General Equilibrium and Market Socialism: Clarifying the Logic of Competitive Markets*

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Abstract

We describe two versions of general equilibrium, each highlighting different features of the price system, the standard (Walrasian) version with its emphasis on the decentralization/information role of prices and another emphasizing what we call the appropriation/incentive role of competitive prices. Through their different implications for market socialism, we illustrate the differences between these two approaches to general equilibrium.

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1 Introduction

Since its inception, consensus has prevailed within general equilibrium theory. The line from Walras [1874, 1877] to Debreu [1959] and beyond has seen the gradual sloughing off of extraneous/erroneous details and accumulation of logical precision to provide a more comprehensive and translucent formulation of a vision found in Walras. Firmly rooted in a tradition widely regarded as the most mathematically mature, general equilibrium theory is one of the least controversial branches of economics. One may argue for or against its importance as a source of economic insight, but there is much less room for arguing about what general equilibrium theory is and what it has to say.

We do not share this view. Our position is not that there has been a misapprehension of the Walrasian tradition. Quite the contrary, we shall take pains to point out its grip on general equilibrium. Rather, we want to loosen its hold—to distinguish between general equilibrium and its Walrasian representation (WGE), and to offer something else instead. To summarize, we claim that there are two images of a price system and, while they are by no means mutually exclusive, WGE captures only one.

Ordinarily, to point out the limitations of a theory, it is useful to call attention to a discrepancy between its predictions and some empirical phenomenon. We shall want to do that here. Because general equilibrium theory is valuable as a conceptual tool with broad scope rather than an instrument with specific empirical content, contradictory empirical evidence is difficult to obtain. There was, however, one very important encounter between general equilibrium and an 'empirical application,' namely market socialism, where the 'predictions' based on WGE were not borne out by the facts.

In this essay, we critically examine the reciprocal influence between market socialism, most notably the work of Lange [1938] and Lerner [1944], and WGE. We shall argue that the Lange/Lerner attempt to graft WGE onto a socialist economy was a logically compatible coupling: market socialism fit the image of the price system emphasized by WGE remarkably well. Not only did the Walrasian model of competitive markets inspire market socialism, but in its encounter with market socialism important properties of the Walrasian tradition were highlighted, notably the decentralization/information role of prices.

But the connection between general equilibrium and market socialism might have been otherwise: if another image of the price system had been incorporated, the principles of general equilibrium *could have* demonstrated that market socialism was much more problematic than Lange and Lerner believed. In other words, through their different implications for market socialism, we shall illustrate the differences between the Walrasian and another image of the price system.

2 Features of Walrasian General Equilibrium

In describing WGE, we take care to separate the formal properties of the theory from those that, although crucial to its interpretation, can be logically dissociated from it. We highlight three features: (1) price-taking, (2) *tâtonnement*, and (3) the decentralization/information role of prices. Only the first is unambiguously a component of its axiomatization; the other two are extensions and interpretations of it. Together, the three formed the seed for market socialism.

2.1 Price-taking: Encapsulating the economy

Households and firms take prices as given, and an explanation as to why they do is not a part of the *formal* theory. When justification is called for, appeal is made to background conditions not explicitly part of the theory. The most commonly invoked of these conditions is large numbers of buyers and sellers. Upon closer inspection, large numbers is supplemented by the assumption that the commodities traded are homogeneous rather than idiosyncratic and personalized—to rule out monopolistic competition. This leads to *thick markets* as the background condition from which the price-taking hypothesis is seen to follow.

The starting point for a general equilibrium model is the 'basic data' of the economy, listing the characteristics of the individual agents—their tastes, endowments, production possibilities, and ownership shares of firms. Without distinguishing between households or firms, call v_i the characteristics of agent i. The economy is then given by $\mathcal{E} = \{(v_i)\}$. Price-taking is called upon to define the utility- or profit-maximizing response $v_i \mapsto \phi_i(p)$, the vector (or set of vectors) of commodities that the price-taking maximizer with characteristics v_i would choose if the price vector were p.

The main consequence of price-taking is that it leads to the *encapsulation* of the basic data of the economy by demand and supply functions, i.e., as far as competitive analysis is concerned, $\mathcal{E} = \{(v_i)\}$ is effectively replaced by the reduced form $\{(\phi_i(\cdot)\}$. Even more succinctly, an equilibrium of $\mathcal{E}$ is a p for which $0 \in \sum \phi_i(p)$.

Encapsulation is a brilliant device. If the aim of general equilibrium is to provide a theory of relative prices in a thick markets environment, encapsulation is an efficient way of translating the basic data into an immediately usable form. Indeed, encapsulation is so compelling as to appear to be inevitable, as is the statement "the reduction of $\mathcal{E} = \{(v_i)\}$ to $\{(\phi_i)\}$ is necessary for describing/defining competitive general equilibrium." There are formal tricks one can use to pin-point the zero of the aggregate excess demand function without using demand functions at all, e.g., Arrow and Hahn [1971, p. 114]; nevertheless, these devices are not taken as serious

alternatives to Walrasian encapsulation.

Before going on we call attention to the fact that neither Jevons [1879] nor Edgeworth [1881] used Walras' method of encapsulation to define equilibrium. Jevons used the notion of arbitrage plus the first-order calculus conditions for a utility maximizer to define equilibrium in a simple setting with two commodities and two types of individuals. His efforts have been criticized as incomplete because he did not follow Walras' method of demand-and-supply/encapsulation in formulating general equilibrium. Edgeworth, formalizing some of Jevons' insights, made a very conscious effort to avoid encapsulation because he regarded it as begging the question of how and why individuals would be price-takers. Edgeworth used the more primitive notion of contract and recontract, now known as the core, as his way of showing how competitive equilibrium would arise when markets are thick. Makowski and Ostroy [1991b] follow yet another approach to arrive at competitive equilibrium without Walras' method of demand-and-supply. This will be discussed briefly in the concluding section; like Edgeworth, we utilize some of Jevons' insights, but in a somewhat different way.

2.2 Tâtonnement: Price-taking away from equilibrium

Even though the definition of Walrasian equilibrium is only a statement about a zero of the aggregate excess demand function, the overwhelming weight of the Walrasian tradition has been to see the economy $\mathcal{E}$ through its encapsulation $\{(\phi_i)\}$. Once demand-and-supply is taken as the 'practical starting point' for general equilibrium, price-taking takes on a life of its own as the behavioral rule describing the actions of a perfect competitor both in *and out of* equilibrium. Nowhere is this more evident than in the focus on *tâtonnement*.

For Walras, *tâtonnement* was the (erroneously constructed) method of proof to demonstrate the existence of equilibrium. Whether Walras intended *tâtonnement* to be only a hypothetical adjustment process to demonstrate existence or whether he also thought of it as showing how markets actually came into equilibrium is not always clear.[1] What is clear, however, is that *tâtonnement* fits the analytical perspective in which the basic data of the economy are encapsulated *before* describing either competitive equilibrium or the way the economy arrives at equilibrium.

To illustrate the extent to which encapsulation of $\mathcal{E}$ by $\{(\phi_i)\}$ is taken as the effective starting point for WGE, consider the following remarks by Arrow [1959] about *tâtonnement*:

> In this essay, it is argued that there exists a logical gap in the usual formulations of the theory of the perfectly competitive economy, namely,

[1]See Jaffé, "Another Look at Leon Walras's Theory of *Tâtonnement*," in Walker [1983].

> that there is no place for a rational decision with respect to prices as there is with respect to quantities. ...
>
> The standard development of the theory of behavior under competitive conditions has made both sides of any market take the prices as given by some outside agency. ....
>
> Each individual participant in the economy is supposed to take prices as given and determine his choices as to purchases and sales accordingly; there is no one left over whose job it is to make a decision on price. (pp. 41-43)

These statements testify to the fact that encapsulation is taken for granted in the description of a perfectly competitive economy.

2.3 The decentralization/information role of prices

Encapsulation of $\mathcal{E} = \{(v_i)\}$ by $\{(\phi_i)\}$ is not only a brilliant device for describing competitive equilibrium, it is also a remarkable phenomenon in itself with implications for market efficiency. But it was not until the debates about market socialism that its significance was clearly appreciated.

Encapsulation permits the reduction of $\{(v_i)\}$ to $\{(\phi_i)\}$, and from this we can hope to find a p such that $0 \in \sum \phi_i(p)$. Because equilibrium is given in encapsulated form, whereas efficiency is defined with respect to $\{(v_i)\}$, its efficiency properties are not immediately apparent. Efficiency requires *de*-encapsulation, i.e., the reverse operation going from $(z_i \in \phi_i(p))$ to comparisons with other allocations in the economy in terms of the basic data $\mathcal{E}$.

A remarkable implication of de-encapsulation is:

(1) an equilibrium allocation is efficient in the Pareto sense.

Loosely speaking, the result supports the Invisible Hand notion that perfect competition encourages self-seeking agents efficiently to exploit their economic possibilities.

The reduction of $\mathcal{E}$ to $\{(\phi_i)\}$ is based on a specific pattern of ownership/property rights. It was well-understood that the concept of efficiency is not specific to an economy with private property. "A collectivist society of any type would necessarily confront the same economic problems, in the formal sense, as an individualistic one.... For the principles of marginalism are the logical, mathematical, and hence universal, principles of economy...." (Knight [1936], pp. 255-256).

For market socialism, it was essential to know the limits of the relation between encapsulation and efficiency, e.g., is encapsulation compatible with efficiency only for

the given ownership rights? The more general study of efficiency in an institution-free setting requires modification as to what constitutes the 'basic data' of the economy. In $\mathcal{E}$ the characteristics of agents, their tastes and technologies, are lumped together with legal/ownership restrictions. Following Debreu, denote the basic data of the economy *before* legal restrictions have been imposed as $E = \{(\nu_i), \omega\}$, where ν_i represents tastes and inalienable productive characteristics of a household or the technology of a firm and ω represents aggregate supplies of alienable commodities. It is in the form E that Pareto-efficiency is expressed.

From the contributions of many including Pareto, Barone, Lange, Lerner, Koopmans, Arrow, Debreu and others, we know that the relation between pricing and efficiency is not tied to a particular pattern of ownership. To relate pricing to the more general concept of efficiency in E, an alternative method of encapsulation may be used. If i is a household, let $\phi_i^{\alpha_i}(p)$ be the price-taking response of a utility-maximizing household whose budget constraint is defined by the parameter α_i; and if i is a firm, let $\phi_i^{\alpha_i}(p) \equiv \phi_i(p)$ be its profit-maximizing response. To elaborate, for the household the resource endowments and ownership shares of firms used to defined a household's budget constraint in $\mathcal{E}$ is replaced by the budget constraint $\{z_i : pz_i = \alpha_i\}$, where the sum over households of the α_i equals $p\omega$ plus the value of firms' production.

Under certain convexity qualifications, the following states that with this more general method, encapsulation can be regarded as the canonical means of establishing efficiency.

(2) By varying $\{(\alpha_i)\}$, any efficient allocation in E can be achieved as an equilibrium of the economy encapsulated as $\{(\phi_i^{\alpha_i})\}$.

Results (1) and (2) are sometimes referred to as the First and Second Theorems of Welfare Economics. They point to a remarkable duality: Hidden beneath efficient allocations are efficiency prices; and if agents act as price-taking maximizers based on the information regarding relative social marginal valuations in efficiency prices, an efficient allocation of resources will result. This duality inspired Lange and Lerner: Let agents simply act as price-takers and the economic problem can be efficiently and decentrally solved. Resources will automatically flow to their highest valued uses. Note well that this holds whether or not agents possess monopoly power, provided they follow the price-taking, maximizing *Rule*.[2]

[2]This was one of the key insights of the market socialists: "On a competitive market the parametric function of prices results from the number of competing individuals being too large to enable any one to influence prices by his own action. In a socialist economy, production and ownership of the productive resources outside of labor being centralized, the managers certainly can and do influence prices by their decisions. Therefore, the parametric function of prices must be imposed on them by the Central Planning Board as an *accounting rule*" (Lange [1938], pp. 80-81).

Refining this remarkable duality is one of the notable achievements of WGE. We have already observed that both Lange and Lerner made important contributions toward the final synthesis. Other notable benchmarks along the way were, first, the developments in linear and non-linear programming, with their emphasis on shadow prices; and, subsequently, the application of convex analysis and the separation theorem.

Observe that in the spirit of encapsulation, efficiency prices are given exogenously by a 'Walrasian auctioneer' or some 'central planning board'. There may be a communication process between the center and the agents 'on the spot' required to discover the market clearing prices; but it is assumed that agents will cooperate with the price-setting agency, not try to willfully distort the latter's collected information (i.e., not try to exercise monopoly power in influencing the final announced prices). In the modern jargon, the incentive/revelation issues are ignored. This is the point we now want to take up.

Summarizing, the first image of the price system is that prices are efficiency prices; they reflect the social valuations of the last infinitesimal unit of each type of resource.

3 Where do prices come from?: An alternative image of the price system

Let us now try to penetrate beneath the price-taking veil.

It is an old and seminal idea in economics, dating back at least to Adam Smith's times, that perfect competition between economic agents will lead to the emergence of prices and price-taking behavior, which will lead to efficient trading. Schematically:

$$\text{perfect competition} \longrightarrow \text{the competitive price system} \longrightarrow \text{efficiency.}$$

In this schema, "perfect competition" does not refer to *passive* price-taking, but rather to the *active* rivalry between economic agents which determines Walrasian prices and which is so severe that no economic agent can effect the levels of these prices (i.e., as a synonym for the absence of monopoly power). To avoid confusion, in this essay we will always use the term "perfect competition" to denote the active sense of the word.

Define a Perfectly Competitive Equilibrium (PCE) as a price-taking equilibrium in which—because the force of competition is so strong—each agent *actually* cannot influence market-clearing prices by altering his demands or supplies. Schematically:

$$\text{PCE} = \text{WE} + \text{PED},$$

where WE stands for a Walrasian (price-taking) equilibrium and PED stands for perfectly elastic demands and supplies. Evidently a PCE is not just a price-taking equilibrium; e.g., under text-book conditions the latter can be illustrated in an Edgeworth Box (two-person, pure exchange) economy, provided the two individuals passively follow the price-taking *Rule*. But an Edgeworth Box equilibrium is not a PCE: either individual, by altering his demands or supplies (e.g., misrepresenting his preferences), could influence market clearing prices. The example illustrates that the price system in a PCE is not just an efficiency price system, but something more.

For several years now, we have been investigating the nature of a PCE. We have discovered that a PCE allocation is one in which each agent *fully appropriates* his contribution to society (Ostroy [1980], Makowski [1980a]). Now the idea of full appropriation is familiar from the image of a perfectly discriminating monopolist: he fully appropriates the contribution of his production via the high prices he demands for his goods. But the view that a perfect competitor is also a full appropriator takes us into an unfamiliar terrain. Here is the intuition: We are familiar with the idea that a perfect competitor is someone who has no remaining bargaining/monopoly power because all his trading partners have *perfect substitutes* relative to trading with him. But what does the availability of perfect substitutes mean, viewed in general equilibrium terms? It must mean that the perfect competitor has fully appropriated his contribution to his trading partners relative to their outside options, because if he did not fully appropriate then they would be strictly worse off if they were forced to trade without him (contradicting the availability of a perfect substitute for him). Alternatively expressed, in terms of the nature of PCE prices rather than PCE allocations, under perfect competition *the price system is the means for rewarding every agent with his full social contribution.* Suggestively, call an agent's full social contribution his social marginal product (MP); then perfectly competitive equilibrium prices are not just efficiency prices but *marginal product (MP) prices*, in the sense that they are the means for rewarding everyone with his social marginal product.

An example will help fix ideas. We know that in any price-taking equilibrium, each worker's real wage will equal the marginal product of the last infinitesimal unit of labor he supplies. But if firms' production functions exhibit strictly decreasing returns to labor and a worker's total labor supply is large, then his total labor income will be strictly less than the total product of his labor (his inframarginal units of labor generate some profits for the firm in which he works). That is, efficiency prices will reward the worker who is supplying a large mass of labor and who is passively following the price-taking *Rule*, with strictly less than his social marginal product. Notice in this example the worker actually has some monopoly power although he does not exert it: if the large worker reduced his total labor supply—violating the *Rule*—then the equilibrium wages would rise since the marginal product of the last infinitesimal unit supplied would rise. Contrast this to a perfectly competitive worker, whose labor

supply is small relative to the market supply of labor, essentially infinitesimal. Now we can identify the MP of the last infinitesimal unit of labor that he supplies with *his* MP; i.e. under perfect competition, prices are not just efficiency prices but MP prices.

In what sort of environments will PCE exist? From the example, models with a nonatomic continuum of agents—where agents are automatically infinitesimal—are the natural candidate environments: when the number of commodities traded is not too 'large', PCE will typically exist in such environments. But more surprisingly, there are also interesting examples of PCE in economies with a finite number of agents (e.g., perfectly competitive double auctions are discussed in Makowski and Ostroy [1987]).

Profits also have a meaning in a PCE: A firm's profits exactly measure that firm's social contribution. The intuition goes as follows. Recall a firm's profits are the difference between its total revenue and total cost. Now in a PCE, a perfectly competitive firm charges such a high price for its output that it fully appropriates the social value of its production (otherwise its customers would not have a perfect substitute relative to buying from it), and its total costs measure the opportunity cost of its resources employed (e.g., its real wage payments measure the total product that its workers could produce elsewhere); hence the difference between its total revenue and total cost just measures its social contribution (net of the resources it uses). Thus, for example, zero profits means a zero MP for the firm: the value of its output just equals the social opportunity cost of its resources. More generally, the size of the firm's profits measure the extent that the social value of its output exceeds the social opportunity cost of the resources it has utilized.

By contrast, in a price-taking equilibrium, a firm's equilibrium profits need not reflect its social contribution. For example, consider an industry with a single firm having a constant returns to scale technology. If the firm follows the profit-maximizing *Rule* then it will earn zero profits. (This follows from constant returns plus the fact that the contribution of the last infinitesimal unit supplied by a price-taking firm just equals the social opportunity cost of the resources it utilizes to produce the last unit). But if the firm is the sole potential producer in this industry, the social losses may be very substantial in the absence of its production, i.e., the MP of its production may be very large (e.g., consider Edwin Land and the potential loss of welfare in the absence of polaroid cameras). Observe that as in the labor example, the price-taking firm in this example has monopoly power, although it refrains from exerting it: by violating the *Rule*, it could increase its profits to a sizable figure by artificially restricting supply and hence increasing the marginal valuation of its output.

Summarizing, the second image of the price system is that it is the means for rewarding all agents, including all firms, with their social marginal products. This

image only characterizes the price system that would emerge under perfect competition; it is not just the image of an efficiency price system. We shall see that MP prices—as opposed to merely efficiency prices,—have remarkable incentive properties.

4 The issue of incentives in general equilibrium

From the work of Pigou, we are familiar with the intuitive idea that giving people their marginal products is good for incentives since it leads to no divergence between private benefits and social contributions. Pigou applied the idea mainly to the commodity margin, that is, the margin emphasized by efficiency prices: the last infinitesimal unit of a commodity supplied or demanded. But the intuition also extends to the individual *agent* margin—viewing the whole agent, with his entire vector of demands and supplies, as the marginal unit added to the economy. To use a familiar illustration, we sometimes casually refer to the good incentives for resource allocation that would result from rewarding each *worker* with his full social marginal product in each possible employment: Given this menu of possible rewards, by choosing to work at the job that maximizes his private utility, the worker will automatically choose the socially efficient employment. Now change the context slightly and imagine a worker who can either truthfully or untruthfully represent his preferences over jobs; if he knows that he will always be rewarded with his MP, no matter what job preferences he announces, then he will have the right incentives for revealing his preferences truthfully. The two variants are really two sides of one coin: in the jargon of mechanism design theory, the former is an indirect (do-it-yourself) mechanism for allocating people to jobs, corresponding to the latter direct revelation mechanism for solving the allocation problem.

To give a second illustration, imagine an entrepreneur who can innovate one (and only one) of two possible products. If the entrepreneur can appropriate the full social benefit of either product—i.e., if he is a perfectly competitive innovator,—then he will of his own accord choose the socially efficient innovation. The intuition why may be expressed in Pigovian terms: the social optimization problem—maximize the gains from trade—becomes the entrepreneur's private maximization problem—maximize profits. There is no divergence between his private benefits and his social contribution. The moral is that rewarding firms with their MPs, no matter what course of action they undertake, gives good incentives for innovation. [The pioneering paper on the possibility of perfect competition with innovation is Hart [1979]; see also Hart [1980], Makowski [1980a]. The implications of the idea for the First Theorem of Welfare Economics are discussed in Makowski and Ostroy [1991a]; we will return to this in the Conclusion.]

We have jumped a bit ahead in our story. These observations need to be placed

into historical context. The great historical example showing why the decentralization/information role of prices needs to be supplemented by the appropriation/incentive role is the debate on market socialism. Indeed, the research on mechanism design that sensitized economists to the importance of incentives grew out of this debate.

5 Market Socialism as an extension of WGE

The purpose of this section is to point out the logical affinities between WGE and market socialism. Our position is that market socialists took the Walrasian method of encapsulation rather literally.

Although market socialists took a bold step beyond, Walras may have been the pioneer. According to the authority of Jaffé, "No one has better characterized the true nature of Walras' original accomplishment than Walras himself when he jotted down on a scrap of paper in his archives: 'I am not an economist. I am an architect. But I know political economy better than the economists do' " (Walker [1983], pp. 78-79). Summarizing Walras' intentions with respect to his *Elements of Pure Economics*, Jaffé says:

> The *Elements* was consequently designed, not as a "study of men as they live and move and think in the ordinary business of life" (Marshall), but as a theoretical representation of a just economy from the standpoint of "commutative justice"; "distributive justice" called for separate treatments in the *Etudes d'economie sociale*. (Walker [1983], p. 348)

Gaps between commutative and distributive justice are due to the distribution of property.[3] Lange, Lerner and others took the idea one step further, but in a direction towards which Walras was already pointing. We have no idea whether Walras would have approved of the extension, but it was carried out in large part to achieve distributive justice.

Market socialism arose as an effort to reconcile a view such as Mises', that without prices and markets a socialist economy would lead to chaos, with the opposite view that in a socialist economy they would be unnecessary. In an early article by Lerner [1934], the author acknowledges the critical role that prices and markets perform. To illustrate, he quotes Trotsky:

> If there existed the universal mind that projected itself into the scientific fancy of Laplace; a mind that would register simultaneously all the

[3]It is certainly true that in comparison to Jevons and Menger, Walras' motivation is distinctive, but it is not so different from that of J. B. Clark who was not such a system builder, or believer in the mathematical method.

> processes of nature and of society, that could measure the dynamics of their motion, that could forecast the results of their inter-reactions, such a mind, of course, could *a priori* draw up a faultless and an exhaustive economic plan, beginning with the number of hectares of wheat and down to the last button for a vest. In truth, the bureaucracy often conceives that just such a mind is at its disposal; this is why it so easily frees itself from the control of the market and of Soviet democracy.
>
> Economic accounting is unthinkable without market relations. (pp. 58-59)

The following is a summary of Lerner's *Economics of Control* [1944] showing how price-taking could be used to mimic the behavior of markets. A necessary condition for efficiency is: "The optimum division of a factor among different uses implies that the value of its marginal product is not less than the value of any alternative marginal product." But, "To bring this about in any real society involves an infinitely complex problem." (Here, Lerner again refers to the quotation above.) However, "It can be solved with the help of the price mechanism and a simple *Rule* that must be followed by the managers of every production unit. ... The *Rule* is: If the value of the marginal (physical) product of any factor is greater than the price of the factor, increase output. If it is less, decrease output. If it is equal to the price of the factor continue producing at the same rate. (For then the right output has been reached)" (pp. 59-64). The *Rule*, of course, comes from the first-order conditions for profit-maximization by a price-taker.

The remarkable role of prices in permitting such a complex problem to be efficiently solved in a decentralized manner is elaborated further:

> The simple *Rule* carried out by each manager in his own plant, with no knowledge whatever of values of marginal products anywhere except in his own plant, will bring about the optimum division of each factor between the production of different goods.
>
> This does not mean that there is nothing for the Ministry of Economic Planning to do. It means only that the Ministry should not try to concern itself with details that can much better be attended to by the manager on the spot if the appropriate rules are provided for him in conjunction with the pricing mechanism. (p. 64)

Lange [1938] called his proposal for market socialism the Competitive Solution, and to the extent that the price-taking hypothesis is synonymous with competitive behavior, the terminology is justified. While there is a question as to whether Walras thought of *tâtonnement* as the way competitive markets actually came into equilibrium or as a hypothetical algorithm to find market-clearing prices, for Lange and

Lerner there is no doubt; *tâtonnement* was to be literally applied. A key function of the Central Planning Board would be to make adjustments in prices in response to excess demands. Indeed, this form of communication among price-taking households and firms with the CPB acting as the Walrasian Auctioneer is precisely the way in which market socialism exploits the decentralization role of prices.

The lesson is that *if* individuals follow price-based rules—if behavior can be encapsulated—and *if tâtonnement* 'works', market socialism can lead to efficient resource allocation.[4]

6 Hayek's critique of market socialism

Hayek was the most prominent critic of market socialism. He devoted several essays to this effort (see Hayek [1935], [1948]), but we shall concentrate on the most frequently cited of these contributions, "The Use of Knowledge in Society" (Hayek [1945]). We shall argue that despite the clarity and power of his argument, there was an important sense in which his critique missed its mark. Ironically, his argument was flawed by the same over-emphasis on the decentralization role of prices to the exclusion of their appropriation origins that characterizes WGE and market socialism.

The point of departure for Hayek's critique is:

> The economic problem of society is thus not merely a problem of how to allocate "given" resources—if "given" is taken to mean given to a single mind which deliberately solves the problem set by these "data." It is rather how to secure the best use of resources known to any members of the society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge which is not given to anyone in its totality. (pp. 519-520)

Whereas market socialists recognized and even seemed to embrace this problem in order to show that the decentralization role of prices could be abstracted from a private enterprise economy, Hayek appeared either to ignore or dismiss their claims. Referring to the issue of divided knowledge, "This character of the fundamental problem has, I am afraid, been rather obscured than illuminated by many of the recent refinements of economic theory, particularly by many of the uses made of mathematics." (p. 520).

[4]Here is a good place to illustrate the reciprocal influence between market socialism and WGE. Lange's [1938] articulation of the use of prices in an iterative and decentralized resource allocation procedure (a *tâtonnement*) was subsequently formalized by Arrow and Hurwicz [1960].

Hayek makes a distinction between different kinds of knowledge, the scientific knowledge in the hands of experts and the detailed, mundane knowledge of 'time and place' involved in countless economic decisions. Both are required, but Hayek claims that the importance of the latter has been ignored by those who advocate planning. On the surface at least, it is difficult to accept his characterization of market socialists. For example, Lerner's emphasis on the importance of leaving the operation of the *Rule* to the plant manager (to 'the manager on the spot') rather than the Ministry of Production would seem to indicate awareness of the importance of time and place.

It might be argued that while market socialists saw the need for decentralization of decision-making, they did not recognize the full extent of the problem. For example, recall that the Walrasian model is typically regarded as applying to a thick markets environment with possibly many but nevertheless standardized commodities. If we focus on the myriad of choices with respect to time and place involved in manufacturing even a standardized commodity and think of these as different commodities, this would seem to place an unrealistic burden on the pricing authority. Indeed, one could begin to argue that the 'real' set of commodities is so specialized and detailed that it would contradict the existence of divided knowledge for the Ministry of Production to know which prices to announce.[5]

However, when Hayek gives an example to illustrate the function of the price system that he claims is being ignored, there is little to distinguish it from something market socialists might have used. "Assume that somewhere in the world a new opportunity for the use of some raw material, say, tin, has arisen, or that one of the sources of supply of tin has been eliminated. It does not matter for our purpose—and it is significant that it does not matter—which of the two causes made the tin more scarce. ... The mere fact that there is one price for any commodity—or rather that local prices are connected in a manner determined by the cost of transport, etc.—brings about the solution which (it is just conceptually possible) might have been arrived at by one single mind possessing all the information which is in fact dispersed among all the people involved in the process ." (p. 526).

Read today, what is striking about Hayek's essay is the absence of any emphasis on incentives. Nevertheless, one may be tempted to say that even if the words are not there, the incentive issue should be 'understood.' To indicate that this is not the case and that Hayek's argument does require bolstering, consider an extract from a more recent commentary on market socialism by Friedman [1981]. Speaking of the functions that prices serve in a market economy, the author says:

> Fundamentally prices serve three functions in such a society. First, they

[5]John Roemer points out to us that Hayek did take the argument in this direction in his 1940 *Economica* article, "Socialist Calculation: the Competitive 'Solution'" (reprinted in Hayek [1948]).

> transmit information. ... The crucial importance of this function tended to be neglected until Frederich Hayek published his great article .... This function is essential, however, for enabling economic activity to be coordinated. .... A second function that prices perform is to provide an incentive for people to adopt the least costly methods of production and to use available resources for the most highly valued uses. They perform that function because of their third function, which is to determine who gets what and how much—the distribution of income. (pp. 7-8)

The latter two functions may be readily joined and the author's position can be summarized as: besides the decentralization role, prices also serve an appropriation function.

Friedman's critique of market socialism differs from that of Hayek. "If what a person gets for his activity does not depend in any way on what he does, if prices do not serve this third function of distributing income, then there is no reason for him to worry about the information that prices are transmitting, and there is no incentive for him to act in accordance with that information" (p. 8). In other words, once the alternative functions of the price mechanism are presented so that they can be logically separated, it becomes apparent that market socialism could exploit the pure decentralization role of prices. Where it breaks down is in exploiting the appropriation role.

7 A mechanism design critique of market socialism and WGE

Mechanism design is a new and important chapter in economics that grew out of the market socialism debate. Since either competitive markets or market socialism could 'theoretically' achieve an efficient allocation of resources under appropriate circumstances, economists boldly abstracted from real-world institutions and investigated whether they could design allocation mechanisms superior to the market mechanism for environments in which the latter was known to perform poorly (e.g., when there is monopoly power, externalities, public goods, or increasing returns). Inspired by Hayek's emphasis as well as that of Lange and Lerner's on the importance of decentralized knowledge, it was taken as axiomatic that a good mechanism should be *informationally decentralized* in the sense of Hurwicz [1960], i.e., each agent should be able to optimize without knowledge of others' tastes or production possibilities.

One of the pioneers in mechanism design, a brief description of Hurwicz's research strategy helps to link our previous discussion to what follows. Initially, Hurwicz focused exclusively on

(i) the information/communication requirements of mechanisms.

For example, could one formally verify Lange and Lerner's informal claim that price-guided mechanisms are informationally more economical than quantity-prescribing mechanisms? The analysis was undertaken without any consideration of

(ii) the incentive properties of mechanisms.

That is, strategic considerations (leading agents to perhaps misrepresent their private information to the center) were ignored. Then, around 1970, the issue of incentives surfaced forcefully, as if a pair of blinders were removed. The term 'incentive compatibility' was coined by Hurwicz in [1972]. Thereafter, incentives took the foreground in the literature on mechanism design. Indeed, for tractability (and perhaps to clarify the distinctions between them) the incentive properties of alternative mechanisms, (ii), typically were analyzed without any consideration of the costs of communication, (i)—reversing the initial trend. The key problem became that of designing mechanisms that would *elicit* accurate/truthful information no matter how cumbersome that actually might be. Anticipating, the distinction between (i) and (ii) corresponds to that between the decentralization and appropriation roles of prices.

Consider Hayek's essay in light of this division. The words Hayek used stressed the communication role of the price system, i.e., (i). But if one focuses on (i) and thus ignores strategic/incentives issues, one can rely, for example, on plant managers following Lerner's *Rule*. Failing to emphasize incentives as he did and concentrating on the problem of communication, Hayek should have arrived at a conclusion much closer to market socialism than he did. Of course it could be pointed out that whereas the division between (i) and (ii) may be analytically useful, it is clearly artificial—any mechanism is a composite of (i) and (ii). If, as it seems to us, Hayek did not recognize the need to separate these two functions (equivalently, to separate communication of information from elicitation of information), his critique of market socialism is 'fuzzy': How much of it depends on (ii) rather than (i)? Friedman's comments suggest that the answer is 'alot.'

The point of view of mechanism design theory, phase (ii), is nicely summarized by Roger Myerson [1989, p. 191]: "The basic insight of mechanism theory is that *incentive constraints* should be considered coequally with *resource constraints* in the formulation of the economic problem. In situations where individuals' private information and actions are difficult to monitor, the need to give people an incentive to share information and exert effort may impose constraints on economic systems just as much as the limited availability of raw materials."

It is phase (ii) of mechanism theory that helped claify the logic of competitive markets. What are the properties of mechanisms that will efficiently utilize resources

and *also* elicit the requisite information to do so? Vickrey [1961] made a key breakthrough. Inspired by Lerner's somewhat vague suggestion in the *Economics of Control* that "when markets are imperfectly competitive, a state agency through 'counterspeculation', might be a able to create the conditions whereby the marginal conditions for efficient resource allocation could be maintained" (Vickrey [1961], p. 8), Vickrey designed an incentive compatible mechanism that indeed could lead to efficiency even in the presence of monopoly power. There was only one drawback: Vickrey's mechanism typically needs outside funding to give the agents with monopoly power good incentives to reveal their private information. Subsequently, Clarke [1971] and Groves [1973] extended the Vickrey mechanism to allow for efficient resource allocation in the presence of public goods and externalities—again with the same drawback: typically there is an absence of budget balancing.

A second result showed the fundamental nature of the family of Vickrey-Clarke-Groves (VCG) mechanisms:

- *any* mechanism that is efficient and incentive compatible must be in the VCG family.

(Green and Laffont [1976], Walker [1978], Holmström [1979]).

At first viewing, the VCG family of mechanisms seems to have little to do with markets or prices. The formulation is in terms of quantities and highly non-linear reward schemes. Indeed, the mechanism designer views himself as far away from the market mechanism: Recall, these mechanisms were intended to efficiently allocate resources in cases when the market tended to perform poorly. But there was a surprising confluence.

We had been working on perfect competition theory, and intuitively—from the full appropriation characterization of PCE discussed in section 3, above—we understood that perfect competition was very good for incentives. When we tried to formalize our understanding, naturally we turned to the tools of mechanism design theory. Surprisingly, we found that VCG mechanisms work precisely because they reward all individuals with their MPs. That is, *they mimic the reward scheme that characterizes the perfectly competitive market!* We also found that the distinguishing feature of a perfectly competitive (market) mechanism, relative to VCG mechanisms applied to non-perfectly competitive environments, is that

- the perfectly competitive mechanism is the only VCG mechanism that is budget balancing and also individually rational[6]

(Makowski and Ostroy [1987]). So, rather ironically, mechanism design theory had unwittingly come full circle. In searching for mechanisms that could improve on

[6]I.e., it satisfies a voluntary participation constraint.

the market, it had unknowingly returned to and clarified the incentive principles underlying competitive markets!

NOTE: All mechanisms in the VCG family reward everyone with their MPs, plus or minus a lump sum transfer. (That is, efficient and incentive compatible mechanisms are unique up to a lump sum.) The perfectly competitive mechanism is the special member of this class in which the lump sums are all zero: recall from section 3, in a PCE everyone is rewarded with exactly their MP. In some very special, non-perfectly competitive environments one can implement a VCG mechanism. That is, one can find feasible lump sum transfers that generate enough revenue to reward everyone with his MP. Alternatively expressed, sometimes one can implement the logic of competitive markets even in non-perfectly competitive environments. (For an example, see Makowski and Mezzetti [forthcoming].) But these cases are exceptional (Walker [1980], Hurwicz and Walker [1983]). For the current essay, the important observation is that efficient *and incentive compatible* mechanisms are based on appropriation logic—give people their MPs—rather than merely on efficiency pricing logic (the image of the price system that inspired Lange and Lerner).

The link between VCG mechanisms and the market mechanism is amplified on in Makowski and Ostroy [1987]. VCG mechanisms are extended to economies with a nonatomic continuum of agents—the environment in which perfect competition is most likely to exist—in Makowski and Ostroy [1992].

8 Conclusion: The lessons of general equilibrium theory

Encapsulation leads toward certain modes of analysis and away from others.

In this essay, we have made an effort to give an insider's critique of general equilibrium theory (in contrast to an outsider's like Hayek). The outsider looks at what WGE has to offer and, like a price-taker, regards it as given, whereas the insider tries to change what s/he does not like.

The two approaches to general equilibrium lead to two images of the price system. Two is better than one; also the second complements the first in at least three important respects:

1. It gives an answer to the question, "Where do prices come from?"
2. It gives a deeper perspective on how the Invisible Hand operates.
3. It shows how competitive markets give good incentives for market-making and innovation.

Amplifying on the first point, the perfectly competitive description of equilibrium *explicitly* provides the background conditions which lend plausibility to price-taking. (Recall the schema in section 3.) Putting these background conditions in the foreground reduces the need to rely on such devices as *tâtonnement* or the Auctioneer to think about how equilibrium might be achieved. Bypassing encapsulation, one can think of individual agents as *price-makers* attempting to achieve their maximum gains much as a perfectly discriminating monopolist, while the force of competition (the availability of perfect substitutes) compels them to settle for certain determinate, i.e., perfectly elastic, terms of trade. Alternatively put, at competitive equilibrium, price-making coincides with price-taking.

In contrast to the encapsulated WGE, where disequilibrium is an aggregate market phenomenon, in the unencapsulated version disequilibrium is experienced as the availability of unexploited arbitrage possibilities/appropriation possibilities. Responsibility for detecting such possibilities by testing their environment lies with individuals, suggesting that they can be left to find prices for themselves. [This point is formally developed in Makowski and Ostroy [1991b]. We show that competitive equilibrium can be thought of as resulting from arbitrage by individuals who do not take the terms of trade as either uniform or given. This yields an alternative to *tâtonnement* or core bargaining as a 'process' by which competitive equilibrium is achieved (in a model with a large number of agents). Notice the process operates through individual efforts to eliminate arbitrage opportunities rather than, as in WGE, through the elimination of excess demands.]

Amplifying on the second and third points, once the appropriation origins of competitive prices is appreciated, incentives are seen to be an integral (rather than an overlooked) element of general equilibrium. Indeed, it is precisely from perfect competition that one learns the nature of good incentives: give everyone his MP. Since MP prices are efficiency prices, we do not lose any of the beautiful insights of duality theory. But we do gain an important bonus, namely, the reason *why* agents will act as price-takers: If they are rewarded with their MPs, then they have no incentive to try to misrepresent their tastes or production possibilities, to try to elicit more favorable terms of trade. They are already *fully* appropriating their contributions; they can hope for no more given the availability of substitute opportunities.

Once recognition is given to the appropriation origin of prices, the singular focus on decentralization is necessarily undercut. One sees that some ('alot' ?) of the credit for why competitive prices are so successful in coordinating economic activity should be given to full appropriation. The appropriation emphasis, that the Invisible Hand works because it rewards everyone with his MP, leads to a very nice dovetailing between general equilibrium welfare economics and the partial equilibrium Pigovian tradition, with its emphasis on bringing private and social benefits into accord. Of

special interest is the fact that the principle — rewarding each agent with his MP is good for incentives, — extends naturally to the incentives for *innovation*. [This theme is formally explored in Makowski and Ostroy [1991a], where an alternative version of the First Theorem of Welfare Economics is given and proved. The alternative version extends the traditional one to a model in which agents have both price-making and market-making capacities. Thus, although markets are incomplete and agents can innovate new commodities, conditions are given under which efficiency will result. From the point of view of WGE, such an extension would appear impossible since price-making and market-making are inconsistent with the passive view of economic agents.]

Having emphasized the complementarities between the two images of the price system, let us conclude by noting a tension which suggests market socialism is much more problematic than Lange and Lerner believed. Property rights are more central in the appropriation, as opposed to the decentralization, view. Recall from section 2 that, in highlighting the decentralization role of prices, the clearest case is made by exhibiting the relation between pricing and efficiency in E rather than $\mathcal{E}$. But, from the appropriation point of view, there is much less room for tinkering with the property rights in the 'Competitive Solution'. Thus, while efficiency prices—as the means for efficient organization—apply to a much larger family of environments than merely competitive ones *provided* agents follow the price-taking *Rule*; once one takes incentives into account, the appropriation role of prices—with its more restrictive demands on the remuneration of agents—takes on the central role.

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Market Equilibrium in the Long Run In the long run, the market price is determined solely by cost considerations, P = min(ATC). If we have P > min(ATC), there are profit opportunities, new firms would enter, and market forces will push down the price until P = min(ATC). If we have P < min(ATC), firms are making losses, firms would exit, and market forces will push up the price until P = min(ATC). If we have P = min(ATC), then whatever quantity is demanded would be willingly supplied, and we are in equilibrium. The demand curve only determines the equilibrium quantity and not the price in