in the production plan to be eventually resolved downstream by consumer rationing (waiting lists and queuing), and not by a designed distribution process.

[15] Which reminds the second Lange's model of a bureaucratic economy without a market for consumer goods.

prospective indexes must be 'personalised'. This would dig a deep difference between the two procedures of distributing commodities among households. Anyway, Malinvaud reiterates his conviction that planning should grant more importance to prices though without giving up all quantitative indexes. Indeed, planning procedures are more complex than the Walrasian *tâtonnement* applied to all commodities or than simply resorting to a decomposition algorithm.

Malinvaud's models of plan decentralisation exhibit a last shortcomings in that they focus only on the stage of plan elaboration but do not say anything about plan execution, i.e. how the optimal plan computed by the CPB is practically implemented, an issue pointed at in the next section.

5. Which impact on French planning and Soviet reforms of planning?

Malinvaud's model of decentralised planning caused little stir while it could have had a significant impact. Not many references to his two articles are found in the literature, except in Mead and Byers (1988), a book published in honour of Malinvaud, and a review by Boyer et al. (1989). Malinvaud himself did not mention the two articles in either his last publication on planning (Malinvaud, 1992) or in his interview with Krueger (2003). Is this due to the model being too much theoretical or to becoming outdated? It seems that other factors have limited the exposure and implementation of the model.

The model has never been practically applied in any planning system. French planning evolved with using simulation models instead of optimisation. Soviet planners and economic mathematicians leaned toward other solutions. The model is not a genuine decentralisation of planning but only a way to involve the enterprises (the consumers) in the process of plan elaboration without giving them up a say in the plan execution.

4.1. Malinvaud's model and French planning

One year after Malinvaud published his 1968 article, a new physical-financial model, coined FIFI, was adopted in French planning (Aglietta & Courbis, 1969) which stopped the process of using an inverse input-output Leontief matrix. FIFI did not refer to neoclassical microeconomics and the general equilibrium theory but to a kind of

Keynesian macroeconomics with the so-called theory of *économie concurrencée*, i.e. an economy threatened by outward – foreign - competition (Courbis, 1975). In an economy widely open to international trade, planning is submitted to the 'external constraint' of international prices and rates of exchange. What could be done with Malinvaud's model of a closed economy (no foreign trade)?

Moreover, Malinvaud's model could not be used since, starting with the preparation of the French VIth Plan (1971-1975), the idea of integrally planning the entire domestic economy was rejected. FIFI is a macroeconomic simulation model where there is no room for microeconomic optimisation à la Malinvaud. With FIFI, a macroeconomic equilibrium in the last year of the five-year plan is looked for in simulating different plan variants satisficing the government objectives with taking into account constraints and behaviours of all economic agents; this is not optimisation but simulation. No prospective quantitative indexes appear in FIFI where all variables are monetary and macroeconomic. There is not a series of successive iterations (reciprocal communication of information) between the CPB (CGP) and the enterprises or consumers. The actual CGP's power cannot compare to the theoretical CPB's power of revising prices (even less quantities) as assumed in Malinvaud's model. At best, some iterations could have related the CGP with state-owned enterprises. It was hardly so since prices in the public sector were kept centrally fixed by the administration and other market prices were free.

4.2. Malinvaud's model and the reforms of planning pushed forward by Soviet mathematicians

In the 1960s, a number of Soviet economists and mathematicians – known as the mathematical school of economic planning, mostly based at the Central Institute of Economic Mathematics (CEMI in Russian) – were involved in a discussion and debates about Brejnev's reforms and their aftermath. They were advocating that Soviet planning must rely on plan optimisation after giving up the former methodology of taut quantitative planning (and rationing) with material balances.

Their starting point was a manuscript written by Kantorovich in 1939 and eventually published twenty years after (Kantorovich, 1959). Kantorovich made a plea for optimal planning that would use dual prices of a linear programme; just like the price prospective indexes in Malinvaud's procedure. Paradoxically, Malinvaud never was invited in the Soviet Union to participate in the aforementioned discussion, contrarily to other French economists namely, for instance, Claude Gruson, Pierre Uri, Yves Ullmo, Jean Bénard or Anton Brender. Kantorovich argued that all computations of the optimal plan must remain centralised in the Gosplan, CEMI and LEMI (the Siberian branch of CEMI). Once calculated at the Gosplan, the optimal (numerical) solution should be mandatorily implemented in the enterprises, like in previous taut planning.

Starting from this standpoint, Soviet mathematical-economic literature gave rise to 'planometrics' » (Zauberman, 1967) that is a series of centralised and decentralised models of planning; all the authors involved in plan modelling campaigned for introducing optimal planning in the USSR (Ellman, 1968). The idea was to build up a complex of interconnected (through computers) models that would function as an automat of the Soviet economy. Industrial ministries and big state-owned enterprises should participate to the planning procedure through computerised exchanges of numerical information with the Gosplan. Very similar to Malinvaud's model.

In the 1960s, running an economy of the USSR's size with a single big central computer could not be imagined[16]. Though, using the Dantzig-Wolfe decomposition algorithm could be an option after interconnecting a giant central computer managing a principal programme (PP) with peripheral computers optimising their own sub-programmes (SPs) at ministry or enterprise level. The Dantzig-Wolfe algorithm decomposes a linear programme for an economy with n goods ($i = 1, \ldots, n$) and m industries ($k = 1, \ldots, m$) into one PP and m SPs; its optimal solution is computed with the simplex method. After affecting an objective function to all SPs, their mathematical solutions are computed under their technological constraints. Aggregating all SPs' optima under the PP's own constraints, at each iteration, leads to the overall optimal solution (for both the PP and SPs) after a finite number of iterations. This way, decentralised industries (Soviet industrial ministries) and big enterprises were associated to the central plan elaboration, but the objective function to be optimised remained the CPB's (Gosplan) one (the PP). At the next step of plan execution, Soviet planning kept on being hyper-centralised. Thus, the procedure was not as much decentralised as Malinvaud contends (1967, p. 171, 176). It could have been more decentralised in the

[16] Namely due to the low capacity of computers available by 1965.

context of France where communication of information between the CGP, sectoral 'modernisation commissions' (industry representatives) and state-owned enterprises was taking place in a fully-fledged market economy (or with inter-enterprise 'direct links' according to a famous phrasing used during the economic reforms in the USSR). Neither Soviet projects of optimal planning, nor Malinvaud's procedure did foresee any communication between enterprises (outside of planner's control) which would have been an actual plan decentralisation and not simply a decentralisation of computing the optimal plan.

A next issue is that the Dantzig-Wolfe algorithm converges toward the optimum after a finite though big number of iterations, an issue neglected by Malinvaud. For practical purpose, the optimal plan has to be mathematically approximated after a small number of iterations, before having found the optimal solution (Pugachev, 1965).

In the USSR, in 1966, was launched an attempt at building up an automat of the planned economy. The whole domestic economy should be run with a complex of models conceived by Fedorenko (1972) and known as SOFE in Russian – relying on the Dantzig-Wolfe algorithm. SOFE was supposed to become an automatised regulator of the Soviet economy led by the Gosplan. Due to the high number of required iterations before converging to the optimum, SOFE was used for computing different variants as proxies for the optimal plan. Computation was achieved through an automatised computational system of planning known as the ASPR in Russian. To make it feasible, the Gosplan, industrial ministries and big enterprises were equipped with a network of computing centres – 600 in 1965 and 1,050 in 1970, plus 200 connected enterprises – communicating by means of their connection to the ASPR. In 1972, 42 industrial ministries and *glavki* (administrative heads for a group of products within a ministry) have joined the ASPR with connected computers.

The automat first was used for testing the SOFE complex of models, asking ministries and enterprises to deliver to the Gosplan fictitious figures about their 'sectoral' plans. This worked well. But when it came to communicating the "true" figures about ministries and enterprises' activity for elaborating the 1976-1990 long-term plan, the system was blocked. Ministries and enterprises refused to communicate their "true" figures. Information retention went on with preparing the five-year and annual plans. Even worse, ministries and enterprises "cheated" as usual in transmitting biased information and fake figures to make their plan easier to fulfil and get rewards (bonuses) for plan fulfilment.

Malinvaud, the Soviet mathematical school and central planners have unheeded that any redistribution of information is also a redistribution of decision-making power, and that the latter redistribution was not accepted by Soviet ministries and big enterprises. This practical experiment exhibits that Malinvaud's and other mathematical planning procedures neglect the institutional dimension of a planned economy. Walbroeck (1964) had already pointed at this weakness.

The failure of the Soviet planning automat unveiled the shortcomings of decentralised planning procedures à la Malinvaud as well as those supported by Soviet mathematicians. All have missed an analysis of how the procedures could be implemented and enforced to materialise the optimal plan. They are strictly theoretical schemes.

4.3. The collapse of planning: what about the future?

The Soviet-type planning system collapsed for many reasons starting with its actually declining economic performances – a long run decrease in the rate of economic growth. Planning did not cure economic instability; the tempo of plan execution triggered specific economic cycles generated by the central planner itself (Bauer, 1978). In the last decade before the collapse of centrally planned economies, not only economic growth declined down to negative rates, but open inflation emerged as it is usual in an excess demand (supply shortage) economy. In other words, planning no longer appeared as a hedge against economic crises. The faith in planning started vanishing.

The above-mentioned decline was accompanied with an increasing number of critical analyses as regards the inner inconsistencies witnessed in the Soviet planning system. Just to mention a few, the criticisms targeted the command-economy, its taut planning with quantitative objectives, the ratchet principle (Keren, 1972; Weitzman, 1980), the Micawber effect[17] (Dyker, 1985), with its subsequent supply uncertainty (Andreff, 1993) and, finally, its overall outcome being a shortage economy (Kornai, 1980). On the top of that, bureaucratic decision makers were empowered as a social

[17] An incentive to plan over-fulfilment in state-owned enterprises due to the CPB placing a high premium on simply avoiding under-fulfilment at any cost.

strata (*nomenklatura*) within the public authorities as well as in state-owned enterprises and systematically reacted to wrong incentives for fulfilling the plan; therefrom cheating and resorting to black market supply became a recurrent managerial behaviour in the face of central bureaucrats. Under fire of so many in-depth criticisms of Soviet-type planning, the theory of planning went at bay.

A last point to be stressed is about the incentives assigned to the enterprises by planners and bureaucrats. In the Soviet planning system, everyone was cheating on plan fulfilment data, from enterprise managers up to industrial ministries. All were exhibiting ex post statistics higher than ex ante plan objectives in view to being rewarded with premiums and bonuses for annual plan fulfilment and over-fulfilment. Those economists who intended to tackle the issues raised by this kind of hierarchical bureaucracies skipped out the theory of planning and analysed the principal-agent model in depth, coming out with a model of bureaucracy (for example: Keren, 2010). In the French context, a theory of incentives was elaborated on to be applied to any hierarchical process of decision-making, in particular in the state sector and when public expenditure is at stake (Laffont & Tirole, 1993).

Such is the mood in which Malinvaud (1992) underlined a sharp decline in public interest for planning in the wake of the collapse of communist centrally-planned economies. The success story, from Lange to Tinbergen, of the theory of planning became ambiguous for the two polar cases of taut planning in a command economy and indicative planning in a market economy. Malinvaud argued that planning was very useful in certain contexts over a certain lapse of time such as in post-war France or in the economic take-off in India. By 1992, the state was downsized everywhere and the role of planning was re-assessed downwards.

However, according to Malinvaud (1992), actual economies cannot meet the prerequisites (assumptions) of the theoretical model of instantaneous perfect market competition so that inter-temporal allocation of resources remain an issue that planning still can tackle. Perfectly flexible prices guaranteeing market equilibrium are out of reach: many prices are rigid with subsequent market disequilibria. The market fuels inequalities when it is not stabilised; with bigger and more complex globalised markets, stability is now out of control. Domestic economies are immersed into globalisation and require international measures in long-term perspective leaving no room for national planning to survive.

In the future, planning should stick to the study of supplying public goods and designing mid-term governmental policies for which usual planning techniques (dynamic input-output or macro-econometric models, cost-benefit analysis) are no longer efficient. Planning institutions are to be considered as part of a larger set of public institutions that must be flexible and adaptable. Referring to Pierre Massé (the 'father' of French planning), Malinvaud "also does believe" that there are still good arguments for keeping an influent and advising CPB while final decision-making remains in the hands of the Parliament. He concludes (p. 24): *"With the conception I have taken here, planning has a broader function than the setting up of national plans and it exists even if no such plan is made"*. Malinvaud still trusted planning in 1992.

6. Edmond Malinvaud and disequilibrium economics

Malinvaud's intellectual trajectory seems very similar to Kornai's. An article written by Kornai together with a young mathematician (Kornai & Liptak, 1962) benefited from Malinvaud's strong support within the editorial board of *Econometrica*. But a next article (Kornai & Liptkak, 1965) was even more brilliant. Liptak had the genius idea of reformulating the procedure of quantity decentralisation in terms of the game theory. He suggested to treat a two-level (PP and SPs) linear programme as a polyhedric game where one player is the CPB (PP) and the other player is the "team of all sectors" (SPs) optimising together a common objective function. The resolution of the polyhedric game with a Brown-Robinson procedure is interpreted as a series of successive decisions made in a fictitious game where each sector (industry) separately assesses its production plan allocated by the CPB and then sends back to the CPB its recommendations for resource allocation at the next iteration. The CPB reallocates resources accordingly.

The optimum is obtained when the resolution process of the game reaches the saddle point. It is a minimax solution if the objective function of the sectoral primal problem consists in maximising the value of production while the dual problem is to minimise the value of sectoral constraints, both maximum and minimum having a same numerical value (duality theorem). The procedure is more decentralised than in

Malinvaud's model since the sectors are allowed to send recommendations to the CPB. Malinvaud regrated that he did not know the Kornai-Liptak 1965 model when he conceived his own model. He offered a chapter to Kornai (1967) in a book he co-edited together with M.O.L. Bacharach where his 1967 article is published. Kornai's (1967) article sticks to the 1965 Kornai-Liptak procedure but underlines all the major differences between mathematical programming of the plan and the traditional methods actually used in elaborating the plan in Hungary. Taut planning eventually was abandoned in 1968, Hungary switching to a more macroeconomic and indicative planning.

From 1963 to 1968, Kornai collaborated with the Institute of Economic Planning and the National Planning Office in Hungary. He participated to the conception and elaboration of a system of operational planning models with a central PP and 18 sectoral SPs using both the Dantzig-Wolfe algorithm and the Kornai-Liptak 1965 procedure (Kornai, 1969). Kornai organised and managed data collection and computation of plan variants. But given the short capacity of electronic computers available at that time, the Kornai-Liptak algorithm was very slow to converge due to the quantity of data and the number of iterations required, so that the algorithm eventually was replaced by crude approximations of the optimum. It is difficult to know whether the Hungarian National Planning Office and sectoral ministries had actually taken on board all this computing work or not (Andreff, 2014), but Kornai (2005) confessed his feeling that mathematical planning remained alien to the bureaucratic planning office. Nevertheless, he was sorry that the collapse of communist regimes discredited the very idea of planning and remained prone to think that indicative planning does fit in a market economy. An argument that is definitely in tune with Malinvaud's. But nobody would like to hear the message any more after 1990. Hungary stopped genuine planning of its economy in 1989 and France in 1992. Economic globalisation definitely killed both French indicative planning and the Hungarian attempt at decentralised planning.

With economic globalisation and its current crisis, is it time for a second thought about planning? There is no signal in this direction. Moreover, the Walrasian *tâtonnement* was theoretically devalued when Sonnenschein (1973), Debreu (1974) and Mantel (1974) demonstrated that convergence to the optimum may or may not work with general (unspecified) household demand functions. Convergence is certain if, and only if, the

Arrow-Debreu net demand curve – equation (1) above – has a specific form (identical and continuous) which guarantees appropriate demand reactions to price variations and brings closer to the optimum after each iteration. If the net demand curve has not this specific form, then when the price of a commodity increases the net demand for it may decrease as well as increase. Consequently, a logical demonstration that the Walrasian system of prices and quantities converges towards the optimum becomes impossible. Therefore, *tâtonnement* can be unstable and non-converging. The Sonnenschein-Debreu-Mantel demonstration implies, in theory, that iterations à la Walras-Lange can end up with excess supply or excess demand; in which case general equilibrium is nothing more than an aggregate of partial equilibria in some markets and partial disequilibria in other markets. Moreover, if some prices are not infinitely flexible as assumed in the Walrasian model, but rigid or sticky, then quantities do not react to price signals in good proportions or do not react at all (Varian, 1975).

Although neither Malinvaud, nor Kornai mentioned the Debreu-Mantel-Sonnenschein theorem, both engaged in a new avenue for research in the late 1970s: analysing quantitative disequilibria – or non-Walrasian equilibria with fixed prices. It is a logical step forward for all the economists who, for years, have witnessed and analysed disequilibria in centrally-planned economies, namely Josef Brada, Wojcieh Charemza, Christopher Davis, Vladimir Dlouhy, Paul Hare, David Kemme, Mario Nuti, Richard Portes, Gérard Roland, Jozef van Brabant, Jan Winiecki, and David Winter. The book edited by Davis and Charemza (1989) makes this new interest in disequilibrium economics explicit among the former 'sovietologists'. The same year a major textbook in macroeconomics contended that disequilibrium economics studying the implications of sticky prices and wages has run out of (main)stream because it "*has 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*" (Blanchard & Fischer, 1989, p. 373).

Malinvaud's (1977) book, and an article published later (Malinvaud, 1982), are absolutely in line with disequilibrium economics as conceived by Clower, Leijonhuvfud and, in particular Barro-Grossman (1971). A kind of standard version of disequilibrium economics is due to Benassy (1982 & 1983). In Krueger (2003), Malinvaud reminds: *«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".*

Malinvaud (1977) argues that it is not partial disequilibrium in each market which is to be analysed, but simultaneous and interdependent disequilibria that are cumulative in an aggregated excess supply or an aggregated excess demand in the labour market on the one hand. On the other hand, in the market for goods fixed prices and short-term quantitative adjustments come out with excess supply or excess demand either. In disequilibria markets, the purchase (or sale) is the quantity which is actually traded while demand (or supply) is the quantity that an individual is willing to trade[18]. In the Walrasian equilibrium theory where prices are assumed to instantaneously adjust, the demand is equal to purchase and the supply equals sale. But when prices are fixed or sticky, adjustments proceed in quantity, and the double equality does not hold any more (p. 50).

Like in the Barro-Grossman model, the short-side market rule is at play in Malinvaud (1977): "in each market it is the short side that determines the transaction, and the long-side which is rationed[19]. If in a market one purchaser is rationed there cannot be any seller rationed in the same market and vice versa" (p. 52). Then follows an analysis of seller markets (at least one purchaser rationed) and purchaser markets (at least one seller rationed) in tune with Benassy (1975).

In the foreword to his book, Malinvaud (1977, p. 17) points at two shortcomings of his fixed-price model: a/ when excess supply or excess demand becomes very big, some assumptions of the model must be dropped; b/ some markets may exhibit prices that are different from fixed prices, i.e. a parallel or informal economy emerges and thrives. This is exactly the economic context for which Kornai (1980) conceived his economics of shortage.

[18] Coined 'notional' demand (or supply) in Clower (1965).

[19] In a market in excess demand, the short side is supply; in a market in excess supply, the short side is demand.

Kornai's shortage economy is characterised by a double excess demand respectively in the market for goods and the labour market[20] in Soviet-type centrally planned economies, i.e. a repressed inflation regime according to Malinvaud-Benassy. In fact, in Kornai's (1980) model most disequilibria are generated in a third market which is absent from Malinvaud 1977, the market for producer goods (inputs). The major determinant of shortages was the market for inputs in centrally planned economies. Moreover, in Kornai's approach, a same market for a particular input may simultaneously exhibit an excess demand and an excess supply due to frictions during the quantitative adjustment. This is the reason why Kornai adopts a much *more microeconomic* standpoint than in Clower (1965), Barro-Grossman, Benassy, Malinvaud, Portes-Winter (1980) and most disequilibrium analyses emerging at that time.

What Kornai is interested in is not only how each individual economic agent behaves, but also how each of his/her decisions is made depending on the specific day and location where each good is traded in potentially disequilibrium markets. Then his analysis comes down to a more disaggregated '*infra-micro-economic*' level, just like in Debreu (1959) according to Kornaï (1980). Contrarily to Clower-Barro-Grossman and Malinvaud, Kornai looks for the infra-micro-economic foundations of microeconomic and macroeconomic disequilibria. He considers that shortages (or surpluses) must be registered and analysed separately at the aforementioned infra-micro-economic level and, consequently, he is opposed to the short-side rule that aggregates all instantaneous decisions made by all individual agents into an effective macro demand (or macro supply). If all is aggregated, forced substitution between goods accepted by economic agents, typical of the Kornaian shortage economy and centrally-planned system, cannot occur. Curiously, Malinvaud (1977) resorts to a similar argument (p. 23-24) though without disaggregating supply and demand in each of the two markets in his model.

Kornai's (1980) book was praised to the skies for a decade or so, until the break-up of Soviet-type centrally-planned economies. After a while, recurrent shortages were cured during the post-communist transition to a market economy. Kornai's version of disequilibrium economics was soon forgotten. In 2003, Malinvaud was no longer optimistic about a survival of the Barro-Grossman version of disequilibrium economics that *"proved to be little rewarding for these colleagues … My own conclusion is that the research in*

[20] On the contrary, in capitalist market economies both markets are in excess supply.

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" (Krueger, 2003, p. 192-193). Kornai and Malinvaud abandoned nearly at the same time their research on decentralised planning and switched to disequilibrium economics but, in a matter of some years, the latter lost any kind of attractiveness to a majority of professional economists, namely among the youngest.

I would like to finish on a personal (foot)note. Neither Malinvaud nor Kornai was awarded the Bank of Sweden Prize in economics in memory of Alfred Nobel[21]. Kornai (2005) clearly expressed his frustration, Malinvaud did not.

7. Conclusion

Working with the Walrasian *tâtonnement* was considered at a time as the highway for elaborating the decentralised plan of a domestic economy. Edmond Malinvaud was a major contributor to this train of thought which reached a dead-end because of economic globalisation, de-regulation and de-planning policies, and the impossible theoretical demonstration that, in general, *tâtonnement* converges to the optimum. The pathway taken by Malinvaud and other theoreticians involved in the discussion about the Walrasian *tâtonnement* and decentralised planning was disequilibrium economics. The latter also vanished after two decades or so. In the face of the subprime and then Covid 19 crises, solutions were not looked for in a comeback to planning or in lessons to be drawn from disequilibrium economics. Nevertheless, beyond Malinvaud's contributions to microeconomics, econometrics and macroeconomics, his model of decentralised planning should not be left unheeded, as it was mostly the case so far.

[21] I had nominated both of them when I was requested to support a few names by the Prize selection committee, from 1988 to 1992. Unsuccessfully.

References

Aglietta M., Courbis R. (1969), 'Un outil pour le plan: le modèle FIFI', *Economie et Statistique*, 1(1), 45-65.

Andreff W. (1978), 'Structure de l'accumulation du capital et technologie en URSS', *Revue d'Etudes comparatives Est-Ouest*, 1, 47-88.

Andreff W. (1993), *La crise des économies socialistes: La rupture d'un système*, Grenoble, Presses Universitaires de Grenoble.

Andreff W. (2014), 'Le réalisme économique de Janos Kornaï: évolutif et éclectique', *Economies et Sociétés*, série 48(6), 1039-1061.

Andreff W. (2021), 'Janos Kornai: a non-mainstream pathway from economic planning to disequilibrium economics', *Public Choice*, 187(1-2), 63-83.

Arrow K.J., Hurwicz L. (1960), 'Decentralization and computation', in Pfouts R.W. (ed), *Essays in Economics and Econometrics*, Chapel Hill, University of North Carolina Press.

Babeau A., Derycke P.-H. (1967), *Problèmes techniques de planification*, Paris, Sirey.

Bain J.A. Jr, Miller J.B., Thornton J.R., Keren M. (1987), 'The ratchet, tautness, and managerial behavior in Soviet-type economies', *European Economic Review*, 31, 1173-1201.

Barone E. (1908), 'The ministry of production in the collectivist state', *Giornale degli economisti,* republished in von Hayek F.A. (ed), *Collectivist economic planning*, London, Routledge & Kegan, 1935.

Barro R.J., Grossman H.I. (1971), 'A general disequilibrium model of income and unemployment', *American Economic Review*, 61(1), 82-93.

Bauer T. (1978), 'Investment cycles in planned economies', *Acta Oeconomica*, 21(3), 243-260.

Benassy J.-P. (1975), 'Neo-keynesian disequilibrium theory in a monetary economy', *Review of Economic Studies*, 42(4), 502-523.

Benassy J.-P. (1982), *The Economics of Market Disequilibrium*, New York, Academic Press.

Benassy J.-P. (1983), 'The three regimes of t %

he IS-LM model: A non-Walrasian analysis', *European Economic Review*, 23(1), 1–17.

Blanchard O., Fischer (1989), *Lectures in Macroeconomics*, Cambridge, MA, MIT Press.

Boyer M., Dagenais M.G., Salvas-Bronsard L. (1989), 'L'empreinte de Malinvaud. Compte rendu de «Mélanges économiques. Essais en l'honneur de Edmond Malinvaud', *L'actualité économique. Revue d'analyse économique*, 65(2), 263-296.

Clower R. (1965), 'The Keynesian counter-revolution: A theoretical appraisal', in Hahn F.H. and Brechling F.P.R. (eds), *The Theory of Interest Rates*, London, Macmillan.

Dantzig G.B., Wolfe P. (1961), 'The decomposition principle for linear programs', *Econometrica*, 29(4), 767-778.

Davis C., Charemza W. (eds) (1989), *Models of Disequilibrium and Shortage in Centrally Planned Economies*, London & New York, Chapman and Hall.

Debreu G. (1959), *The Theory of Value. An Axiomatic Analysis of Economic Equilibrium*, New Haven, Yale University Press.

Debreu G. (1974), 'Excess demand functions', *Journal of Mathematical Economics*, 1(1), 15-21.

Dostaler G. (2007), 'Edmond Malinvaud, expliquer et combattre le chômage', *Alternatives économiques*, n° 257.

Dyker D.A. (1985), *The Future of the Soviet Economic Planning System*, London & Sydney, Croom Helm.

Ellman M. (1968), 'Optimal planning', *Soviet Studies*, 20(1), 112-36.

Fedorenko N.P. (1972), 'The current stage and future projects of creating automatised control systems of industrial enterprises' (in Russian), *Ekonomika i Matematitcheskie Medody*, n°2.

Kantorovich L.V. (1959), *The Best Use of Economic Resources*, Cambridge, MA, Harvard University Press (translation in 1965).

Keren M. (1972), 'On the tautness of plans', *Review of Economic Studies*, 39(4), 469-486.

Keren M. (2010), 'The bureaucrat's game: A building stone of a new perspective on economic systems theory', 69th International Atlantic Economic Conference, Prague, March.

Koopmans T. (1957), *Three Essays on the State of Economic Science*, New York, McGraw-Hill.

Kornai J. (1967), 'Mathematical programming of long-term plans in Hungary', in Malinvaud E. and Bacharach M.O.L. (eds), *Activity Analysis in the Theory of Growth and Planning*, London, Macmillan.

Kornai J. (1969), 'Multi-level programming: A first report on the model and on the experimental computations', *European Economic Review*, 1(1), 134-191.

Kornai J. (1980), *Economics of Shortage*, Amsterdam, North Holland Publishing.

Kornaï J. (2005), *A Gondolat Erejével, Rendhagyo Önélettrajz*, French translation *A la force de la pensée: Autobiographie irrégulière,* Paris, L'Harmattan (2014).

Kornai J., Liptak T. (1962), 'A mathematical investigation of some economic effects of profit sharing in socialist firms', *Econometrica*, 30(1), 140-161.

Kornai J., Liptak T. (1965), 'Two-level planning', *Econometrica*, 33(1), 141-169.

Krueger A.B. (2003), 'An Interview with Edmond Malinvaud', *Journal of Economic Perspectives*, 17(1), 181-198.

Laffont J.-J., Tirole J. (1993), *A Theory of Incentives in Procurement and Regulation*, Cambridge, MA, MIT Press.

Lange O. (1936), 'On the economic theory of socialism', *Review of Economic Studies*, 4(1 & 2), October 1936 & February 1937, 53-71 & 123-142.

Lerner A.P. (1934), 'Economic theory and socialist economy', *Review of Economic Studies*, 2(1), 51-61.

Lerner A.P. (1946), *The Economics of Control*, New York, Macmillan.

Malinvaud E. (1954), 'Aggregation problems in input-output models', in Barna T. (ed), *The Structural*

Interdependence of the Economy, New York, John Wiley.

Malinvaud E. (1957), *Initiation à la comptabilité nationale*, Paris, Presses Universitaires de France.

Malinvaud E. (1967), 'Decentralized procedures for planning, in Malinvaud E. and Bacharach M.O.L. (eds), *Activity Analysis in the Theory of Growth and Planning*, London, Macmillan.

Malinvaud E. (1968), 'Notes sur l'étude des procédures de planification', *Revue Canadienne d'Economie/Canadian Journal of Economics*, 1(1), 16-36.

Malinvaud E. (1969a), 'First-order certainty equivalence', *Econometrica*, 37(4), 706-718.

Malinvaud E. (1969b), *Leçons de théorie micro-économique*, Paris, Dunod.

Malinvaud E. (1970a), 'The consistency of nonlinear regression', *The Annals of Mathematical Statistics*, 41(3), 959-969.

Malinvaud E. (1970b), 'Procedures for the determination of a programme of public consumption', *European Economic Review*, 2(2), 187-217.

Malinvaud E. (1971), 'A planning approach to the public good problem', *Swedish Journal of Economics*, 73(1), 96-112.

Malinvaud E. (1977), *The Theory of Unemployment Reconsidered*, Oxford, Basil Blackwell.

Malinvaud E. (1978), *Méthodes statistiques de l'économétrie*, Paris, Dunod.

Malinvaud E. (1980), *Profitability and Unemployment*, Cambridge, Cambridge University Press.

Malinvaud E. (1981), *Théorie macroéconomique*, Paris, Dunod.

Malinvaud E. (1982), 'An econometric model for macro-disequilibrium analysis', in Hazewinkel M. and Rinnooy Kan, A.H.G. (eds), *Current Development in the Interface: Economics, Econometrics, Mathematics*, Heidelberg, Springer.

Malinvaud E. (1983), *Essais sur la théorie du chômage*, Paris, Calmann-Lévy.

Malinvaud E. (1991a), *Voies de la recherche macroéconomique*, Paris, Odile Jacob.

Malinvaud E. (1991b), 'A medium-term employment equilibrium', in: Barnett W., Cornet B., d'Aspremont C., Gabszewicz J. and Mas-Colell A. (eds), *Equilibrium Theory and Applications*, Cambridge, Cambridge University Press.

Malinvaud E. (1992), 'The future of economic planning', *Indian Economic Review*, Special Number, 15-24.

Malinvaud E. (1994), *Diagnosing Unemployment*, Cambridge, Cambridge University Press.

Mantel R. (1974), 'On the characterization of aggregate excess demand', *Journal of Economic Theory*, 7(3), 348-53.

Marschak T. (1959), 'Centralization and decentralization in economic organizations', *Econometrica*, 27(3), 339-430.

Marschak T. (1960), 'Pricing and capital budgeting in the French nationalized industries', *Journal of Business*, 33(2), 133-56.

Marschak T., Radner R. (1972), *Economic Theory of Teams*, New Haven, Cowles Foundation and Yale University.

Mead M., Byers P. (1988), *Mélanges économiques. Essais en l'honneur de Edmond Malinvaud*, Paris, Editions de l'Ecole des Hautes Etudes en Sciences Sociales.

Montias J.M. (1959), 'Planning with material balances in Soviet-type economies', *American Economic Review*, 49(5), 963-985.

Pareto V. (1906), *Manuel d'économie politique*, Paris, Giard & Brière.

Pugachev V.F. (1965), 'An approximation scheme of multi-level optimal planning of the domestic economy, (in Russian), in Vichnev S.M. (ed), *Economic-mathematical Methods*, Moscow, Misl, vol. 2.

Sonnenschein H. (1973), 'Do Walras identity and continuity characterize the class of excess demand functions?', *Journal of Economic Theory*, 6(4), 345-354.

Taylor F.M. (1929), 'The guidance of production in a socialist state', *American Economic Review*, 19(1), 1-8.

Uzawa H. (1958), 'Iterative methods for concave programming', in Arrow K.J., Hurwicz L. and Uzawa H. (eds), *Studies in Linear and Non-Linear Programming*, Redwood City, Stanford University Press.

Varian H.A. (1975), 'On persistent disequilibrium', *Journal of Economic Theory*, 10(2), 218-227.

Walbroeck J. (1964), 'La grande controverse sur la planification et la théorie économique contemporaine mathématique', *Cahiers de l'ISEA*, série G, n°19, 3-24.

Weitzman M.L. (1980), 'The "ratchet principle" and performance incentives', *Bell Journal of Economics*, 11(1), 302-308.

Wicksteed P.H. (1910), *The Common Sense of Political Economy*, London, Routledge.

Zauberman A. (1967), *Aspects of Planometrics*, London, Athone Press.