Quantitative Economic Modeling vs Methodological Individualism ?

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RÉSUMÉ

L'école autrichienne a longtemps été hostile à la formalisation mathématique en sciences économiques et sociales parce qu'elle jugeait celle-ci antinomique de l'appréciation individualiste des phénomènes sociaux. Cet article tente de proposer une voie de modélisation quantitative individualiste à partir de la critique des modélisations holistes, mais il met également en évidence le dilemme devant lequel se trouve la modélisation économique quantitative : il faut en effet choisir entre des représentations globales, qui malheureusement gomment l'individu et des modèles individualistes qui ne peuvent être exhaustifs. Ces deux types de modèles ont leurs logiques propres d'élaboration (construction statistique pour les uns, expérimentale pour les autres etc.), mais doivent être considérés comme complémentaires pour faire progresser la compréhension des phénomènes économiques et sociaux.

SUMMARY

During a long time, the Austrian Economic School was against any mathematical formalization in social and economic sciences because it would be opposed to an individualist point of view of social phenomenons. We try to find an quantitative individualism modelling way from a criticism of holist modelling. But this paper tries to improve the dilemma of the quantitative modelling : we have to choose between whole representations - which denies individuals - and individualist models which are'nt able all to represent. Each one of these models have got his own logic of elaboration (statistical, experimental etc.) but we have to consider they are complementary from a scientific point of view.

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"*The determination of the coefficients economically most advantageous can only be done in an experimental way : and note on a small scale, as could be done in a laboratory ; but with experiments on a very large scale, because often the advantage of the variation as its origine precisely in a new and greater dimension of the undertaking. Experiments may be successful in the sense that they may lead to a lower cost combination of factors ; or they may be unsuccessful, in wich case that particular organization may not be copied and repeated and others we'll be prefered, wich experimentally have given a better result.*" **E. BARONE**, 1908, "The Ministry of Production in a Collectivist State", F.A.HAYEK (ED.), *Collectivist Economic Planning*, London, Routeledge, 1935, p.288.

0 - INTRODUCTION

The Austrian Economic School is against any mathematical formalization in social and economic sciences. First, it denies individuals, and secondly, mathematical functions (continued one) assume that individual are interchangeable and replaced by abstract entities[1]. Our purpose is to improve that mathematical modelling is not necessarily contrary of an individualist analysis of society. Scientific knowledge increases in mean of measurement. So we have to identify and evaluate the right size and we have not to forget individual and limits of our tools. With their mathematical economic tools, macro-economists had admitted they had reduced individual behavior representations, and the planists had disturbed coordination and efficiency of individual decisions (with the "imperative planning"). But, it seams that mathematical economics only and partially explains economic phenomenon if mathematical and economical logics can be related. Any way, mathematical economic can't give reliable forsights[2]. Holist models, because they have to get a whole representation (they use the aggregate variables), deny individuals and provide a mediocre representation of information and communication between the individuals during their transactions. It seems possible to make models with individual and informational sizes ; we call such a way "individualist modeling". It tries to explain economical and social behavior and to underline coordination phenomenons and spontaneous order. Holist models can be improve by econometric methods, but individualist models can't do that. It seems that experimental method could be the better way to improve such models. We can believe that a whole individualist model could be build. We can imagine such a model, but it would be nor calculable during an human life neither useful because it would be replaced by the market. So that economist have to choose between individualist (and partial) or holist (denying individual) models.

[1] The Austrians consider historical data collection don't increase economic knowledge (S.LONGUET, 1998, pp.21-23).

[2] Conjonctural analysis tries to find parameters which determine the trend of the main economic indicators. The problem is that these parameters are never only economic and reductable to a theory. See R.COURBIS, (1995), "De la modélisation macro-économétrique à la modélisation macro-politique - propos d'étape", *Journal de la Société de Statisitique de Paris*, N^{o}136(1), pp.47-70.

1 - HOLIST ECONOMIC MODELING'S CRITICISMS

During the twenties and thirties, new mathematical economic tools appeared. In an hand, the Socialists (orthodox one and market one) have tried to set operational planning of the economy; and in an other hand, Neoclassical and Keynesian economists (some of them are physicians) have built econometric method which they have applied to their models. After the seventies, these models can provide good results, because the economies get more and more integrated. It seems that the mediocre representation of communication and information in these models, reinforce the bad results of them[3] ; especially because of the aggregated variables technique - we meet some problems of interpretation. Finally, planning as mathematical substitution of market was unsuccessful.

1.1 - Information Modeling, Communication, and Behavior

Neither neoclassical nor keynesian models have integrated information representation process. Furthermore, econometric equations are seldom in harmony with theoretical one. It was defined at first, in physics, with the concept of entropy - *i.e.* level of information which describes the degree of organization of a system. Then, social sciences used concept of information through a few definition. In microeconomic models, information is a factor of uncertainty reduction. In statistics, R.A.FISHER has proposed the concept of "pertinent information" to reduce data sets[4] - since T.HAAVELMO, macro-econometric models has got stochastic characteristic. C.E.SHANNON has proposed a communication model with a transmitter and a receiver[5] completed by N.WIENER who has introduced the feed-back. Sociology was interested by that last conception, but Economics didn't. All of these models used systemical approach. The role of information in the models is rather ambiguous. In the walrasian model there is a contradition when we assume that prices give information about market (quantity, agents etc.) and in the same time, information are free and easely to access. Furthermore, we don't see how information can transmitted between agents when we leave the classical assumption of purely and perfectly competition. The way lead us to a paradox underlined by I.KIRZNER (1979), in which agents already know the information they are looking for. The rational expectation hypothesis[6] - *i.e.* agents have got together

[3] See "La modélisation macroéconomique comme processus de communication - réflexions pour une formalisation finaliste des équations de comportement", *Mimeo GAMA*, University of Paris X- Nanterre, Séminaire Modem-junior, 15th may 1997.

[4] R.A.FISHER, *Statistical Methods for Research Workers*, Oliver and Boyd, 1925.

[5] C.E.SHANNON and W.WEAVER,*The Mathematical Theory of Communication, Chicago, University of Illinois*, 1949.

[6] Proposed by J.F. MUTH, "Rational Expectations and the Theory of Prices Movements",

a rather good expectation of future economic situation - wich is often used in microeconomic and macroeconomic models is usually wrong[7]. Formalization of agents behavior in microeconomic models is setting on the rationality axiom - the bounded rationality theory of H.A.SIMON don't invalidate rationality axiom. However, this mechanism is a rather good individual representation but macroeconomic transposition implies some interpretations troubles. The econometrics is not able to give equations which would represent behaviors perfectly, so we can wonder if we would have to formalize new "analogical" equations (R.BUDA, 1997). In the "holist" models we don't find in equations any representation of agent's purposes or level of knowledge ; these sizes could help us to get equations better. Furthermore, R.E.Jr. LUCAS (1976) has critiqued stability of behavior equations. When we estimate coefficients from an usual economic environment, we can't make a good simulation of an unusual economic environment, because the coefficients are no longer pertinent. Problems become more important by use of aggregation technique. R.E.Jr. LUCAS (1976) has observed that stability of behavioral equations is neve warranted, because coefficients estimation is based on usually economical politics. The size of the trouble depends on the aggregation methods[8].

1.2 - The Aggregation Problem

The purpose of aggregation is to explain the economic situation by global mechanism, with some collective entity obtained by calculation of individual sizes (agents, products, activities or financial assets). It permits to investigate with only a few fictitious agents, activities and products. We assume that entities (aggregates) can represent *e.g.* behavior of the individual. If we accept to loose some information, aggregation technique is useful to make whole analysis from an synthetical and pedagogical point of view. But even if we respect the condition of homogeneity of data[9], new entity usually have no longer same properties than his

Econometrica, N°29(6), 1961, pp.315-35.

[7] R.COURBIS explains that agents make expectation "on the wrong foot" : when they have been too much optimistic in a first period, then they become systematically pessimistic - see our paper "L'horizon économique est-il toujours lisible ?", Compte-rendu libre des Journées de prévision du GAMA : L'économie mondiale et l'économie française à court terme, moyen terme et long terme, *Mimeo GAMA*, 20 février 1996.

[8] But R.E.Jr.LUCAS doesn't use knowledge process in his rational expectation models.

[9] It exists two kinds of aggregation technique : perfect aggregation and representative agent aggregation. In first case, we assume that some linear functions can permit to calculate the new aggregated variable from individual data (we have to separately calculate endogenous and exogenous variables of a model). In the second case, there is another assumption about statistical property of data : they have to follow the Central Limit Theorem - See E.MALINVAUD, *Voies de la recherche macroéconomique*, Paris, Seuil, Coll.Points, 1991, pp.184-221.

individuals[10]. Drawbacks don't depend on the level of aggregation. Even if we use a weak level of aggregation, some important drawbacks appear. If we examine production from each firm, we can assume stability of products. We have to consider the effect of technical progress ; the products are always transforming during an period of observation - this problem is known by statisticians when they try to calculate prices indexes. This transformation can be slow or chaotic, but anyway the product is no longer the same at the end of the period. Such samples data of products cant be aggregated because, homogeneity hypothesis is wrong - it exists inheritance relationship between the products[11]. In fact, **the number of different products we can observe in an economy, permit to give the age of this economy. So, we can no longer admit that a strongly aggregated model would represent an industrial economy. Aggregation technique can't make appear any technical progress**[12]. Furthermore, the aggregation technique reduces the environment of the agents. In fact, each agent can observe all around a lot of other agents, activities etc[13]. So, some of transactions take place by chance. If we make aggregation, we can no longer simulate the complexity of individual decisions[14].

1.3 - "Imperative" Planning *vs* "Indicative" Planning

We can observe two kinds of planning policies. The first one, "Imperative planning" (in socialist economies) organized the allocation of economic resources and the other, "Indicative planning", tried to lead the decision of all the national economic agents. The first one tried to replace completely or partially ("Market socialism") the market. In a centralized economy, a planning administrator had to calculate and decide the best allocation of resources between the different economic agents. We assumed that State knows the welfare of each agent, and that

[10] For a general point of view, see the Paradox of Quételet (1835) ; See too C.W.J. GRANGER, "The Effect of Aggregation on Non-Linearity", *Working Paper University California San Diego*, Aug., 1989, 25 p.

[11] In theoretical models proposed by P.SRAFFA, *Production of Commodities by the Mean of Commodities*, Cambridge, Cambridge UP., 1960, and with less emphasis in empirical model W.LEONTIEF, *La structure de l'économie américaine 1919-1939*, Paris, M.T.Génin, (French translation, 1958), 278 p.

[12] R.M.SOLOW has tried to resolve this with his theory of "Vintage Capital" ("Technical Change and the Aggregated Production Function", *Review of Economics and Statistics*, N^{o}39, 1957, pp.312-20 ; and "Invesment and Technical Progress", in K.J.ARROW, S.KARLIN, P.SUPPES (EDS), *Mathematical Methods in the Social Sciences*, Stanford, Stanford UP, 1960, pp.89-104.

[13] Each agent can assimilate only a few information of his environment (F.A.HAYEK, 1967, p.49), but the model as not to reduce this environment because of this ground.

[14] Individuals and not aggregates make decision (F.A.HAYEK, 1952).

it exist an hypothetical "social welfare". Such an economic government denied individuals and sovereignty of individual decisions. Socialist planning began with the concept of quantitive production standards : man-power balances (the marxian concept of work socially useful was not very easy to measure) and material balances[15]. Some problems of incentive (because of the lack of payment and purpose of the agents) and convergence toward optimal solution (because of the lack of pertinent informations) were appeared[16]. That the reason why O.R.LANGE (1936-37) has proposed a planning walrasian process the "Market socialism" - *i.e.* the production goods market was controlled but the consumption goods one was rather free[17]. The both kinds of socialist planning (marxian[18] and walrasian one) has met redhibitory problems. When socialist economist tried to solve them, some of them concluded to the preeminence of the market[19], some other discovered the "Marginalist theory" again. "Indicative planning" and Econometrics met the same kinds of problems. Economic environment was not efficently represented by econometric tools and, in the same time, economies became more and more interdependent. Furthermore, some assumptions of mathematical economics should be reexamined[20] : the continuity of economic functions was justified by the aggregation technique - but what would mean to speak of $ 2.990000005 or 2.5 economic agents ? We have explained that aggregation was criticable[21] - *Cf. Supra*. We can observe that holist economic modelling are not able to propose efficient calculation procedures of individual activities when individual size is pertinent. The first reason is that macroeconomic models provide potential but not prospective representations of future economic situation and secondly, planning processes try to substitute necessary procedure for a lot of contingent actions. Is it possible to

[15] See A. ZAUBERMAN, *Aspects of Planometrics*, London, Athlone Press, 1967, 318 p.

[16] They were underlined by L.MISES in 1920 "Die Wirtschaftsrechnung im Sozialistischen Gemeinwesen", *Archiv für Sozialwissenschaft*, Vol.47, (trans. : *Economic Calculation in the Socialist Commonwealth*, 1935) and by F.A.HAYEK "The Nature and History of the Problem" (*Ibid.*, pp.1-40).

[17] O.R.LANGE has proposed the "Market socialism" in two papers published in the Review of Economic Studies, N^{o}4(1) oct.1936 et N^{o}4(2) feb. 1937 with the title *On the Economic Theory of Socialism* reprinted in 1964 in B.E.LIPPINCOTT (ED.). K.J.ARROW and L.HURWICZ improved the existency of solution such a planning process - see "Decentralization and Computation in Resource Allocation", in R.PFOUTS (ED.), *Essays in Economics and Econometrics in Honor of H. Hotelling*, Chapel Hill, 1960.

[18] O.R.LANGE (1970, pp.49-62) proposed a marxian systemic control of the production.

[19] O.R.LANGE has used a market to obtain pertinent prices information by iterative calculation.

[20] L.MISES (1938) criticized the application to economics of the differential equations to represent economic calculation of agents. Utility functions (ordinal and cardinal one) was criticized by M.ROTHBARD. They imply a psychologic reduction.

[21] See too the Sonnenschein Theorem ("Do Walras Identity and Continuity Characterize the Class of Community Excess Demand ?", *Journal of Economic Theory*, N^{o}6, 1973) which deny to build general economics laws from continuous functions.

build a new modelling which associates classical methods and individual size ? We shall examine this question now.

2 - TWO TRIALS OF INDIVIDUALIST MODELLING

An individual scale modelling proposition appeared in the fifties[22], today known under the name of "micro-simulation" ; this technique has be able to develop because of the progress of data process. Our purpose is not only to consider individual scale, as micro-simulation do it, but to use communication and knowledge acquisition behavioral functions in methodological individualist models. We provide two examples of such models. The first one, **COPIE -** *i.e.* **C**omportements **O**ccultes **P**endant une **I**nterrogation ou un **E**xamen - represents pupils and teachers behaviors at school[23]. This model try to examine the effect of transmissions of informations between the different agents, especially cheating during exams. The second model, **SINGUL -** *i.e.* **S**imulation **IN**dividualiste de **G**estion des **U**tilités **L**ibres -, represents transactions of agents in a market of one good. This model try to show how transactions can take place out of the walrasian equilibrium. At the end of this part, we'll examine the mode of validation of such models.

2.1 - A learning individualist modelling - the COPIE model

COPIE is a dynamic model in which we try to represent as realistic as possible we can, the relationship between actors of a classroom - teachers, pupils etc., see Appendix A. We have divided the period of simulation in twenty parts to make a correspondence between the twenty points of the mark and the lessons. In the model, we assume that each pupil has got an ability to "record" the lessons. Then the model calculates the result of the individual learning process during exams, and it focuses about a few pupils who have got propansion to cheat. We define four repression politics against cheat who bring about the behavior of the cheater pupils, so that we can calculates losses and gains of each pupils - these who have succeed their exam with or without any cheat, these who have not succeed with or without cheat. In this model we try to have a better appreciation of the individual behavior rationality. We can find intuitive results (repressive politics are more efficient than permissive one) but we obtain richer information about the process (especially we underline the role of the information level of each pupil) - see Appendix A. We can find the famous non intentional effect of F.A.HAYEK (1952),

[22] G.H.ORCUTT "A New Type of Socioeconomic System", *Review of Economics and Statistics*, N^{o}58, 1957, pp.773-97.

[23] About a preliminary analyze of the school as a market see R.BUDA, "La logique marchande en classe - analyse et modélisation de la rationalité scolaire", *Mimeo GAMA*, Université de Paris X-Nanterre, nov., 1996.

when pupils are able to cheat because of the teacher politics. When we compare the both pupils behaviors - to cheat or not to cheat -, we can show the individual and social bad effect such behaviors. We can compare the difference between exams and competitions, in terms of efficiency of learning and we examine the effect on the level of information. However, the mechanism of learning is open to criticism, concerning the measure of the intelligence of pupils and the process of learning.

2.2 - A Model of market exchange with one good - SINGUL model

With the SINGUL model, we try to analyze the imperfect information hypothesis on a market with one good but without any speculation. Each agent try to get some unit of the good. We assume that each agent has got a level of the good and a wished level of this good (they manage their inventory to obtain a this level). To reach their purpose, we assume they can meet some of the other agents of the market and they try to contract (to buy unit of good if their inventory is not enough, to sell in the other case). Contracts take place if the both are all right with the price. They bargain the price (each seller has got a minimum price and each buyer has got a maximum price). But the price of the transaction is not exactly halfway between minimum price seller and maximum price buyer. We assume that the both agent who are made bargain, are not equally motivated to contract. The most they have to buy to complete their stock, the most they accept the terms of the exchange of the other agent. The most of transaction take place out of the equilibrium point, but at each time, they are mutually advantageous. In a first version of the model, each agent try to contract immediately. In a second version of the model, each agent makes a classification of the agents he have met from the better to the worse (in terms of prices). At each meeting, the both agents assign a rank each other (*e.g.* [1,1] if they assign number 1 each other). We can calculate solution of the market at rank one - *i.e.* we only keep the [1,1] transactions. We can calculate at rank two too. We keep all the couples [1,1] first, then [1,2], [2,1] and [2,2]. In the model we can simulate a behavior of relaxation of negociation margin, or new partners search - see Appendix B.

2.3 - The problem of the validation of the individualist models

For the quantitative economic model, the validation is usually statistic. A few micro-simulation models use statistic validation too - after an individual analyze, the modeler makes aggregations to propose general conclusions. But our individualist models can't do that. The communication, learning, and information relationship can't be reduced by aggregation. Furthermore, this kind of modelling don't look for a generalization.

TABLE #1 - *Results of the COPIE model simulations*

1ERE	CLASSE											
CONTR.		1	2	3	GAINS	PERTE	BILAN	BO/MA	MOYEN	CREEL	MOYRE	ECART
ELEVE	#001	9	10	15	0	-26	-26	0	11.33	32	9.71	1.62
ELEVE	#002	15	14	15	0	0	0	0	14.67	43	11.64	3.03
ELEVE	#003	15	1	0	0	-188	-188	0	5.33	26	7.07	-1.74
ELEVE	#004	12	1	0	0	-35	-35	0	4.33	29	10.46	-6.13
ELEVE	#005	9	2	0	0	-8	-8	0	3.67	20	2.71	0.96
ELEVE	#006	6	1	2	0	-9	-9	-1	2.97	14	5.43	-2.46
ELEVE	#007	12	2	0	0	-187	-187	0	4.67	22	8.09	-3.42
ELEVE	#008	14	14	17	0	0	0	0	15.00	44	9.66	5.34
ELEVE	#009	11	10	7	0	0	0	0	9.33	27	6.60	2.73
ELEVE	#010	10	1	1	0	-60	-60	0	4.00	19	7.07	-3.07
ELEVE	#011	10	0	0	0	-144	-144	0	3.33	21	4.09	-0.76
ELEVE	#012	13	17	14	0	0	0	0	14.67	44	8.01	6.66
ELEVE	#013	12	11	16	0	0	0	0	13.00	36	4.76	8.24
ELEVE	#014	17	12	10	0	0	0	0	13.00	37	8.52	4.48
ELEVE	#015	14	16	12	0	0	0	0	14.00	42	12.00	2.00
ELEVE	#016	11	0	2	0	-99	-99	0	4.33	21	7.53	-3.20
ELEVE	#017	17	5	0	1	-119	-118	0	7.33	42	12.29	-4.96
ELEVE	#018	13	1	0	0	-151	-151	0	4.67	21	8.07	-3.40
ELEVE	#019	7	1	1	0	-5	-5	0	3.00	18	6.01	-3.01
ELEVE	#020	8	0	0	0	0	0	0	2.67	19	5.80	-3.13
ELEVE	#021	15	11	12	0	0	0	0	12.67	37	11.67	1.00
ELEVE	#022	14	16	17	0	0	0	0	15.67	46	12.00	3.67
ELEVE	#023	8	2	3	0	-7	-7	0	4.33	10	8.80	-4.47
ELEVE	#024	10	1	1	0	-100	-100	0	4.00	24	10.74	-6.74
MOYCON		12	6	6	-	-	-	-1	8.00	8.42		
COUFRA		-8	-20	-20	1	-1138	-1137	BAV= 366	KNO= 694	-6.76		

The model COPIE was validated by a calibration. The sample of data comes from the marks of four classes of an high school. We have started simulation of second quarterly with the averages of first quarterly, for each pupils. We have compared the new averages with the real one - see Appendix A. The value of marks depends strongly on the initial real value of marks. We have calculated two gaps : the average-gap[24] and the algebraic-gap[25] - See Table #1 in one simulation we can obtain rather good results : average-gap = -0.42 and algebraic-gap = -6.76. To calculate the coefficients of a few equations, we have made reflexion about a questionnary process - See Table #2. From an individualist point of view, because of the problem of statistical treatment, we have better to need the least coefficients possible.

TABLE #2 - Questionnary for calibration of the COPIE model[26]

1	How many hours do you need to follow courses by a week ?
2	How long time do you spend to learn your lessons ?
3	How long time do you spend to other activities ?
4	How many topics can you identify, which get trouble your attention during your last lesson ?
5	How long time were you disturb by such ideas during your last lesson ?
6	Do you thing these ideas during the lessons, could disturb efficiency of your learning ?
7	If you try to free ride during an exam, can you estimate your probability to be discover by teacher?

The SINGUL model doesn't need any coefficient - See Appendix B. We simulate behavior with stochastic process (Random function), so that we had to find of a qualitative validation process. The best one seemed to be the experimental one - *i.e.* based on data collection from experimentations which took place with real actors in an controllable environment (V.L.SMITH, 1989). With experimental economics, it is possible to make ceteris paribus analysis ; but with econometrics, we cant. During the experiment, real actors make decisions that we can directly observe and measure (collect of data). Especially, A.H.WILLIAMS has proposed in 1980, to collect experimental data (volumes, prices, number of contracts, etc.) through linked computers. The ECHANGE software we have developed follows this principle - See Appendix C. The SINGUL model is a simulation tool with can be parametred by experiment (through the ECHANGE software). We can test a large panel of behaviors (prices-purpose, inventory- purpose, new partners search etc.). Then experiments would give among a lot of behavioral equations the best

[24] Simulated average - real average.

[25] Sum of all average-gaps.

[26] Some questions present deotological problems.

one - after a qualitative analysis of the experimental results See Fig.#1. The relationship between simulation and experiment seems to be full of promise from an instrumental and theoretical point of view. The both Micro-simulation and Experimental Economists specialists alreadly use it[27]. Furthermore, this relationship is interesting from the institutional point of view. Experimental economics studies the HAYEK's coordination hypothesis (V.L.SMITH, 1991), and the HAYEK's knowledge theory (C.SCHMIDT, D.W.VERSAILLES, 1999) would be an interesting base of development of such individuals models.

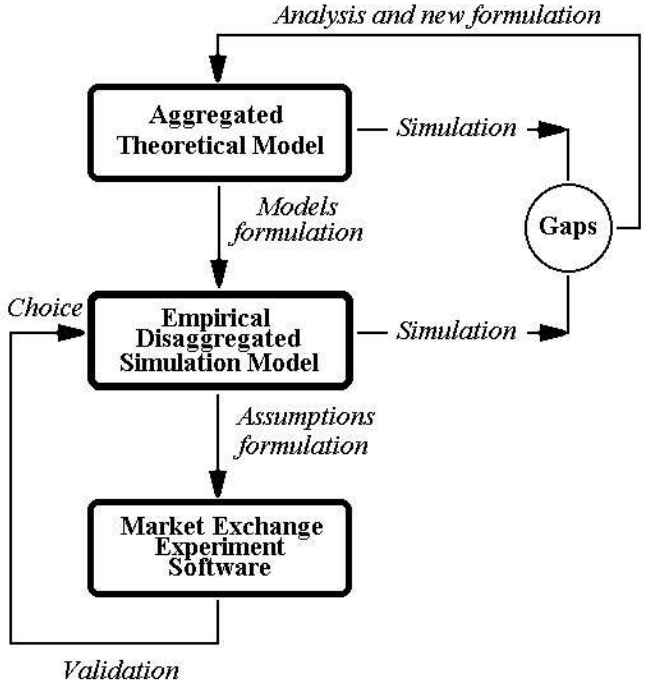

Figure #1 - Theoretical, empirical, and experimental system

3 - THE LIMITS OF THE INDIVIDUALIST MODELLING

During the last parts, we have shown that it is possible to built a model which partially represents an economic reality (a market) or social reality (a class). Is generalizing of such models possible and useful[28] ? The conception problems are easier than implementation and resolution one.

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[27] See D.K.GODE and S.SUNDER, "Allocative Efficiency of Markets with Zero-intelligence Traders : Market as a partial Substitute for Individual Rationality", *Journal of Political Economy*, N^{o}95, 1993, pp.1217-39.

[28] See M.ALLAIS (1954) who made a macroeconomic model based on sums of individual accounts.

3.1 - Conception of an hypothetical whole individualist model

We can easily conceive a whole individualist model. If we imagine a society without any State - we can do that, trade did exist before states F.A.HAYEK, 1988 - and if we assume that agents are not definitively labelled (sellers, buyers, producers, workers etc.) - we can do that because, e.g. a producer has anyway to eat every day and so he becomes a consumer - See Appendix D. With such a model - if it exist -, we could represent communications between agents. The agents receive and send all the time information from and to their environment - nobody knows everything, so everybody searches the information he needs ; information are revealed by prices (F.A.HAYEK, 1937 et 1981). Some networks appear (e.g. between workers in their firm and the manager) which are organizations or institutions. This manager collects all the time technical (which can update his own production technique) and trade information (which help him to calculate the better quantity and prices of his products) - L.LACHMANN (1986) proposed to make difference between additive information and complementary information. We could represent justice problems. We could simulate robberies - transfer without any compensation of goods with a decrease of the health capital of the victim -, murders - health capital of the victim decreases to zero - etc. We would have to consider psychological criteria of behaviors (when appears the behavior of robbery, murder etc.). This network could be observed in terms of "rules" (F.A.HAYEK, 1973).

3.2 - Implementation of an hypothetical whole individualist model

We could write a program from the conception of such a whole (international, national etc.) model. For simulating each transaction, we only have to call a SINGUL-subroutine which could calculate quantitities, prices etc. Modification of the agents allocations would imply new decisions, new transactions, new allocations etc. However, it seems unreal to develop such a project[29]. First, initializing would be a monumental operation. We would have to get value to several millions of variables for each group of individuals. We couldn't randomly choice them, because we would have got coherence problems - we risk to obtain an economic situation which never have had to exist. To solve this problem, modelling-maker would have two solutions : 1° - he would collect all the data about agents, products, relationships, etc. but it would assume a enormous logistic, a free and right access to several milliards of data. 2° - he would make a retrospective simulation - when economy was a primary one (with only a few products and activities) ; but

[29] When O.R.LANGE (1967) proposed his decentralized planning, he thought he has resolved all difficulties because he used a computer.

he would need a monumental time to reach the industrial period of the economy he studies. In all cases, he would have to check the account equilibria - *i.e.* detect, find and correct all the errors. Furthermore, some arithmetical problems and calculate duration problems would appear. O.MORGENSTERN (1950) explained that he would meet accuracy problems and he would have to calculate a monumental quantitity of equations for solving a rather small economy. L.ROBBINS (The Great Depression, London, Macmillan, 1934) spoke about a size of one million of equations, and F.HAYEK (ED.)(1935, op.cit.) spoke about hundred millions. If we assume a plan-administrator who can access to all the necessary information, and use the SINGUL model to calculate transactions in an economy of one million inhabitants and one thousand goods. He would have to calculate 10^{13} (if we assume hundred meeting per each agent) et 10^{21} (if we assume generalized meeting). Duration calculation would be approximatively a month (with a 1 GHz processor) and he would meet the problem of accuracy (over-float error would appear)[30]. Even if we would resolve the problem of accuracy, we increase the problem of duration.

3.3 - Useless of an hypothetical whole individualist model

E.BARONE explained that market already calculates him-self easily and correctly the transaction. In fact, the subjectivism of methodological individualism implies all point of view (the point of view of one agent and his partners too) but we can't substitute it.

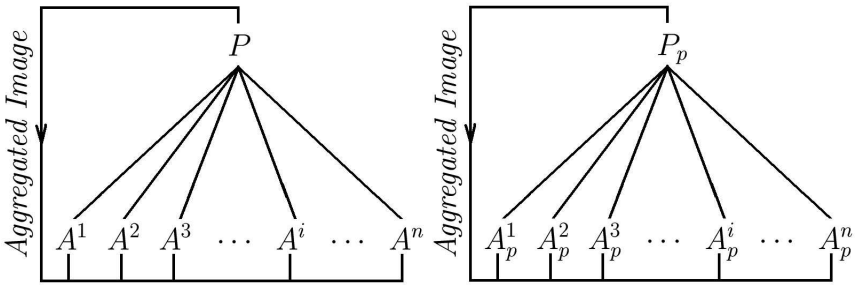


Fig.#2 - Comparison between two modes of calculation

On the contrary, "holist" models reduces reprentation to only one point of view, the algorithm one. We contest here the equilibrium paradigm. Modelling-

[30] About the GNOMBR program which give an accuracy of 2500 digits with elementary arithmetical operations, see R.BUDA, "Présentation d'un outil de contrôle de la précision des calculs en modélisation macroéconomique", *Mimeo GAMA*, Université de Paris X-Nanterre, août, 1996. About the general problem of computer's arithmetics, see M. DAUMAS, J.M. MULLER (EDS), *Qualité des calculs sur ordinateurs - vers des arithmétiques plus fiables ?*, Paris, Masson, 1997, 164 p.

maker is in front of two traps - see Fig.#2 - : 1° - in a centralized point of view, he built a model with only one algorithm P_p - *i.e.* planning processor - which receives the information from some of agents A^i, then he calculates and transmits aggregated image of the economy to each agent. 2° - in a decentralized point of view, he collects the results of calculations of each agent A^i_p - *i.e.* agent i-processor - and he calculates the aggregated image of the economy. If we assume that both ways are possible, we could observe that information would be poor upstream and downstream in centralized process, and it would be rich upstream and poor (and useless) downstream in decentralized process.

TABLE #3 - Typology of modelling representations

	AGGREGATION LEVEL		
CALCULATORS	VERY STRONG	WEAK	NO
ONLY ONE	Mono-dimensional Macro-econometric Modelling	Multidimensional Macro-econometric Modelling	Methodological Individualism Modelling
A FEW	Procedures of the Market Socialism		Methodological Individualism Modelling
ONE PER AGENT	?	?	Market it-self

To end, we can say that individualist modelling would be complementary to "holist" modelling where this last modelling can't get good results - *i.e.* when individual size in necessary to understand the mechanisms of economic and social situations). These both modelling methods are particularly complementary if modelling-makers won't to substitute models to the individual choices - See Table #3.

4 - REFERENCES

ALLAIS M., (1954), *Les fondements comptables de la macro-économique - les équations comptables entre quantités globales et leurs applications*, Paris, PUF, Coll. Dito, (Rééd.1993), 96 p.

BARONE E., (1935), "The Ministry of Production in The Collectivist State", in F.A.HAYEK (ED.), *Collectivist Economic Planning*, London, Routeledge & Kegan pp.245-90.

BUDA R., (1999), "Market Exchange Modeling - Experiment, Simulation Algorithms, and Theoretical Analysis", Communication in Experimental Economics

- European Regional Meeting of the E.S.A., Grenoble, 8-9 octobre, *Working Paper MODEM*, N^{o}99(13), 17 p.

COURBIS R., (1977), *Modèles de prix pour la prévision et la planification*, Paris, Dunod, Coll. Finance et économie appliquée, 435 p.

HAYEK F.A. (Von), (1935), "The Nature and History of the Problem", in F.A.HAYEK (ED.), *Collectivist Economic Planning*, London, Routeledge & Kegan, pp.1-40.

HAYEK F.A. (Von), (1937), "Economics and Knowledge", *Economica*, N^{o}4, pp.33-54.

HAYEK F.A. (Von), (1945), "The Use of Knowledge in Society", *American Economic Review*, N^{o}35(4), pp.519-30.

HAYEK F.A. (Von), (1952), *The Counter-Revolution of Science*, Glencoe, Free Press, (Trad. partielle, Scientisme et sciences sociales).

HAYEK F.A. (Von), (1967), *Studies in Philosophy, Politics and Economics*, London, Routeledge.

HAYEK F.A. (Von), (1973), *Law, Legislation and Liberty - Vol.1 - Rules and Order*, London, Routeledge, (Trad.1985).

HAYEK F.A. (Von), (1976), *Law, Legislation and Liberty - Vol.2 - The Mirage of Social Justice*, London, Routeledge, (Trad.1981).

HAYEK F.A. (Von), (1988), *The Fatal Conceit - The Errors of Socialism*, London, Routeledge, (Trad.1993, PUF).

HAYEK F.A.(ED.), (1935), *Collectivist Economic Planning - Critical Studies on the Possibilities of Socialism*, London, Routeledge & Kegan Paul Ltd, 293 p.

KIRZNER I., (1979), *Perception, Opportunities and Profit*, Chicago, Chicago UP.

LACHMANN L., (1986), *The Market as an Economic Process*, Oxford, Basil Blackwell.

LANGE O.R., (1964), "On the Economic Theory of Socialism", in B.E.LIPPINCOTT (ED.), *On the Economic Theory of Socialism*, New York, McGrawHill, pp.55-143.

LANGE O.R., (1967), "The Computer and the Market", in C.H.FEINSTEIN (ED.), *Socialism, Capitalism, and Economic Growth*, Cambridge, Cambridge UP, pp.158-61.

LANGE O.R., (1970), *Introduction to Economic Cybernetics*, London, Pergamon Press, 183 p.

LONGUET S., (1998), *Hayek et l'école autrichienne*, Paris, Nathan, Coll. Circa, 192 p.

LUCAS R.E.Jr., (1976), "Econometric Policy Evaluation : A Criticism", *Journal of Political Economy*, N^{o}83(6), pp.1113-144.

MISES L. (Von), (1935), "Economic Calculation in the Socialist Commonwealth", in F.A.HAYEK (ED.), *Collectivist Economic Planning*, London,

Routeledge & Kegan, pp.87-130.

MISES L. (Von), (1938), "Les équations de l'économie mathématique et le problème du calcul économique en régime socialiste", *Revue d'économie politique*, pp.1055-1062 (repr., 1987, *Revue d'économie politique*, N^{o}97(6), nov.-déc., pp.899-906).

MORGENSTERN O. (1950), *On the Occuracy of Economic Observations*, New York, Princeton UP.

ROTHBARD M., (1991), *Économistes et charlatans*, Paris, Belles lettres, Coll. Laisser- faire, 310 p.

SCHMIDT C., VERSAILLES D.W., (1999), "Une théorie hayekienne de la connaissance économique ?", *Revue d'économie politique*, N^{o}109(6), pp.817-32.

SMITH V.L., (1989), "Theory, Experiment and Economics", *Journal of Economic Perspectives*, N^{o}3, pp.151-69.

SMITH V.L., (1991), "Markets as Economizers of Information : An Experimental Examination of the Hayek hypothesis", in V.L.SMITH (ED.), *Papers in Experimental Economics*, Cambridge, Cambridge UP, pp.221-35.

WILLIAMS A.H., (1980), "Computerized Double Auction Markets : Some Initial Experimental Results", *Journal of Business*, Vol.53, pp.235-58.

APPENDIX A - The COPIE Model

1 - Survey of the equations

During the course - A pupil i which belongs to a class of N pupils, has got the following properties : courage $COUR_i$ and mind $INTE_i$. He has got a probability $CODAG_i$ to encode information correctly which describes his level of understanding the courses (equations # 1, 2, and 3). We assume the lesson is divided in twenty parts, then pupil will have to give back each part during the test (equation # 4). During the course, the pupil i is interested by some themes $THEM_i$ different than the course (equation # 5). Then the pupil i will choose between to talk about a theme, and to ear the course. It depends on his last mark at the test $NOTE^i_{c-1}$, its coefficient $coefnote$ and P_THEM_i which evaluates the theme which pupils is talking (equations # 6 and 7). The pupil i accumulates some knowledge $KNOW^i_j$ during the course which takes place during j periods (equation # 8.a, 8.b, 8.c, and 9). The coefficient concours and coufraud (resp.) are parameters to describe a contest test and the cost of free-riding (resp.) and k is the rank of the pupil which is talking with the pupil i during the course. When pupils are talking during courses, they miss some data (equations # 10.a, 10.b, 11). $\overline{LACUN}$ is a level of crowding effect. When pupils are talking, the pupils who has got the following parameters $\overline{INTE}$ and $\overline{COUR}$ can no more understand the course. The Model calculates the general level of knowledge of the pupils during a period (equation # 12). The conditions of learning ($apprent$ is a learning parameter) depend on the level of knowledge of the pupil i at the end of period j and the probability to correctly encode the course (equation # 13). The pupils cant understand the next course, during $t+1$, without a minimal level of knowledge $S\_KNOW^0_t$.

During the test - The pupil i answer to the test with a paper $FEUIL_i$. There are three cases : 1^o - the pupil knows the lesson, 2^o - the pupil believes he knows (but he mistook) and, 3^o - the pupil don't know the answer (equations # 14.a and 14.b). According to the level of parameter $\overline{FRAUD}$, pupil i tries to free-ride. He can be catch according, $flagdeli$ his probability to be catch. Furthermore, k is the rank of pupil which free-ride with pupil i. Pupil k give the information $KNOW^k_j$ to pupil i. This information can obviously be wrong. The policy of teacher is described with equations # 17.a, 17.b, and 17.c. The mark of pupil i at the test c is $NOTE^i_c$ (equation # 18.a and 18.b). For each correct answer to question j, pupil win one point $POINT^i_j$. Parameter $fraud$ is initialized at zero if pupil didn't free-ride or didn't be catch.

2 - Liste of the equations of COPIE Model

(i) − Basic Equations

$$Cour_i \sim \mathcal{N}(m_{cou_i}, \sigma_{cou_i}) \tag{1}$$
$$Intel_i \sim \mathcal{N}(m_{int_i}, \sigma_{int_i}) \tag{2}$$
$$Codag_i \sim \mathcal{N}(m_{cod_i}, \sigma_{cod_i}) \tag{3}$$
$$P\_Theme_i \sim \mathcal{N}(m_{pth_i}, \sigma_{pth_i}) \tag{4}$$

(ii) − During The Course

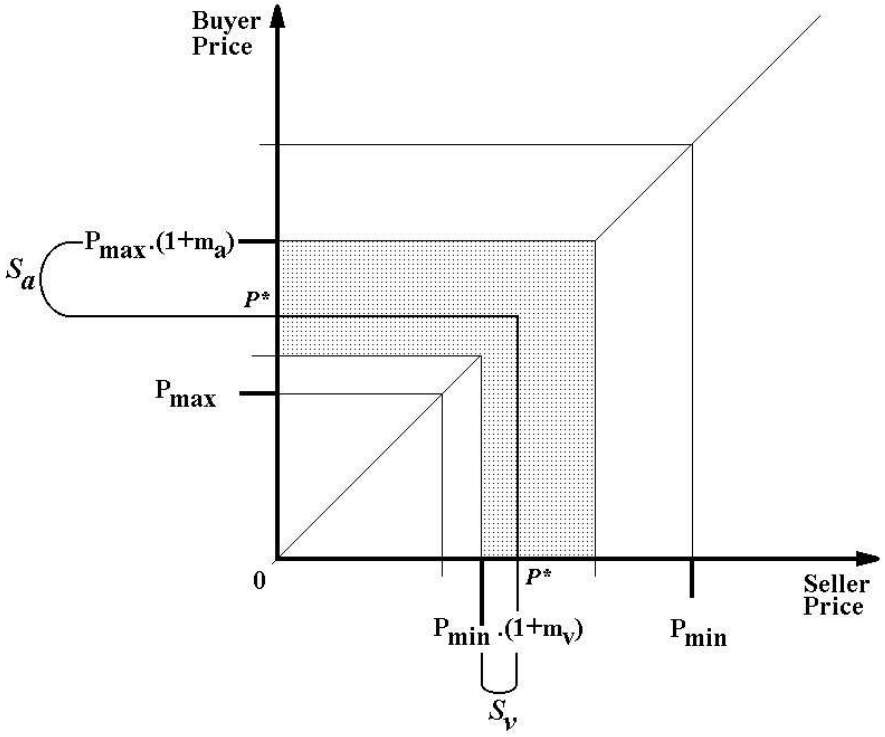
$$Sujet = \{Sujet_j\}_{j\in[0,20]} \tag{5}$$
$$Theme_i = \{Theme^i_j\}_{j\in[0,20]} \tag{6}$$
$$P\_Sujet^i_j = \{CoeffNote * Note^i_{c-1}\}_{j\in[0,20]} \tag{7}$$
$$with \begin{cases} Know^i_j =' 0' \\ Know^i_j = Sujet_j \quad and \\ Know^i_j \neq Sujet_j \end{cases} \tag{8}$$
$$P\_Theme_i > CoefConcours * P\_Sujet_i + CoutFraude \tag{9}$$
$$then \begin{cases} Know^i_j =' 0' \\ Know^k_j =' 0' \end{cases} \tag{10}$$
$$if\ Know^i_j =' 0' \begin{cases} then\ Lacune^i_j = 1 \\ else\ Lacune^i_j = 0 \end{cases} \tag{11}$$
$$hence\ Lacune_j = \sum_{j=1}^{20} Lacune^i_j \tag{12}$$
$$if \begin{cases} Cour_i \leq \overline{Cour} \\ Intel_i \leq \overline{Intel} \end{cases} \tag{13}$$
$$and\ if \sum_{i=1}^{N} Lacune^i_j \geq \overline{Lacune} \tag{14}$$
$$Stock\_Know_t = \sum_{i=1}^{N}\sum_{j=1}^{20} Know^i_j \tag{15}$$
$$Codag_{i,t} = Codag_{i,t-1} * apprent \tag{16}$$
$$and\ apprent \leq 1 \tag{17}$$
$$if\ Stock\_Know^t_i \leq \overline{Stock\_Know^0_i} \tag{18}$$

(iii) − During The Test

$$Feuil^i_j = Know^i_j if\ Know^i_j = Sujet_j\ then\ Point^i_j = 1 \tag{19}$$
$$hence\ Note^c_i = \sum_{j=1}^{20} Point^i_j - CoutFraude * Fraude \tag{20}$$
$$with \begin{cases} CoutFraude = \overline{CoutFraude} \\ CoutFraude_{t=0} = CoutFraude_0 \end{cases} \tag{21}$$
$$then \begin{cases} CoutFraude_{t=t+h} = Coutfraude_0 + 1 \\ h \in [0,20] \end{cases} \tag{22}$$

APPENDIX B - The SINGUL Model

The curve of bargaining in SINGUL



2 - Liste of the equations of SINGUL Model

(i) BASIC EQUATIONS

$$Patrim_i^t = \overline{Patrim_i^0} \tag{1}$$

$$Stock\_Courant_i^t = \overline{Stock\_Courant_i^0} \tag{2}$$

$$Stock\_Desire_i^t = \overline{Stock\_Desire_i^0} \tag{3}$$

$$Prix\_Max_i = \overline{Prix\_Max_i} \tag{4}$$

$$Prix\_Min_i = \overline{Prix\_Min_i} \tag{5}$$

$$Marge_i = \overline{Marge_i} \tag{6}$$

$$\alpha_{i,j}^t = \frac{|\Delta_j^t|}{|\Delta_i^t| + |\Delta_j^t|} \tag{7}$$

$$with \begin{cases} \Delta_i^t = Stock\_Courant_i^t - Stock\_Desire_i^t \\ \Delta_j^t = Stock\_Courant_j^t - Stock\_Desire_j^t \end{cases} \tag{8}$$

(ii) SIMONIAN EQUATIONS

$$if\ Prix\_Max_{Acheteur} < Prix\_Min_{Vendeur} \tag{9}$$

$$then\ Prix^t_{i,j} = \alpha^t_{i,j}.Prix^t_i + (1-\alpha^t_{i,j}).Prix^t_j \tag{10}$$

$$else \begin{cases} Prix^t_{i,j} = \psi.Prix^t_i + (1-\psi).Prix^t_j \\ \psi = 0\ or\ 1 \end{cases} \tag{11}$$

a) $\Delta_i < 0$ **(*i* buyer) et** $\Delta_j > 0$ **(*j* seller)**

$$\begin{aligned} Prix^t_i.(1-Marge_i) &\leq Prix_{i,j} && (12)\\ Prix^t_j.(1-Marge_j) &\geq Prix_{i,j} && (13)\\ Prix^t_i &= Prix\_Max_i && (14)\\ Prix^t_j &= Prix\_Min_j && (15) \end{aligned}$$

b) $\Delta_i > 0$ **(*i* seller) et** $\Delta_j < 0$ **(*j* buyer)**

$$\begin{aligned} Prix^t_i.(1-Marge_i) &\geq Prix_{i,j} && (16)\\ Prix^t_j.(1-Marge_j) &\leq Prix_{i,j} && (17)\\ Prix^t_i &= Prix\_Min_i && (18)\\ Prix^t_j &= Prix\_Max_j && (19) \end{aligned}$$

(iii) STIGLERIAN EQUATIONS

$$if\ agent\ i\ buyer \begin{cases} Prix^t_{i,j} = Inf_h(Prix^t_{j,h}) \\ with\ h \in [1, P_{i-r}] \\ and\ r = \left\{Rang(j)\right\}_{Order(i)} \end{cases} \quad (20)$$

$$and\ agent\ j\ seller \begin{cases} Prix^t_{j,i} = Sup_k(Prix^t_{i,k}) \\ with\ k \in [1, P_{j-r'}] \\ and\ r' = \left\{Rang(i)\right\}_{Order(j)} \end{cases} \quad (21)$$

(iv) SATISFACTION EQUATIONS

a) *i* **is buyer**

$$Satis_i = 1 - \left(\frac{Prix^t_{i,j} - P_0}{P_{100} - P_0}\right) \quad (22)$$

$$with \begin{cases} P_{100} = Prix\_Max_i \\ P_0 = Prix\_Max_i.(1+Marge_i) \end{cases} \quad (23)$$

b) *i* **is seller**

$$Satis_i = \left(\frac{Prix^t_{i,j} - P_0}{P_{100} - P_0}\right) \quad (24)$$

$$with \begin{cases} P_{100} = Prix\_Min_i \\ P_0 = Prix\_Min_i.(1-Marge_i) \end{cases} \quad (25)$$

APPENDIX C - The ECHANGE[31] Experimental Software

The ECHANGE software get the meeting of a lot agents (75 maximum) on a false market of nine goods. The soft collects some data during exchanges, that we can analyze. Echanges take place through annoncements of agents.

Description of a session of the game

First of all, operators have to fill a questionnaire. The software calculates randomly the inventories of each good, then according to the answers of each operator, the software calculates their purposes.

1° - Price of regional and national data are displayed (advertising, announcements etc.).

2° - Each operator can do one or more announcements to buy or sell commodities.

3° - Each operator ave buy National Announcement Daily and receive freely regional one.

4° - Each operator can answer to the announcers and pay for transportation of commodities.

5° - ECHANGE calculates results of transactions and then displays them for each operator. The software calculates Utility of each operator and make them in order.

[31] Free sample available at $http://www.chez.com/rbuda/prg/demo\_echange\_20.zip$