# A GENERAL NET STRUCTURE FOR THEORETICAL ECONOMICS

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## Introduction

Economic thought has generated no shortage of urgent philosophical and methodological issues. Does economics make progress ? What is the epistemological status of its laws ? What logical relations hold between rival economic theories ? Can a rational choice be made between them ? How do the different branches of economics fit together, and how are they tested ? By and large, informal debate in the philosophy of economics has a poor record in making progress towards resolving these kinds of questions. Even the very concept of 'competition' between theories - one of the most central themes in the philosophy of science - has received hardly any clarification where economics is concerned.

In our view a systematic inquiry into these types of problem ought to commence with a detailed study of the logical and conceptual form of economic theories. This means reconstructing mathematical economics as a collection of axiomatic theories whose logical structure and conceptual interrelations can be investigated. It is towards this goal that the present paper is addressed. We shall examine a cross-section of major economic theories and depict them in a unified context which brings out the main connections between them; the resulting structure will be called a theory net.

We do not claim that this net covers all the important theories of mathematical economics, or that these theories could not be portrayed in a different arrangement; but we would argue that the proposed net includes a sufficiently rich and representative selection of theories, exhibited in the most uniform way. The aim is that this net should then serve as a basic and general framework for further studies of the logical structure of theoretical economics. In particular, when considering a

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new theory T not belonging to the net, it should be possible to establish either how the net can be extended to include T, or, if T cannot be fitted in, what member of the net can act as a suitable 'contact point' for expressing logical relations between T and the net as a whole. The latter process will be briefly illustrated below.

As far as the choice of a suitable metascientific framework is concerned, we shall employ some of the concepts and methods of the so-called structuralist account of empirical theories[1]; the economic systems discussed here will be characterized as theory cores in the sense of Balzer & Sneed (1977/8). Though the structuralist view is not satisfactory for all metascientific purposes, in a previous paper - Pearce & Tucci (1982)- we indicated a series of pragmatic grounds for preferring this approach in the early stages of reconstructing economic theories. On the other hand, our concept of theory net will be somewhat more general than in the usual structuralist treatment.

## 1. Research Traditions in Economics

Like all major scientific disciplines (natural as well as social), economics has developed under the influence of distinct 'schools of thought' or research traditions.[2] However it is characterized, a research tradition usually embodies a number of key theoretical and methodological assumptions which help to determine the main lines of research and contribute to their subsequent cognitive evaluation. Equally important for shaping the development of a science is the 'dialogue' that exists between one research tradition and its rivals; many disputes within economics can be traced to the apparent competition existing between different schools in their efforts to explain, predict or control particular economic phenomena.

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1. The 'structuralist' view of theories derives from the approach adopted in Sneed (1971); a concise resumé of its main concepts can be found in Stegmüller (1979), especially the appendix. For more details on the application of this framework to the reconstruction of economic theories, the reader is referred to Pearce & Tucci (1982).

2. If desired, the notion of a research tradition can be understood in the sense of Laudan (1977); however, we shall not make any explicit use here of Laudan's account of scientific progress.

In economics it is customary to distinguish the classical tradition, including Marxian economics, from the neoclassical school beginning with Walras. Additionally, one might single out Keynsian economics as well as the approach of von Neumann as further, independent branches. A rough historical guide might go thus:

Figure 1

| | Neoclassical | | Classical |
|---|---|---|---|
| | Walras | | Smith |
| | Edgeworth | | Ricardo |
| | Wicksell | | Marx |
| | Marshall | | . |
| Keynes | . | | . |
| | . | von Neumann | |
| | . | | . |
| | Debreu | | Sraffa |
| | NeoWalrasian | | |
| | Disequilibrium School | | |

For our purposes it is not essential that this diagram be historically complete or indubitably accurate. In fact, its main lines could well be altered to suit an individual economist's or historian's point of view. The important point to stress is that economic theorists, at the present time as well as in the past, can be loosely grouped into rival 'factions', deriving their assumptions and construing their differences in terms of one or more of the leading traditions indicated.

Of the criticism that representatives of the various schools raise against eachother, the following types are perhaps most prevalent: that a given theory does not describe or explain the 'real' economic world; that a rival theory is not consistent; or that, though consistent, it employs highly questionable assumptions. These kinds of conflict have contributed significantly to the development and refinement of the various economic theories. A recent, well-known example is afforded by the so-called capital controversy initiated in Cambridge in the 1960's and directed at the concept of capital in neoclassical theories. In this instance, the critiques proffered by neo-Ricardian economists, though quite destructive in intent, contributed much to modify and sharpen the neoclassical viewpoint, represented especially by the neo-Walrasian and disequilibrium schools.

Analysing the aims, assumptions and methods of its various research traditions is unquestionably an important component in the rational reconstruction of the development of economics; but it is not the only ingredient. Ultimately, the cognitive success or failure of any scientific research programme is measured by the theories it produces, the explanations and predictions they provide, and the advantages and drawbacks they contain by comparison with their rivals. These factors cannot be judged only through an informal, historical analysis of economics, but require careful logical analysis as well; and, to some extent at least, logical analysis can underpin historical exegesis.

This is not to argue that the logical and historical studies of science are in conflict. Indeed, though it is not always appreciated, these types of inquiry are quite complementary. But a historical study that focuses exclusively on the 'tradition-bound' character of the discipline under consideration can sometimes come to grief over issues that are fundamentally logical in kind. As a case in point, consider the concept of competition between theories. If two theories belong to rival research traditions, it is tempting to construe them as rivals, especially if the parent traditions differ greatly in some relevant respects. Yet the theories themselves could be in good mutual agreement: supplying the same solutions to numerical problems, and predicting similar qualitative forecasts of the outcome of a given economic event. Still, they could be genuine rivals at some more fundamental level, e.g. employing (partially) different sets of theoretical concepts. Once again, conflict might be more apparent than real; their concepts might be distinct but related, as frequently occurs in science when two theories are shown to be equivalent, or when one is reducible to the other. At bottom, such connections are logical relations, and the products of rival research traditions may still partake of them.

Even if two economic models contradict in their numerical predictions, some care must be exercised in construing them as rivals; they could reach good agreement over a restricted domain of phenomena, or diverge only in some limiting cases. Both theories might be then accepted, but for different purposes, e.g. as applying under different economic circumstances. Again, this problem can be resolved through a greater understanding of the logical structure and empirical content of the theories and of the formal connections holding between them.

In view of the above remarks it may come as no surprise to learn that the logical analysis presented below cuts across the main historical lines of Figure 1. The theories involved will be much more closely associated than their usual characterization suggests, and the whole question of competition between them is thrown into doubt. It becomes possible to view members of this net of theories not as rivals, but as capturing different aspects of economic 'reality', each making an individual contribution to the arrangement of a more general structure.

As far as the composition of the net is concerned, we have decided to concentrate attention on theories of growth, since it is growth, with its conflicting aspects of equilibrium and crisis, that gives rise to the greatest controversy within economic disputes. Problems like consumer behaviour or single enterprise production programmes do not, by contrast, appear to be provocative of major conflicts in economics.

## 2. Theory Nets

Before proceeding to a description of the net we have in mind for economics, we should pause to discuss something of the nature and purpose of the concept of theory net. On a very rough and intuitive level we can say that a net is a device for representing a collection of different theories, or different branches of one theory, under the same roof. A little more precisely, we regard a net as a structure having the shape of an inverted tree whose nodes comprise logically reconstructed (e.g. axiomatic) theories, and whose branches are taken to represent logical relations between the connected elements. One reason for gathering theories into a net is that the resulting structure can then be treated as a single entity in a number of metascientific and methodological contexts. Its cognitive content can be expressed, its relation to other nets can be studied, and so forth.

A theory net may serve historical or purely logical ends. In the former case it may be natural to restrict membership in a net to just those theories that are the products of a given research tradition during some fixed historical interval. The evolution of the tradition over time can then be characterized by the appropriate sequence of nets generated by each interval of the period in question. It was this aim that structuralists had in mind when they devised a notion of net and applied it to some episodes in the development of classical physics.[3] But a net can also be employed without regard to historical origins, simply to frame as many theories as possible in a given unified context. In this case logical considerations are paramount and membership in a net is open to any theory that satisfies the requisite conceptual constraints.

Making these constraints precise is not a straightforward matter,

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3. See e.g. Sneed (1971), Balzer & Sneed (1977/8) and Moulines (1979).

and a full discussion lies beyond the scope of the present paper.[4] Briefly, however, we would argue that a net should be construed in such a way that its overall cognitive content can be seen as depending uniformally on its individual component theories and their inter-connections, and that where possible the net structure which exhibits the strongest form of logical relations between components should be preferred. Logical strength can be interpreted in different ways here, e.g. as maximum connectedness of the net (having as few loose branches as possible), or as tightest linkage (strongest logical relation joining individual theories), or as a combination of each.

With this in mind, we shall take a net to be a partially ordered set possessing a maximal element; more exactly, as a structure $N = \langle \Pi, \alpha \rangle$ where $\Pi$ is a finite, non-empty collection of theories partially ordered by the relation $\alpha$, and satisfying the following property:

(I) There is a $T_0 \in \Pi$ such that for all $T \in \Pi$, $T \alpha T_0$.

It remains to consider on what basis to restrict possible selection of $\Pi$ and $\alpha$.

Intuitively, the main desideratum is that $\Pi$ should consist of theories that share a good deal of conceptual structure, and that $\alpha$ should somehow reflect or 'bring out' this common ground as fully as possible. On the other hand, to demand, as structuralists have, that all theories in $\Pi$ should possess an identical conceptual structure ( set $M_p$ of potential models) and differ only in the form of their laws, seems definitely too strong a requirement. The danger here is that such a strict concept of net can never be applied to any interesting examples from actual science; so a more flexible notion of net is desirable.

Suppose that the reconstruction of each scientific theory under consideration specifies for it a definite language or set of non-logical (descriptive) terms. Possible intertheoretic relations can then be loosely divided into two sorts: those which involve a (potential) change of language, and those which do not. For example, if a theory T <u>entails</u> a theory T' it is supposed that the language of T includes at least all the terms from the language of T' (and perhaps more); the same assumption

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4. A more detailed discussion may be found in Pearce & Rantala (1982), though their notion of net is adapted to the more general metascientific framework described in Pearce & Rantala (1981).

is not required if T' is reducible to T, since here translation may be irrevocably involved.

Our basic idea is then to restrict the intra-net relation $\alpha$ to those that do not incorporate translation, and construe correspondences like reduction as inter-net relations.[5] One important relation of the former kind can be defined as follows. Let T, T' be any reconstructed theories in the languages L, L' respectively; let M and M' be their classes of models. We say that T is an extension of T', in symbols $T\varepsilon T'$, if either (a) $L'\subset L$ and $M|L'\subset M'$, or (b) $L\subset L'$ and $M\subset M'|L$.[6] We propose, following Pearce & Rantala (1982), to consider theory nets $N = \langle \Pi, \varepsilon \rangle$ based on extension, where $\Pi$ is any set of theories partially ordered by $\varepsilon$. Condition (I) then ensures that any theory T in $\Pi$ is an extension of the maximal element $T_0$, say, though the language of T need not necessarily contain all concepts from $T_0$ (L may of course extend the language of $T_0$).

Nets based on extension seem to satisfy all the relevant intuitive desiderata and look likely candidates to fulfil the methodological role envisaged. They permit conceptual enrichment or curtailment among their theories, and so should be widely applicable to real scientific examples. Yet a degree of conceptual continuity is present in this sort of net, and condition (I) guarantees that the net is 'pivoted' about a single uppermost point. Moreover the relation $\varepsilon$ is sufficiently strong, and contains ordinary entailment as well as the structuralist relation of specialization as special cases. Finally, despite their increased generality, it is still possible to define standard logical relations like reduction between $\varepsilon$-nets in a uniform way.[7]

## 3. The Net Structure

The net we shall describe in this section comprises seven economic models or theories. The base or maximal element of this array is an economic model that we shall label General Disequilibrium Theory (GDT).

Around the turn of this century the main focus of the neoclassical research tradition was on economic equilibrium, since it was commonly held that when markets were free of significant external disturbances they would tend towards an equilibrium situation. A change of interest

5. Two theories in the same net may still be correlated by reduction, but they are not then directly linked by the $\alpha$-relation.

6. For any language L and L' with $L\subset L'$, and any class of models M for L', we denote by $M|L$ the class of models for L formed from M by deleting from each $\underline{m}\in M$ all the components which correspond to terms in $L' - L$.

7. Cf. Pearce & Rantala (1982).

was induced, historically, by the Great Depression. Neoclassical economists then began to study situations in which demand and supply were not equal in every market, especially labour markets (the case of labour unemployment). Consequently, an interest was also taken in short-run perturbations and situations for which the standard Walrasian adjustment mechanism was not free to operate (Hicks, Keynes). The various models of disequilibrium theory were essentially derived from this change of perspective, and many authors see their origins as emanating from the work of Hicks in particular. Important recent variants of the theory have been developed especially by the French School, notably from the work of Benassi; the version of GDT that we shall outline might be seen as the most general form of disequilibrium theory.

Assumptions

Throughout the sequel we employ three important assumptions in order to simplify the presentation; these are not in principle restrictive, and do not affect the basic form of the net. They are:

(i) Each economy is taken to have a finite number of n industries, each producing a single commodity.

(ii) Each of the n industries employs only one technical production process, using only one type of labour.

(iii) Constant returns to scale prevails. That is, the scale of production can be altered without changing the inner proportion of factors and products.

The last two conditions allow us to replace a set of n production functions by a single $n \times n$ matrix. Changes in the level of production can therefore be represented by a similitude transformation of the technical matrix operated by a diagonal matrix, as occurs in a standard Leontief model.

The various theories below will be reconstructed as cores in the sense of Balzer & Sneed (1977/8). That is to say, we shall specify for each theory T: a collection of structures called potential models, a subclass of these called (proper) models - each of which satisfies the laws of T - and a separation of the components (terms) of T into those which are theoretical and those which are nontheoretical with respect to T. At this juncture we do not wish to take sides on the somewhat controversial issue of how such a separation should be effected for scientific theories in general.[8] For this reason we shall construe the theoretical/nontheoretical dichotomy simply as the distinction between endogenous

8. For a criticism of the structuralist construal of the theoretical/nontheoretical distinction, see Pearce (1981).

and exogenous variables of the system. This has the advantage of being in keeping with the regular practice of economists, as well as avoiding the difficulties that surround the explication of this dichotomy within the Sneedian approach. For present purposes we shall also ignore the problem of whether any constraints in the structuralist sense are applicable to the theories in question, and we omit constraints from their formulation. Throughout, we denote by R the set of non-negative real numbers.

(A) General Disequilibrium Theory (GDT)

A potential model of GDT is a three-sorted structure of the following shape:

$$\underline{m} = \langle J, C, C', \{L\}; A, l, X, D, k, d, \theta, v, p, r, w \rangle$$

The domains of m are made up as follows:

| | |
|---|---|
| $J = \{\alpha_1 \ldots \alpha_n\}$ | is a finite set of industries; |
| $C = \{\beta_1 \ldots \beta_n\}$ | a finite set of commodities, one for each industry; |
| $C' = \{\beta_1 \ldots \beta_m\}$ | is a subset of C, called the set of capital goods; |
| $\{L\}$ | represents a single type of labour. |

Nontheoretical functions (exogenous variables) are:

| | |
|---|---|
| $A: J \times C \to R$ | is a production matrix; |
| $l: J \to R$ | is the labour function; |
| $X: C' \cup \{L\} \to R$ | is the initial resources of capital and labour; |
| $D: R^{2(n+m)+1} \to R^n$ | is the demand function. |

Theoretical functions (endogenous variables) are:

| | |
|---|---|
| $k: J \to R$ | representing the level of production; |
| $d: C \to R$ | is the total demand; |
| $\theta: J \to R$ | is the excess value; |
| $v: C' \to R$ | is a price function (service of capital goods); |
| $p: C \to R$ | is a price function (production prices); |
| $r: C' \to R$ | is a rate of profit; |
| $w \in R$ | is a uniform wage. |

Most of the components of m are self-explanatory; all except wage and demand can be thought of as real-valued functions (the former is a constant or 0-ary function, the latter takes n-tuples of real numbers as values). Thus, $A(\alpha_i, \beta_j)$ denotes the quantity of the $j^{th}$ product used in the $i^{th}$ industry, for unitary level of production; $l(\alpha_i)$ denotes the quantity of labour used in the $i^{th}$ industry, for unitary level of production, and so on. Level of production k denotes the number of units of each commodity produced, total demand d is considered to be constant for each product, and the excess value θ denotes for each industry a share of value not included among profits or wages, to be distributed over the community of economic agents. Notice that for each of the m capital goods we distinguish two types of prices: production price p corresponds to the production costs of one unit of the commodity in question, and the service of capital goods v signifies the rent of one unit of the capital commodity for use in production over the time interval considered. These, of course, determine the dimension of the demand function D.

Following usual practice, we assume that D can be obtained from the standard process of maximization of the consumer utility functions which do not themselves appear in the model. Since utility functions have normally been regarded as exogenous variables in the system, the nontheoretical character of the demand function clearly follows. We shall not discuss here the question of whether or how the utility functions can be empirically determined. We merely note that generally demand is an n-valued function (one for each market) whose arguments are all the price parameters of the model (v,p,θ,r,w) which gives it the dimension $R^{2(m+n)+1}$. (See also equation (4) below).

$\underline{m}$ is a proper model of GDT, i.e. it satisfies the theory's laws, if and only if the following four conditions hold. For brevity we use matrix notation, where, for any function f of the model, $\underline{f}$ denotes the vector or matrix obtained by evaluating f over each argument in its domain.[9]

$$(1) \quad \underline{Av} + \underline{lw} + \underline{\theta} = \underline{p}$$
$$(2) \quad \underline{v} = \underline{rp}$$
$$(3) \quad \underline{kA} \leqq \underline{X}$$
$$(4) \quad \underline{d} = D(v,p,\theta,r,w) \quad \text{and} \quad \underline{k} \lesseqgtr \underline{d}$$

(1) - (4) can be understood as follows. (1) determines production price as the total of all costs incurred in the production process. (2) determines for each capital good the rate of profit as the ratio of service to production price. (3) states that the quantity of resources used throughout the whole economy does not exceed the amount of resources

9. The axioms below can be expanded out in the natural way using row by column matrix products; for any f, $\underline{f}$ is of course a row or column vector depending on its position in the axioms.

initially given; and (4) compares the demand and supply for each market. Since we are dealing here with a disequilibrium structure, demand is of course not necessarily equal to supply. The theory core of GDT can now be expressed in the obvious way as the triple.

$$< M_p, M_{pp}, M >$$

where $M_p$ is the set of all potential models, $M_{pp}$ (the set of <u>partial potential models</u>) is obtained from $M_p$ by deleting from each $\underline{m} \in M_p$ all the theoretical components,[10] and M is the subcollection of $M_p$ consisting of all structures that satisfy (1)-(4).

(B) <u>Unemployment Disequilibrium Theory</u> (UDT)

This theory is an extension of GDT with the same potential models. Its proper models satisfy (1)-(4) with strict inequality holding for the last argument of axiom (3), i.e. for the value X(L). Since this argument concerns labour, these models cover the situation of labour unemployment in the economy; and the special role that labour plays in an economy makes them of particular interest. Keynsian theories can be analysed within this type of system.

(C) <u>Equilibrium Theory</u> (ET)

This theory also extends GDT with the same class of potential models $M_p$. Proper models satisfy (1)-(4) with equality holding in the last two conditions. Within this extension fall all the usual short run equilibrium models which do not assume uniformity of rate of profit. Following the standard treatment, if the free entry of producers is assumed, constant returns to scale would imply that all excess value is equal to zero.

(D) <u>Uniform Rate of Profit Equilibrium Theory</u> (UET)

This is the most usual type of Walrasian equilibrium theory. We characterize it as the extension of ET whose models satisfy $\theta = 0$, and for which r is single-valued, i.e. $r \in R$. This ensures uniformity of rate of profit.

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10. The 'nontheoretical' sublanguage, say $L_0$, for the structure $\underline{m}$ contains the terms A,l,X,D as its nonlogical vocabulary. $M_{pp}$ is thus just equal to the class $M_p | L_0$.

(E) Von Neumann Equilibrium Theory (VNET)

Models of this extension satisfy all the 'laws' of UET, together with the added conditions

$$k(\alpha_1) = \delta X(\beta_1), \ \ldots, \ k(\alpha_m) = \delta X(\beta_m)$$

for $\delta$ a fixed, positive constant. Here the produced capital goods are proportional to the initially given capital goods; thus models of this kind are commonly used to study the growth of economies under the assumption of proportional growth for each sector.

(F) Sraffa Disequilibrium Theory (SDT)

Models of this theory satisfy GDT with $\theta$ equal to zero, and r single-valued.

(G) The Sraffa Real System (SRS)

The models and potential models of this theory are like those of SDT but with the components {L} , X,D,k,d and $\theta$ discarded and with r as a non-theoretical constant; models satisfy what remains of equations (1) and (2), i.e.

$$\underline{Av} + \underline{lw} = \underline{p}$$
$$\underline{v} = \underline{rp}$$

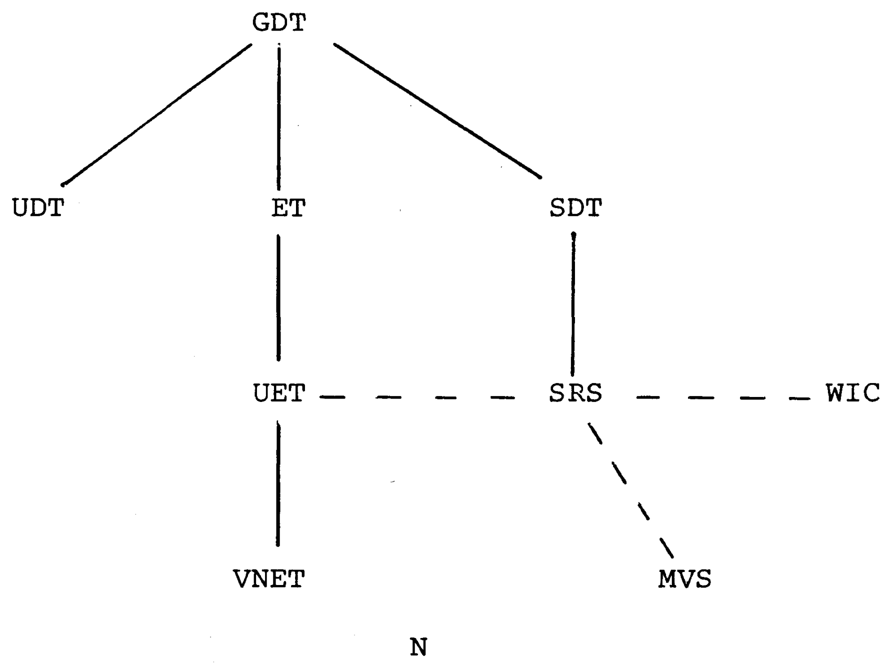
Notice that (F) retains information about supply and demand in each market, whilst (G), which corresponds to the usual mathematical formulation of the system of Sraffa (1960), omits this factor entirely. In the standard Sraffa analysis there is no concern for the demand situation, and r becomes nontheoretical with respect to SRS since the level of supply for each market as well as the distribution of surplus between profits and wages is thought to be exogenously determined.[11]

The theories described above clearly form a net under extension $\varepsilon$, whose base is GDT. Actually, the only point at which conceptual change occurs is the passage from SDT to SRS; though uniformity of rate of profit in (D)-(G) could already be stipulated at the lèvel of potential

11. A mathematical formulation of the Sraffa system is given in Tucci (1976). For further details on the economic nature of all theories described above, the reader is referred to Laise & Tucci (1981, a,b,c,d)

models. The net, which we label 'N', has the shape indicated by the bold lines in the following diagram:

Figure 2




In this picture the solid lines represent a relation of extension between the connected theories - the 'lower' theory extending the 'higher' one. We have also included two new systems, MVS and WIC, to illustrate how some rather different types of economic theory may also be linked to N via logical relations with the Sraffa system. Very briefly, they can be understood as follows.

MVS is the reconstruction of a Marxian value system; in place of the 'price' and 'rate of profit' of SRS, it contains a new theoretical component called 'labour value'. The two systems can be formally compared by relating MVS to a special type of Sraffa system in which wages are considered to be paid in advance and are thus part of the production process. Under this assumption the systems possess identical nontheoretical structures (partial potential models), and a logical connection between them can be established. For details the reader is referred to Pearce & Tucci (1982).

The second system, WIC, is a formalization of a capital theory due to Wicksell, of the type discussed in Laise & Tucci (1980). The theory is even more remote from N, *prima facie*, since it has a quite different conceptual structure even at the nontheoretical level. In its most common version, models of the theory contain only one industry, with one production incorporating an infinite number of techniques. The arguments of the production function are labour and land considered over a finite sequence of time intervals. Logical relations between WIC and members of N can be obtained by first introducing an infinite set of matrices in the Sraffa theory, then defining conditions that permit a translation of this type of set into a Wicksell production function; we shall treat this problem in detail in a future study.

It should also be noticed that though the extension relation forms the key link between members inside N, other logical relations between these theories should not be ignored. The connection between UET and SRS, for instance, is quite subtle, and of considerable methodological interest.

One interesting way to generalize the net would be to introduce a time variable in each theory so that its behaviour as a dynamical economic model can be analysed. The details would be too involved for the resources of the present paper, but a few remarks on the topic will be useful for understanding the economic nature of the disequilibrium structures.

When disequilibrium exists within an economy - i.e. when some excess demands are non-zero - it is usually assumed that 'signals' are emitted from the uncleared markets, the actions of which modify some of the parameters (usually price parameters) of the model, inducing a corresponding change in the state of the economy. Thus, although disequilibrium theory can be reconstructed as a static system, it can be thought to possess an intrinsically dynamical character. To each economy in a disequilibrium state could be associated a set of differential equations:[12]

$$\begin{aligned}
\dot{p} &= f_p(E,\ldots)\\
\dot{v} &= f_v(E,\ldots)\\
\dot{\theta} &= f_\theta(E,\ldots)\\
\dot{r} &= f_r(E,\ldots)\\
\dot{w} &= f_w(E,\ldots)
\end{aligned}$$

12. The excess demand function E below is defined by E = d - k.

that provide a mathematical representation of the influence of non-zero excess demands on the dynamics of the price variables. Notice that in a complete dynamical model the f's will generally contain other variables besides E, and additional differential equations might possibly be required.

Depending on the shape of the f's, the evolution of the economy can occur along a vast range of different paths; but it should be observed that, in any case, market conditions play as fundamental a role in the disequilibrium approach as they do in a traditional Walrasian analysis.

## 4. Concluding Remarks

A comparision of figures 1 and 2 reveals some important similarities and differences. Like figure 1, the net N has several distinct 'branches'; they reflect, of course, alternative lines of approach to extending the general disequilibrium theory. But the presence of GDT in N forms a point of connection for all its theories, and this creates a startling departure from the 'chronological' picture described in figure 1. From the historical perspective one would expect the theories of rival economic research traditions to be conceptually rather disparate; the logical viewpoint adopted in figure 2 shows this not to be the case. Elements of the classical, neoclassical and Keynsian traditions rub shoulders under the same umbrella, and even the 'horizontal' intra-net relations (like that of UET to SRS) should exhibit a strong form of correspondence. Figure 2 is also quite 'unfaithful' to the actual historical genesis of its theories: earlier theories often appear lower down the net than later ones.

The acceptance of N as a framework for future meta-economic studies could also create an impact on the established methodology of research in theoretical economics itself. It suggests, for instance, that the 'destuctive' aim of finding fault with 'rival' theories could be far less fruitful than, say, precisely distinguishing the range of application of one theory from that of another. This should provide a much greater understanding of why, when approaching a particular economic problem, one set of theoretical procedures is more effective than another.

Finally, we turn briefly to the difficult question of how 'empirical' is economics. In the structuralist framework the factual claim or empirical content of a theory is expressed as a relation between its mathematical core K and its class of intended applications I. So far for each theory in N we have specified K but not I; so the question remains open[13].

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13. N is thus a core net in the sense of Balzer & Sneed (1977/8).

At the present stage, however, it seems that the task of capturing I ( a subclass of the partial, potential models) for each theory is formidable, if by 'intended application' one means a concrete economic system like "Japan 1970". A more modest task can be undertaken instead. One may study the structures in $M_{pp}$ that can be expanded into models of each theory; they represent just the successful potential applications of it. An investigation of these will reveal whether or how the theory rules out any possible economic states of affairs; and it can clarify, in particular, to what extent the theory makes any non-vacuous empirical claim at all.

It is quite easy to see that GDT is not empirical in this sense, because to <u>any</u> partial, potential model of it we can append a set of theoretical functions whose values can be chosen to make the resulting structure a disequilibrium model, i.e. one that satisfies (1)-(4). But this situation is no longer true of some extensions of GDT: there may exist partial, potential models of these theories which cannot be expanded into proper models. Put another way, the equations of the theory have no solution for some admissible nontheoretical states.

As a case in point we can mention that conditions concerning the existence of technological unemployment can be provided such that the equilibrium situation given by (C), (D) and (E) cannot obtain. (Cf. Fukuoka (1955), Laise & Tucci (1981a)). Formally, the level of initially given resources and the technical parameters can be chosen so that there do not exist nonnegative levels of production that would allow one of the initially given resources (usually labour) to be fully employed. This fact suggests, of course, that the theories have definite empirical content. Conversely, Morishima (1964) has stated non-trivial conditions on the technology and demand functions such that equilibrium as characterized by UET can always be obtained;[14] such conditions can be seen as sufficient, therefore, for indicating a class of 'successful' potential applications of the theory.[15]

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14. For other types of condition concerning an equilibrium model with an infinite set of technologies, see Laise & Tucci (1981).

15. An earlier version of this paper was presented at the colloquium "Philosophy of Economics", Universität München, July 26-28, 1981. The authors would like to thank the organizing committee, for assisting them in obtaining financial support from the British Council and the C.N.R. (Rome), as well as the participants of the symposium for helpful comments.

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