

Kolm as a Contributor to Public Utility Pricing, Second Best Culture and the Theory of Regulation

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Abstract

The main objective of this paper is to highlight the fundamental and pioneering contributions made by S.C. Kolm in the area of traditional public economics. Most of them have been published in French over a decade (from the mid sixties to the mid seventies) and they illustrate, at best, the tradition of the French school of "ingénieurs économistes". They had a profound impact on the career of the second author and his desire to become an economist. It is a pleasure for him to recognize this intellectual influence and to pay his tribute.

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1 Introduction

Serge-Christophe Kolm has made important contributions to many different areas of public economics. Some of his books and papers have benefited from a large audience as they were translated from French into English or published in English in international scientific journals. This is the case for instance of most of his articles and monographs on the theory of justice and inequality measurement. Unfortunately, as for an iceberg, this part of his scientific output dissimulates another part which was his main research area from the mid sixties to the mid seventies and is, unfortunately, not as known as it should be from the rest of the community. While also normative, these contributions differ from his later contributions in that field of economics both in terms of motivations and objects. As we will see, he was very much concerned and interested by the rationale(s) for a public sector intervention and the qualitative and quantitative features of the optimal public policy with a major focus on the rules for an efficient management of public organizations.

The following sample of citations illustrates¹ his perspective : ” L’économie politique est fondamentalement une science normative. So but final est de conseiller des actions. A qui ? parfois à des entreprises, parfois à une classe sociale, mais le plus souvent à une état. Or si on peut aller assez loin dans l’analyse positive du secteur privé pour n’en déduire qu’à la fin des actions publiques à entreprendre ou à ne pas faire, dans l’étude du secteur public la plupart des variables spécifiques rencontrées sont instrumentales pour ce centre de décision lui-même. En conséquence, l’optique normative est beaucoup plus répandue dans toute l’économie publique que dans l’analyse des mécanismes de marché. L’économie publique recherche donc les actions et l’organisation optimale du secteur public”²...” *L’économie normative est la branche de l’économie politique qui dit ce qui doit être fait. Ell est surtout utile pour l’économie publique en indiquant les actions optimales de l’état...*”³ *Ces principes se manifestent d’abord dans cette branche nouvelle de l’économie politique qu’est l’économie publique. celle ci- a pour tâche d’analyser le rôle économique et de définir les comportements socialement optimaux, de l’état, du secteur public, et de toutes les institutions de nature plus ou moins politiques. Puisque ”laissez-fair” est toujours une des solutions possibles du problème normatif ”que faire?” posé, l’économie publique doit commencer par*

¹We wish we could bring more evidence of Kolm’s main interest in the subject and the intellectual and practical origins of such concern. Due to a lack of space, we cannot provide a very detailed report on these aspects. We strongly recommend reading the introduction of Kolm (1971a) which contains a complete and nice description of the approach as well as chapter 2 of the same book which contains ”le dialogue du libéral et du dirigiste”, a truly monumental piece of pedagogy.

²Kolm (1971c) on pages 3-4.

³Kolm (1971b), on page 395.

déterminer quelles activités doivent être réalisées par ces organismes et lesquelles doivent être laissées au marché.....*Théorique cet ouvrage a un but éminement pratique : montrer comment doivent être gérés et produits les services considérés et les biens qui les rendent. C'est donc une étude d'économie normative, ou prescriptive, qui cherche et expose le choix optimal pour la société dans diverses situations.* Les variables instrumentales à déterminer sont les qualités, les quantités, le mode de production, l'allocation, l financement, la nature institutionnelle de ces activités. L'allocation peut être quantitative ou par vente à des prix ou tarifs. Dans ce dernier cas, elle fournit au moins une partie du financement, et le fait qu'il reste ou non un déficit est essentiel pour la question de la décentralisation du management de cette activité..”⁴

Among other things, he has written many papers on public utility pricing and more generally on the nature and role of "public" prices in economies displaying various forms of imperfections and subsequently likely to perform poorly on the allocation and distribution fronts. Kolm (1971a) offers a very nice and stimulating presentation of the problems faced by public utilities and the so-called "services publics"⁵ : " Les prix des "grands services publics inquiètent la population, forcent les gouvernants à des choix difficiles,Dans quelles proportions la radiodiffusion, la télévision, les musées, les orchestres, les théâtres, etc, doivent-ils être financés par l'état, par les spectateurs ou auditeurs (droits d'entrée, taxes sur récepteurs ou paiement plus spécifique possible de la réception),..... Le budget de la SNCF doit-il être équilibré ? Cet équilibre n'est-il pas le critère et le moyen d'une saine gestion ?.... N'est-il pas injuste que l'ensemble des contribuables français subventionnent les parisiens en comblant le déficit de la RATP, ce qui, de plus, encourage l'engorgement de la capitale ?.....*Pourquoi l'enseignement supérieur ne se financerait-il pas lui-même en faisant payer les étudiants qui auraient par ailleurs accès à des prêts à long terme ?*". He is aware of the fact that the frontier between private and public institutions is sometimes tiny and in any case difficult, if not impossible, to draw : "On a coutume d'opposer public et privé. en fait, l'administration pure et l'entreprise purement privée ne sont que deux pôles entre lesquels s'étend une vaste plage continue d'organismes divers, plus ou moins proches de l'un ou de l'autre, intermédiaires entre eux de façon variées : entreprises nationalisées, administrations vendant leurs services, services autonomes, régies, concessions,.....”⁶.

⁴Kolm (1971a) on pages 20-21 and 23.

⁵The terminology "services des masses" used in Kolm (1971a) refers to services which represent an important part of the consumption of everybody in the economy. On page 23, he writes "Le téléphone, l'enseignement collectif, la poste, les transports par route, rail ou air, les adductions d'eau et d'électricité, la distribution par centres commerciaux, la radiodiffusion et la télévision, les services hospitaliers, la voirie, l'égout, l'embellissement des villes, la plupart des services administratifs en constituent des cas typiques".

⁶Kolm (1971c) on pages 6-8.

This research is materialized by a very rich and voluminous production which is listed at the end of this paper. The main motivation and "raison d'être" of our paper is to contribute to their diffusion as much as we can as we think these papers represent at best an intellectual tradition in public economics quite active in France under the impulse of the "ingénieurs économistes". In addition to this historical exploration of one epoch of Kolm's itinerary, we would like to emphasize the modernity of his approach and results as well as the creativity and the large spectrum of methods and concepts he was able to invent and(or) use along this way. The paper is divided in two parts.

The first part consists in an historical presentation of some of his main ideas and achievements on several issues relative to the optimal management of the public sector or part of it. This part pursues two objectives. On one hand, we want to show how Kolm's works were in the continuation of the work of his precursors in the community of French "ingénieurs économistes" . These economists display several common features. The name "ingénieur économiste" refers to the fact that they all went through the major engineering schools ("grandes écoles") and received there (and before) a solid education in science as well as in engineering. In addition to this background and to the resulting willingness to adopt a scientific approach of economic problems , many of them did belong to the research and executive divisions of the nationalized industries or the administration. Their interest for economics and the topics on which they were more inclined to work originated in these practical concerns and the continued interaction between theory and practice has been a remarkable feature of these developments. This certainly does not mean that they were simply applying existing economic principles without creating or inventing anything on their own. In fact, many important papers in theoretical public economics have been written by some of those people. The point that we want to make here is that the source of inspiration of the problem, which was leading to a theoretical "detour" and a pure research output, according to usual academic standards, was their professional activity and the various challenges, debates and policy issues resulting from their duties. As employees of the public sector, they had indeed to come with responses to questions that were raised. In doing so however, and this is the second point that I want to stress, they looked for a response based on a solid and coherent theoretical formulation of the problem under scrutiny. These culture and practice differ strongly from the "culture" of some other civil servants were willing to depart from these demanding principles and to base their recommendation on so-called intuitive principles. The fact that Kolm belongs to the first group not only appears in his work but in the following citations. He writes for instance "Grâce à une pléiade de grands homes la méthode scientifique investit peu à peu l'économie politique au long du XIX ième siècle, et celle-ci s'y conver-

tit complètement dès la fin de la seconde guerre mondiale. En conséquence, l'économie se détache maintenant très loin en avant de toutes les autres soit-disant sciences sociales dans la voie de la scientification..."⁷ and "Malheureusement les hommes de la politique, de la presse, de l'administration ou des affaires tranchent de façon extrêmement superficielle, en ne considérant qu'un aspect du problème et en négligeant les autres. mais comme chacun monte en épingle un effet différent, les solutions préconisées s'opposent souvent à l'extrême. et comme aucun ne peut convaincre scientifiquement les autres dans le dialogue d sourds qui s'établit, chacun érige son idée en principe pour éviter d'avoir à en discuter les fondations...et défend sa position comme s'il s'agissait d'une option politique, la force de conviction servant de substitut à la profondeur de l'analyse"⁸.

This historical presentation is organized around the principle of marginal cost pricing. As we could not cover everything, we had to make a choice. this choice of course had to be representative of a both his interests and style. We think that that selection is appropriate as, not only this principle is far more subtle that it look at first glance, but also a door to penetrate into the world of second-best public economics. There is no need to remind here how important and useful is that principle in standard microeconomics. It is also controversial when comes the time of application as its implementation raises a number of difficulties which have motivated some of Kolm's work as well as the works of some of his precursors and successors. Like many of his contemporaries, Kolm contributed to the analysis of that principle in showing how to use it in settings departing from usual ones and also how to alter and (or) extend it when its direct application was obstructed by institutional constraints. In derives the policy implications of this principle and its extensions in particular on pricing the goods and services produced or regulated by the public sector.

As we will argue, Kolm is in some sense at the crossroad of two periods or waves in the field of public economics as practiced by the French "ingénieurs économistes". He comes after very eminent precursors who made seminal contributions to theoretical microeconomics and were able to provide solutions to several important policy issues which were on the top of the agenda after world war II. But beyond this respect for this very respectable legacy, he was aware of the limits and the necessity of extending. He contributed himself to that but some of the tools from game theory and the economics of information were not yet

⁷In Kolm (1971a) on page 15-16. On page 1(, footnote 2 contains a very severe criticism of the French economists appointed by universities. For him the mediocrity of those economists is however compensated by the work of the "ingénieurs économistes" as he writes "Alors que quelques ingénieurs et scientifiques français reconvertis à l'économie ont réalisés les meilleurs travaux du monde dans leur domaines (Allais, Boiteux, Debreu-un exilé-, mmalinvaud et certains autres, l'économie universitaire officielle française reste la risée du monde...".

⁸Kolm (1971c) on page 8.

well developed. While very ahead of his times, some of his contributions pave the way to the modern approach in terms of incentive constraints and mechanism design. We will show how this has been analysed and explored by his successors. They were able to offer a deep understanding of the limits of the marginal cost principle from different angles. The terminology successors refer to several things. Many of them are also part of this community of French "ingénieurs-économistes" and share the methods and concerns of their predecessors : a strong belief in the usefulness of microeconomics and in the necessity of basing policy recommendations on solid theoretical foundations. Some of these successors mostly specialize into the examination of the theory and its extensions while some others. In contrast to the precursors who were themselves directed confronted to the management problems of the public sector, the successors are facing a new age or period characterized by a (de) regulation process of huge parts of the public sector. To accompany this process in providing helpful guidelines and principles to managers, regulators and public policy makers is the current challenge of real world public economics.

The paper aims to offer a brief description of Kolm's scientific record in public economics from a historical perspective. It is divided in two parts. In a first part, we argue that the choice of the topics as well as the methodology were very much in the continuation of what was done in France since World War II under the leadership of the French engineers. Then, in a second part, we will show how this tradition has been pursued in many new and important directions without any major and discontinuous change in the method and the agenda. To some extent, Kolm is in between two periods and has played a major role with respect to both : he has extended the results of his precursors and applied their methods to many new areas and he has also prepared the grounds for the successors through several papers where he has anticipated some of the questions which are or has been at the forefront of the more recent scientific agenda.

2 The Precursors

In many countries, the production and distribution of several important economic (private) goods and services is under the control of the public sector. In addition, the government contracts with private firms to supply goods and services, both directly to itself and to individuals. We are not going to review the list of arguments which support the view that the government should control these specific activities. The most widely heard is that private firms pursue the maximization of profits of their owners, and not the welfare of the nation. But we know that private firms, in pursuing their narrow self-interest in competitive markets,

can be thought of as pursuing the public interest. There is not necessarily a conflict between the pursuit of private interests and what is in the public interest. However, when markets failures occur, firms 'pursuit of profit maximization might not result in an efficient resource allocation.

The most important market failure that has led to public production arises when market are not competitive. A common reason that markets may not be competitive is the existence of increasing returns to scale. In that case, economic efficiency requires that there be a limited number of firms. Industries where increasing returns are so significant that only one firm should operate in any region are referred to as natural monopolies⁹. In these situations, we cannot rely on competitive forces to ensure that the industry is efficient. Efficiency require that price equal marginal cost. But if the firm charges marginal price, it will suffer a loss since marginal cost is lower than average cost¹⁰.

Once it is admitted that some form of public intervention is needed, a number of questions arise : what should be the principles to guide the production/investment decisions of the firms in charge of these activities and what should the pricing rules to be used ? In case of a deficit, how the revenues required to pay this loss are to be raised ? When the natural monopoly produces several commodities (multi-product), the pricing question becomes more complex and a number of new issues emerge mostly because some inputs are common to the production of all of the services. In such setting, we may, for instance, wonder if any departure from the marginal cost pricing principle should apply uniformly to all commodities and services or else if higher charges on some services could be used to subsidy other services.

These matters were the questions faced by a group of French economists just after World War II. As reported by Drèze (1964) : "During World War II two graduates from the "Ecole Polytechnique", Maurice Allais and Pierre Massé, renewed a long tradition of contributions to mathematical economics started by Cournot and the engineer Dupuit a hundred of years before and more recently maintained by such well-known econometricians as F. Divisia and R. Roy.... Shortly after the war, the problems of reconstruction and of management of the newly nationalized industries (electricity, gas, coal mining) gave Allais, Massé, and their colleagues, students and followers ample opportunities for applying and developing their theories.....The continued interaction between theory and practice has been another remarkable feature of these developments. While the pure theorist Allais was consulted about the management of the coal mines, Massé or Boiteux, who had executive responsibilities

⁹In his mathematical derivation of the conditions for a Pareto optimum,, Allais (1945) allows explicitly for the existence of two sectors : a competitive sector and a sector composed of natural and other monopolies.

¹⁰Stiglitz (1988) offers a nice simple exposition of this failure as well as the limits of the threat of entry.

at EDF, developed original contributions to decision or price theory....By then what has sometimes been referred to as the *French "marginalist" or "mathematical" school* was born; an important stream of scientific activity was under way that has developed continuously ever since.....This development has taken place largely outside the traditional professional circles and channels. Members of this school did and do belong to the staffs of the engineering schools or statistics departments, to the research as well as the executive division of the nationalized industries, or to the administration.....The theorists and the executives share the view that there is no sound policy unless it is based upon a sound theory, whereas empirical relevance and verification make for sound theories. The fact that so much work has been motivated by empirical problems and that it eventually led to practical implications may partly account for the soundness of the theories".

I would like to see the contributions of the French engineers as an intellectual response to the questions raised by the public management of natural monopolies¹¹

· "Much of the success of the French marginalist school in solving difficult practical problems in this area rests ultimately upon a sound and sometimes subtle understanding of the classical marginal cost concepts". The precursors have concentrated most on their attention on the pricing and investment issues. Here, I will mostly focus on the pricing issue. It is not as simple as it may look at first glance. On the cost side, it is by no means clear that the managers should value inputs according to market prices. If there are some distortions in the rest of the economy (in particular if there are some differences between consumption and production prices), the shadow prices reflecting the true social cost or value of these inputs may differ from the market prices. While aware of these issues, it is fair to recognize that the precursors have not truly investigated the question of the adequate vector of prices to evaluate the cost of inputs. While implicit in the conduct of various cost-benefit analysis of public projects (in particular when deciding which rate of discount to be used), the topic was not (at that time) subject to a systematic exploration for itself. Instead, given such a vector of input prices, the attention was on the determination of the total (long-term and short-term, average and marginal,...) cost curves of the multi-product public firm. We will denote by C the total (long-term or short term, depending upon the context) cost function of the public firm :

$$C = C(q_1, q_2, \dots, q_K) \tag{1}$$

¹¹The papers collected in *Vingt Cinq Ans d'Economie Electrique* offer a nice overview of these contributions together with their motivations.

where $\mathbf{q} = (q_1, q_2, \dots, q_K) \in \mathfrak{R}_+^K$ denotes the vector of outputs of the firm. Once these curves have been calculated, we are in position to provide answers to the questions raised by these economists : What are the optimal levels of investments (plant sizes and designs) and prices ? In a first best world (all markets are opened, lump-sum transfers are feasible policy instruments, no distortions and "pathological" behavior in the rest of the economy,...), selling products according to their marginal cost is a necessary condition for social optimality. In the case where a pricing policy is a vector of linear prices $\mathbf{p} = (p_1, p_2, \dots, p_K) \in \mathfrak{R}_+^K$, optimal prices and quantities are therefore related by the following equations :

$$p_k = \frac{\partial C}{\partial q_k}(\mathbf{q}) \text{ for all } k = 1, \dots, K \quad (2)$$

It follows that once we have been able to determine the cost function(s), we are in position to compute the optimal prices. This means that the work has been transferred from economics to operations research, applied mathematics and statistics. Indeed, the cost function is not a primitive of the problem but instead the result of an optimization which can turn to be more or less complicated. The area of operations research relevant to proceed depends upon the nature of the variables : linear and non-linear programming, dynamic programming, integer programming and combinatorial optimization,.....In any case, the description of the variables and constraints of the problems calls for a solid understanding of the technological alternatives that could be considered and, in that respect, being an engineer was certainly a good preparation. In fact, it seems that the entire task has truly two different components :

- First, we need a comprehensive description of the commodity space : What is the relevant value of K ?
- Second, we then need an extensive analysis of the technologies from an engineering perspective.

The first task should not be neglected. It should be reminded that from the perspective of an economist, a commodity or service is not simply described by its physical attributes and characteristics but also by the time/period, the place and the contingencies of delivery. The cost of serving customers may display important differences according to the period and (or) place of delivery. Besides a direct concern due to investment/storage possibilities and availability of some natural resources, distinctions based upon temporal considerations play an important role as soon as some factors can be used for the production of the output(s) at different periods. Distinctions based on spatial considerations also play a critical role as soon as some transportation cost is involved in addition to production costs : the derivation of the cost function in the case where the clients are located on a true geographic network are known

to be among the hardest problems in operations research. Finally, as soon as uncertainty is part of the problem, the definition of the commodity/service calls for a detailed description of the conditions under which delivery will ultimately take place. The combination of the three dimensions may lead to a rather large commodity space : one unit of electricity may be priced differently according to the period of the year which is considered, the location of the client and the clauses of delivery originating, for instance, in the choice of interruptibility standards.

As already alluded to, the French engineers were certainly well prepared and talented to conduct the second task with success and making their ideas operational. Their work is a perfect illustration of the derivation what has been called by Chenery (1949) engineering production functions. Instead of using statistical data, the promoters of this approach suggest to use engineering data. As noted by Chenery " Industry studies have generally used statistically determined cost curves. Since these curves are based of necessity upon productive combinations which it has proved feasible to entrepreneurs to try out, they cannot usually tell us much about the broader range of productive possibilities which have been explored experimentally but not adopted commercially. The lack of this information is a great handicap in many types of economic discussion.....Before suggesting a way of using engineering data in economic analysis, we must consider the problems which the engineer himself is trying to solve. Since his initial aim is to discover all feasible ways of making a given product or performing a given service, his first concern is not with particular inputs but with the nature of the chemical and physical transformations which are involved in the productive process. he breaks down the process of production into convenient units whose performance he attempts to describe by formulae based on the laws of physics and chemistry. Since an elementary analysis in terms of the properties of each piece of equipment is often impractical, the engineer must usually resort to testing various sizes and combinations of equipment to determine the effect of such variable as size, speed, temperature, etc..upon total performance. One basic difference between engineering analysis and economic analysis, then, is the units which are considered fundamental. While the economists deals with plants firms or industries, the engineer must deal primarily with separate physical processes.... If the economist wishes to use engineering data to construct a production function, he must go back to the intermediate stage in engineering calculation at which the various types of inputs are considered. These data are founds in engineering textbooks. In order to use it conveniently, the economist must abandon his convention of using one-dimensional inputs and use multi-dimensional inputs as the engineer does". The French engineers have applied this

methodology¹² with success to many different industries including for instance coal mining, electricity, natural gas, and railways.

One spectacular application of marginal cost pricing is peak load pricing : it concerns non-storable commodities with periodic demand fluctuations (transportation, mail, telecommunications, power supply,...). It is based on a simple description of the commodity space consisting in a division of the period of reference which is considered (say a year or a day) into smaller periods (say months or day and night) : time is therefore considered as the relevant dimension of differentiation. An aggregate demand to the firm is a temporal profile of consumptions: in electricity this vector is often represented (after rearrangement) as a curve, the so-called load duration curve, as time is treated as a continuous variable. The calculation of the cost curve based upon engineering data will be specific to the industry which is considered. For instance, in the case of electricity, this amounts to the determination of the optimal capacity configuration once the fixed and operating cost of each conceivable generating unit (coal, gas, nuclear, hydro,..) have been evaluated¹³. Let us consider the simplest cost situation , namely, that defined by constant returns to scale, fixed plant capacity and short-term marginal costs that are constant and that do not depend upon plant size. It is readily verified that the (short-term) total cost function per period is then :

$$c(q, z) = \begin{cases} \beta z + bq & \text{if } q \leq z \\ \infty & \text{if } q > z \end{cases} \quad (3)$$

where q is the output per unit of time, z is the fixed capacity, β is a marginal capacity cost and b is a short-term (operating) marginal cost; $\beta + b$ is then the long-term marginal cost. For a temporal profile of consumptions $\mathbf{q} = (q_1, q_2, \dots, q_K)$ where K is the number of periods, we obtain the following (short-term) total cost function:

¹²This paper is obviously biased towards the contributions of French engineers as our priority here is to point out the filiation of Kolm. I confess that a deeper investigation would have produced a more balanced evaluation of the impact of engineers on microeconomics and in particular on pricing and investment problems, outside my home country. Chenery (1949) is a remarkable paper that should be read by anybody interested in that area. Interestingly, he points out an analysis of air transport by Bréguet (the famous French aviator, airplane designer, and industrialist) summarized by Phelps-Brown (1936) who uses a technique to derive a cost curve based on engineering experience. Stigler (1940) has also defended the advantages of the engineering approach but the suggestion does not seem to have been taken up by economists at the time. since then, many economists have argued against the statistical approach and used instead the engineering approach (see Marsden, Pingry and Whinston (1974) and the survey of Wibe (1984)).

¹³Approaches based on engineering and financial data have also been used in settings different from cost minimization. A quite remarkable illustration is Massé and Gibrat (1957) application of linear programming to investment in the french electric power industry.

$$C(q_1, q_2, \dots, q_K; z) = \begin{cases} \beta z + b \sum_{k=1}^K q_k & \text{if } \sup_{1 \leq k \leq K} q_k \leq z \\ \infty & \text{if } \sup_{1 \leq k \leq K} q_k > z \end{cases}$$

In this problem, the non decomposability arises from the fact that there is an input (the capacity here represents a plant or machine with a given size) that can be used repeatedly for the production in all periods. Other channels of interdependence across periods could also be considered, like for instance through inventories. In the long run, the capacity will be adjusted to the peak consumption. Boiteux (1949) and others have applied with success the marginal cost principle to this setting.

Another set of applications of marginal cost pricing emerges when the heterogeneity dimension is spatial instead of being temporal. As soon as some transportation cost must be incurred prior to final consumption, the derivation of the optimal transportation network (sometimes, even, transportation and production activities are closely related) is a key feature of the cost minimization operation. Besides the combinatorial design of "roads", the choice of the dimension of pipes is also an important component of the transportation cost. As noted by Chenery (1949), in the case of natural gas transportation, the amount of gas transported by a pipe depends upon its diameter, the pressure of the gas, and the pressure drop along the line. Hence capacity may be increased by either increasing the diameter, the pipe thickness or the pumping capacity (which will depend upon the spacing of compressors stations). Chenery uses an empirical relationship between these three engineering variables, known as Weymouth's formula, together with some other basic relationships to determine the cheapest transportation capacity. This is a perfect illustration of the relevance of the engineering approach as in this particular spectrum of applications, the key ingredient is an equation governing the flow of compressible fluids through pipes.

Kolm has derived many ingenious and important implications of the marginal cost pricing principle to several allocation problems. His book "Le Service des Masses" (1971) which is part of his "Cours d'Economie Publique" is a perfect illustration of the intellectual tradition of French engineers which has been briefly described above. He has sometimes developed his own general terminology in order to show the profound unity between problems which are different only on the surface. Chapter 11 entitled "Structures variétales" is a discussion of the commodity space : Kolm calls *variété* the specification of a commodity/service according to the period, place or conditions of delivery. In many chapters, he also examines the issues related to the cost side. Kolm (1971) is devoted to a class of problems where some features describing the "quality" of one or several variétés/services produced by a public

firm/administration are influenced by the joint consumption of these services by the users. Consider the case where $K = 1$ i.e. the situation where only one service is produced and let i be an index to identify any particular consumer of this service. Let q^i to denote the quantity of service consumed by i , $(q^1, q^2, \dots, q^N) \in \mathfrak{R}_+^N$ to denote the vector of consumptions in the population (where N is the number of consumers) and $q \equiv \sum_{i=1}^N q^i$ to denote the aggregate consumption. The key concept introduced by Kolm in his book is the notion of "fonction d'encombrement". In the case where the quality itself is one dimensional and denoted by w , this function relates the level of quality w to the profile of consumptions (q^1, q^2, \dots, q^N) and a another vector $z = (z_1, z_2, \dots, z_M)$ describing the levels of M decision variables which are often (according to Kolm) quantities of specific inputs.

$$w = w((q^1, q^2, \dots, q^N), z)$$

He calls uniform the case where the "fonction d'encombrement" is anonymous i.e. such that :

$$w = w(q, z) \tag{4}$$

To illustrate how he derives the pricing application of marginal cost pricing, we consider below the uniform case and we assume that $M = 1$. In his chapter 5, he derives the first order conditions for optimality. Let $U^i(q^i, w)$ be a utility function describing, in monetary units, the welfare derived by consumer i when he/she consumes q^i units of the service with a quality equal to w and let $C(q, z)$ to denote the total cost incurred by the public firm to produce a total quantity q and buy the input z .

Kolm demonstrates that the first order optimality conditions are described by the equations :

$$\frac{\partial U^i}{\partial q^i}(q^i, w) = \frac{\partial C}{\partial q}(q, z) - \frac{\partial w}{\partial q}(q, z) \left(\sum_{j=1}^N \frac{\partial U^j}{\partial w}(q^j, w) \right) \text{ for all } i = 1, \dots, N \tag{5}$$

$$\frac{\partial C}{\partial z}(q, z) = \frac{\partial w}{\partial z}(q, z) \left(\sum_{j=1}^N \frac{\partial U^j}{\partial w}(q^j, w) \right) \tag{6}$$

The first equation can be reformulated as :

$$\frac{\partial U^i}{\partial q^i}(q^i, w) + \frac{\partial w}{\partial q}(q, z) \frac{\partial U^i}{\partial w}(q^i, w) = \frac{\partial C}{\partial q}(q, z) - \frac{\partial w}{\partial q}(q, z) \left(\sum_{\substack{j=1 \\ j \neq i}}^N \frac{\partial U^j}{\partial w}(q^j, w) \right) \quad (7)$$

which means that the marginal willingness to pay of user i for the consumption of this service is equal to the marginal social cost which is the sum of the marginal cost of production and the "external" marginal social cost. The combination of the two equations lead to the following new equations :

$$\frac{\partial U^i}{\partial q^i}(q^i, w) = \frac{\partial C}{\partial q}(q, z) - \frac{\frac{\partial w}{\partial q}(q, z)}{\frac{\partial w}{\partial z}(q, z)} \frac{\partial C}{\partial z}(q, z) \text{ for all } i = 1, \dots, N$$

In his chapter 6, Kolm derives the pricing rules which decentralize the optimal allocation. It is simple to verify that to do so, the (linear) price p^i of the service that should be paid by user i must satisfy :

$$p^i = \frac{\partial C}{\partial q}(q, z) - \frac{\partial w}{\partial q}(q, z) \left(\sum_{\substack{j=1 \\ j \neq i}}^N \frac{\partial U^j}{\partial w}(q^j, w) \right) \text{ for all } i = 1, \dots, N \quad (8)$$

We deduce from the above equations that optimal pricing is in general discriminatory. As noted by Kolm, there is however an important case where discrimination vanishes. It corresponds to the situation where the impact of a single user on aggregate consumption and therefore on w can be considered as negligible. In such case, the optimal prices are uniform across users :

$$p^i = \frac{\partial C}{\partial q}(q, z) - \frac{\partial w}{\partial q}(q, z) \left(\sum_{j=1}^N \frac{\partial U^j}{\partial w}(q^j, w) \right) \text{ for all } i = 1, \dots, N \quad (9)$$

and equivalently using (8) :

$$p^i = p \equiv \frac{\partial C}{\partial q}(q, z) - \frac{\frac{\partial w}{\partial q}(q, z)}{\frac{\partial w}{\partial z}(q, z)} \frac{\partial C}{\partial z}(q, z) \text{ for all } i = 1, \dots, N \quad (10)$$

Besides uniformity, we note that the right-hand side consist of cost data and data on the "fonction d'encombrement". Each specific problem will be described by a cost function c and a "fonction d'encombrement" w . The cost function is a familiar concept while the

”fonction d’encombrement” is less so in economic analysis. It is very interesting to point out that the engineering approach, that we have discussed extensively above, as a ”marque de fabrique” of the French engineers, seems to be perfectly suited to deal with this new notion. In his chapter 7, entitled ”Exemples”, Kolm presents many practical problems for which the abstract model described above is very convenient. His list of examples includes : road transportation, railways transportation, stochastic congestion, traffic accidents, pollutions and queues. Let us say some few words on some of them to show (convincingly !) that engineering expertise cannot be avoided here. In the case of road transportation, he considers the case of an highway with a number z of lines : q is the aggregate traffic and w is the average speed. Under some particular assumptions, Kolm derives the following technical relationship between the three variables :

$$w(q, z) = \frac{z - bq + \sqrt{(z - bq)^2 - 4acq^2}}{2aq}$$

where a , b and c are parameters. This ”fonction d’encombrement ” is quite special and in fact, given a relationship between traffic density and speed, the equation describing the evolution of the traffic flow is a complicated partial differential equation. The analysis of traffic flows is a well defined area of applied mathematics and engineering sciences which is obviously needed to apply marginal cost pricing to road congestion. An early analysis of optimal tolls based on these principles and empirical ”fonctions d’encombrement” is due to Lévy-Lambert (1968).

The case of stochastic congestion will be the topic of the second half of this paper. In this setting, z represents the capacity of a given equipment and w denotes the reliability level defined for instance as the probability of every customer having its demand satisfied. The exact value of w will depend of the details of the stochastic model. This model applies to many different industries : the delivery of electricity, gas, water may be interrupted or rationned due for instance to adverse weather conditions, a power outage or a breakdown. In banking, z represents the amount of total deposits of the bank and w the probability for a client of being unable to withdraw some cash (Edgeworth (1888)). This case will be studied extensively in the second part of this paper.

Queuing is a very important topic as for many many public administrations/ utilities a demand which cannot be satisfied immediately can sometimes be delayed instead of being cancelled. Waiting costs cannot however be ignored and the question of an optimal organization of the service taking into account these costs raises problems for which the framework developed by Kolm (he calls it ”encombrement d’attente”) is very much appropriate. He

devotes the last third of his book to the application of marginal cost pricing to this class of problems. I am not aware of any similar systematic attempt. The relationship with engineering and operations research is obvious as reflected for instance by the use of the mathematics of queues when the arrival of new demands are described as Poisson processes.

In doing so and in order to examine the main features of the pricing rules which are obtained, Kolm considers several properties of both the cost function c and the "fonction d'encombrement" w . He makes a distinction between the property of "rendement quantitatif constant" which applies to c and the important property of "rendement qualitatif constant" which applies to w and asks for :

$$w(q, z) = \phi\left(\frac{q}{z}\right)$$

His book contains many results¹⁴ on the relationships between the financial consequences of marginal cost pricing and the nature of the returns of the "fonction d'encombrement". In his chapter 15, he also develops the notion of "capacity commune" as a key common feature of the cost problems under consideration. It will play a critical role in the rest of this paper and has already appeared in formula (). In his terminology, we will have a situation of common capacity when the same input (equipment, machine,...), can be used to produce several "variétés" of the same service as long as the limit is not reached. He writes nicely "la capacité commune est à la fois une consommation privative entre consommateurs de la même variété et une consommation collective entre consommations de variétés différentes". In this chapter, he also states some conditions satisfied by such optimal capacity.

This section on marginal cost pricing has privileged the French contribution as I wanted to illustrate how Kolm's contributions were positionned in the continuation of this intellectual tradition. This could leave the reader with the impression that on one hand only French engineers were actively participating to these developments and that, on the other hand, there was some unanimity upon the fact that this pricing policy was the right one to implement as soon as competitive markets could not be designed to produce and distribute this commodity/service. In light of these questions, I would like to conclude this paragraph by some brief comments.

According to Coase (1970), Hotelling (1938) should certainly be credited for being among the first to suggest the use of marginal cost pricing for public utilities and enterprises for modern discussion. Hotelling recognizes the major influence of Dupuit. In the U.K., the major event was the appearance of Meade (1944) (which first came out as a paper of the

¹⁴I will not discuss here his analysis of optimal investment policies in a truly dynamic framework.

economic section of the Cabinet Office as part of how state enterprises ought to be run, with no thought of publication but (due to the enthusiasm of Keynes both as adviser of the treasury and editor) as part of a symposium in the *Economic Journal*) where he defends strongly the idea of marginal cost pricing; Fleming wrote "the proposal for marginal cost pricing is not, I think, open to serious criticism". In the meantime, Meade had become head of the economic section of the Cabinet Office and a paper was prepared setting out the policy which it was considered ought to be followed in the nationalized industries, and this included a suggestion for adopting marginal cost pricing. According to Coase, "This proposal was not, however accepted by the minister concerned and marginal cost pricing has played no part in the pricing policies of the nationalized industries. As it happens, pricing policies in the nationalized industries have tended to develop in ways I find very congenial, and some of the most interesting work of which I know in the field of pricing is being conducted in the nationalized electricity supply in Britain. The nationalized industries have in fact followed a completely different line from that suggested by the marginal cost pricing proposal as originally conceived, and in the meantime, of course, enthusiasm in the profession for marginal cost pricing has become less pronounced".

In the U.S., research was also active on these ideas. Some economists have expressed a strong enthusiasm regarding the work accomplished by the French engineers and their ability to make operational these ideas while some others have formulated express dissent from the view that price should be made equal to marginal cost. Among the advocates, Nelson (1963), for instance, writes "The word "Applications" in my title has shrunk all the way from plural to singular. For so far as I know, the only public utility enterprise in the world to proceed from the theory of marginal cost pricing to both a schedule of rates and a series of rules for investment policy is Electricité de France". He presents an outline of marginal cost pricing as applied by E.D.F. Few years earlier, Marschak (1960) also offers a very complete and lucid analysis of their contribution. He writes "It is only recently that American economists have begun major efforts to apply welfare economics to the decisions of specific public enterprises. they have principally chosen the difficult field of water-resource policy , one of the very few important areas of American public enterprise where such efforts are feasible. In France, on the other hand, where the post war public sector includes important basic industries, a major share of economists's output since the war has concerned the application of welfare economics principles to policy-making in these industries.....The French theoretical work on investment choice parallels recent American discussion; the work on peak load pricing antedates recent American results; and some of the work on optimal pricing under the no-deficit constraint has no American counterpart.....The French's economists' practical

success ought to encourage those American economists who have been urging American public enterprises to adopt policies closer to those which the efficiency conditions of welfare economics imply". However, it is interesting to note that Marschak identifies three classes of difficulties in accepting and applying this solution. While aware of the difficulties resulting from its application, Vickrey (1948)(1955) has been an important supporter of marginal cost pricing and has made important applications of these ideas to the pricing of public transportation. Among the opponents, Coase (1946) was certainly among the most active. Clemens (1941) had already expressed a dissent and in his discussion of Nelson (1963), he writes "I am rather skeptical on marginal cost pricing proposals as commonly put forth. In my mind they are oversimplified. If the assumptions are granted, one cannot quarrel with the theory, but the assumptions are such as to make the applicability in practice extremely questionable. The tariff vert is a more sophisticated version of marginal cost pricing but one which is nevertheless subject to some of the usual infirmities". He lists eight infirmities. Both Marschak's three classes of difficulties and Clemens's eight infirmities (and to some extent many reservations expressed by the strongest opponents) are mostly motivated by second best considerations. Besides these considerations that will be discussed more extensively in the next subsection, both allude to the enormous practical difficulties of satisfactorily defining and measuring the relevant marginal cost in the face of indivisibilities, uncertainties, joint products, the possibility of expanding or expanding various elements of plant over varying time periods, etc,". In that respect, it is interesting to point out some conflict among the type of marginal cost that should be taken into consideration¹⁵. As noted by Drèze (1995) " Vickrey advocates prices reflecting continuously (in time)¹⁶ short run marginal social cost while Massé advocates prices reflecting long run marginal cost". The following citation from Boiteux (1949)(1951) illustrates at best the French perspective : "La théorie de la vente au coût marginal paraît susceptible de nombreuses interprétations. Vendre au coût marginal, c'est fixer un prix égal au coût de production d'une unité supplémentaire. Ce coût diffère évidemment suivant que l'on envisage de produire une seule fois cette unité supplémentaire, ou au contraire d'augmenter dorénavant d'une unité le flux de biens que l'on produisait jusqu'alors : la production à titre exceptionnel d'une unité supplémentaire isolée ne saurait justifier une modification des équipements; l'accroissement définitif du flux de production en revanche pourra s'accompagner d'une réadaptation des équipements au nouveau niveau de

¹⁵Concerning peak load pricing, Joskow (1976) makes a distinction between the American, French and British approaches. Berg and Tschirhart (1995) point out that marginal-cost pricing can be found incognito in the 1978 Public Utility Regulation Policy Act (PURPA) and that PURPA promoted six pricing standards in the name of efficiency and conservation.

¹⁶This is often referred to as spot pricing or responsive pricing (See e.g. Vickrey (1971)).

production.

La notion de tarif implique l'idée de flux. On n'établit pas une tarification pour établir un stock accidentellement disponible, mais pour obtenir un équilibre durable entre le flux de la demande et le flux de la production.....

C'est là tout au moins une conception du prix marginal. A l'opposé, on y trouve celle que révèle l'apologue du voyageur supplémentaire : un train va partir; il y reste une place vide; un voyageur se présente qui est disposé à l'occuper s'il ne doit pas payer trop cher. Le coût du transport de ce voyageur supplémentaire ne porte que sur les quelques grammes de charbon nécessités par la traction de son poids et sur les molécules de moleskine qu'il arrachera à la banquette pendant la durée du voyage.....”

The disagreement between the two approaches concerns the extent to which the prices of these commodities should be adjusted continuously in response to foreseeable fluctuations in either supply or demand. According to Drèze (1995) : ”The alternatives are relatively stable prices leading to inefficient use and occasional quantity rationing, or unpredictable price variations, which entail costs to users like monitoring prices and adjusting quantities”¹⁷. Quite interestingly, the practices have evolved since the early implementations of these ideas in the fifties. The green tariff has been followed at EDF by major innovations in the eighties and nineties originating from the difficulty of forecasting peak loads far ahead and implying the desirability of adjusting tariffs at short notice. We will come back on these pricing innovations and others in the second part of the paper.

3 The Successors

The precursors have been mostly interested in deriving operational implications of marginal cost pricing. One important exception is of course Boiteux's seminal paper (1956) in which he derives optimal pricing of a public monopoly subject to a public constraint.

We have concluded the previous subsection by reporting some of the the criticisms that were formulated by eminent U.S. economists against marginal cost pricing. The necessity of raising public funds to finance the deficit resulting from the application of this pricing policy is among the most important arguments supporting these dissent views. This theme is also a major concern in Kolm's work on public pricing. In Kolm (1971c), he offers a very nice analysis of the multiplicity of roles played by prices and of the potential conflicts between

¹⁷Marschak(1960) also provides an interesting analysis of this controversy. After presenting what was considered as an ideal rule by the French engineers, he writes ”The view that the social cost of instability exceeds the social cost of such temporarily non-marginal pricing seems to be accepted in formulating actual pricing reforms. The prices initially approximated are those appropriate in long-run equilibrium”.

these roles. Under the heading "Les Fonctions Sociales des prix Publics", he develops a very stimulating and modern analysis of the use of these prices as policy instruments¹⁸. He writes¹⁹ " Un tarif a une double incidence directe sur les *usagers* et sur le *budget du service*, qui créent elles-mêmes des incidences directes multiples; on peut respectivement les appeler *incidence aval* et *incidence amont* ou "effet de prix" et "effet de budget". Par son effet sur les usagers, le tarif influence leur consommation de ce service, leurs consommations de biens et services complémentaires et substitués par effet de substitution, toutes les consommations et productions de ces personnes par effet de revenu; par l'intermédiaire de ces réactions, il influence aussi les productions de biens et services complémentaires et concurrents.....; tous ces effets à leur tour, influencent le degré de réalisation des objectifs sociaux. Par ailleurs, le tarif influence le solde budgétaire du service. ce solde agit à son tour sur les budgets publics et a par là trois types d'effets : (1) il influence les autres recettes et dépenses publiques, et en particulier les impôts et les autres services publics, (2) il agit ainsi sur les fonctions des finances publiques, allocation publique, distribution des revenus et effets macroéconomiques, et d'autre part (3) il influence le degré d'autonomie des divers éléments de la hiérarchie politique et administrative et par là l'efficacité de cette organisation". The first incidence i.e. the role of prices as signals of social costs (in the French language, this is referred to as "la vérité des prix") has been the main focus of the advocates of marginal cost pricing. While not ignored, the second incidence was considered less important. Instead, in all his contributions, Kolm always derives the budgetary implications of marginal cost pricing. In Kolm (1971c), he writes²⁰ "Voici donc posé le dilemme fondamental de la tarification publique : un prix a plusieurs fonctions sociales qu'une certaine structure technique de la production rend incompatibles en ce sens que le meilleur niveau pour l'une est mauvais pour l'autre. Ainsi s'opposent les rôles du prix comme outil d'information et de coordination sur les marchés et comme source de revenu, en bref ses fonctions marchandes et financières, ou, pourrait-on dire, ses efficacités interne et externe". Kolm (1971a) writes²¹ : " La seconde fonction provient de ce que l'équilibre budgétaire est une condition nécessaire d'autonomie complète.....Or l'autonomie fait que des décisions de production et de gestion du service sont prises par des personnes qui connaissent mieux sa fonction de production et les caractéristiques des demandes des usagers. Son avantage est donc encore, de décentralisation des décisions, mais au lieu que ce soit entre le service et les usagers, cest maintenant entre le service et une autorité qui le superviserait. On peut appeler la première la décentralisation aval des

¹⁸This issue was explored early in Kolm (1968a).

¹⁹On pages 31-32.

²⁰On page 11.

²¹On pages 96-97.

décisions et la seconde la décentralisation amont des décisions, la référence étant maintenant le service". Kolm (1971c) writes²² "Par rapport à un état où l'équilibre budgétaire est exigé, d'une part l'assurance que le déficit sera comblé par un budget public ôte à la direction de l'entreprise l'incitation directe à satisfaire le public au mieux et au moindre coût, d'autre part l'autorité publique qui gère ce budget doit contrôler la gestion du service, ce qui cause des coûts d'administration et surtout empêche que des décisions soient prises par les personnes les mieux informées et rapidement".

Kolm (1971b) points out the internal contradictions of the structure of prices. He writes²³ "La règle de vente au coût marginal a pour but de promouvoir la décentralisation des décisions par le système de prix. d'autre part, l'équilibre budgétaire d'une entreprise a pour principal intérêt d'assurer son indépendance : c'est donc aussi un instrument de décentralisation des décisions. Or, quand à la fois la production est à rendement croissant et le produit doit être vendu à un prix uniforme, la vente au coût marginal entraîne le déficit. Il y a donc contradiction entre ces deux outils de décentralisation des décisions.

To understand why the existence of a deficit is perceived by Kolm and others as socially costly, it is important to remind that the virtues of marginal cost pricing rely upon a set of assumptions defining what is traditionally described as a first best economic environment. The systematic exploration of the optimal departures from marginal cost pricing (and other first best allocation or pricing rules) resulting from the consideration of second best economic environments has been one of the major areas of research in theoretical public economics since the seventies²⁴. The new generation of French engineer-economists²⁵, following Kolm and the precursors, has made seminal contributions to these topics ranging from second-best

²²On pages 10-11.

²³On pages 399-400.

²⁴Guesnerie (1995) considers second-best modelling as one important development of modern public economics. He notes however that "the effects of the innovation have been slow. The earlier neoclassical tradition, a branch of which has culminated in the development of the so-called Arrow-Debreu model, had generated a coherent body of knowledge which was and remains extremely influential among economists. The ideas, models and intuitions propagated by such a tradition have deeply impregnated the profession and can still be viewed as one of its dominant theoretical "cultures".

²⁵This new generation has contributed to most of the topics of modern economics. In this group, Guesnerie's research agenda on general second-best environments on the one hand and Laffont's works on the economics of regulation on the other hand are, in many respects, the closest to the work of the precursors including Kolm.

modeling²⁶ to the economics of regulation²⁷. Even, if that was not the main concern of the precursors, we must of course mention the pioneering contribution of Boiteux (1956) where he derives, independently of Ramsey (1927), the optimal pricing rules of a public utility subject to a budget constraint. Kolm (1971b,d) has developed a general theory of optimal pricing when some economic agents are subject to some second best constraints that he calls value constraints; these constraints are either constraints on prices or on budgets (like in Boiteux). Besides the fact that Boiteux's rule appears as a corollary of his general result, it should be noted that his general theory allows a careful analysis of many other questions. He offers a very innovative exploration of the consequences of imposing balance of payment restrictions on international economic policies. He also provides a set of general results on optimal local departures from marginal cost prices where local means that we are in some neighborhood of the first best allocation. In such case, the social deadweight loss is a negative definite quadratic form with respect to distortions, and optimal distortions are quite easy to derive. Kolm obtains²⁸ results on optimal distortions in the case where

²⁶In his presidential address to the European economic association, Guesnerie (1995) writes "Second-best studies have challenged a number of ideas and intuitions of the so-called *first best culture*. But the body of knowledge which they have generated does not have the coherency, the appeal or the clarity that would allow to build a genuine *second-best culture*. Consolidating a second-best body of knowledge that would truly encompass the first-best conceptions, integrating it better within the mainstream culture of the profession is in my opinion a desirable aim and constitutes one of the current challenges to public economics..... *The starting point is here an education exposed, through the direct or indirect influence of allais, Boiteux, Malinvaud, Kolm..to the teachings of the French school of "ingénieurs économistes" which promoted a variant of the first-best tradition*".

²⁷Laffont and Tirole writes "Academics have traditionally emphasized institutional and empirical research on regulatory issues, but there is also a substantial and useful heritage in the area. By and large, the most successful contributions refers to the normative aspects of natural monopoly pricing..... *Despite some headway on the pricing front the traditional theoretical approach has stalled precisely where the new regulatory economics has sprung : the incentive front*. To be certain, received theory implicitly touches on incentive issues : the Ramsey-Boiteux model rules out government transfers precisely because they might be abused, and the Averch-Johnson model describes a regulated firm's self-interested input choices. *But received theory can only go so far. A more rigorous and realistic approach must adhere to the discipline of the broader principal-agent theory*. Modeling must include a full description of the firm's and the regulators's objectives, information structures, instruments, and constraints. Information structures and the set of feasible regulatory schemes must as much as possible reflect real-world observational and contractual costs... *From this perspective there are three reasons why regulation is not a simple exercise in second-best optimization theory : asymmetric information, lack of commitment, and imperfect regulators*. Asymmetric information limits the control the regulator can exert over the firm. The difficulty for the regulator to commit to incentive schemes, for contractual or legal reasons, also reduces the efficiency of regulation. last the regulators or politicians may be incompetent, have their own hidden agenda, or simply be captured by interest groups; they may then not optimize social welfare. Only a thorough investigation of these limits to perfect regulation can shed light on many issues of the traditional agenda of regulatory economics".

²⁸These results also appear in Kolm (1969a). Kolm (1968b) is a very useful application of these principle to an environment where two transportation alternatives (say road and metro), both subject congestion, are in competition. Given that the unit price of road services departs from its marginal social cost, what should be the optimal pricing of a metro ticket ?

endogenous distortions correct exogenous ones and in the case where the role of distortions is to raise an exogenous budget.

We are not going to review here the diversity of situations and constraints leading to second-best environments and offering some rationale to depart from marginal cost pricing. According to Guesnerie (1975b) " Second best problems arise when the actual realization of first best optima through competitive markets, as indicated by the main theorem of welfare economics, becomes impossible. One can distinguish for the sake of simplicity three different types of reasons preventing the decentralized attainment of Pareto optima through a competitive procedure.

(1) Certain markets cannot be organized (forward markets, risk markets,...) whereas others cannot be cleared (keynesian underemployment,...)

(2) Lump-sum transfers postulated by the traditional welfare theory cannot be implemented in the real world.

(3) Even if all markets do exist and if any lump sum transfer is feasible, certain agents may have a noncompetitive behavior".

The second reason is often listed as the main argument to explain why public funds are costly. If the public budgets cannot be raised through that neutral tool, then it must be the case that some "imperfect" taxation devices are used to do so. Among these instruments appear primarily consumption taxes : the vector of taxes is defined as the difference between the vector of consumption prices and the vector of production prices. The interested reader will find in Guesnerie (1995b) a complete analysis of several important extensions of the basic Walrasian model of general equilibrium where these new instruments are introduced together with the other variables and constraints describing the public sector (production of public or private goods, pricing of public utilities, quantity controls,...) that could be considered. It should be clear that the derivation of the optimal public policy cannot avoid a complete preliminary analysis of the structure of the set of tax equilibria. This is not an easy task and the set of equilibria displays some unusual features leading to different sorts of nonconvexities which make the analysis more complicated and optimizing over that set of equilibria calls for prudence. Social optimization provides a set of shadow prices for each commodity (the Lagrange multipliers attached to the scarcity constraints). These shadow prices give the right social valuations of an exogenous manna of extra endowments. Contrary to first-best optimization, these social opportunity costs do no coincide any longer, in general, with market prices. The extent of the discrepancy between prices and values will vary across problems²⁹. In many problems, like for instance the production of pure public

²⁹Drèze and Stern (1990) is also an excellent reference on this topic.

goods³⁰ or private goods by the public sector, the vector of shadow prices coincide with the vector of production prices. In some other problems, like for instance the production of private goods by the public sector when the supply behavior of the private sector is noncompetitive, but lump sum transfers are feasible, the vector of shadow prices coincides with the vector of consumption prices. In some other problems, like the one considered by Boiteux (a public firm subject to a budgetary constraint) where lump sum transfers are also feasible, the derivation of the shadow prices show that the vector of Boiteux prices is a convex combination of the vectors of market and shadow prices.

The implications of these considerations for the marginal cost doctrine are quite important. As pointed out by Guesnerie (1980) "In a first-best world, pricing policies obey a simple principle : the price of the marginal unit sold to each consumer should equate its marginal cost. even if the implementation of such a rule may raise further problems, it is of universal theoretical validity.

In a second best world where the absence of markets or behavioral constraints prevent the attainment of first-best Pareto optima, the prescriptions for optimal pricing policies lose both simplicity and universality. Simplicity, because prices should no longer equate marginal costs, even if marginal costs were computed on the social value of commodities rather than production prices, but should take into account other elements such as demand elasticities. Universality, because the difficulty of designing piecemeal policies defining rules valid for one sector independently of government action in other sectors has been constantly emphasized by second-best theory. In particular, the pricing rules which are established from one theoretical model do depend in some sense on the whole set of policy and behavioral assumptions made in the model. Changing the policy tools available to the government not only changes the optimal prices which would emerge but also possibly the qualitative features of the optimal pricing rule and the type of information required for its implementation. It is then quite important for policy purposes to understand the logic of the derivation of pricing rules in order to evaluate their sensitivity to modifications of policy and behavioral assumptions". This strongly suggest that we should investigate the the principles governing the derivation of second-best pricing rules in a general equilibrium setting instead of a sequential examination of the recommendations attached to any particular environment. For instance, if we think that marginal cost pricing should be abandoned because it leads to a deficit, the exploration of the new pricing rules should not exclude (unless explained otherwise) additional instruments that would allow to relax the constraints. For instance in a problem à la Boiteux, given the existence of an "exogenous" distortion, it makes sense

³⁰Guesnerie derives a modified Samuelson 's rule.

to use "endogenous distortions" like consumption taxes or quantity controls³¹. The shadow cost of the budgetary constraint will depend upon the spectrum of instruments and we should further anticipate that besides their allocational role, pricing policies will also play a distributional role.

It was implicit in our discussion of these issues that any normative or positive exploration of the optimal pricing policies must be conducted in a general equilibrium framework with the goal of obtaining an accurate theoretical understanding of the economic interdependencies which should be taken into consideration in the design of these policies. Too often, these interdependencies and the difficulties resulting from this approach are partly ignored by partial equilibrium derivations based on more or less sophisticated versions of the consumer surplus. This is far from being a secondary issue as demonstrated by Guesnerie (1975a). As already discussed, the rationale for the control by the public sector of some specific firms or industries arise from the non-convexity of production sets in a situation with high fixed costs and increasing returns to scale. As noted by Drèze (1995) "The presumption in this setting was that marginal cost pricing with deficits financed by lump-sum taxes would sustain a first-best efficient, if such an allocation were feasible at all. In other words, the presumption was that an analogue of the first welfare theorem holds for marginal cost pricing equilibria". Guesnerie has demonstrated³² that this presumption fails as a general proposition. The existence of Pareto improving income redistributions challenges the classical view on separation of efficiency and equity³³. The analysis of the set of Pareto optima in second-best environments reveals that this phenomenon is also present there.

³¹In second-best environments, quantity rationing, in kind transfers and all sorts of instruments disqualified by the first best culture turn out to be very valuable, as demonstrated for instance by Guesnerie and Roberts (1987) and Wijkander (1988).

³²Beato and Mas-Colell (1985) have produced an example where even aggregate productive efficiency is violated. Guesnerie's seminal paper has impuled a vast literature including among others Bonnisseau and Cornet (), Brown and Heal (1979) and Vohra (1992). The reader may refer to the special issue of the Journal of Mathematical Economics devoted to these questions (Cornet (1988)). The theory of general equilibrium has also been extended to cover other "correct" rules of management which differ from marginal cost pricing (Ramsey-Boiteux, two-part tariffs,...). The conclusions reached by these papers concerning the welfare properties of these equilibria are also negative (see e.g. Brown and Heal (1980), Dierker (1991)). Brown and Heal (1983) offers a nice discussion of some of these issues in a simplified general equilibrium framework.

³³This view has been expressed by many authors. Brown and Heal write "In the Arrow-Debreu model, equity and efficiency are independent dimensions, and much of our accepted welfare economics and cost-benefit analysis rests, explicitly or implicitly, on this fact. The examples we present demonstrate that, once we admit increasing returns, the situation is fundamentally different. Because, some are efficient and others inefficient, one can no longer judge between alternative distributions purely in terms of equity. It is necessary to consider both the equity and efficiency dimensions simultaneously" while Blackorby (1990) claims that "...if second-best considerations are taken seriously, then it is much more difficult, if not impossible, to divorce efficiency from equity than one might have thought from the use of first-best economic models".

While devoting some special attention to the problems raised by the deficit³⁴, Kolm discusses extensively all the other implications of acting in a second best environment. He points out in many occasions the distributional role of public prices. Kolm (1971c) writes³⁵ "Enfin, les tarifs des services publics peuvent être utilisés à fin de redistribution du revenu effectif, et donc du bien être, dans la société, par exemple en demandant moins cher à certaines catégories d'usagers que l'on veut favoriser. L'économiste normatif traditionnel s'oppose à cette action : il vaudrait mieux, dit-il effectuer cette redistribution par des transferts directs et laisser les bénéficiaires dépenser cet argent comme ils le préfèrent plutôt que de subventionner leur consommation du service en question. cette argumentation est très judicieuse. Mais qu'en reste t-il si, en fait, ces transferts ne sont pas effectués. Rien ne justifie, alors, de ne pas utiliser le tarif à fin de redistribution...". He was clearly considering as a postulate that lump sum transfers simply do not exist. For instance, in (1971c) he writes³⁶ "mais l'argument présenté contre l'emploi des prix à fin de justice distributive présente un défaut plus grave. c'est que les transferts forfaitaires et impôts de capitation proposés comme alternative simplement n'existent pas et ne peuvent exister. en effet, ces opérations doivent avoir une assiete composée de critères objectifs. Or les propriétés qui définissent ces derniers peuvent en général être modifiées, avec plus ou moins de facilité par les personnes concernées". Besides equity and justice considerations, he explores in great details in chapter 3 of Kolm (1971c) the different costs of tariffs and public funds including the macroeconomic costs which would appear if the analysis was conducted in a non Walrasian framework where markets do not necessarily clear through prices.

Before moving to the next and last part of our description of the influence of Kolm on his successors, we would like to point that while we have limited most of the above discussion to linear prices, Kolm has also investigated more sophisticated pricing rules involving non linearities. Kolm (1969b) contains very important developments on the possibilities opened by general tariffs³⁷. In this monograph, he derives indeed many interesting results on the

³⁴The publication in France in 1967 of the "Rapport du Comité Interministériel des Entreprises Publiques" called "Rapport Nora" pointing out the importance of the deficits of the main French nationalized firms has originated a lot of controversy between economists.

³⁵On page 13.

³⁶On pages 73-74. On page 399, in Kolm (1971b), he also claims that " Quand les transferts interindividuels sans restriction des théoriciens n'existent pas, les prix ont un rôle de distribution du revenu. Dans le monde réel, la répartition des impôts, qui est l'instrument de ces transferts (avec quelques subventions) est limitée et les prix restent la principale voie de distribution du revenu.....".

³⁷Interestingly, in many occasions (for instance in Kolm (1971c) on pages 12-14), he calls the attention on the fact that first order optimality demands that the marginal price and the marginal cost are equal, but not that the marginal price be constant : he calls "inframarginales" the units preceding the marginal one. These units could be sold at a different price. He immediately infers from this observation that adequately chosen non linear tariffs could reconcile optimality and budget balance. But he also recognizes, almost immediately

properties of optimal (with respect to some social objectives) non linear tariffs under various sets of constraints. It contains a presentation of the general mechanism design problem where the difficulties raised by the fact that the preferences of the customers are privately known are first isolated before being taken into consideration in the last two chapters of the book. In reference to the benchmark case where informational matters are ignored (that he calls "l'optimum"), he writes³⁸ "Il ne tient souvent pas compte explicitement du fait que le tarif doive en général être le même pour de nombreux usagers". Under the heading "La communauté", he provides a very stimulating presentation of the constraints attached to these observability issues³⁹ and derives the properties of the the optimal solution when these constraints are incorporated : the formula in the middle of page 95, characterizing the optimal gap between the marginal tariff and the marginal cost is nothing less than the formula found in any modern textbook on optimal regulation of monopolies⁴⁰. Under the heading "discrimination", he refers to the various forms of tariffs that are met with a special attention to the case of two-part tariffs (he uses the word "forfait" to defined the fixed part of the payment) but more importantly to the determination of a partition of the population into groups where a specific tariff is attached to each group⁴¹. Specifically, he decomposes the general problem into three nested problems :

- (1) Le "Problème de Complexité " : how many groups ?
- (2) Le "Problème d' Affectation" : how customers are assigned to the groups⁴² ?

after these good news, that the implementation of the tariffs may raise new costs. We reach the limit of the marginal analysis as for instance in the case of two-part tariffs the computation of the forfait requires information on the preferences of the customers beyond the marginal valuation (he calls it "valeur d'usage"). There is then a risk of suboptimal exclusion that he calls "risque d'exclusion intempestive". The possibility of differential pricing is a point which is also raised by some of the opponents to marginal cost pricing. The lack of consideration for this flexibility is listed among the eight "infinites" of marginal cost pricing considered by Clemens (1963). He writes: "In my mind, the EDF is the victim of the same fallacy that characterizes Hotelling's thesis; namely, the failure to allow for differential pricing. Optimization of social welfare does not require that all output be priced at marginal cost; all that is required is that the marginal unit be priced at marginal cost. This requirement may be met satisfactorily and without government subsidy by a well designed rate system".

³⁸On page 14. On page 48, he also writes "Mais toute cette analyse suppose que chaque usager peut être soumis individuellement à un tarif propre, et elle ne tient pas compte explicitement des coûts de tarification et de l'absence de connaissance parfaite".

³⁹On pages 84-87.

⁴⁰His computation, on page 98, of what he calls the "forfait optimal" follows from what he has introduced under the name "droit d'abstention" which is strictly analogous to what is referred today as the participation constraint.

⁴¹On page 114, he writes "La discrimination du tarif peut être entre les usagers, entre les éventualités, entre les variations de chaque paramètre et en particulier entre les unités de chaque quantité ou les variétés de chaque quantité".

⁴²His discussion on pages 118-122 of the criteria to assign customers to groups is very insightful even if not formulated with the modern terminology of the theory of incentives. His distinction between "critère

(3) Le "problème de Communauté" : How optimal tariffs in each group are determined ?

His work contains a lot of important insights and uses advanced and sophisticated techniques. For instance, he determines the qualitative features of the optimal tariff when the number of prices is fixed to an exogenous finite number (this constraint being justified by cost of tariffs considerations). He provides a detailed study of the multiproduct case with the incorporation of constraints on prices reflecting the existence of secondary markets⁴³. We were particularly strongly impressed by his treatment of the assignment problem as an linear program with integer constraints. It is interesting to point out that in this monograph (in contrast, to the books discussed in the preceding paragraphs), the cost of public fund is introduced in a reduced form through a single parameter $1 + \lambda$, a practice completely adopted by most of the contemporary authors in the economics of regulation.

We now arrive to the last part of the first section of this paper describing the anticipations of Kolm's contributions on the contemporary economics of regulation. We have previously introduced his distinction between the "incidence aval" and the "incidence amont" of the budget and have focused until now on the "incidence aval". Chapter 4 in Kolm (1971c) is, in my opinion, an extremely important and early contribution to the theory of organizations and the analysis of agency costs that arise as soon as several economic agents with conflictual interests interact through complicated (contractual) relationships. The lack of autonomy resulting from a budget deficit or the authority of a supervisor on prices, outputs, investments and other dimensions of the firm or administration are central to the exploration of what he has referred to as the "incidence amont". He writes⁴⁴ "Si le service a un déficit, celui-ci doit être comblé par un budget public. Les autorités politiques et administratives qui choisissent ce dernier doivent connaître l'usage, estimer l'utilité, décider des montants et vérifier l'emploi de ces fonds, et, au besoin, elles doivent pouvoir imposer la conformité de la loi budgétaire. Elles doivent donc exercer un contrôle de disposer d'un droit de commande sur le service (ce peut être la menace de ne pas renouveler ou de diminuer la subvention au prochain exercice. Il en résulte par rapport à un état d'équilibre budgétaire :

- (1) des coûts d'administration pour ces décisions et contrôles financiers et techniques
- (2) *une perte d'information due au fait que des décisions sont prises par l'autorité ad-*

fondamental" and "critère de reconnaissance" is very useful. He writes "La recherche d'un critère objectif bien corrélé à la disposition à payer est un vieux problème des monopoles privés. Dupuit (pour le monopole public) suggère que les passagers sur son pont soient tarifés selon leur couvre-chef : à même intensité de besoin les bourgeois à chapeau acceptent un prix plus élevé que les ouvriers à casquette".

⁴³His constraints can also be reinterpreted as no cross-subsidization constraints. A contemporary analysis of the set of prices meeting these conditions appears in Faulhaber (1975).

⁴⁴On pages 79-80.

ministrative et politique au lieu de l'être par le service qui connaît généralement mieux les possibilités techniques et les besoins des usagers

(3) un gain possible de spécialisation et d'économie d'échelle dû à la réalisation de certaines tâches de prélèvement financier, de choix budgétaire et de comptabilité par une administration centrale ou spécialisée plutôt que par le service

(4) *un gain de conformité du service aux choix de la société exprimés par la voie politique*

(5) un gain possible de coordination avec les situations et choix des autres services publics

(6) un changement de comportement des dirigeants du service par diminution de leur domaine de choix

(7) *un changement de comportement des dirigeants du service par modification de leurs incitations, et en particulier par perte de l'incitation directe à maximiser le surplus budgétaire puisque, quelque négatif qu'il soit, ce déficit est couvert par le budget public."*

While not formulated with the modern terminology, this statement of this problem echoes in many respects what is now referred to as a mechanism design issue⁴⁵. He sketches the various benefits, costs and constraints involved in the hierarchical relationship between the central political and administrative authorities and the manager(s) of the service. The chapter is devoted to an analysis of these various issues attached to the problem and also contains some mathematical preliminary analysis of some of those. We are not going to review the totality of this rich material but offer instead a brief selective inspection of few key ideas and insights that were well ahead of his time and will receive a general formulation explained at the end of this section.

Interestingly, Kolm operates a distinction between the costs of communication/organization and the costs of incentives. He analyses the first dimension by introducing a graph theoretical formulation where the vertices and the edges represent respectively the members of the service and the channels of communication between them : he characterizes the graphs which minimize a cost which adds the cost of channels and the cost of messages. He then proceeds to an analysis of the costs of incentives which is somehow premonitory. He writes⁴⁶ : "Transferts d'information et organisation du travail et du pouvoir selon les connaissances répondent au problème du *savoir* des membres. reste celui du *vouloir* : il ne suffit pas qu'ils

⁴⁵He offers a very stimulating discussion of the notions of centralization and decentralization while regretting that they are usually not defined with enough accuracy. On page 82, he writes : "Pour dresser le bilan social du tarif il faut estimer les gains et les pertes de cette autonomie. Malheureusement, nous ne pouvons pas pour cela nous appuyer sur une théorie élaborée et bien connue comme nous avons pu le faire pour les mécanismes de marché car il n'existe rien de tel pour les organisations administratives. Nous devons donc ici forger nos outils. ceci a l'air d'une digression mais est nécessaire pour donner une base solide à l'étude de rentabilité du degré de centralisation ou décentralisation".

⁴⁶On page 89-90.

sachent bien agir sachent bien agir, encore faut-il qu'ils le veuillent. *Pour réaliser sa raison d'être, une administration est mue par des membres dont les raisons d'agir peuvent être fort différentes du seul but de remplir cette fonction sociale. Faire que malgré cela leurs choix servent au mieux cette fin est le problème d'incitation.* L'incitation a deux facteurs et l'incitation publique deux objectifs. Les premiers sont les motivations des personnes et les conditions dans lesquelles elles décident. Les seconds sont l'efficacité productive et le meilleur service du public d'une part et la conformité administrative et politique de l'autre". After discussing in turn the meaning of these notions, he aims to compare the respective performances of three different organizational modes that he calls Gestion Commerciale, Gestion Autonome and Gestion Administrative Intégrée". We are not going to define precisely all of them. The first one corresponds to pure delegation to the private sector while the last one would correspond to an organization receiving all its instructions from some central administrative/political authority. The second one is somewhere in between. In his comparative analysis, he clearly identifies the trade-off which is a cornerstone of the modern approach : the organizations which perform well in terms of cost optimization and quality of service perform more poorly in terms of conformity to the objectives of the society. For instance, in his examination of the third organization, after arguing that it was " a priori la meilleure lorsque l'utilité du service rendu est révélée par la voie politique", he also asserts⁴⁷ " *Par contre, l'efficacité productive du service et la satisfaction de ces usagers demandent la meilleure connaissance possible à la fois de sa fonction de production et des caractéristiques de la demande. Or les membres du service ont en général sur ce plan un avantage parfois considérable, sur ceux des administrations plus centrales. Les interférences directes de celles-ci risquent donc d'être néfastes de ce point de vue. Mais le service n'utilise convenablement sa connaissance que s'il y est incité. Bien qu'ignorant les actes précis les meilleurs, l'autorité dispose souvent d'un excellent moyen de réaliser cette incitation : c'est de vendre le produit et de choisir le profit comme indicateur de succès au niveau duquel attacher sanctions et récompenses. Il suffit en particulier que ces dernières soient tout simplement des rémunérations personnelles fonctions croissantes de ce bénéfice, ce qui nous ramène à une gestion commerciale ou, éventuellement autonome*". The third appendix of his chapter is devoted to an analytical formulation of this tradeoff where the cost of public funds $1 + \lambda$ stands for the agency cost while the inefficiency costs⁴⁸ resulting from poor incentives are themselves captured by a single number which only appears in the case where the organization is fully integrated. While insightful, this reduced

⁴⁷On page 100.

⁴⁸We refer te reader to the textbook of Stiglitz (1988) on pages194-210 for a stimulating presentation of the arguments and evidence concerning the comparison of efficiency in the public and private sectors as well as an anlysis of the bureaucracy.

form did not provide a complete understanding of the channels through which the incentives operate. This has been done in modern times by the new economics of regulation which was itself constructed on the solid bases established in the eighties by the theory of incentives and the economics of information.

In presenting the contributions of the French precursors of Kolm to the derivation of the optimal rules of management of public monopolies, we have insisted on the historical context. To some extent, the new economics of regulation is also the product of two forces : a specific social and economic demand arising in many countries together with some important developments in economic theory. During the eighties, we observed a renewed interest in the regulation of natural monopolies and oligopolies⁴⁹. As noted by Laffont and Tirole (1993) : "In the policy arena discontent was expressed with the price, quality, and cost performance of regulated firms and government contractors. The remedies sought in specific industries differed remarkably : more powerful incentive schemes were proposed and implemented, deregulation was encouraged to free up competition and entry, and in some countries changes in ownership (privatization) occurred".

While different in terms of policy motivations and theoretical emphasis, the modern theory of regulation⁵⁰ is to a large extent in the continuation of the practical and theoretical construction of the predecessors. Among other things, the lack of focus on incentives issues by regulatory theory was perceived as a serious limitation. As noted by Laffont and Tirole (1993) : "The academic debate attempted to shed light on some shortcomings of the generally accepted theory of regulation. Regulatory theory largely ignored incentive issues. Because exogenous constraints rather than the limited access to information of regulators were the source of inefficient regulatory outcomes, the theory of regulation did not meet the standards of the newly developed principal agent theory whose aim is to highlight the information limitations that impair agency relationships. Furthermore, the considerably simplified formal models that assumed away imperfect information were less realistic in that they implied policy recommendations that require information not available to regulators in practice⁵¹".

⁴⁹See Spulber (1989).

⁵⁰It should be pointed out that this theory mostly uses the partial equilibrium framework.

⁵¹We will not examine the "sociology" of these regulatory agencies. The French engineers economists listed above as the precursors, were acting inside the firms on behalf of the general interest . Further regulation was not needed. Some of the pioneers have expressed their skepticism about the social benefits to be expected from the new regulation. Concerning electricity, Boiteux (2007) writes "la mission qu'avait reçue EDF était, d'une part de produire au coût minimum et, d'autre part, de vendre au prix de revient (marginal de long terme au sens des experts) sans chercher à profiter de son monopole pour rançonner la clientèle. Ce comportement vertueux, qui suscite aujourd'hui l'incrédulité, n'apparaissait pas invraisemblable du temps des trente glorieuses et de ce que l'on appelait encore les grands commis de l'état". With nostalgia and irony, he also alludes to the "disparition" in the political economy approach of the actors defined in the traditional

The contemporary theory analyses regulation, in particular the regulation of natural monopolies, as the strategic outcome of an agency relationship. Any description of this sequential strategic interaction calls for a very careful examination of the regulatory environment which must be consistent with the firms's and regulators' information structures, constraints and feasible instruments. Constraints are often classified into three types : informational, transactional, and administrative and political. Of course, these constraints limit the efficiency of the control of government agencies and prevent the regulator from implementing his preferred policy (whatever it may be)⁵². The nature of the regulatory instruments and incentive schemes that could be used by the regulator can also vary across problems. they typically use accounting and demand data to monitor a firm's performance. Accounting data are mainly the firm's aggregate cost or profit which the demand data on which contracts can most easily be based are prices and quantities. It is then important to know the scope of possibilities opened to the regulator. According to Laffont and Tirole, current incentive schemes can be analysed along two dividing lines. The first is whether the government is allowed to subsidize (or tax) regulated firms, that is , whether regulated firms can receive public funds and thus to cover all their costs through direct charges to private customers. the second is the power of the incentive schemes, that is the link between the firm's transfer from the government and/or the firm's prices and its cost or profit performance.

Laffont and Tirole (1993) offers a nice classification⁵³ of the more important existing regulatory schemes (including cost-plus contracts, price caps and cost of service regulation) along these two dimensions. They also revisit the received theory in particular marginal cost pricing and the criticisms formulated against its use by Coase and others (to which we have already alluded) and Boiteux-Ramsey pricing. Interestingly, they operate a clever distinction

normative approach of our textbooks as the benevolent social planners corresponding here to the managers of the firms, assumed indeed to be obedient civil servants instructed to follow marginal cost pricing rules. "A force d'enseigner aux jeunes générations que l'intérêt général, c'est l'intérêt de la classe au pouvoir (et non l'intérêt collectif tel que le conçoit la classe au pouvoir), à force d'expliquer que toute personne qui détient un pouvoir ne renoncera à en user pour s'enrichir que dans la stricte mesure où on l'y obligera efficacement (au lieu d'admettre qu'il en usera d'abord pour mener la mission qui lui a été confiée)....., à force de tout cela, l'entreprise nationalisée a du plomb dans l'aile. Car dans un tel contexte, pourquoi le patron d'une EDF qui serait restée en monopole nationalisé se décarcasserait-il encore à comprimer ses prix de revient s'il n'en tire aucun profit ?..... Si le genre de personnage qui ne se laisserait pas aller à de telles facilités n'existe plus, il faut en effet tirer les conséquences. EDF, privatisée doit être laissée libre de gagner durablement le maximum d'argent, dans les limites de la légalité et des contraintes que va lui imposer un "régulateur". *Mais ce régulateur, ou bien il est compétent et désintéressé, et il subsisterait donc un personnage apte à assumer à sa tête la destinée d'une EDF encore nationalisée; ou bien il est incompétent et/ou intéressé, et cela va poser quelques problèmes.*"

⁵²See Laffont and Tirole (1993) for a more detailed exposition of the limits to efficiency resulting from these constraints.

⁵³See table 1 on page 11.

between three criticisms, which are (as argued previously) also formulated by Kolm : the implications of a deficit, the limits of the marginal analysis and the inappropriate incentives for cost reduction⁵⁴. We now focus on this last point, referred to as incidence amount in Kolm's terminology as it is a key concern of the agenda of the new regulatory economics and will allow us to show how the Kolm's intuitions have been explored and formulated within this new framework.

To do so, we have to depart from the assumption of an exogenous cost function as defined in (1) and consider the following one which represents the controlled experiment of Laffont and Tirole (1993).

$$C = C(\beta, e, q_1, q_2, \dots, q_K) + \varepsilon$$

where as before $\mathbf{q} = (q_1, q_2, \dots, q_K) \in \mathfrak{R}_+^K$ denotes the vector of outputs of the firm, β is a technological parameter, e is the effort or cost-reducing activity and ε is a noise term standing for either forecast errors or accounting inaccuracies. Letting t denote the monetary transfer from the regulator to the firm and $\psi(e)$ the disutility of effort, the firm's objective function is assumed to be :

$$U \equiv t - \psi(e)$$

On the other hand, we denote by $V(q)$ the social value associated with the production q (for instance, in the case of private goods, $V(q)$ is often assumed to be the sum of the net consumer surplus $S(q) - R(q)$ (with $S(q)$ being the gross consumer surplus and $R(q)$ their monetary payments) and the social value of tax savings $(1 + \lambda)R(q)$ (where λ is the shadow cost of public funds). The expected (utilitarian) social welfare is then :

$$W \equiv [V(q) - (1 + \lambda)(t + C(\beta, e, \mathbf{q}))] + U$$

This analytical framework captures most of the eight interactions that Kolm has listed in his approach of the "incidence amount". It is assumed that the regulator does not observe the variables β and e ; the asymmetric information is two dimensional since we have simultaneously adverse selection (lack of observability of the exogenous variable β) and moral hazard (lack of observability of the endogenous variable e). This corresponds to the channels (2), (6) and (7) in his list. From the regulator's viewpoint, is drawn from a cumulative distribution $F(\beta)$ on $[\underline{\beta}, \bar{\beta}]$ with density $f(\beta)$. the regulator observe C and \mathbf{q} (or equivalently, prices

⁵⁴And more generally on the internal structure of the firm; the Averch and Johnson (1962)'s model analysing the effect of rate of return regulation on input choices explore one such impact.

$\mathbf{p} = (p_1, p_2, \dots, p_K)$). Note also that his channel (2) is also effective as W and U do not coincide.

The optimal regulatory policy is derived from the maximization of W under incentive and participation constraints. The two fundamental equations⁵⁵ which summarize the essence of such optimal second-best policy are the following :

$$\psi'(e) = -\frac{\partial C}{\partial e}(\beta, e, \mathbf{q}) - \frac{\lambda}{1 + \lambda} \frac{F(\beta)}{f(\beta)} \left[\psi''(e) \frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) + \psi'(e) \frac{\partial^2 E}{\partial \beta \partial C}(\beta, C, \mathbf{q}) \frac{\partial C}{\partial e}(\beta, e, \mathbf{q}) \right] \quad (11)$$

and

$$\frac{\partial V}{\partial q_k}(\mathbf{q}) = (1 + \lambda) \frac{\partial C}{\partial q_k}(\beta, e, \mathbf{q}) + \lambda \frac{F(\beta)}{f(\beta)} \psi'(e) \frac{d}{dq_k} \left(\frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) \right) \text{ for all } k = 1, \dots, K \quad (12)$$

where $E(\beta, C, \mathbf{q})$ is the level of effort required for a firm of type β to produce \mathbf{q} at cost C . This set of first order conditions illustrate how this (second-best) management policy departs from the standard first-best optimality conditions. Under symmetric information, equations (11) and (12) simply describe equality between social costs and social benefits without any correction except for the second ones which is are modified Ramsey equations if λ is different from 0. Since the pricing dimension of the public policy has been our major concern in this paper, let us focus on equations (1é) in the standard case i.e. the case of private goods where in addition:

$$V(q) = S(q) + \lambda R(q) \text{ with } R(q) = \sum_{k=1}^K p_k q_k$$

i.e. under the assumption of linear prices. Since:

$$\frac{\partial S}{\partial q_k}(\mathbf{q}) = p_k \text{ for all } k = 1, \dots, K$$

equations (12) can be written :

$$p_k + \lambda \left(p_k + \sum_{l=1}^K \frac{\partial p_l}{\partial q_k}(\mathbf{q}) q_l \right) - (1 + \lambda) \frac{\partial C}{\partial q_k}(\beta, e, \mathbf{q}) - \lambda \frac{F(\beta)}{f(\beta)} \psi'(e) \frac{d}{dq_k} \left(\frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) \right) = 0 \text{ for all } k = 1, \dots, K$$

or more compactly :

⁵⁵This modern and synthetic approach of the regulation of multiproduct natural monopolies is due to Laffont and Tirole (1990a,b).

$$L_k = R_k + I_k \text{ for all } k = 1, \dots, K \quad (13)$$

where :

$$L_k \equiv \frac{p_k - \frac{\partial C}{\partial q_k}(\beta, e, \mathbf{q})}{p_k}$$

is commodity k 's Lerner index.

$$R_k \equiv -\frac{\lambda}{1 + \lambda} \left(\sum_{l=1}^K \frac{\partial p_l}{\partial q_k}(\mathbf{q}) \frac{q_l}{p_k} \right)$$

is commodity k 's Ramsey index.

$$I_k \equiv \left[\frac{\lambda F(\beta) \psi'(e)}{(1 + \lambda) f(\beta) p_k} \right] \frac{d}{dq_k} \left(\frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) \right)$$

is commodity k 's incentive correction. Besides the addition of an incentive correction, the pricing structure is determined by a familiar ramsey formula. This decomposition is illuminating as it isolates the budgetary issue from the incentive correction and further points out the parameters likely to shape their respective effects on the Lerner index i.e. departure from the first rule described in equations (13) i.e. marginal cost pricing⁵⁶. This is of course a very significant progress with respect to the intuitions developed in Kolm's works as this general theory is structural and is constructed from basic primitives. Equations () yield another simple but important conclusion : incentives and pricing of good k are disconnected if and only if $\frac{d}{dq_k} \left(\frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) \right) = 0$. Remember that in this general setting, the regulator can use two instruments : a cost-reimbursement rule and a vector of (linear) prices. The optimal price of good k exceeds its symmetric (Ramsey) information level iff $\frac{d}{dq_k} \left(\frac{\partial E}{\partial \beta}(\beta, C, \mathbf{q}) \right) > 0$ or equivalently⁵⁷ iff:

$$\frac{d}{dq_k} \left(\frac{\frac{\partial C}{\partial \beta}(\beta, e, \mathbf{q})}{\frac{\partial C}{\partial e}(\beta, e, \mathbf{q})} \right) > 0$$

Laffont and Tirole call "incentive-pricing dichotomy" the situation where the incentive issue is solved exclusively through the appropriate design of the cost-reimbursement rule. In such environments, the two roles are distangled a single task is allocated to each instrument. This of course implies some specific cost functions as demonstrated by Laffont and Tirole.

⁵⁶As explained in Laffont and Tirole, it also offers a new perspective on the definition of cross-subsidization.

⁵⁷See Laffont and Tirole (1990a).

It should be noted that the framework adopted by Laffont and Tirole to formulate the new issues raised by the regulation of multiproduct natural monopolies is in direct continuation of the normative approach privileged by Kolm and the French engineers. It is just more complicated than the framework adopted by the precursors as new constraints reflecting incentive constraints, lack of commitment or political matters have been added into the optimization problem. The optimal management rules derived in this second-best environments are precise but often derived in a partial equilibrium framework and under specific assumptions on the primitives. In contrast, the general second-best rules derived by Guesnerie are derived in a general equilibrium setting but often take as given the scope of the second best instruments. We have shown that Kolm was somewhere between the two epochs. On one hand, he has continued on the road paved by his precursors enlarging the cope of application of marginal cost pricing with an engineer flavor but on the other hand he has perceived and formulated many of the limits of that "doctrine" and anticipated many of the developments which constitute the forefront of the contemporary approach to regulation.

4 References

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