

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

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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 articles have been accessible to a large audience because they were translated from French into English, or they were published in English in international scientific journals. This is the case, for example, for most of his articles and monographs on the theory of justice and on inequality measurement. However, this part of Kolm's scientific output only represents the tip of the iceberg when it comes to research in public economics, his main research area from the mid nineteen sixties to the mid nineteen seventies. Unfortunately, this research is not that well known to the international academic community. While also normative, these contributions differ from his later contributions to public economics both in terms of motivation and objectives. As we shall show, Kolm was very much concerned and interested with the rationale(s) for public sector intervention and by the qualitative and quantitative features of optimal public policies. In particular, his research has focused primarily on the rules necessary for the efficient management of public organisations.

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The following sample of quotations from his work illustrates his perspective¹:

Political Economy is fundamentally a normative science. Its main aim is the provision of advice on actions. To whom? Sometimes to companies . . . , sometimes to a social class . . . , but most often to a State. But if one can go far enough in the positive analysis . . . of the private sector just to infer at the end the public actions to be undertaken (or not to be done), most of the specific variables encountered in the analysis of the public sector are instrumental for the decision-making unit itself. Consequently, the normative view pertains much more to Public Economics as a whole than to the analysis of market mechanisms.

Public Economics studies therefore the actions and the optimal organisation of the public sector. (Kolm 1971c, p. 4)

Normative Economics is the branch of Political Economy that says what *needs* to be done. It is particularly useful for Public Economics in identifying the optimal actions of the State. (Kolm 1971b, p. 395)

These principles first manifest themselves in the new branch of Political Economy which is Public Economics. It has the task of analysing the economic role, and to define the socially optimal behaviour, of the State, of the public sector, and of all the other institutions more or less political in nature. Because “laissez faire” is always one of the possible solutions to the “what should be done” normative problem that has been posed, Public Economics must begin by determining which activities should be undertaken by these institutions and which should be left to the market.

....

While theoretical, this work has an eminently practical objective: it shows how the services being considered and the goods used to produce them should be produced and managed.² It is therefore a study of normative, or prescriptive, economics which looks for and identifies the optimal choice for society in diverse situations. The instrumental variables to be determined are the qualities, the quantities, the method of production, the allocation, the financing, and the institutional nature, of these activities. The allocation can be quantitative or by sales using prices or tariffs. In the latter case, they provide part of the financing, and whether there is still a deficit or not is essential for the question of the decentralisation of the management of this activity. (Kolm 1971d, pp. 20–21 and 23, footnote added)

Kolm has written many articles and monographs on public utility pricing and, more generally, on the nature and role of “public” prices in economies displaying various forms of imperfections that are likely to result in poor performance on the allocation and distribution fronts. Kolm (1971d) offers a very nice and stimulating presentation of the problems faced by public utilities and of the so-called “services publics” (public goods) problem:

¹ We wish that we could include more evidence of Kolm’s fundamental interest in the subject of this article and of the intellectual and practical origins of his concern with this subject here. While doing so is beyond the scope of the present article, we strongly recommend reading the introduction of Kolm (1971d), which contains a complete and nice description of his approach to public economics, as well as Chap. 2 of the same book containing “le dialogue du libéral et du dirigiste” (the dialogue between a liberal and a ruler), a truly monumental piece of pedagogy.

² Kolm uses the terminology “services publics” or, simply, “services,” to refer to goods and services supplied by the public sector. Our usage of the word “service” should also be broadly construed in this way. When capitalized, “Service” refers to the public firm or administrative agency responsible for providing the public good or service in question. Examples include the Electric Service and the Telephone Service.

The prices of “major public services” upset the population, forcing governments into making difficult choices ...

In which proportions should radio and television broadcasting, museums, orchestras, theaters, etc. ... be financed by the State, or by the spectators or listeners (entrance fees, receiving equipment taxes, or specific payment on the delivery of the service) ...

Should the budget of the S.N.C.F. [the French train service and rail network provider] be balanced? Is not budget balance the criterion and the means for a “healthy management”? ... Is it not unfair that all the French taxpayers subsidize the Parisians in reducing the deficit of the R.A.T.P. [the Parisian transportation network] ... which, moreover, encourages the congestion of the capital? ... Why should higher education not be self financed by charging fees to the students who would have access to long term loans? (Kolm 1971c, pp. 5–7)

Kolm is aware of the fact that the line between private and public institutions is sometimes tiny and, in any case, difficult, if not impossible to draw:

It is customary to contrast public and private. Actually, purely public enterprises and purely private enterprises are only two poles between which extends a continuum of varied institutions, more or less close to one or the other, intermediate between them in many ways: nationalised enterprises, public enterprises selling their services, autonomous Services, concessions, public corporations, ... (Kolm 1971c, p. 8)

Kolm’s research in public economics has produced a very rich and voluminous collection of articles and books. A sample of them is included in the bibliography. The main motivation and “raison d’être” of our article is to contribute to the dissemination of Kolm’s ideas, as we believe that these contributions represent at their best an intellectual tradition in public economics quite active in France by the “ingénieurs économistes” (engineer-economists). In addition to this historical exploration of one epoch of Kolm’s scientific journey, we would like to emphasise the modernity and the results of his approach, his creativity, and the large spectrum of methods and concepts he was able to create and/or use on this journey.

This article presents some of Kolm’s main ideas and achievements on several issues related to the optimal management of the public sector, or part of it. It has two main purposes. On the one hand, we want to show how Kolm’s contributions are a continuation of the research of his precursors in the community of French “ingénieurs-économistes”. These economists share several common features. The name “ingénieur-économiste” refers to the fact that they all went to major engineering schools (the “grandes écoles”) and received (there and in their previous schools) a solid education in science and in engineering. In addition to this background, and as a consequence of their willingness to adopt a scientific approach to economic problems, many of them belonged to the research and executive divisions of the nationalised industries, or of the national ministries. Their interest in economics and the topics on which they were inclined to work dealt with practical concerns. The continued interaction between theory and practice has been a remarkable feature of these developments. These “ingénieurs-économistes” did not simply apply existing economic principles without creating or inventing anything on their own. In fact, many of them also wrote important articles in theoretical public economics. The point that we want to make here is that their professional activities and the various challenges, debates, and policy issues resulting from their duties were the source of

inspiration for the problems they considered, and this leads to a theoretical “detour” from applied concerns to pure research, according to the usual academic standards. As employees in the public sector, these individuals had to develop responses to practical questions that arose. In doing so, however, and this is the second point that we want to stress, they looked for responses based on a solid and coherent theoretical formulation of the problems scrutinised. These practices and “culture” differ sharply from the “culture” of other civil servants who were willing to depart from these demanding principles by basing their recommendations on so-called intuitive principles. The fact that Kolm belongs to the first group is not only apparent from his work, but also from the following quotations.

Thanks to a galaxy of famous men, Political Economy came to use the scientific method more and more throughout the nineteenth century, and it was completely converted by the end of World War II. As a consequence, Economics now stands far ahead of all the other so-called social sciences on the path of scientification.³ (Kolm 1971d, p. 15–16, original footnotes omitted, new footnote added)

Unfortunately, politicians, the press, civil servants, and businessmen, in a way so extremely superficial, only consider one aspect of the problem and neglect the rest. However, as each one of them considers a different effect, the prescribed solutions are contradictory, often extremely. And as they cannot scientifically convince each other in the dialogue of the deaf that they have established, everyone turns his idea into a “principle” so as to avoid having to discuss its foundations . . . and defends his position as if it were a political choice; the power of conviction serves as a substitute for the depth of the analysis. (Kolm 1971c, p. 8)

This historical presentation is organised around the principle of marginal cost pricing. As everything could not be covered, we had to make a choice about what to discuss. This choice, of course, had to be representative of both Kolm’s interests and style. We think that our focus is appropriate because, not only is this principle far more subtle than it looks at first glance, it is also a door to penetrate into the world of second-best public economics. There is no need here to remind the reader how important and useful that principle is in standard microeconomics. Implementing marginal cost pricing in the real world is controversial and raises a number of difficulties that have motivated some of Kolm’s research, as well as that of some of his precursors and successors. Like many of his contemporaries, Kolm contributed to the analysis of this principle by showing how it could be used in settings different from the usual ones, and also by showing how it could be altered and/or extended when its direct application was obstructed by institutional constraints. Kolm derives the policy implications and extensions of this principle, in particular for the pricing of goods and services produced or regulated by the public sector.

As we argue, Kolm’s position is in some way at the crossroad between two periods or waves in the field of public economics as practiced by the French “ingénieurs

³ Kolm severely criticises the French economists appointed by universities. For Kolm, the mediocrity of these economists is however compensated by the work of the “ingénieurs économistes.” Kolm (1971b, p. 15, ft. 2) writes: “While some French engineers and scientists who have converted to the field of economics have completed the best research in the world in their areas (Allais, Boiteux, Debreu—an exile—, Malinvaud, and certain others), official French academic Economics remains a laughing stock worldwide . . .”

économistes.” He comes after very eminent precursors who made seminal contributions to theoretical microeconomics and who were able to provide solutions to several important policy issues at the top of the agenda after World War II. But beyond his respect for this very respectable legacy, Kolm was aware of the limits and the necessity of extending their analyses. Kolm, himself, contributed to this research programme, but some of the tools from game theory and the economics of information that have subsequently proved to be so useful for this task were not yet well developed. Kolm was way ahead of his time, with some of his contributions paving the way towards the modern approach to public sector economics in terms of incentive constraints and mechanism design.

We show how Kolm’s successors analysed and explored this approach. They were able to offer a deep understanding of the limits of the marginal cost pricing principle from different angles. The terminology “successors” refers to several ideas. Many of these individuals are also part of the community of French “ingénieurs-économistes” and share the methods and concerns of their predecessors. They hold a strong belief in the usefulness of microeconomics and in the necessity of founding policy recommendations on solid theoretical foundations. Some of these successors primarily focus on the theory and its extensions, while others derive applied implications of the theory. The precursors were directly confronted with management problems in the public sector; in contrast, the successors are facing a new age or period characterised by a (de)regulation process in substantial parts of the public sector. The current challenge of real world public economics is to provide helpful guidelines and principles to managers, regulators, and public policy makers to accompany the fore-mentioned process.

This article aims to offer a brief description of Kolm’s scientific achievements in public economics from an historical perspective. In Sect. 2, we explain how marginal cost pricing has operated in France since World War II under the leadership of French engineers. In Sect. 3, we argue that Kolm’s choice of topics, as well as his methodology, were very much a continuation of what was done by his precursors. In Sect. 4, we describe the Anglo-American contributions to marginal cost pricing and the controversies raised by the application of this principle. Then, in Sect. 5, we examine Kolm’s contributions to the theory of the second best. We also show how the former tradition has been pursued in many new and important directions without any major and discontinuous change in the methodology and the agenda. In Sect. 6, we argue that Kolm has also made insightful contributions to the theory of organisations and incentives, paving the way to the new approach to optimal regulation of public agencies. Some concluding remarks are presented in Sect. 7.

To some extent, our article aims to demonstrate that Kolm’s contributions lie between two periods and that they have played a major role with respect to both of them. Not only has Kolm extended the results of his precursors and applied their methods to many new areas, he also has prepared the ground for his successors through his research because he anticipated some of the questions that are, or have been, at the forefront of the more recent scientific agenda.

2 The Marginal Cost Pricing Principle and Kolm's Precursors

In many countries, the production and distribution of several important economic (private) goods and services are under the control of the public sector. In addition, the government contracts with private firms to supply goods and services, both directly for itself and for individuals. We are not going to review the list of arguments supporting the view that the government should control these specific activities. The most widely heard argument is that private firms pursue the maximisation 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 market failures occur, the pursuit of profit maximisation by firms might not result in an efficient resource allocation.

The most important kind of market failure that leads to public production arises when markets are not competitive. A common reason that markets may not be competitive is the existence of increasing returns to scale. In such a case, economic efficiency requires that there be a limited number of firms. Natural monopolies refer to industries in which increasing returns are so significant that only one firm should operate in a region.⁴ In such situations, we cannot rely on competitive forces to ensure the efficiency of the industry. Efficiency requires that price equals marginal cost.⁵ However, the firm will suffer a loss if it charges marginal cost because marginal cost is lower than average cost.⁶

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

A group of French economists faced these very questions just after World War II. As reported by Drèze (1964, pp. 4–7, footnotes omitted):

⁴ In his mathematical derivation of the conditions for a Pareto optimum, Allais (1945) explicitly allows for the existence of two sectors: a competitive sector and a sector composed of natural and other monopolies.

⁵ We will not reproduce here the conventional first-best defence of marginal cost pricing as an optimality principle. Most of the textbooks in microeconomic theory provide a description of the assumptions used for its derivation and contain insights on its scope of validity.

⁶ Stiglitz (1988) offers a nice simple illustration of this failure, as well as the limits of the threat of entry.

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, or followers ample opportunities for applying and developing their theories. ...

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 ...

[T]he 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 at EDF [Electricité de France], developed original contributions to decision or price theory. The theorists and the executives fortunately shared 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.

We see the contributions of the French engineer-economists as an intellectual response to the questions raised by the public management of natural monopolies.⁷ As observed by Drèze (1964, p. 8):

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.

Kolm’s precursors concentrated most of their attention on pricing and investment issues. Here, we mostly focus on the pricing issue, which is not as simple as it may look at first glance. On the cost side, it is by no means clear that managers should value inputs according to market prices. If there are some distortions in the rest of the economy (in particular, if there are 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. Although they were aware of these issues, it is fair to say that Kolm’s precursors did not really investigate what vector of prices should be used to evaluate the cost of inputs. While implicit in various cost-benefit analyses of public projects (in particular, when deciding which rate of discount should be used), this topic was not, at that time, subject to a systematic exploration as an end in itself. Instead, the attention was focused on the determination of the total (long-term and short-term, average and marginal, etc.) cost curves of the multi-product public firm given a vector of input prices.

⁷ The papers collected in Nelson (1964) and Morlat and Bessière (1971) offer a nice overview of these contributions together with their motivations.

Let $\mathbf{q} = (q_1, q_2, \dots, q_K) \in \mathbb{R}_+^K$ denote the vector of outputs of a public firm and let C be its total (long-term or short-term, depending upon the context) cost function:

$$C = C(\mathbf{q}). \quad (1)$$

Once this function has been calculated, we are in a position to provide answers to the question 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 open, lump-sum transfers are feasible policy instruments, no distortions or “pathological” behaviour in the rest of the economy, etc.), selling each product according to its marginal cost is a necessary condition for social optimality. In the case where a pricing policy is a vector of linear prices $\mathbf{p} = (p_1, p_2, \dots, p_K) \in \mathbb{R}_+^K$, optimal prices and quantities are therefore related by the following equations:

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

It follows that once we are able to determine the cost function(s), we are in position to compute the optimal prices. Indeed, the work has been transferred from economics to operations research, applied mathematics, and statistics. However, the cost function is not a primitive of the problem, but is instead the result of an optimisation on the part of the firm that can turn out to be more or less complicated. The area of operations research relevant to this optimisation problem depends on the nature of the variables, linear and non-linear programming, dynamic programming, integer programming, and combinatorial optimisation, etc. In any case, the description of the variables and constraints of the problems calls for a solid understanding of the technological alternatives that should be considered and, in that respect, being an engineer certainly is a good preparation for carrying out this kind of analysis. This task has two different components:

First, we need a comprehensive description of the commodity space. What is the relevant value of K ?

Second, we need an extensive analysis of the technologies from an engineering perspective.

The first task cannot be neglected. It should be recalled 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 (or period), the place, and the contingencies of delivery. The cost of serving customers may display important differences according to the time and/or place of delivery. Distinctions based upon temporal considerations play an important role as soon as some factors are used for the production of the output(s) in different time periods, in addition to a direct concern due to investment/storage possibilities and the availability of some natural resources. Distinctions based on spatial considerations also play a critical role as soon as some transportation cost is involved in addition to production costs. Indeed, the derivations of cost functions in the case where clients are located on a 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 a

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. For instance, one unit of electricity may be priced differently according to the time of the year considered, the location of the client, and the clauses of delivery originating, for instance, in the choice of interruptibility standards.

As previously mentioned, the French engineer-economists were certainly well prepared and had the talent needed to conduct the second task. They were also successful in making their ideas operational. Their work is a perfect illustration of the derivation of what [Chenery \(1949\)](#) has called “engineering production functions.” Instead of using statistical data, the promoters of this approach suggested using engineering data. As noted by [Chenery \(1949, pp. 507–510, footnote omitted\)](#):

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 variables 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 economist deals with plants or 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 calculations at which the various types of inputs are considered. These data are found 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.

This methodology was applied by the French engineer-economists successfully in many different industries, including, for instance, coal mining, electricity, natural gas, and railways.⁸

⁸ This article is obviously biased towards the contributions of French engineers as our priority here is to point out Kolm’s lineage. We 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 our home country. [Chenery \(1949\)](#) is a remarkable article that should be read by anybody interested in this topic. Interestingly, he refers to an air transport analysis by Bréguet (the famous French aviator, airplane designer, and industrialist) who uses a technique to derive a cost curve based on engineering experience. Bréguet’s analysis is summarised by [Phelps Brown \(1936\)](#). Stigler, in his contribution to [Yntema et al. \(1940\)](#), has also defended the

One spectacular application of marginal cost pricing is peak load pricing. The peak-load pricing problem arises when there are non-storable commodities with periodic demand fluctuations (transportation, mail, telecommunications, power supply, etc.). Peak-load pricing is based on a simple description of the commodity space. The relevant time period (say a year or a day) is divided into smaller periods (say months or day and night). Time is, therefore, considered as the relevant dimension of product differentiation. The aggregate demand facing the firm is a temporal profile of consumptions. For example, with electricity, this demand is often represented (after rearrangement) as a curve, the so-called load duration curve because time is treated as a continuous variable. The calculation of the cost curve based upon engineering data is specific to the industry considered. In the case of electricity, this task amounts to the determination of the optimal capacity configuration once the fixed and operating costs of each conceivable generating unit (coal, gas, nuclear, hydro, etc.) have been evaluated.⁹

Let us consider the simplest cost situation, namely, that defined by constant returns to scale and fixed plant capacity, with constant short-term marginal costs that do not depend on plant size. It is readily verified that the (short-term) total cost function per period is then:

$$c(q, z) = \begin{cases} \beta z + bq & \text{if } q \leq z \\ \infty & \text{if } q > z, \end{cases} \quad (2)$$

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. The long-term marginal cost is then $\beta + b$. 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:

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

In this problem, total cost cannot be broken down into the sum of costs in each period because 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; for instance, inventories. In the long run, capacity will be adjusted to the peak consumption.

advantages of the engineering approach, but it seems the economists at the time did not take up the suggestion. Since then, many economists have argued against the statistical approach and instead used the engineering approach. See, for example, Marsden et al. (1974) and the survey by Wibe (1984).

⁹ Approaches based on engineering and financial data have also been used in settings different from cost minimisation. The application of linear programming to investment in the French electric power industry by Massé and Gibrat (1957) provides quite a remarkable illustration of this approach.

Boiteux (1949) and others have applied with success the marginal cost principle to this setting.

Another set of applications of marginal cost pricing appears when the heterogeneity dimension is spatial instead of temporal. As soon as a transportation cost is incurred prior to final consumption, the derivation of the optimal transportation network is a key feature of the cost minimisation operation (sometimes, even, transportation and production activities are closely related). Besides the combinatorial design of “roads,” when pipelines are used to transport resources, the choice of the dimension of the pipe 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 on its diameter, the pressure of the gas, and the drop in pressure along the line. Hence, enlarging the diameter, the pipe thickness, or the pumping capacity (this will depend on the spacing of compressor stations) may increase the capacity. 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. In this particular spectrum of applications, the key ingredient is an equation governing the flow of compressible fluids through pipes.

3 Kolm on Marginal Cost Pricing

Kolm has derived many ingenious and important implications from the marginal cost pricing principle for several allocation problems. This section describes his research on this issue through a sample of illustrative applications. His book *Le Service des Masses* (Kolm 1971d), which is part of his *Cours d’Economie Publique*, is a perfect illustration of the intellectual tradition of French engineer-economists that was briefly described above.¹⁰ He has sometimes developed his own general terminology in order to show the profound unity between problems that are only different on the surface. For example, Chap. 11 of Kolm (1971d), 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 a number of chapters in this book, he also examines issues related to the cost of production.

Le Service des Masses is devoted to a class of problems in which the joint consumption of the services by the users influences some features describing the

¹⁰ The terminology “services des masses” (mass services) used in Kolm (1971d) refers to public goods and services used by the general population, e.g., mass transit. Kolm (1971d, p. 23) writes: “Telephone, public education, postal services, transportation by road, water, or air, water and electricity conveyance, distribution centers, radio broadcasting and television, hospital services, road systems, sewage systems, town maintenance, and most administrative services, constitute typical cases.”

“quality” of one or several “variétés”/services produced by a public firm/administration. Consider the case where $K = 1$, i.e., the situation in which only one service is produced. Let i be an index that identifies any particular consumer of the service. Let q^i denote the quantity of service consumed by i , $(q^1, q^2, \dots, q^N) \in \mathbb{R}_+^N$ denotes the vector of consumptions in the population (where N is the number of consumers), and $q \equiv \sum_{i=1}^N q^i$ denotes the aggregate consumption. In his book, Kolm introduces the key concept of a “fonction d’encombrement” (congestion function). In the case where the quality itself is one dimensional and denoted by w , this function relates the quality level w to the profile of consumptions $(q^1, q^2, \dots, q^N)$ and to another vector $z = (z_1, z_2, \dots, z_M)$ describing the levels of M decision variables that are often (according to Kolm) quantities of specific inputs. That is,

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

Kolm calls the case in which the congestion function only depends on the sum, and not the distribution, of consumptions “uniform.” In this case,

$$w = w(q, z). \quad (3)$$

To illustrate how Kolm derives the pricing implications of marginal cost pricing when there are congestible goods or services, we consider the uniform case and we assume that $M = 1$. The first-order conditions for optimality are derived in [Kolm \(1971d, Chap. 5\)](#). Let $U^i(q^i, w)$ be a utility function describing, in monetary units, the welfare derived by consumer i when he consumes q^i units of the service with a quality equal to w and let $C(q, z)$ denote the total cost incurred by the public firm to produce a total quantity q using the input z .

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

$$\frac{\partial U^i(q^i, w)}{\partial q^i} = \frac{\partial C(q, z)}{\partial q} - \frac{\partial w(q, z)}{\partial q} \left(\sum_{j=1}^N \frac{\partial U^j(q^j, w)}{\partial w} \right), \quad i = 1, \dots, N, \quad (4)$$

and

$$\frac{\partial C(q, z)}{\partial z} = \frac{\partial w(q, z)}{\partial z} \left(\sum_{j=1}^N \frac{\partial U^j(q^j, w)}{\partial w} \right). \quad (5)$$

The first equation can be rewritten as:

$$\frac{\partial U^i(q^i, w)}{\partial q^i} + \frac{\partial w(q, z)}{\partial q} \frac{\partial U^i(q^i, w)}{\partial w} = \frac{\partial C(q, z)}{\partial q} - \frac{\partial w(q, z)}{\partial q} \left(\sum_{\substack{j=1 \\ j \neq i}}^N \frac{\partial U^j(q^j, w)}{\partial w} \right). \quad (6)$$

In this equation, user i 's marginal willingness to pay for the consumption of the service is equal to the marginal social cost, which is the sum of the marginal cost of production and the "external" marginal social cost.

Kolm (1971d, Chap. 6) derives the pricing rules which decentralise the optimal allocation. From (4), it follows that the (linear) price p^i of the service that should be paid by user i must satisfy:

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

We deduce from (7) that optimal pricing is in general discriminatory. However, as noted by Kolm, there is an important case in which 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 being negligible. In such a case, the optimal prices are uniform across users:

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

Using (5), (8) can be equivalently written as:

$$p^i = p \equiv \frac{\partial C(q, z)}{\partial q} - \frac{\frac{\partial w(q, z)}{\partial q}}{\frac{\partial w(q, z)}{\partial z}} \frac{\partial C(q, z)}{\partial z}, \quad i = 1, \dots, N. \quad (9)$$

Besides incorporating the uniformity assumption, we note that the right-hand side of (9) consists of cost data and data on the congestion function. Each specific problem is described by a cost function c and a congestion function w . The cost function is a familiar concept, while the congestion function is not so familiar in economic analysis. It is very interesting to point out that the engineering approach, discussed extensively above, which is a trade mark of the French engineers, seems to be perfectly suited to deal with this new concept.

Kolm (1971d, Chap. 7) presents many practical problems for which the abstract model described above is very appropriate. His list of examples includes: road transportation, railway transportation, stochastic congestion, traffic accidents, pollution, and queues. Let us say a few words about some of them to show (convincingly we hope!) that engineering expertise cannot be avoided in these applications. In the case of road transportation, Kolm considers the case of a highway with z the number of lanes, q the aggregate traffic flow, and w the average speed. Under some particular assumptions, he 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 congestion function 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, disciplines which obviously need to apply marginal cost pricing to road congestion. Lévy-Lambert (1968) produced an early analysis of optimal tolls based on these principles and the empirical congestion function.

Stochastic congestion is the topic of a companion article to this one (see David et al. 2011). In this setting, z represents the capacity of a given piece of equipment and w denotes the reliability level defined, for example, as the probability of every customer having its demand satisfied. The exact value of w depends on the details of the stochastic model. This model applies to many different industries in which the delivery of a product (e.g., electricity, gas, or water) may be interrupted or rationed due, for instance, to adverse weather conditions, a power outage, or a breakdown. For a bank, z represents the amount of total deposits of the bank and w the probability that a client is unable to withdraw some cash (see Edgeworth 1888). This case is extensively studied in the companion article mentioned above.

Queuing is a very important topic. For many public agencies and utilities, a demand that cannot be satisfied immediately can sometimes be delayed instead of being not fulfilled at all. However, waiting costs cannot be ignored and the question of an optimal organisation of the service taking into account these costs raises problems for which the framework developed by Kolm (he calls it “*encombrement d’attente*,” i.e., waiting congestion) is very appropriate. He devotes the last third of *Le Service des Masses* to the application of marginal cost pricing to these types of problems. We are not aware of any similar systematic attempt to analyse such problems. The relationship with engineering and operations research is obvious. It is reflected, for example, by the use of the mathematics of queues when increasing demand can be expressed as a Poisson process.

Le Service des Masses contains many results on the relationships between the financial consequences of marginal cost pricing and the nature of the returns of the congestion function.¹¹ For instance, in Chap. 15, Kolm develops the notion of “*capacité commune*” (common capacity) as a key feature that is common to the cost problems considered. This concept plays a critical role in the rest of this article and has already appeared in (2). In Kolm’s terminology, we have a situation of common capacity when the same input (equipment, machine, etc.) can be used to produce several varieties of the same service, as long as the input’s capacity is not reached. Kolm (1971d, p. 254) writes: “Common capacity is both a private consumption between consumers of the same type and collective consumption between different types.” In this chapter, Kolm also develops conditions satisfied by the optimal capacity.

¹¹ We do not discuss here Kolm’s analysis of optimal investment policies in a truly dynamic framework.

4 Anglo-American Contributions to Marginal Cost Pricing

The previous sections dealt with marginal cost pricing. In it, we have highlighted the contributions of the French engineer-economists because we wanted to illustrate how Kolm's own contributions were positioned in the continuation of this intellectual tradition. This could leave the reader with the impression that, on the one hand, only French engineer-economists were actively participating in these developments and that, on the other hand, there was some unanimity that this pricing policy was the right one to implement when competitive markets could not be designed to produce and distribute the commodity/service in question. In this section, we briefly consider some of the Anglo-American contributions to marginal cost pricing.¹²

According to Coase (1970), Hotelling (1938) should certainly be credited for being among the first in the modern literature to suggest the use of marginal cost pricing for public utilities and enterprises. Hotelling recognises the major influence of Dupuit (1844).

In the United Kingdom, the appearance of Meade (1944) was a major event. Originally, it was circulated as a policy brief of the economic section of the Cabinet Office as part of a discussion about how state enterprises ought to be run. It was written without any thought of publication but, due to Keynes' enthusiasm, both as an adviser of the Treasury and as an editor of the *Economic Journal*, it was subsequently published as part of an *Economic Journal* symposium. Meade advocated adopting marginal cost pricing. According to Coase (1970, pp. 115–116):

In the meantime, James Meade had become head of the economic section of the Cabinet Office and Britain had a Labor Government. A paper was prepared by the economic section 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. This proposal was not, however, accepted by the Minister concerned, Herbert Morrison, 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 which 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 industry 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 United States, research was also active with these ideas. Some economists expressed strong enthusiasm regarding the work accomplished by the French engineer-economists and their ability to make the marginal cost pricing principle operational. Some expressly dissented from the view that price should be equated to marginal cost.

¹² By no means would we like the reader to infer from our presentation that little was done on this issue in the US or the UK. Reviewing the developments in these countries goes beyond the scope of this article. In addition to the articles cited in our references and in the masterpieces of Hotelling (1938) and Vickrey (1948, 1955, 1971), the reader will find useful discussions of the early literature in Nelson (1964) and Ruggles (1949).

Among the advocates, [Nelson \(1963, p. 474\)](#), for example, 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 ...

His article outlines how Electricité de France applied marginal cost pricing.

A few years earlier, [Marschak \(1960\)](#) also offered a very complete and lucid analysis of the French engineer-economists’ contributions. 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 postwar public sector includes important basic industries, a major share of economists’ 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 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. ([Marschak 1960](#), p. 133, footnote omitted)

It is interesting to note that Marschak identified three classes of difficulties in accepting and applying this solution. He writes:

The many well-known difficulties in accepting and applying this solution fall roughly into three classes:

1. Deficits in the decreasing-cost enterprises of the non-competitive sector (assuming the other sector to contain only increasing-cost industries) have to be made up and surpluses in the sector’s increasing-cost enterprises have to be paid out. ...

2. It may be that one of the conditions for a Pareto optimum must inevitably be severely violated.¹³ ...

3. There may be enormous practical difficulties of satisfactorily defining the relevant marginal cost in the face of indivisibilities, uncertainties, joint products, the possibility of expanding or contracting various elements of plant over varying time periods, etc. ([Marschak 1960](#), p. 143, footnote added)

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 one of the most active. [Clemens \(1941\)](#) was an early dissenter. In his discussion of [Nelson \(1963\)](#), [Clemens \(1963, p. 482, footnote added\)](#) writes:

¹³ As is well known, at least from the seminal work of [Lipsey and Lancaster \(1956\)](#), if there are already distortions in some sectors of the economy, it may be optimal to depart from marginal cost pricing in the controlled sector.

I am rather skeptical of 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 *tarif vert* [green tariff] is a more sophisticated version of marginal cost pricing but one which is nevertheless subject to some of the usual infirmities.¹⁴

Clemens lists eight infirmities.

Both Marschak's three classes of difficulties and Clemens' eight infirmities (and to some extent many reservations expressed by the strongest opponents) are mostly motivated by second-best considerations. Besides these considerations, discussed more extensively in the next sections, both Clemens and Marschak 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 a plant or expanding various elements of a plant over varying time periods, etc. In this respect, there are conflicts about the type of marginal cost that should be taken into consideration.¹⁵ As Drèze (1995, pp. 117–118) has noted: "Vickrey . . . advocates prices reflecting continuously (in time) *short run* marginal social cost. Massé . . . advocates prices reflecting *long run* marginal cost."¹⁶

The following statement by Boiteux (1951, pp. 56–57) illustrates the French perspective at its best:

The theory of marginal cost pricing can be interpreted in many different ways. Selling at marginal cost means setting a price equal to the cost of producing an additional unit. This cost differs obviously according to whether one plans to produce the additional unit only one time, or, on the contrary, henceforth increase the unit *flow* of goods that one has produced until now: the exceptional production of an additional unit in isolation does not justify a modification of the equipment; a definite increase in the flow of production, on the other hand, may be accompanied by a modification of the equipment to the new level of production.

The concept of a tariff implies the idea of flows. One does not set a price schedule to dispose of an accidentally available stock, but to obtain a long-term equilibrium between the flow of demand and the flow of production. . . .

This at least is one conception of a marginal price. On the contrary, there is also the one revealed by the additional passenger story. A train is about to leave; there is a vacant seat left; a passenger presents himself who is prepared to occupy it if he does not have to pay too much. The cost of transporting this additional passenger only comprises the few extra grams of coal needed to transport his weight and the leather molecules he will extract from the seat during the duration of the journey.¹⁷

¹⁴ The green tariff is an implementation of the marginal cost principles for Electricité de France. For a description of the historical context in which this pricing policy was introduced, the details of this policy, and an estimate of the gains resulting from this change, see Boiteux (1957), Massé (1958), and Meek (1963).

¹⁵ Concerning 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.

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

¹⁷ See also Boiteux (1949, 1956a).

The disagreement between the two approaches pertains to 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, p. 118, footnote added):

The alternatives are relatively stable prices (Massé) leading to inefficient use and occasional quantity rationing, or unpredictable price variations (Vickrey), which entail costs to users like monitoring prices and adjusting quantities.¹⁸

Quite interestingly, practice has evolved considerably since the early implementations of these ideas in the nineteen fifties. The green tariff was followed by major innovations at E.D.F. in the nineteen eighties and nineteen nineties. They originated from the difficulty of forecasting peak loads far ahead of time. This meant that it was desirable to adjust tariffs on short notice. We consider these and other pricing innovations in David et al. (2011).

5 Second-Best Distortions

Kolm's precursors were primarily interested in deriving the operational implications of marginal cost pricing. There is of course one important exception. Boiteux, in his seminal article (Boiteux 1956b) derives an optimal pricing rule for a public monopoly subject to a budget constraint. In Boiteux's setting, the additional constraint (i.e., in addition to the standard resource constraints) has a second-best nature and prevents the realisation of the first-best optimum. The major objective of the theory of second best is to derive general principles about the features of the optimal rules when these additional constraints are active. This theory has taught us one important lesson: Often, the first-best rules must be revised even in sectors where they can be applied due to the existence of distortions in other sectors. As such, a principle like marginal cost pricing may even have become obsolete.

We have concluded the previous section by reporting some of the criticisms that were formulated by eminent American 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 dissident views. This theme is also a major concern in Kolm's work on public pricing. In Kolm (1971c), he analyses the multiple roles prices can play and the potential conflicts that can arise between these roles. Under the heading "Les Fonctions Sociales des Prix Publics" (The Social Functions of Public Prices), he

¹⁸ Marschak (1960) also provides an interesting analysis of this controversy. He presented what the French engineers considered to be ideal rule and wrote:

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. (p. 146)

develops a very stimulating and modern analysis of the use of public pricing as a policy instrument.¹⁹ Kolm (1971c, pp. 31–32) writes:

A tariff has a double direct *effect*, on the *users* and on the *budget of the Service*, which *themselves* create multiple indirect effects; one can respectively call them the *downstream* effect and the *upstream* effect or “price effect” and “budget effect.”

By its effect on the users, a tariff influences: their consumption of this service, their consumption of complementary and substitutable goods and services through the substitution effect, all the consumptions and productions of these individuals through the income effect, ... by the intermediary of these reactions, it also influences the production of complementary or rival goods and services ...; all these effects, in their turn, influence the degree of realisation of the social objectives.

Furthermore, the tariff influences the *budget balance* of the Service This balance in turn operates on the public budgets and has three types of effects: (1) it influences other public receipts and expenses, and in particular tax revenues and other public services, (2) it influences therefore the *functions* of the *public finances*—public allocation, income distribution and macroeconomics effects—, and on the other hand (3) it influences the level of autonomy of several elements of the *political and administrative hierarchy* and thus the efficiency of this 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”—the truth of prices), has been the main focus of the advocates for marginal cost pricing. While not ignored, the second incidence was considered less important. However, in all his contributions, Kolm always derives the budgetary implications of marginal cost pricing, as illustrated by the following quotations.

Here then the fundamental dilemma of public tariff setting is posed: a price has several social functions that a certain technical structure of production renders incompatible in the sense that the best level for one is bad for the other. Therefore one contrasts the roles of prices as tools for information and coordination in the markets and as a source of revenue, in brief, its commercial and financial functions, or, one can say, its internal and external efficiencies. (Kolm 1971c, p. 11)

The second function stems from the fact that budget equilibrium is a necessary condition of complete autonomy. ...

However autonomy leads to production and service management decisions being taken by people who better know its production function and the characteristics of the demands of the users. Its advantage is thus, again, to decentralise decision-making, but instead of being between the Service and its users, now it is between the Service and its regulator. The former can be called the *downstream decentralisation of decision-making* and the latter the *upstream decentralisation of decision-making*, the reference being to the Service. (Kolm 1971d, pp. 96–97, footnote omitted)

Compared to a state in which a balanced budget is required, on the one hand the assurance that the deficit will be made up by a public budget removes from the enterprise’s management the direct incentive to satisfy the public better and at lower cost, on the other hand, the public authority that manages the budget must control the management of the service, leading to costs of administration and especially prevents decisions being taken by the better-informed individuals and quickly. (Kolm 1971c, pp. 10–11)

¹⁹ This issue was earlier explored in Kolm (1968b).

Kolm (1971b, p. 399) points out the internal contradictions of the pricing structure.

The rule of “selling at marginal cost” is intended to promote the decentralization of decisions by a price system. On the other hand, budget balance of an enterprise whose main interest is to assure its independence is thus also an instrument for decentralising decisions. However, when production is subject to increasing returns and the output is sold at a uniform price, selling at marginal cost results in a deficit. There is thus a contradiction between these two tools for decentralising decisions.

To understand why the existence of a deficit is perceived by Kolm and others as socially costly, it is important to remember 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 nineteen seventies.²⁰ The new generation of French engineer-economists, following Kolm and his precursors, has made seminal contributions to these topics, ranging from second-best modelling to the economics of regulation. In this group, Guesnerie’s research agenda on general second-best environments on the one hand, and Laffont’s research on the economics of regulation on the other hand, are, in many respects, the closest to follow the work of the precursors, including Kolm.

We must of course mention the pioneering contribution of Boiteux (1956b) where he derives, independently of Ramsey (1927), the optimal pricing rules of a public utility subject to a budget constraint, although this was not the main concern of the

²⁰ In his Presidential address to the European Economic Association, Guesnerie (1995b) 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 that 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’. (p. 354)

Furthermore:

Second-best studies have challenged a number of ideas and intuitions of the so-called first-best culture. But the body of knowledge 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.” (pp. 354–355)

precursors. Kolm (1971a,b) has developed a general theory of optimal pricing that applies 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 (as in Boiteux). Besides the fact that Boiteux’s rule appears as a corollary of Kolm’s general result, it should be noted that Kolm’s general theory allows for a careful analysis of many other questions. He innovatively explores 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 a neighbourhood of the first-best allocation. In such a case, the social deadweight loss is a negative definite quadratic form with respect to the distortions, and optimal distortions are quite easy to derive. Kolm obtains results on optimal distortions for the case in which endogenous distortions correct exogenous distortions, and for the case in which the role of distortions is to raise an exogenous budget.²¹

We are not going to review here the diversity of situations and constraints leading to second-best environments, i.e., environments for which there is some rationale to depart from marginal cost pricing. According to Guesnerie (1975b, p. 127, footnotes omitted):

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 [sic] 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 revenue cannot be raised using this neutral tool, then it must be the case that some “imperfect” taxation devices are used to do so. Primarily among these instruments are 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 (1995a) a complete analysis of several important extensions of the basic Walrasian model of general equilibrium in which these new instruments are introduced, together with the other variables and constraints describing the public sector that could be considered (production of public or private goods, pricing of public utilities, quantity controls, etc.). Clearly, 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

²¹ These results also appear in Kolm (1969a). Kolm (1968a) provides a very useful application of these principles to an environment where two transportation alternatives (say, road and metro), both subject to congestion, are in competition. Given that the unit price of road services departs from its marginal social cost, what should the optimal pricing of a metro ticket be?

equilibria displays some unusual features leading to different sorts of nonconvexities that make the analysis complicated. Optimising over that set of equilibria calls for caution.

Social optimisation provides a set of social values: one for each commodity (the Lagrange multipliers attached to the scarcity constraints). A commodity's social value is the correct social valuation of an exogenous marginal increase of its endowment. One important area of research is the determination of shadow prices to guide the management of controlled firms. In contrast to first-best optimisation, shadow prices no longer coincide, in general, with market prices. The extent of the discrepancy between prices and values varies across problems.²² In many problems, for instance the problem of optimising the production of pure public goods or private goods by the public sector, the vector of shadow prices coincides with the vector of production prices.²³ In some other problems, for instance, in the production of private goods by the public sector when the supply behaviour 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 yet other problems, like the one considered by Boiteux where lump-sum transfers are also feasible (a public firm subject to a budgetary constraint), the derivation of the shadow prices shows that the vector of shadow prices is a convex combination of the vectors of market prices and social values.²⁴

The implications of these considerations for the marginal cost doctrine are quite important. As pointed out by Guesnerie (1980, p. 51):

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 behavioural 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 basis of the social value of commodities rather than production price—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 behavioural assumptions made in the model. Changing the policy tools available to the government not only changes the optimal prices that 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 behavioural assumptions.

²² See Guesnerie (1979). Drèze and Stern (1990) is also an excellent reference on this topic.

²³ Guesnerie (1995a, p. 183) derives a modified Samuelson rule (see Samuelson 1954) for the provision of a public good due originally to Atkinson and Stern (1974).

²⁴ Guesnerie (1980) explores the nature of the shadow prices in the Boiteux model under alternative assumptions. Hagen (1988) is also an excellent reference.

This strongly suggests that we should investigate 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 example, 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 additional instruments (unless explained otherwise) that would allow the constraints to be relaxed. For example, in a problem à la Boiteux, given the existence of an “exogenous distortion,” it makes sense to use “endogenous distortions” like consumption taxes or quantity controls.²⁵ The shadow cost of the budgetary constraint depends on the spectrum of instruments available. We should further anticipate that pricing policies would play a distributional role, not just an allocational role.

Our discussion implies 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 to be taken into consideration in the design of these policies. Too often, these interdependencies as well as the difficulties resulting from this approach are partly ignored by partial equilibrium derivations based on more or less sophisticated versions of consumers’ 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, p. 116):

The presumption in this setting was that marginal cost pricing with deficits financed by lump-sum taxes would sustain a first-best efficient allocation, 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 (1975a) has demonstrated that this presumption fails as a general proposition.²⁶ The existence of Pareto-improving income redistributions also challenges the classical view on the separation of efficiency and equity.²⁷ The analysis of the set of Pareto optima in second-best environments reveals that this phenomenon occurs there too.

²⁵ In 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 example, by Guesnerie and Roberts (1987) and Wijkander (1988).

²⁶ Beato and Mas-Colell (1985) have produced an example in which even aggregate productive efficiency is violated. Guesnerie’s seminal paper has inspired a vast literature, including Bonnisseau and Cornet (1990), 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 (see Cornet 1988). The theory of general equilibrium has also been extended to cover other “correct” rules of management that differ from marginal cost pricing (Ramsey–Boiteux, two-part tariffs, etc.). The conclusions reached in these articles concerning the welfare properties of these equilibria are also negative. See, e.g., Brown and Heal (1980) and Dierker (1991). Brown and Heal (1983) offer a nice discussion of some of these issues in a simplified general equilibrium framework.

²⁷ This view has been expressed by many authors. Brown and Heal (1979, p. 573) write:

While devoting special attention to the problems raised by the deficit, Kolm extensively discusses many implications of acting in a second-best environment.²⁸ In particular, he draws attention to the distributional role of public prices. Kolm (1971c, p. 15) writes:

Finally, the prices of public services can be used for the purpose of redistributing actual income, and hence well-being, in society, for example by requiring certain categories of users that one wants to favour to pay less. The traditional normative economist is opposed to this action: it would be better, he says, to implement this redistribution by direct transfers and to allow the beneficiaries to spend this money as they prefer rather than to subsidise their consumption of the service in question. This argument is very sound. But what happens if, in fact, the transfers are not made? Nothing justifies, then, not using the tariff for redistributive ends ...

Kolm was clearly considering as a postulate that lump-sum transfers simply do not exist. For example, Kolm (1971c, p. 73–74) writes:

But the argument offered against the use of prices for the end of distributive justice has a more serious defect. It is that the standard transfers and poll taxes proposed as an alternative simply do not exist. Indeed, these operations must be based on objective criteria. Yet, the properties that define them can be modified, with more or less ease, by the concerned individuals ...²⁹

Besides equity and justice considerations, Kolm (1971c, Chap. 3) explores in great detail the different costs of tariffs and public funds, including the macro-economic costs that would appear if the analysis was conducted in a non-Walrasian framework in which markets do not necessarily clear through prices.

While we have limited most of the preceding discussion to linear prices, we would like to stress that Kolm has also investigated more sophisticated pricing rules involving nonlinearities. Kolm (1969b) contains very important developments on

in the Arrow–Debreu model ... [e]quity 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 one admits 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.

Blackorby (1990, p. 748) 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.”

²⁸ In 1967, the “Rapport du Comité Interministériel des Entreprises Publiques” (known as the “Rapport Nora”) was published in France. It highlighted the importance of the deficits of the main French nationalised firms and generated considerable controversy among economists.

²⁹ Kolm (1971b, p. 399) also claims that:

When the theorists’ unrestricted interpersonal transfers do not exist, prices have a role in income distribution. In the real world, the distribution of taxes, which is the instrument of these transfers (with some subsidies) is limited, and prices remain the main way to distribute income.

the possibilities opened up by general nonlinear price schedules.³⁰ In this monograph, he derives many interesting results about the properties of optimal (with respect to some social objective) nonlinear price schedules under various sets of constraints. This monograph contains a general presentation of nonlinear tariff mechanisms. It identifies the difficulties raised by the fact that the customers' preferences are privately known, which are analysed in the last two chapters of Kolm's book.

In reference to the benchmark case in which informational matters are ignored—what he calls “l'optimum” (the optimum), Kolm (1969b, p. 14) writes: “But it does not often explicitly explain why the price in general has to be the same for the many users.”³¹ Under the heading “La communauté” (Society), Kolm (1969b, pp. 84–87) provides a very stimulating presentation of the constraints associated with these observability issues, and he derives the properties of the optimal solution when these constraints are incorporated. Kolm's formula characterising the optimal gap between the marginal price and marginal cost is nothing less than the formula found in any modern textbook on the optimal regulation of monopolies.³² Under the heading “discrimination,” Kolm refers to the various forms of price schedules that are observed, with special attention paid to the case of two-part tariffs. More importantly, he determinates how to optimally partition the population into groups, with

³⁰ Interestingly, on many occasions (e.g., Kolm 1971c, pp. 12–14), Kolm draws attention to the fact that first-order optimality requires that the marginal price and marginal cost be equal, but not that the marginal price be constant. He calls the units preceding the marginal one, “inframarginales” (infra-marginal). These units could be sold at a different price. He immediately infers from this observation that appropriately chosen nonlinear price schedules could reconcile optimality and budget balance. But Kolm also recognises, following this good piece of news, that the implementation of such schedules raises new costs. We reach the limit of marginal analysis when, as in the case of two-part tariffs, information about the preferences of the customers in addition to the marginal valuation—what he calls “valeur d'usage” (usage value)—is required for the computation of the fixed charge. This leads, then, to a risk of suboptimal exclusion that he calls “risque d'exclusion intempestive” (ill-timed risk of exclusion).

The possibility of differential pricing is a point that is also raised by some of the opponents to marginal cost pricing. The lack of consideration for this flexibility is listed among the eight “infirmities” of marginal cost pricing considered by Clemens (1963). Clemens (1963, p. 484) writes:

In my mind, the E.D.F. 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 . . .

³¹ Kolm (1969b, p. 48) also writes: “But all of this analysis assumes that each user can be subjected to an individualized price, and it does not explicitly take into account the costs of setting tariffs and the lack of perfect knowledge.”

³² See Kolm (1969b, p. 95). The computation of what Kolm (1969b, p. 98) calls the “forfait optimal” (optimal lump-sum payment) follows from what he has introduced under the name “droit d'abstention” (right of abstention), which is strictly similar to what is referred to today as a participation constraint.

a specific price schedule for each group.³³ Specifically, he decomposes the general problem into three nested problems:

1. “Le Problème de Complexité” (the complexity issue): How many groups?
2. “Le Problème d’Affectation” (the assignment issue): How are customers assigned to the groups?³⁴
3. “Le Problème de Communauté” (the society issue): How are optimal tariffs determined in each group?

Kolm’s work contains many important insights and uses advanced and sophisticated techniques. For example, he determines the qualitative features of the optimal price schedule when the number of distorted prices is a fixed exogenous finite number (this constraint being justified by the cost of administering the schedule). He provides a detailed study of the multiproduct case, incorporating constraints on prices reflecting the existence of secondary markets.³⁵ We were particularly strongly impressed by his treatment of the assignment problem as a linear programme with integer constraints. It is interesting to point out that in [Kolm \(1969b\)](#), in contrast to the books discussed earlier, the cost of public funds is introduced in a reduced form through a single parameter $1 + \lambda$, a practice completely adopted by most of the contemporary authors writing on the economics of regulation.

6 Asymmetric Information, Incentives, and Regulation

Kolm was also very interested in the theory of organisations and institutions. [Kolm \(1971c, p. 125\)](#) writes:

Economists have a lot to say about markets. However they are only one of the methods used by society to produce and distribute goods and services. Another is the organisation, both in public administration and within private enterprises, and it is used for many purposes other than purely economic. But about organisations economic theory says almost nothing. It was

³³ [Kolm \(1969b, p. 114\)](#) writes: “The price discrimination can be *between the users*, *between the contingencies*, between the variations of each parameter and in particular *between the units of each quantity* or the varieties of each quantity . . .”

³⁴ The discussion in [Kolm \(1969b, pp. 118–122\)](#) of the criteria to assign customers to groups is very insightful even if it is not formulated using the modern terminology of the theory of incentives. His distinction between “critère fondamental” (fundamental criterion) and “critère de reconnaissance” (recognition criterion) is very useful. [Kolm \(1969b, p. 121\)](#) writes:

The search for an “objective” criterion well correlated with willingness to pay is an old problem for private monopolies. Dupuit (when considering public monopoly) suggests that passengers on his bridge should be charged according to their occupation: for the same intensity of need the middle-class with hats should accept a higher price than workers with caps!

³⁵ His constraints can also be reinterpreted as no cross-subsidization constraints. A contemporary analysis of the set of prices meeting these conditions appears in [Faulhaber \(1975\)](#).

generally thought that this subject pertained to sociology rather than political economy. ... Everyone will agree, we think, that if one looks in this literature for tangible ideas that are not obvious, the yield is extremely poor. But one finds that the application of the economic *method* of analysis to the analysis of organisations is very fruitful ...

Kolm considered the economic theory of organisations as valid if it was able to explain why hierarchical organisations were frequently observed. He also paid a great deal of attention to the costs resulting from conflicts among the members of an organisation, and the necessity to build the appropriate incentives.

Kolm's analysis of information and incentives anticipates subsequent developments in the contemporary literature on the economics of regulation. We have introduced Kolm's distinction between the "incidence aval" and the "incidence amont" of the budget and have focused until now on the former. Kolm (1971c, Chap. 4) is, in our opinion, an extremely important and early contribution to the theory of organisations with its analysis of the agency costs arising as soon as several economic agents with rival interests interact through complicated (contractual) relationships. The lack of autonomy resulting from a budget deficit, or the limited authority of a supervisor on prices, outputs, investments, and other dimensions of the firm or administration, are central to the exploration of what he referred to as the upstream incidence. Kolm (1971c, pp. 79–80) writes:

If the Service has a **deficit**, it must be covered by a public budget. The political and administrative authorities who choose the latter must know the usage, estimate the utility, decide on the amounts and verify the use of these funds, and, if necessary, they should be able to impose compliance with the budgetary law. They must therefore exercise a supervisory right to command the Service (this may be the threat not to renew or to lower the subsidy next time). The result is, by comparison with a state of budget balance: (1) administrative costs for these decisions and financial and technical controls, (2) a loss of information due to the fact that decisions are taken by the administrative and political authority rather than by the Service which is generally better informed about the technical possibilities and the users' needs, (3) a potential gain of specialisation and economies of scale due to the realisation of certain tasks of financial withholding, budgetary and accounting choices made by a central or specialised administration rather than by the Service, (4) an increase in the conformity of the Service with the choices of Society expressed by political means, (5) a possible improved coordination with the situations and choices of other public Services, (6) a change in the behaviour of the managers of the Service by reducing their domain of choice, (7) a change in the behaviour of the managers of the Service by modifying their incentives, and in particular by the loss of the *direct* incentive to maximise [the budget surplus] because however negative it is, this deficit is covered by the public budget ...

While not formulated using modern terminology, this statement of the problem echoes in many respects what is now referred to as the mechanism design or principal-agent problem.³⁶ He sketches the various benefits, costs, and constraints

³⁶ Kolm offers a very stimulating discussion of the notions of centralisation and decentralisation, although he deplores the lack of accuracy in their definitions. Kolm (1971c, p. 82) writes:

To draw up the social balance sheet for the tariff it is necessary to estimate the gains and losses of this autonomy. Unfortunately, for this we cannot rely on a well-developed and well-known theory as we have done for market mechanisms because no such thing exists

involved in the hierarchical relationship between the central political and administrative authorities and the manager(s) of the Service. This chapter is devoted to an analysis of the issues attached to the principal-agent problem. Preliminary mathematical analyses for some of them are also included. We are not going to review the totality of this rich material, but instead we offer a brief selective discussion of a few of Kolm's key ideas and insights. These were pioneering ideas and they received a general formulation, as explained at the end of this section.

Interestingly, Kolm distinguishes between the costs of communication and organisation 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 organisation and the channels of communication between them. Kolm characterises the graphs that minimise the total cost of channels and messages, and then he analyses the costs of more or less foreseeable incentives. Kolm (1971c, pp. 89–90) writes:

Transfers of information and the organisation of work and power according to knowledge answers the problem of the members' *knowledge*. It remains to consider their desire to act: it is not sufficient that they know what to do, they must want to do it. . . .

To achieve its goals, an administration is driven by its members whose reasons for acting can be very different from that needed to fulfill this social function. In spite of this, to make their choices best serve this purpose is the problem of incentives.

Incentives have two *factors* and public incentives two *objectives*. The former are the *motivations* of individuals and the *conditions* in which they make decisions. The latter are *productive efficiency* and the best *service of the public* on the one hand and administrative and political *conformity* on the other hand.

After discussing in turn the meaning of these concepts, Kolm compares the respective performance of the three different organisational modes he calls "Gestion Commerciale," "Gestion Autonome," and "Gestion Administrative Intégrée" (Business Administration, Autonomous Administration, and Integrated Administration). These terms are not going to be precisely defined here. The first corresponds to the pure delegation of decisions to the private sector, while the third corresponds to an organisation receiving all of its instructions from some central administrative/political authority. The second lies somewhere in between the other two.

In his comparative analysis, Kolm clearly identifies the trade-off that is a cornerstone of the modern approach to organisation theory: the organisations that perform well in terms of cost optimisation and quality of service perform relatively poorly in terms of conformity to the social objectives of society. For example, when examining the third organisational form, Kolm (1971c, p. 100) argues that it is "*a priori* best when the utility of the service is revealed by political means." But Kolm (1971c, p. 100) also asserts:

for administrative organisations. We must therefore build our own tools. . . . [This] might seem like a digression but it is necessary to give a solid basis for a cost-benefit analysis of the degree of centralisation or decentralisation.

However, the productive efficiency of the Service and the satisfaction of its users require the best possible knowledge of its production function and of the characteristics of demand. But the members of the Service usually have an advantage here, sometimes considerable, over those of the central administration. Direct interference from the latter is therefore very likely to be harmful from this point of view. But the Service only uses its knowledge appropriately if there is an incentive to do so. Although uninformed about the precise actions that are best, the authority often has an excellent way of achieving this incentive: it is to sell the product and choose profit as an indicator of success, attaching penalties and rewards to its level. It suffices, in particular, that the latter are simply personal remunerations that are an increasing function of this profit, which brings us back to business or, possibly, autonomous management.

Kolm (1971c, Chap. 4, Appendix 3) is devoted to an analytical formulation of this trade-off. In Kolm's analysis, the cost of public funds $1 + \lambda$ stands for the agency cost, whereas the inefficiency costs resulting from poor incentives are captured by a single number that only appears when the organisation is fully integrated.³⁷ While insightful, this reduced form does not provide a complete understanding of the channels through which the incentives operate. A more complete analysis has recently been provided by the new economics of regulation, which was itself built on the solid bases established in the nineteen eighties by the theory of incentives and the economics of information.

We have insisted on the historical context in presenting the contributions of Kolm's French precursors to the derivation of the optimal rules for the management of public monopolies. 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 important developments in economic theory. In the nineteen eighties, we observed a renewed interest in the regulation of natural monopolies and oligopolies.³⁸ As noted by Laffont and Tirole (1993, p. xvii):

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 regulation is to a large extent the continuation of the practical and theoretical construction of its predecessors.³⁹ Among other things, the earlier lack of focus on incentive issues by regulatory theory was perceived as a serious limitation. As noted by Laffont and Tirole (1993, p. xvii, footnote added):

³⁷ The reader can refer to Stiglitz (1988, pp. 194–210) for a stimulating presentation of the arguments and evidence concerning the comparison of efficiency in the public and private sectors, as well as an analysis of the bureaucracy.

³⁸ See, for example, Spulber (1989).

³⁹ It should be pointed out that this theory mostly employs a partial equilibrium framework.

[T]he 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 practice.⁴⁰

The contemporary theory analyses regulation, in particular the regulation of natural monopolies, as the strategic outcome of an agency relationship. The legacy is however important and useful. Indeed, as [Laffont and Tirole \(1993\)](#) note:

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 refer to the normative aspects of natural monopoly pricing . . . (p. 19)

⁴⁰ We do not examine the “sociology” of these regulatory agencies. The French engineer-economists listed above as the precursors in this school were acting inside public firms for the general interest. There was no need for further regulation. Some of the pioneers expressed their scepticism about the social benefits to be expected from the new regulation. On electricity, [Boiteux \(2007, p. 6\)](#) writes:

The mandate received by EDF was, on the one hand to produce at minimum cost and, on the other hand, to sell at cost (“long-term marginal” as defined by experts) without trying to take advantage of its monopoly to exploit the customers. This virtuous behaviour, which now raises feelings of disbelief, did not seem implausible during the “Thirty Glorious Years” [i.e., 1945–1975] and of what were called “the senior officials of the State.” [The French text says “les grands commis de l’État,” which implies that these officials serve the general interest.]

With nostalgia and irony, [Boiteux \(2007, pp. 14–15\)](#) also alludes to the “disparition” (disappearance) in the political economy approach of the actors defined in the traditional normative approach of our textbooks to be benevolent social planners, corresponding here to the managers of the public firms, assumed indeed to be obedient civil servants instructed to follow marginal cost pricing rules:

To succeed in teaching the younger generations that the general interest, which is the interest of the class in power (and not the collective interest as defined by the class in power), by succeeding in explaining that anyone with power will not renounce using it for his own enrichment except in strict moderation when it is efficacious (instead of admitting that he will use it first to complete the mission entrusted to him), . . . by succeeding in all this, the nationalised enterprise is like a bird with a lead shot in its wing.

For, in such a context, why would the boss of an EDF which remains a nationalised monopoly bust his gut to reduce costs if he does not receive any benefit? . . .

If the kind of person that does not give in to such easy options no longer exists, it is necessary to draw the consequences. EDF, privatized, should be left free to earn—on a long-term basis—as much money as possible, within the limits of legality and the constraints imposed on it by a “regulator.” (However, either this regulator is competent and disinterested, and would thus be a person who is himself suitable to lead a still nationalised EDF, or he is incompetent and/or self interested, and this will pose some problems!)

Despite some headway ... on the pricing front ... [t]he 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. ... [A]symmetric 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 agendas, 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. (pp. 34–35)

Any description of this sequential strategic interaction calls for a very careful examination of the regulatory environment, which must be consistent with the firm's and regulator's 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 its preferred policy (whatever that may be).⁴¹ The nature of the regulatory instruments and incentive schemes that can be used by the regulator may also vary. Accounting and demand data are typically used to monitor a firm's performance. Accounting data consists mainly of a firm's aggregate cost or profit, while the demand data, on which contracts can most easily be based, consist of prices and quantities. It is then important to know the scope of possibilities available to the regulator. According to Laffont and Tirole, current incentive schemes can be analysed along two dimensions. The first is concerned with whether the government is allowed to subsidise (or tax) regulated firms; that is, whether regulated firms can receive public funds and cover all of their costs by directly charging their private customers. The second is concerned with the power of the incentive schemes, i.e., 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, Table 1, p. 11) offer a nice classification 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, Boiteux–Ramsey pricing, and marginal cost pricing and the criticisms formulated against its use by Coase and others (as discussed above).

⁴¹ See Laffont and Tirole (1993) for a more detailed exposition of the limits to efficiency resulting from these constraints.

Interestingly, they make a clear distinction between three criticisms, also formulated by Kolm (as previously argued): the implications of a deficit, the limits of marginal analysis, and the inappropriate incentives for cost reduction.⁴²

We now focus on the last point, referred to as “incidence amont” (upstream incidence) in Kolm’s terminology, as it is a key concern on the agenda of the new regulatory economics. It will allow us to show how Kolm’s intuitions have been explored and formulated within this new framework.

To do so, we need to depart from the assumption of an exogenous cost function C , as defined in (1). Instead, we suppose that C can be written as:

$$C = C(\beta, e, \mathbf{q}) + \varepsilon,$$

where, as before, $\mathbf{q} = (q_1, q_2, \dots, q_K) \in \mathbb{R}_+^K$ 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 representing either forecast errors or accounting inaccuracies. This specification of C corresponds to the controlled experiment in Laffont and Tirole (1993). 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:

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

We denote by $V(\mathbf{q})$ the social value associated with the production $\mathbf{q}$. For example, in the case of private goods, $V(\mathbf{q})$ is often assumed to be the sum of the net consumer surplus $S(\mathbf{q}) - R(\mathbf{q})$ (where $S(\mathbf{q})$ is the gross consumer surplus and $R(\mathbf{q})$ is the revenue of the firm) and the social value of tax savings $(1 + \lambda)R(\mathbf{q})$ (where λ is the shadow cost of public funds). The expected (utilitarian) social welfare is then:

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

This analytical framework captures most of the eight interactions that Kolm has listed in his approach to the upstream incidence. The regulator is assumed not to observe the variables β and e . Asymmetric information is thus two-dimensional because we simultaneously have adverse selection (lack of observability of the exogenous variable β) and moral hazard (lack of observability of the endogenous variable e). This corresponds to Channels 2 and 7 in Kolm’s list. From the regulator’s viewpoint, β is drawn from a cumulative distribution $F(\beta)$ on $[\underline{\beta}, \bar{\beta}]$ with density $f(\beta)$. The regulator observes C and $\mathbf{q}$ (or equivalently, prices $\mathbf{p} = (p_1, p_2, \dots, p_K)$). Note also that Kolm’s Channel 2 is also effective because W and U do not coincide.

⁴² More generally, it is important to determine how the internal structure of the firm affects the firm’s decisions. For example, the effect of rate-of-return regulation on input choices are analysed in the model of [Averch and Johnson \(1962\)](#).

The optimal regulatory policy is derived from the maximisation of W given the incentive and participation constraints.⁴³ The two fundamental equations that summarize the essence of such an optimal second-best policy are the following:

$$\begin{aligned} \psi'(e) = & -\frac{\partial C(\beta, e, \mathbf{q})}{\partial e} \\ & - \frac{\lambda}{1+\lambda} \frac{F(\beta)}{f(\beta)} \left[\psi''(e) \frac{\partial E(\beta, C, \mathbf{q})}{\partial \beta} + \psi'(e) \frac{\partial^2 E(\beta, C, \mathbf{q})}{\partial \beta \partial C} \frac{\partial C(\beta, e, \mathbf{q})}{\partial e} \right] \end{aligned} \quad (10)$$

and

$$\begin{aligned} \frac{\partial V(\mathbf{q})}{\partial q_k} = & (1+\lambda) \frac{\partial C(\beta, e, \mathbf{q})}{\partial q_k} \\ & + \lambda \frac{F(\beta)}{f(\beta)} \psi'(e) \frac{\partial}{\partial q_k} \left(\frac{\partial E(\beta, C, \mathbf{q})}{\partial \beta} \right), \quad k = 1, \dots, K, \end{aligned} \quad (11)$$

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 illustrates how this (second-best) management policy departs from the standard first-best optimality conditions. With symmetric information (i.e., when β and e are publically observable), (10) and (11) simply describe the equality between social costs and social benefits, where the social costs include a correction term if λ is different from 0.

The pricing dimension of the public policy has been our major concern in this article, so let us focus on (11) for the standard case of private goods with the assumption of linear prices. We assume that

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

Because

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

by letting $p_l(\cdot)$ denote the inverse demand function for good l , (11) can be rewritten as:

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

⁴³ This modern synthetic approach to the regulation of multiproduct natural monopolies is due to Laffont and Tirole (1990a,b).

or more compactly as:

$$L_k = R_k + I_k, \quad k = 1, \dots, K, \quad (12)$$

where

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

is commodity k 's [Lerner \(1934\)](#) index,

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

is commodity k 's [Ramsey \(1927\)](#) index, and

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

is commodity k 's incentive correction.

We see that the Lerner index L_k , which measures the optimal departure from marginal cost pricing of good k , is decomposed into two terms, a Ramsey index and good k 's incentive correction. This decomposition is enlightening because it isolates the budgetary issue from the incentive correction, and it identifies the parameters likely to shape the Lerner index with their respective effects.⁴⁴ This is, of course, a very significant advance with respect to the intuitions developed by Kolm because this general theory is structural and is constructed from basic primitives.

The decomposition in (12) yields another simple but important conclusion: incentives and the pricing of good k are disconnected if and only if $\frac{\partial}{\partial q_k} \left(\frac{\partial E(\beta, C, \mathbf{q})}{\partial \beta} \right) = 0$. Recall 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 if and only if $\frac{\partial}{\partial q_k} \left(\frac{\partial E(\beta, C, \mathbf{q})}{\partial \beta} \right) > 0$ or equivalently:

$$\frac{\partial}{\partial q_k} \left(\frac{\frac{\partial C(\beta, e, \mathbf{q})}{\partial \beta}}{\frac{\partial C(\beta, e, \mathbf{q})}{\partial e}} \right) > 0.⁴⁵$$

The situation where the incentive issue is solved exclusively through the appropriate design of the cost-reimbursement rule is called the “incentive-pricing dichotomy” by [Laffont and Tirole \(1993\)](#). In such environments, the incentive and pricing issues are separated, with a single task allocated to each instrument. This,

⁴⁴ As explained in [Laffont and Tirole \(1993\)](#), it also offers a new perspective on the definition of cross-subsidization.

⁴⁵ See [Laffont and Tirole \(1990a\)](#).

of course, implies that the cost functions exhibit specific functional structure, as demonstrated by Laffont and Tirole.

7 Conclusion

The framework adopted by Laffont and Tirole to formulate the new issues raised by the regulation of multiproduct natural monopolies extends the normative approach pioneered by Kolm and the French engineer-economists. It is more complicated than the framework adopted by their precursors because new constraints reflecting incentive constraints, lack of commitment, or political matters have been added to the optimisation problem. The optimal management rules derived in such second-best environments are precise, but are often derived in a partial equilibrium setting with specific assumptions on the primitives of the model. In contrast, the general second-best rules derived by Guesnerie (1995a) 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 situated somewhere between these two epochs. On the one hand, he continued on the road paved by his precursors, enlarging the scope of application of marginal cost pricing with an engineering flavour. On the other hand, he identified and formulated many of the limits of that “doctrine,” anticipating many of the developments that constitute the forefront of the contemporary approach to regulation. This article does not fully present the totality of the contributions to conventional public economics he made during this period. Obviously, his strong interest in normative and welfare economics motivated contributions in other parts of public economics including, among others, the theory of justice and its application to the determination of the optimal income tax, tax evasion, the theory of public goods, health economics, the value of human life, and cost-benefit analysis of public safety. We strongly believe that those issues that we have privileged in our exposition fairly represent his personal touch, and illustrate the connections to the interests of scholars before and after him.

To conclude, it is worthwhile to point out that, in addition to these contributions to public economics, Kolm was able to write, during the same period, several books and articles on the economics of the environment, monetary economics, macro-economics, and welfare economics. In addition to these academic and scientific activities, he also actively participated in many policy debates and published in the main French newspapers. Serge Kolm is a distinguished citizen and scientist.

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