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The evolutionary dimension within economic thought

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THE EVOLUTIONARY DIMENSION WITHIN ECONOMIC THOUGHT

BY

**James Julius Neidhart
BS, Ohio State University, 1988
MA, University of New Hampshire, 1990**

DISSERTATION

**Submitted to the University of New Hampshire
in Partial Fulfillment of
the Requirements for the Degree of**

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in

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DEDICATION

May the merit gained
In my acting thus
Go to the alleviation of the suffering of all beings
My personality throughout my existences,
My possessions
And my merit in all three ways
I give up without regard for myself
For the benefit of all beings.

Just as the earth and other elements
Are serviceable in many ways
To the infinite number of beings
Inhabiting limitless space
So may I become
That which maintains all beings
Situated throughout space
So long as all have not attained
To peace.

"Transference of Merit and Self-surrender"
The Sevenfold Puja
Friends of the Western Buddhist Order

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Most importantly, I thank all of the people that have offered me their friendship throughout graduate school. In particular, thanks to Bruce Elmslie for hiking trips filled with philosophical and economic reflection, my two office-mates (Toni James and Andrew Houtenville) for not changing the lock on the door, both my proper and extended family for support over the years, and lastly, all of the people at Aryaloka retreat center, Abhirati community, and the FWBO sangha for establishing the conditions which allowed me to discover Buddhism in a way that I could both accept and understand.

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What then is truth? A movable host of metaphors, metonymies, and anthropomorphisms: in short, a sum of human relations which have been poetically and rhetorically intensified, transferred, and embellished, and which, after long usage, seem to a people to be fixed, canonical, and binding.

Nietzsche

A knife is not true or false, but someone who grasps it by the blade is in error.

Rene Dumal

ABSTRACT

THE EVOLUTIONARY DIMENSION WITHIN ECONOMIC THOUGHT

by

James Julius Neidhart
University of New Hampshire
September, 1996

This dissertation integrates the concepts of circular causality, emergence, and hierarchical organization through an investigation of the evolutionary dimension within economic thought. The different sections of this dissertation represent complementary perspectives on this theme.

The first chapter introduces the concept of circular causality and the technique of causal diagramming. These tools are used in the second and third chapters to highlight the evolutionary dimension within the history of economic thought. The particular theorists and groups of articles discussed include Adam Smith, Alfred Marshall, the Increasing Returns debates of the 1920's, Gunnar Myrdal, and Nicholas Kaldor. The significance of the Increasing Returns debates is that it represents a bifurcation within economic theory: a point at which a choice needed to be made between what *appeared to be* mutually exclusive methods of analysis (i.e., the equilibrium and evolutionary perspective). The implicit decision was to further

develop equilibrium theorizing. As a result, both Myrdal and Kaldor were, by necessity, outspoken critics of this equilibrium based methodology. These criticisms are highly significant due to their detailed analysis of what evolutionary theory is not.

Hierarchical nesting and the defining characteristics thereof emerge quite naturally within the theories of these above mentioned evolutionary economists. This manifested for some of the later theorists as an implicit, and frequently explicit, refusal to use a general equilibrium framework in their models of the economy (i.e., an aggregation of the parts to form the whole). Such a methodology would have been in direct conflict with their intuitions regarding the economic process. The different layers of the economy that they did identify are found to be amenable to conceptualization as self-reinforcing processes.

In the fourth chapter, this hierarchical nesting of concepts is developed more generally, and grounded more firmly, as a residual of mental conception and dualistic thought. It is hoped that these latter ideas might serve as a future foundation, however rough, from which a truly evolutionary perspective can emerge: one which is applicable to the whole range of human experience.

INTRODUCTION

The purpose of this dissertation is to explore the historical and philosophical foundations from which a truly progressive theory of socio-economic change might emerge. I have chosen to characterize this theory as *evolutionary*. Webster's (1979) defines evolution as:

An unfolding, opening out, or working out; process of development, as from a simple to a complex form, of gradual, progressive change, as in a social and economic structure.

This distinctly English word, developed during the 17th century, possesses a sense of emergence which I attempt to be true to, while concurrently recognizing that such a facet may be quite beyond the grasp of the intellect.

A distinguishing feature of the following dissertation is that it does not contain a wealth of mathematical formalism. While it does not seem that mathematics is a necessary condition for valid theory, it still remains a very powerful language which can help to clarify one's thinking and thus must not be dismissed wholesale. However, a more serious error would be to assume that the structure of mathematics is homologous to the structure of reality. The trick is to determine the role that mathematics, and arithmorphic concepts in general, can play. It will be contended that the answer to this question is intimately connected with the concept of emergence. Although the following dissertation draws from the field of economics in particular, it is meant to be applicable to the social sciences in general.

This dissertation is divided into four major chapters. The first chapter establishes a language with which to discuss the concept of circular causality. This includes a general introduction to causal loop diagramming and the division between co-dependent and stabilizing circularities. This framework is used extensively within the following chapters.

The second and third chapters highlight self-reinforcing circular relations within the history of economic thought: in particular, the division-of-labor and extent-of-the-market hypothesis and variations thereof. This dimension is analyzed in isolation from the equilibrium dimension for the sake of clarity, but if the two were combined one would have a non-linear system. Starting from the writings of Adam Smith, the second chapter moves on to Alfred Marshall, and then concludes with the Increasing Returns debates of the 1920's. The third chapter explores Gunnar Myrdal and Nicholas Kaldor's models of socio-economic progress, followed by a discussion of some aspects of the evolutionary dimension within contemporary economic thought. The division between the second and third chapters is marked by a bifurcation within economic theory which resulted in the proliferation of the equilibrium, at the expense of the evolutionary, dimension of economic thought. As a consequence, the theorists included in the third chapter have, by necessity, been outspoken critics of this myopic methodological emphasis on equilibrium processes within economic theory.

The fourth chapter is an attempt to clarify a theory of hierarchical composition, originally inspired by the research contained in the second chapter, which can serve as the foundations of an evolutionary paradigm. To accomplish this task, it begins with a

general discussion of the relationship which is assumed to exist between sensory perception, mental conception, and experience. This is followed by brief discussions of sensory perception and mental conception, which are then used, in coordination with concepts of circular causality, to develop and motivate a presentation of the conceptual hierarchy. This latter theoretical perspective, i.e., a nesting of conceptually discrete theoretical relationships which manifest through variations in the spatio-temporal dimensions of perception, is proposed as the foundations for future evolutionary thought. The fourth chapter closes with the presentation and extension of an existing theory of institutional change which highlights the hierarchical layering within the socio-economic process. In summary, this fourth chapter contributes to the investigation of the fundamental philosophical issues which underlay self-reinforcing systems in the social sciences.

CHAPTER 1

A LANGUAGE FOR SELF-REINFORCING SYSTEMS

Causal Loop Diagramming

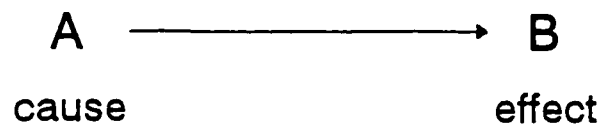
What is the essence of economic change and development, of economic evolution? Many contemporary economists recognize the presence of irreversibility, hysteresis, path dependency, and multiple equilibria, but do our theories demonstrate such possibilities? If a theoretical alternative is necessary, must we start from scratch or can we build one from the theoretical designs left by past authors? Ideally, any such framework should be able to represent both stable equilibrium and evolutionary relations. One promising candidate which meets these criteria is General Systems Theory. However, rather than arguing against the theoretical *status quo* in economics and for this alternative, a task done quite eloquently in the past (e.g., Kornai 1971), the following dissertation highlights the presence of general systems thinking within the history of economic thought. With this goal in mind, it is necessary to introduce some new concepts which derive from General Systems Theory and the conceptual dichotomy between positive and negative circular causal relations.

What is circular causality?¹ Let's begin by considering a simple linear

¹ The interested reader is referred to Goodman (1974) for a more detailed discussion on causal loop diagramming and the interaction of positive and negative feedback loop relationships within the field of System Dynamics (see also, Boulding 1968 and Maruyama 1968). Furthermore, anyone who dismisses

cause→effect relationship between two variables. This definition of linear causality will cover situations in which some change in A is associated through time with some change in B. "A" and "B" are generic labels which can represent simple magnitudes or nth order derivatives.² Using an arrow to symbolize the elapse of time and to demonstrate the direction of causality, this is represented as follows:

Figure 1: Linear Causality



Therefore, the presence of event A is associated with the presence of event B, and changes in A are associated with changes in B. But, the presence of B or changes in its value *will not* influence A. The dependence is strictly asymmetric.

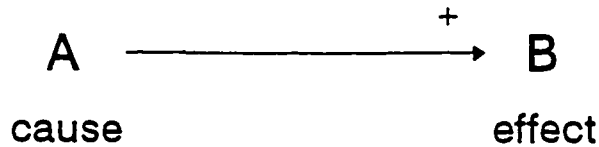
Within this framework, there are three possible types of first order relationships. First, there is the possibility that an increase in one variable is associated with an increase in the other (i.e., $\Delta A \rightarrow \beta \Delta B$; $\beta > 0$ with ΔA and ΔB being some unit of

an operational role for the notions of causality would be referred to Simon (1953). The general thrust of the reasoning is that causality has no meaning in a non-hierarchical world. However, in a world of what Simon terms "causal ordering," a knowledge of causal relations is an indispensable informant of action. My understanding of *causality* and *association* involves the recognition of relatively stable interrelations between perceptually distinct elements which lead to a recognition of their tendency to covary together within the underlying process of reality. It has an epistemological, rather than an ontological meaning.

² See Appendix B for a brief comparison between qualitative and quantitative methods of investigating the dynamic behavior of systems.

change).³ This relationship is characterized as being positive and our causal link is qualified with a positive sign.

Figure 2: Positive Linear Relation



The second type of first order relationship is when an increase in one variable is associated with a decline in the other (i.e., $\Delta A \rightarrow \beta \Delta B$; $\beta < 0$; causal link qualified with a negative sign). Lastly, there is the possibility of no perceptible relationship between the two variables. However, even if a relationship between variables has not manifested in the past, it may remain an inherent possibility. While this possibility is not of much importance in strictly linear relationships, it is of considerable importance when thinking about the emergence of novelty within circular causal systems.

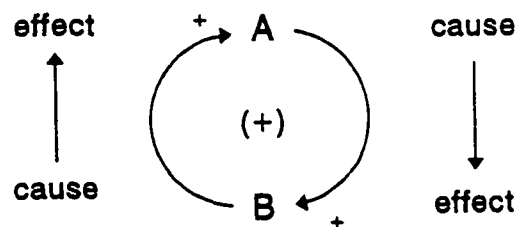
Circular causality extends the ideas of linear causality by including the dependence of A on B. As a result, the clear distinction between cause and effect which exists in linear causality becomes blurred. Events A and B appear to occur together: change in A causes change in B, causing further change in A, and therefore further change in B. Furthermore, while the variables are obviously interdependent, it may also be the case that they depend on one another for their very existence (i.e., a mutual *sine qua non*).

³ It is also possible to talk in terms of partial derivatives. Such formulations are traditionally used to determine stability, but these quantitative techniques have been forsaken in favor of a qualitative presentation since this dissertation is directed primarily at the social sciences as a group and such mathematical formalism might serve as quicksand for some (present author included). Lastly, the notion that valid ideas must be embodied in mathematical rigor is a ridiculous contention reminiscent of past claims by the Catholic Church that holy thought can only be expressed in Latin.

For example, there may be an ecosystem consisting of complex interdependent interactions of bacteria, insects, plants, and animals which represents a *pattern of stable relations* which have evolved between the individual organisms over time. Single organisms within such complex patterns of interdependence may *require* the presence of other organisms within this pattern in order to survive. However, since circular causal relations have the potential to perpetuate inefficiency and the retention of unnecessary elements within such patterns, the removal of a single element may not always be significant to the dynamics of what appears to be a interdependent pattern (e.g., the appendix in the human body).

It is possible to classify circular causal relations into two different types by noting the number of negative linear causal links within a complete loop (i.e., from A back to A). If this number is even the loop is called a positive loop, and if odd, a negative loop (similar to the multiplication of positive and negative numbers). The circularity diagrammed in Figure 3 is a *positive circular relation* and is qualified by the sign in parentheses.

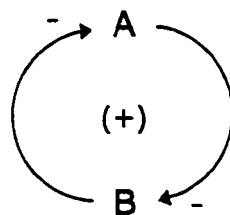
Figure 3: Positive Circular Relation



Since causality "flow" in both directions, from A to B and from B to A, a change of any variable in this loop will ripple through the other variables and inevitably have repercussions on itself.

Looking at the linear composite of this circular relation, if subsequent changes in the variables of a positive circular loop are increasing (e.g., $\Delta A \rightarrow \beta \Delta B$; $\Delta B \rightarrow \alpha \Delta A$; $\beta\alpha > 1$), it will *explode* or *implode* depending on the direction of initial change.⁴ This language of explosion/implosion (hereafter, referred to simply as explosive) highlights the fact that the quality of the interdependent pattern of variables will not remain the same, it will cease to exist as it was. Its growth will be exponential in form. Such a relation is referred to as a *complementary co-dependence* when $\alpha > 0$ and $\beta > 0$. Within this classification scheme, two elements which share a mutually negative relationship (i.e., $\beta < 0$ and $\alpha < 0$) will result in a divergent explosion (e.g., an initial decrease in A causes an increase in B, which causes a further decrease in A, and the cycle continues). This *divergent co-dependence* between A and B is diagrammed in Figure 4.

Figure 4: Divergent Co-Dependence



⁴ The following analysis treats these relationships as difference rather than differential equations. This approach provides a clearer qualitative presentation. Those who prefer a quantitative approach can consult, e.g., Chiang (1984: Chapter 14).

Since divergent co-dependence represents the rise/decline of two (sets of) variables, the continued growth of one is systemically dependent on the decline of the other. If the latter variable is unable to decline any further, then the growth of the former must cease. For example, the theory of subsistence wages posits a biological minimum below which wages cannot fall without destroying the quality of the laborer. Therefore, profit growth through wage reductions possesses a 'natural' limitation.

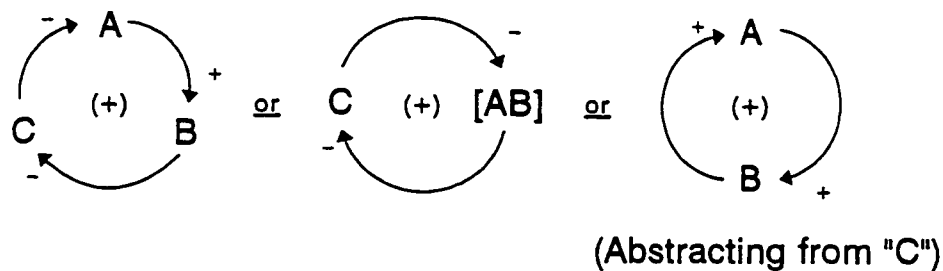
The remaining parameter range, $1 > \beta\alpha > 0$, results in dampened growth: an initial change in A causes a change in B, which still results in a further change in A. However, subsequent changes *decline* in value and the circularity does not have explosive implications (e.g., money supply growth and Keynesian concepts of induced consumption)⁵. This class of circular relations is referred to as complementary and divergent *dynamic adjustments*. While dynamic adjustments will not result in instability nor stability, the amplification of perturbations may engender the unfolding of relations which do lead to instability.

While these categorical types have been illustrated using only two elements, positive loops may contain more than two variables and therefore be composed of multiple negative and positive links. In such cases, the individual negative links (recall that this is an even number) serve to demarcate the sets of variables which diverge from one another as the dynamics of the process unfold; one set will increase, while the other decreases. Therefore, one should speak of complementarity and divergence between *sets or patterns of variables* within a positive circular relation rather than labeling entire loops

⁵ It is of significant importance to note that these examples represent the two major points of policy intervention in the economy: monetary and fiscal.

in this fashion. In addition, since divergence is inherently dichotomous (e.g., a variable must become either more or less of what it is), any divergent co-dependence with greater than two elements must possess some degree of complementary co-dependence. The following diagram demonstrates how the circular relation between three variables, an indirect complementarity between A and B, and a divergence between C and [AB], with the brackets representing a set of variables, can be presented in different ways.

Figure 5: Complementary/Divergent Co-Dependent Relations



Even though the third representation abstracts from C, the complementary process between A and B still requires the presence of C for continued existence.⁶ However, a representation which abstracts from C may not appear to be empirically inaccurate until the qualitative contribution which element C makes to the process is visibly degraded to such an extent that the complementary co-dependence between A and B is effected.

A minor point which needs to be made explicit is that while the individual linear relationships between elements (e.g., $A \rightarrow B$) can change from being positive to negative by simply redefining one of the variables (A or B), the *overall quality* of the circular

⁶ For example, some research in economic development which explores the divergence between developed and underdeveloped regions posits that the complementarities within geographical regions are *themselves within* a context of divergent co-dependencies between countries (e.g., Gunnar Myrdal 1956, 1957). In contrast, other development theorists discount the importance of this developed/underdeveloped divergence in conceiving of economic growth as a predominantly endogenous endeavor within a given region (e.g., Rostow 1962).

relationship remains intact after such semantic shifts. This means that the individual relations between elements within a positive circular causal loop may be either divergent or complementary depending on the *meanings* and *valuations* assigned to the individual elements. However, while such semantic shifts will change the tone of one's discussion, the underlying relations will be the same. Of course, the causal relation between qualitatively identical variables which enter the same process individually (e.g., individual income amongst individuals or regional industrial infrastructure between regions) are immune from such semantic manipulations. These classificatory distinctions between different positive circular causal relations are summarized in Table 1.

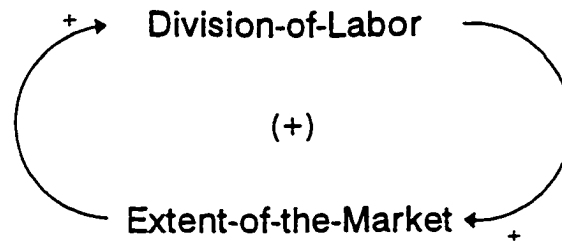
Table 1: Two Variable Positive Circularities without Structural Change				
Parametric Possibilities			Categorical Typing	Characteristic Dynamic of Change
α	β	$\alpha\beta$		
$\alpha > 0$	$\beta > 0$		Complementary Circularity	Variables reinforce one another in mutual growth or decline
$\alpha < 0$	$\beta < 0$		Divergent Circularity	Variables diverge from one another. Delineates between sets experiencing growth versus decline
		$ \beta\alpha > 1$	Explosive Co-Dependence	Destroys the aggregative quality within the systemic relations
		$0 < \beta\alpha < 1$	Dynamic Adjustment	Adjusts quantitative relations without destroying their aggregative quality

The main reason why positive loop relations have not played an explicitly strong role in economic theory is that they do not contribute in any way to the quality of stability (i.e., the requisite for structural identification). For example, the possibility of complementary co-dependence within a set of variables, a relationship which presents no impediments to infinite expansion, has led many theorists to reject such relationships outright (e.g., see Hont 1983; Sraffa 1926). This underemphasis is perhaps due to the fact that some classes of positive loop relations do exist peacefully within the ivory towers of economic theory, e.g., instances of complementary dynamic adjustment (e.g., monetary stock changes and Keynesian investment) and divergent co-dependence (e.g., natural monopoly and technological lock-in). It will be suggested in this dissertation that complementary co-dependencies, the one type excluded, represent the conceptual counterpart to the historical process of evolutionary development.

Regardless of this mainstream tendency to disregard complementary co-dependencies within contemporary economic theory, such relations are found at the historical foundations of economic thought: Adam Smith's analysis of the division-of-labor.⁷ This is diagrammed in Figure 6.

⁷ Josiah Tucker and James Oswald seem to have been the first to postulate the possibility for complementary co-dependence within the division of labor (Hont 1983; Elmslie 1995). However, this proposition was rejected by David Hume since such relations could hypothetically progress indefinitely. The uniqueness of Adam Smith's approach was that he proposed exogenous constraints on the system which is perhaps the reason why Smith's ideas were more acceptable to Hume than Tucker's. However, it should be noted that Smith's constraints were founded on his conservative opinion that science had progressed as far as possible and would soon be engaged in the mere retention of a static body of knowledge (Elmslie 1994a).

Figure 6: The Division-of-Labor

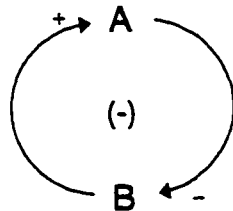


The division-of-labor is limited by the amount of goods that can actually be sold, i.e., the extent-of-the-market. Since the extent-of-the-market is determined by the cost/price of production, which is influenced by the division-of-labor, a potential complementary circularity is established. Every economist should be familiar with this relationship even though it remains a marginal concept along the fringes of economic theory (Liejonhufvud 1986).

While Smith's discussion of this circularity supports the conclusion that he viewed it as displaying some degree of co-dependence, this does not lead to infinite growth since Smith imposed limits on the growth of the variables themselves. Therefore, the economy may emerge through a co-dependent unfolding ($\alpha\beta > 1$) and then manifest only a steady state existence. For Smith, the upper constraint on economic development results from the 'natural' limits inherent to scientific knowledge which place an upper bound on the division of labor. This shifting of dynamic relations represents changes occurring between both the variables of the pattern and the pattern within its environment. Such is the case with most organisms or cultures which seem to unfold into some peak state and then decline or demonstrate oscillatory behavior around a steady state.

The exploration of steady state relations involves a distinctively different type of circular relation: one in which the causal link between A and B is negative, while that between B and A is positive (or vice versa). This *negative circular relation* is diagrammed in Figure 7.

Figure 7: Negative Circular Relation



An increase in A causes a decrease in B ($\beta < 0$), while this decrease in B causes a decrease in A ($\alpha > 0$). The value of $\beta\alpha$ will still determine the quality of the interactive process (i.e., explosive versus adjustment), but since subsequent changes of a given element do not reinforce one another, the dynamic process will be oscillatory: $|\beta\alpha| < 1$ leads to convergent oscillations which restore a state of balanced relations while $|\beta\alpha| > 1$ leads to explosive oscillations. This latter parameter range involves the amplified variance of the variables under observation which thereby leads to a degeneration of the coherence within the pattern (e.g., the San Francisco suspension bridge which was destroyed through oscillatory amplification of structural flex during heavy winds). The pattern *per se* seems to disintegrate as it "decouples" into the stable configurations of its compositional components. While many stable systems have evolved within, and hence been dynamically coupled to, a context of oscillatory relations (e.g., plants and climate), it does seem probable that oscillatory amplifications may undermine

their continued existence.⁸ However fruitful a discussion of this latter category may be to understanding systemic degeneration, I will limit myself to a discussion of what I call *stabilizing circularities* ($|\beta\alpha| < 1$).

Stabilizing circularities are characterized as *goal-seeking* and *relation preserving* since they dampen perturbations within the system and thereby preserve the quantitative relations between its structural qualities (i.e., equilibrium). This ecological balance within a pattern of variables is determined by the interactive nature of its parts and their environment. The conceptual "poles" of attraction around which these stabilizing circularities act are taken as given. Table 2 summarizes the aforementioned types of negative circular causalities.

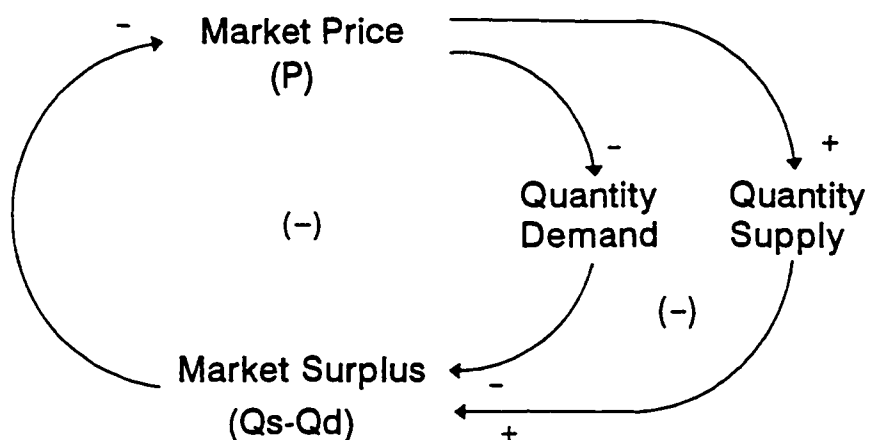
⁸ Economic examples include agricultural markets which experience unstable negative circularities which result in wildly fluctuating prices due to delays between production and consumption decisions (see Goodwin 1990). These price fluctuations lead to the bankruptcy of some farms, and the removal of some farms from the heterogeneous set of all farms may result in a transition to more stable relations. These ideas can also be used to characterize the Great Depression as a degeneration of economic relations (i.e., consumer confidence in banks and the stability of paper wealth) which resulted in a "slip" of the economy back to more primitive interactive relations and structural forms. Policy supports in agriculture and legislation within the banking industry attempt to sever such destructive circular relations within the current economic environment.

Table 2: Two Variable Negative Circularities without Structural Change				
Parametric Possibilities			Categorical Typing	Characteristic Dynamic of Change
α	β	$\alpha\beta$		
$\alpha < 0$	$\beta > 0$		Negative Circularities	Given a pole of attraction, causes oscillations about this pole in response to perturbations
$\alpha > 0$	$\beta < 0$			
		$ \beta\alpha > 1$	Explosive Oscillations	Breaks down coherence of systemic relations through amplitude amplification
		$ \beta\alpha < 1$	Stabilizing Oscillations	Preserves quantity and quality of relations

Traditionally, economics has emphasized stabilizing circularities since they preserve relations and represent the equilibrating dimension within the flux of reality.⁹ An economic example of such relations is supply and demand analysis, as represented in Figure 8.

⁹ In his discussion of complex phenomena, Hayek (1967d:27) contended that our main interest is in those structures in which a "complex pattern has produced properties which make self-maintaining the structure showing it."

Figure 8: The Stabilizing Circularity of Supply and Demand



Market price (P) determines the quantity of goods that producers offer for sale (Q_s) and the quantity of goods that consumers wish to purchase (Q_d). Defining market surplus as $Q_s - Q_d$, it is assumed that higher prices will elicit an increase in this value through larger Q_s and smaller Q_d . Furthermore, changes in price are negatively related to market surplus such that if $Q_s - Q_d > 0$ then $\Delta P < 0$, $Q_s - Q_d < 0$ then $\Delta P > 0$, and $Q_s - Q_d = 0$ then $\Delta P = 0$ (i.e., market clears at existing price). This last possibility represents a market equilibrium in which both buyers and sellers are content with the level of consumption and production given the price of goods in the market. Within this dynamic process, any perturbation from the market clearing price is dynamically purged from the system.¹⁰ The goal of the market is set by the marginal cost of production (i.e., technology and input costs) and the marginal utility of consumption (i.e., preferences and incomes), which are both exogenous factors at this level of analysis.

¹⁰ The cobweb model is the explosive counterpart to this stable market perspective (e.g., see Goodwin 1990).

One caveat needs to be made at this point: When using circular causal diagrams to draw conclusions concerning the dynamic behavior of a system, it is important to distinguish between *rate-to-level* and *information or proportional* causal relations. A rate-to-level relation is a causal link between a variable and its rate of change (e.g., population and the number of births per year), while a proportional relation is between two different variables (e.g., division-of-labor and extent-of-the-market). With rate-to-level relations, a decrease in one variable will not necessarily lead to a decrease in the other. For example, a decrease in the number of births per year will not necessarily cause a decrease in the population: population may continue to rise, just at a lower rate. In order to explicitly account for this, rate-to-level relations are distinguished from proportional relations through the use of a *dashed line* (see Appendix B for illustrations). Although this makes a prediction of the particular dynamic behavior of the system more complex, it does not significantly alter the qualitative behavior of the causal loop (i.e., explosive or stabilizing).

Circular Loops and Endogeneity

Now that the basic concepts of circular causation have been presented, it is possible to move on to a more general discussion. When a system changes, it is generally assumed that this change is not arbitrary or random, but that it reflects the interdependent relations between different variables. Although both linear and circular accounts of causal relations have been a standard fare of human thought throughout history, Western science has tended to overemphasize the former rather than the latter. One example is the first mover argument for the existence of God: A being unaffected by and immune to the system it creates. A less dramatic example involves the game of billiards: one predicts the effect of sending the cue ball in motion as it disturbs a triangular arrangement of multicolored balls at the other end of the table. The player who surveys the existing arrangement of balls and strikes the cue ball with a pool cue is frequently exogenous to this representation. However, the player's skills can be endogenized in one's concept of the system, e.g., as they view the spatial arrangement of the balls or attempt to disturb their opponent's concentration. Frequently, our explanation of the system begins and ends with each individual shot since the mechanics of billiards seems to be uninfluenced by one's concept and perception of the multi-colored pattern of balls.

Even evolutionary theory has been expressed in a linear manner, e.g., the fitting of an organism to an external and independent environment to determine species survival.¹¹ However, perhaps it is more accurate to endogenize the organism's influence on its environment such that both the organism and its environment are conceived to co-evolve in mutual dependence (e.g., Kauffman 1988; Wuketits 1987). For example, the co-evolutionary theories of Norgaard (1984, 1985, 1987) concerning the interrelations of the economy and environment embody such a perspective. The evolutionary emphasis in this dissertation concerns this latter notion of the co-dependent and mutually reinforcing changes that occur within and between different patterns of variables. Such evolutionary thinking is not a novel insight of current generations, but rather an insight in search of formal theoretical embodiment. The following chapters highlight this evolutionary dimension within the theories of different economists throughout history. In this way, it is hoped that the reader will see the central importance these ideas held within past attempts to model the economy and also the promise they hold for future theorizing. Since the distinction between co-dependent and adjustment circularities is determined by parameter values rather than sign and since these parametric relations are not static, one must acknowledge the possibility that a system's predominant dynamic behavior will shift between these two categories.

An important issue in identifying circularities within economic theory involves the boundaries which a theorist establishes for the system under observation, i.e., which

¹¹ This perspective is neo-Darwinian and should not be considered the only school of thought in evolutionary biology. It is, however, safe to say that it has enjoyed academic dominance in the past and continues to be used by many outside biology as an acceptable theory of evolution.

variables are relevant. In setting these boundaries, one implicitly limits the applicability of the theoretical model. For example, the economic status of Afro-Americans in the 30's and 40's is obviously an economic issue. If, however, there are causal determinants which fall under the rubric of anthropology or sociology, should they be included in the theoretical model? If these variables are important factors in explaining the dynamic behavior of the phenomena under observation, of course they should. As Rostow (1990:482) stated,

... one should take the problem in all its complexity as the discipline and bring to bear around it relevant insights from whatever branch of knowledge that appears to have something to offer. There is little to be said for those who -- as analysts or teachers -- cut the problem down to the size of the method or discipline to which they are committed.

Such an interdisciplinary approach was practiced by Gunnar Myrdal. Although Myrdal's training was in neoclassical economic theory, his investigation of the economic status of Afro-Americans led him to conclude that the distinction between relevant and irrelevant variables could not be done along sectarian lines (i.e., on the basis of *a priori* assumptions concerning what "economic" variables are). A complete answer to this economic question required anthropological, psychological, and sociological variables in order to fully reflect the circular and cumulative influences that governed race relations within the U.S. during Myrdal's lifetime. The major problem with theories constructed along strict disciplinary tradition rather than causal relatedness is that they allow for the possibility that fertile circularities are sterilized within our models.

This desire to make the discipline fit the problem rather than vice versa is very important from an evolutionary perspective. For example, the economic system has

demonstrated an ability to evolve into greater levels of complexity, yet satisfactory theories of such change have eluded economists. One possible explanation is that by concentrating on "economic" variables, our theoretical models exclude important positive circularities which would lend a greater degree of endogenous change to our concepts. If a theoretical model lacks such relations, change within the system must be introduced through external stimuli. It is a distinguishing characteristic of many older models of economic growth and development that they require exogenous stimulation (e.g., constant population growth, technology transfer, or fiscal injection) in order to display growth. Arrow (1962:155) once commented that a "view of economic growth that depends so heavily on an exogenous variable ... is hardly intellectually satisfactory."

One can speak of expanding economic theories to include previously excluded variables and hence capturing previously amputated circular relations. Ulanowicz (1986:60) has commented on this:

One begins with a field of vision limited to a certain small portion of the universe. One then catalogues the behavior of the delimited system, as well as all those influences that cross the system boundary in any direction. If it happens that the original system contains only a segment of a feedback loop, then the behavior of this causal pathway will appear strictly nonautonomous ... However, if one enlarges the system boundary so as to include the entire feedback loop ... semi-autonomous behavior 'emerges' from an increase in scope.

One might even go so far as to augment the methodological criteria of a 'good' model (e.g., ideas such as simplicity, fruitfulness, logical completeness and consistency) to include the recognition of positive circularities in order to theoretically embody the possibilities for endogenous change. However, economics was not always so strict about excluding psychological, sociological, and political variables in the past. The field was

also much more willing to propose theories which possessed strong complementary co-dependent dimensions. It is to an investigation of these facets within the history of economic thought that this dissertation now turns.

CHAPTER 2

AN EVOLUTIONARY DIMENSION WITHIN ECONOMIC THEORY

The first theorist discussed from this evolutionary perspective is Adam Smith. This is an obvious place to begin due to Smith's role in the establishment of Economics (actually, Political Economy in those days) as a field of study. Furthermore, it is very easy to distill a vivid mapping of positive circularities within Smith's theory of economic growth. Although the emphasis he placed on the relationship between the division-of-labor and extent-of-the-market is widely accepted informally, theoretical embodiments of such endogenous change has occurred only recently (e.g., Krugman 1991c). Other evolutionary facets of Smith's theories were de-emphasized since they involve political relations. For example, the crumbling of social relations within Medieval Europe and the rise of capitalism were seen to be mutually dependent events. By combining Smith's discussions of natural liberty, private property rights, capital stock accumulation, division-of-labor and extent-of-the-market, a clear and concise genesis story of the modern economy emerges.

Alfred Marshall is the second economist explored. This choice not only acknowledges Marshall's contributions to economic theory, but also his self-proclaimed emphasis on biological analogies. For instance, in the preface to the 8th edition of his Principles of Economics (1990[1920]:xii), he wrote that the "Mecca of the economist lies in economic biology rather than in economic dynamics." For this reason alone, any

thorough exposition on the evolutionary dimension within the history of economic thought would be hard pressed to not include a discussion of Marshall's ideas. But more importantly, Marshall elaborates on Smith's theme of the division-of-labor by identifying both a differentiating and an integrating dimension. This distinction led Marshall to acknowledge the different levels within the economy at which complementary processes occur.

Of course, if the claim is made that evolutionary dimensions are implicit within the writings of past theorists, it is necessary to provide some explanation as to why such facets have been downplayed within the received wisdom of economic theory. To this end, this essay proceeds from Marshall into a *series of articles* published between 1922 and 1930 by a number of different economists within the pages of the Economic Journal. This episode and its topic of discussion will be referred to as the Increasing Returns debates. While the theories of both perfect competition (Pigou 1927, 1928) and imperfect competition (Robinson 1933; Chamberlin 1933) emerged from the debris of these debates, this controversy also marks a distinct bifurcation point within economic inquiry. It is at this turning point in economic theory that the specifically evolutionary dimensions of Smith and Marshall's thought are exorcised from professional circles. Articles which attempted to embody evolutionary insights such as Young's (1928) "Increasing returns and economic progress" are misplaced, only to be rediscovered as the urge to understand the evolutionary dimension of the economy has resurfaced.

As a result of the Increasing Returns debates, the role of increasing returns was limited to those inherent to a particular system, e.g., those found within a specific firm

(i.e., monopoly) or region. This fact restricted investigations of complementary co-dependencies to those which were bounded through either a divergent co-dependence or environmental parameter which stabilized the system. However, although unbounded evolutionary relations *per se* were not within the realm of acceptable theory, there was research published after the 1930's which worked within this intellectual atmosphere to advance the evolutionary perspective. Three main groupings along these lines will be explored in the chapter following the present one: (1) Gunnar Myrdal's models of international development, (2) Kaldor's North-South model, and (3) W. Brian Arthur's concept of technological lock-in.

Adam Smith: The Wealth of Nations

Division of Labor

Viner (1928:116) commented that one can enter Smith's model of the economy "at any point without doing violence to the logic" since it is "a coordinated and mutually dependent system of cause and effect relationships." The most obvious entry point from an evolutionary perspective is the division-of-labor concept, which Smith viewed as the fundamental determinant of the wealth of nations.¹² Economists will be familiar with his famous quote concerning the manufacture of pins: by combining their efforts under a single roof, Smith argued that workers are able to specialize in a single aspect of the production process and thereby produce more together than is possible apart. Pin manufacturing is not only a particular trade itself,

... it is divided into a number of branches, of which the greater part are likewise peculiar trades. One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on, is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper ... I have seen a small manufactory of this kind where ten men only were employed ... Those ten persons, therefore, could make among them upwards of forty-thousand pins in a day. ... But if they had all wrought separately and independently ... they certainly could not each of them have made twenty, perhaps not one pin in a day. (Smith 1937[1776]:4-5)

¹² Leijonhufvud (1986) reminds us that "Smith's division of labor - the core of his theory of production - slips through modern production theory as a ghostly technological-change coefficient or as an equally ill-understood economies-of-scale property of the function" (see also Georgescu-Roegen 1976:Chapter 2; Stigler 1976:1209). Stigler (1951) attempted to reintroduce Smith's ideas as "the core of a theory of the functions of firm and industry," but his article has been neglected by the profession.

This division-of-labor or specialization permits an increase of the total product in three ways: (1) Specialization on an isolated task allows the worker to establish special skills and greater dexterity with respect to the task at hand. In a sense, the basic actions become habitual or second nature, require less thought, and allow greater concentration on the finer details of the work. (2) There is a savings in labor time since the transition between individual steps in the production process is reduced. While this time would have been spent idly, it is now spent productively. (3) Lastly, Smith believed that workers whose sole focus is on a single task would be so engrossed that they would understand it more deeply than someone performing the same task less frequently. As the drive to reduce the time spent working bears down upon these "focused" workers, they are able to formulate novel ways of performing their specific task which reduces their time commitment and material waste.¹³

Not only did Smith have a notion of the vertical division-of-labor (i.e., the separation of one productive process into multiple, specialized steps), but he also recognized the horizontal division-of-labor (i.e., the separation of trades). This is witnessed, for example, in his separation of peculiar trades within the economy and even philosophers (inventors) from the common lot of people (Elmslie 1994b). When one considers production as a generic conversion of raw characteristics to refined characteristics, it becomes apparent that the distinction between vertical and horizontal

¹³ Rosenberg (1976:863) included the division of a single responsibility into two distinct ones when the task which affords less reward was neglected in favor of a task which gives greater reward. Therefore, the separation of two such tasks through specialization leads to greater productivity as a whole. Rosenberg develops Smith's example of the combination of military, legislative, and judicial power in a single individual. Once these duties were separated, the distinct tasks were performed better individually than they had been as a whole.

division-of-labor is based on proprietary rights within the economy and serves to identify the parties to whom the productivity advantages will accrue. Therefore, while the productivity gains from a vertical division-of-labor can be internalized within a single firm, productivity gains from a horizontal division-of-labor are internalized within a broader sphere (e.g., city, region, or national economy). Although Smith seemed to foresee this point in his discussion of the evolution of towns and cities, it was left to Alfred Marshall to fully embody this idea in his economic theory.

Returning to Smith's analysis of the division-of-labor, he believed there were definite limitations to this method of increasing production. First, there may be an input to the production process which is only available on a limited basis. For example, he felt that specialization would be most extensive within the production of manufactured goods, as opposed to agriculture. The reason for this asymmetry was the dependence of agriculture on climate.

The nature of agriculture indeed, does not admit of so many subdivisions of labour, nor of so complete a separation of one business from another, as manufactures. ... The occasions for those different sorts of labour [e.g., ploughman, harrower, sower of seed, and reaper of corn] returning with the different seasons of the year, it is impossible that one man should be constantly employed in any one of them. This impossibility of making so complete and entire a separation of all the different branches of labour employed in agriculture, is perhaps the reason why the improvement of the productive powers of labour in this art, does not always keep pace with their improvement in manufactures. (Smith 1937[1776]:6)

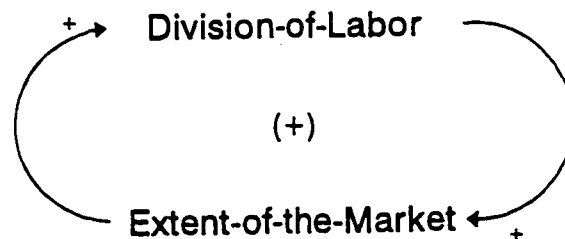
Changing seasons serve to limit the extent to which the agricultural process can be divided and controlled: all plants are sown in the spring and harvested in the fall. In Leijonhufvud's (1986) words, agriculture faces a timing problem.¹⁴

A more significant limiting factor for Smith was the extent-of-the-market. Quite simply, it does no good to produce forty thousand pins in a day if no one is willing to trade for them.

As it is the power of exchanging that gives occasion to the division of labour, so the extent of this division must always be limited by the extent of that power, or, in other words by the extent of the market. (Smith 1937[1776]:17)

The effective demand must be present in order for the fruits of the division of labor to be realized. This positive circularity between the division-of-labor and extent-of-the-market is diagrammed in Figure 9.

Figure 9: The Division-of-Labor and Extent-of-the-Market Circularity



Elaborating on the first link within this circularity, that between the division-of-labor and extent-of-the-market, the productivity advantages of specialization will manifest as a decreasing cost of production. As stated previously within Smith's pin factory example, this is simply a matter of organizational improvement since workers are able

¹⁴ A more detailed analysis of such limitations is embodied in Georgescu-Roegen's theoretical distinction between funds and stocks (1971:Chapter 9), and will be discussed later in this dissertation.

to produce more output on average. For example, at one time everyone in a community engaged in hunting, fishing, cooking, and maintaining a shelter as a daily chore. In time, individuals began to specialize in only one aspect of this set of chores and the community became more productive as a whole. This resulted in a lower per unit cost and allowed communities with an advanced division-of-labor to extend their market to neighboring areas. The market progressed from being merely domestic, to being regional, and even foreign in scope. It is in coordination with this expansionary tendency that the advantages of easy access to water transport (i.e., the natural geographical advantages of a specific region) allow a market to be extended at a lower cost. This argument was used by Smith to explain the economic prosperity of England:

England, on account of the natural fertility of the soil, of the great extent of the sea-coast in proportion to that of the whole country, and of the many navigable rivers which run through it, and afford the conveniency of water carriage to some of the most inland parts of it, is perhaps as well fitted by nature as any large country in Europe, to be the seat of foreign commerce, and manufactures for distant sale, and of all the improvements which these can occasion. (Smith 1937[1776]:393)

However, for a person to specialize in fishing, they must be able to exchange the surplus of this activity for other things they need.

... the certainty of being able to exchange all that surplus part of the produce of his own labour, which is over and above his own consumption, for such parts of the produce of other men's labour as he may have occasion for, encourages every man to apply himself to a particular occupation, and to cultivate and bring to perfection whatever talent or genius he may possess for that particular species of business. (Smith 1937[1776]:15)

Therefore, it is a worker's ability to acquire the necessities of life which they themselves do not produce (i.e., the extent-of-the-market or opportunities for trade) which provides

the conditions which allow for specialization. In this way the causal connection is brought back full circle.

This circularity between the extent-of-the-market and division-of-labor finds expression in Smith's recognition that some specialized trades would not be present in small markets.

There are some sorts of industry, even of the lowest kind, which can be carried on no where but in a great town. A porter, for example, can find employment and subsistence in no other place. A village is by much too narrow a sphere for him; even an ordinary market town is scarce large enough to afford him constant occupation. In the lone houses and very small villages which are scattered about in so desert a country as the Highlands of Scotland, every farmer must be butcher, baker, and brewer for his own family. (Smith 1937[1776]:7)

As the market expands, an individual's opportunity to specialize is enhanced and the division-of-labor is extended.

These details of the division-of-labor and extent-of-the-market circularity are important to develop since they allow a more concise discussion of Smith's treatment of money and our species' propensity to "truck, barter, and exchange." Smith believed that both of these factors work to augment the opportunities for trade. For example, money serves as a universal standard of exchange which makes trade easier, and thereby engenders a higher degree of specialization.

... when the division of labour first began to take place, this power of exchanging must frequently have been very much clogged and embarrassed in its operations ... every prudent man in every period of society, after the first establishment of the division of labor, must naturally have endeavored to manage his affairs in such a manner, as to have at all times by him, besides the peculiar produce of his own industry, a certain quantity of some one commodity or other, such as he imagined few people would be likely to refuse in exchange for the produce of their industry. (Smith 1937[1776]:23)

The human propensity to "truck, barter, and exchange" was also seen as a catalyst to trade.

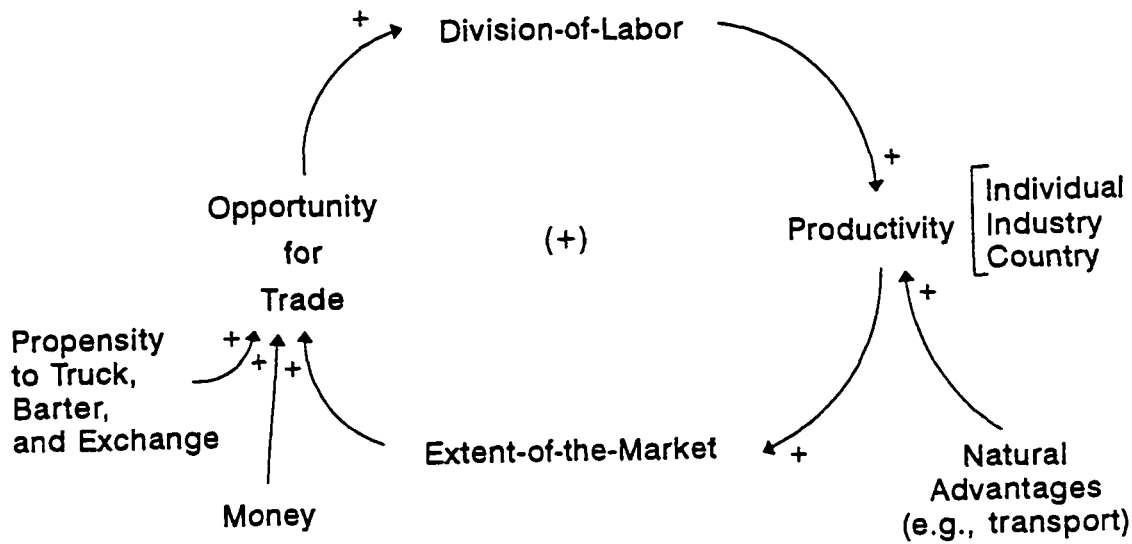
As it is by treaty, by barter, and by purchase, that we obtain from one another the greater part of those mutual good offices which we stand in need of, so it is this same trucking disposition which originally gives occasion to the division of labor. (Smith 1937[1776]:15)

This propensity to exchange "originally gives occasion to the division of labor," because without it our species would never have begun trading amongst themselves. Smith believed that this propensity was a *unique* characteristic of human beings (Smith 1937[1776]:13).

It is interesting to note that this whole exposition takes place in the first four chapters of The Wealth of Nations. The next seven chapters are dedicated to stabilizing circularities which represent the equilibrating dimensions of the economic system; for example, the price of commodities, wages of labor, profits on stock, labor supply, and population growth.¹⁵ Figure 10 illustrates the positive circularity which has been distilled from Smith's writings so far.

¹⁵ These aspects have been explored by Mayr (1971) and Richardson (1984).

Figure 10: A Detailed Division-of-Labor and Extent-of-the-Market Circularity



Accumulation of Capital

The accumulation of capital, explored in Book III of The Wealth of Nations, is a significant factor which influences this division-of-labor and extent-of-the-market circularity.¹⁶ In fact, Smith viewed the accumulation-of-capital as a necessary *precursor* to the division-of-labor. Going back to the very beginnings of a market oriented economy, Smith believed that it was necessary to initially have a surplus of agricultural produce.¹⁷ Surplus agricultural production allowed the division-of-labor to occur in other sectors of the economy by permitting an individual to specialize in producing goods

¹⁶ This facet has been explored in past literature (e.g., Thweatt 1957, Brewer 1991).

¹⁷ Although his emphasis was less than that of the Physiocrats, Smith saw agriculture as a necessary and natural first step of economic development. In fact, he believed that economies which did not grow initially through agriculture, then manufacturing, and finally through foreign trade had progressed in an "unnatural and retrograde order" (Smith 1937[1776]:360).

other than food. But even then, the individual still needed to accumulate a stock of such necessities before they could apply themselves fully to a narrow trade. In discussing the acquisition of subsistence goods by a specialized worker, Smith comments:

... this purchase cannot be made till such times as the produce of his own labor has not only been completed, but sold. A stock of goods of different kinds, therefore, must be stored up somewhere sufficient to maintain him, and to supply him with the materials and tools of his work, till such time, at least, as both of these events can be brought about. (Smith 1937[1776]:259)

Not only is the division-of-labor dependent on the accumulation of a stock of goods, but the accumulation of this stock is not necessary *before* the division-of-labor unfolds.

In that rude state of society in which there is no division of labor, in which exchanges are seldom made, and in which every man provides every thing for himself, it is not necessary that any stock should be accumulated or stored up beforehand, in order to carry on the business of society. (Smith 1937[1776]:259)

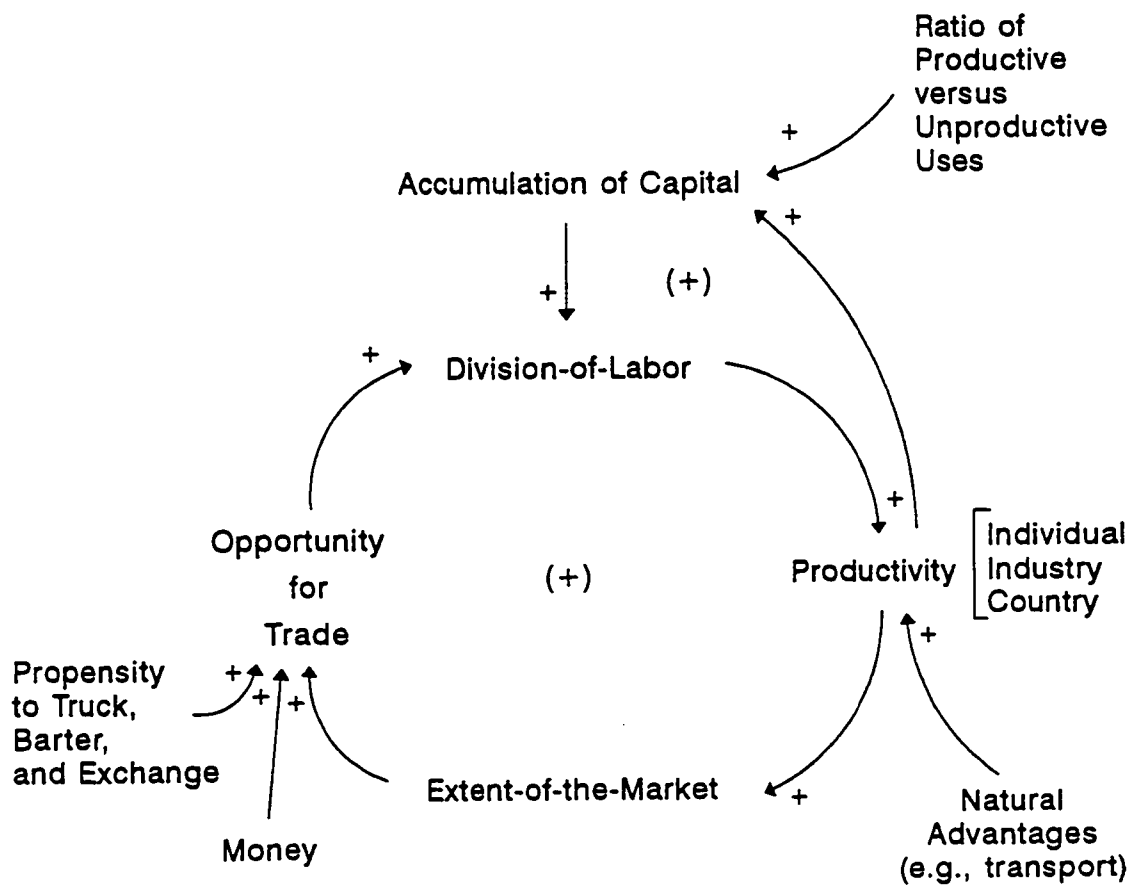
Therefore, the accumulation of stock and the division-of-labor share a complementary relationship; neither was present in the absence of the other and the presence of one implied the presence of the other. Smith explicitly recognizes this circularity in a later comment,

As the accumulation of stock must, in the nature of things, be previous to the division of labor, so labour can be more and more subdivided in proportion only as stock is previously more and more accumulated ... The quantity of industry, therefore, not only increases in every country with the increase of the stock which employs it, but, in consequence of that increase, the same quantity of industry produces a much greater quantity of work. (Smith 1937[1776]:260)

Within this accumulated stock of capital, Smith distinguished between productive and unproductive use as an exogenous determinant of the self-reinforced rate of accumulation. This categorization hinges on the notion that the value of unproductive

uses of accumulated stock perishes the moment it is used and often leaves no trace of value behind. In contrast, productive uses physically manifest this added value such that it can be used to "put into motion a quantity of labour equal to that which had originally produced it" (Smith 1937[1776]:314-315). The use of funds for either re-investment or "idleness" thereby influences the extent of the division-of-labor and ultimately determines the annual produce of the land and labour of the country. In this way, Smith declared that "every prodigal appears to be a public enemy, and every frugal man a public benefactor" (Smith 1937[1776]:324). Figure 11 augments the previous circularity to include these relations.

Figure 11: The Inclusion of the Accumulation of Capital



Political and Legal Context of the Economy

The fact that this accumulation-of-capital and division-of-labor complementarity is emphasized in most research discussing Smith's theories is not surprising when one considers that the accumulation-of-capital, through the choice to invest, seems to be the only external factor (besides money) to an otherwise endogenous system. However, this complementary pattern of circular relations is constrained by formidable relations within

the social structure of society. In particular, Smith discussed the influence of the power structure within the then current class divisions (i.e., nobility, merchants, and peasants) on an individual's Natural Liberty or "right to freely pursue one's interest" (Reid 1989:25). It was changes within the *status quo* class structure of society (i.e., the dominance of the nobility over other classes through the exercise of physical power and hereditary right) which permitted the full emergence of the economic circularities previously discussed.

Not until the power of the nobility started to decline were individuals given an incentive to accumulate capital, improve the productivity of their land, and hence provide the surpluses that permitted extensive specialization to occur.¹⁸ As Brewer (1991:4) noted, savings become dependent on the social and legal framework, which thus becomes "the ultimate determining factor in economic growth." This view, however, seems a bit extreme since the socio-political relations were reflections of economic relations and both were co-dependent on one another. For example, although towns were formed in response to the need for a centralized market for trade, they soon found themselves in the very center of these evolving socio-political relations. Once trade between the town and its immediate surroundings was established, trade between more remote regions began to occur. Merchants who had previously conducted trade between countries began to develop local trade routes to take advantage of productivity and specialization differences between towns and regions. This coupling of previously independent towns

¹⁸ The connection between the rights of one person and liberty of another is also found in J.R. Commons' Legal Foundations of Capitalism (1924). Like Smith, Commons noted the complementary relation between England's common law and the evolution of market economies.

expanded the markets available for both buying and selling goods, increased the division-of-labor, and allowed for a growing level of capital accumulation. This unfolding economic pattern contributed to the process by which towns became *independent political entities*. All the inhabitants of the town became,

... jointly and severally answerable for the whole rent [due to the king]; but in return being allowed to collect it in their own way, and to pay it into the king's exchequer by the hands of their own bailiff. (Smith 1937[1776]:375).

In this manner, towns became functionally synonymous in the king's eyes to the nobility with their hereditary land holdings and indentured serfs. Towns became the seats of "order and good government, and along with them the liberty and security of *individuals*" (Smith 1937[1776]:379, emphasis added). Smith noted that the nobility "despised the burghers [towns], whom they considered not only as a different order, but as a parcel of emancipated slaves, almost of a different species from themselves" (Smith 1937[1776]:376).

As the merchant class rose in power by feeding and being fed by the growth of cities, this ascendance was coupled with a decline in the nobility's power and a rise in what Smith called Natural Liberty. For example, an individual peasant could escape from the traditional economic and socio-political dependence exerted by their dominant lord by entering into the evolving market economies within the cities. Such possibilities were quite novel at this point in history.

If in the hands of a poor cultivator, oppressed with the servitude of villanage, some little stock should accumulate, he would naturally conceal it with great care from his master, to whom it would otherwise have belonged, and take the first opportunity of running away to a town. The law was at that time so indulgent to the inhabitants of towns, and so desirous of diminishing the authority of the lords over those of the country, that if he could conceal himself there from the

pursuit of his lord for a year, he was free forever. Whatever stock, therefore, accumulated in the hands of the industrious part of the inhabitants of the country, naturally took refuge in cities, as the only sanctuaries in which it could be secure to the person that acquired it. (Smith 1937[1776]:379)

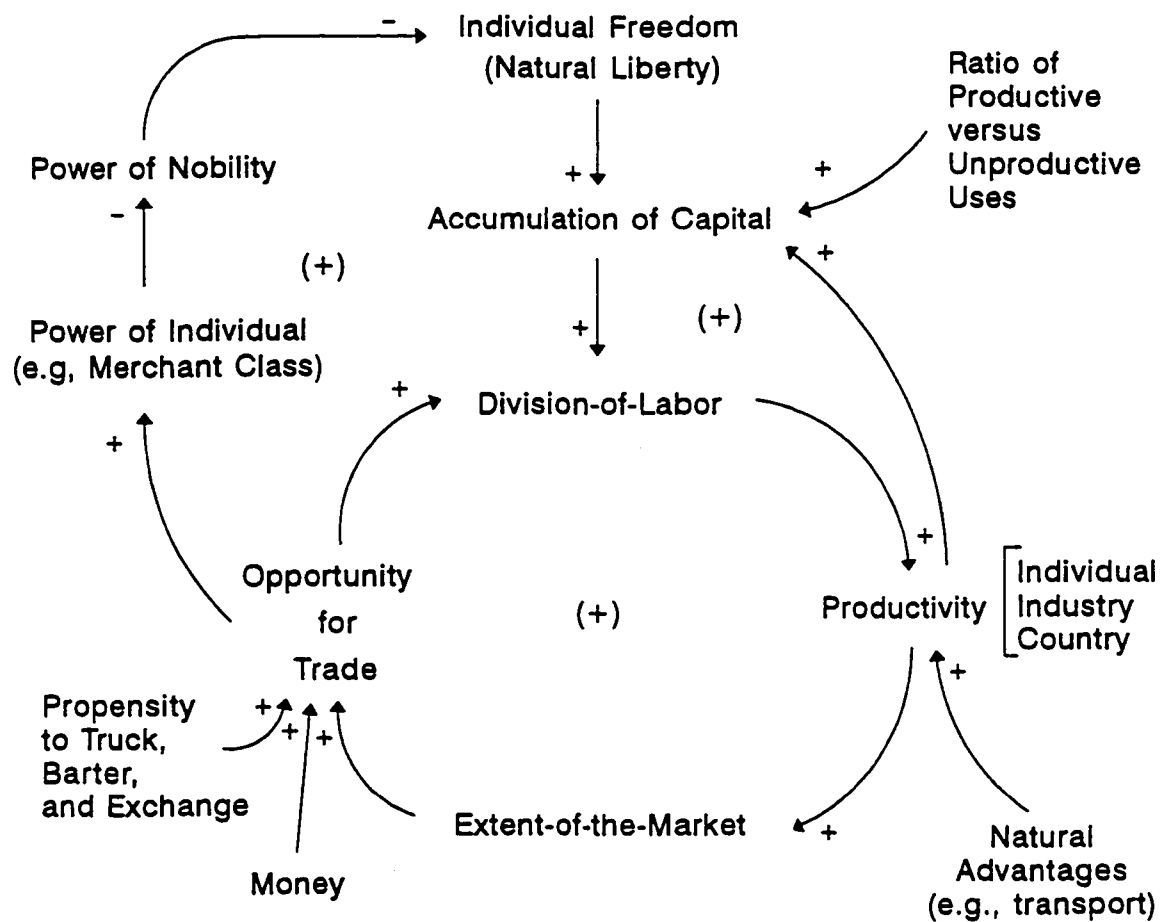
When the nobility was stronger, they had the right to take the possessions of an individual under their protection. Under such circumstances, there was no such thing as personal property, and therefore the division-of-labor was restricted. Society was unable to develop a full network of markets since specialization required the accumulation of stock.

Furthermore, Smith believed the nobility fueled their own destruction since they frequently used the surplus extracted from their dependents to buy consumption goods on the evolving market rather than investing it in their productive land holdings (i.e., an unproductive use of accumulated stocks). By trading their surplus for "trinkets and baubles, fitter to be the play-things of children than the serious pursuits of men, they became as insignificant as any substantial burgher or tradesman in a city" (Smith 1937[1776]:391). In addition, these purchasing decisions fed the expanding web of interrelations which were destroying the very social structure upon which their world was built.

This discussion highlights Smith's clear recognition of the importance of social relations within society. The economy would not have unfolded to its full potential without initial changes in the social relations of society. However, as these socio-political changes fed into changing economic relations, these latter changes served as the basis from which deeper social change occurred. As Reisman (1976:14) commented, for Smith, "the institutional and normative framework of society cannot be simply dismissed

with a *ceteris paribus* assumption: economic activity itself is alone enough to prevent *ceteris* from remaining *paribus*." This rich conception of the complementary circularities found within Smith's socio-economic theory are diagrammed in Figure 12.

Figure 12: The Complementary Dimension of Smith's Socio-Economic Evolution



Limits to Growth

Having explored Smith's self-reinforcing process of economic prosperity, one will naturally ask if Smith foresaw any limits to this progressive spiral. While it was the lack

of definite constraints on this spiral of growth which caused Hume to reject Josiah Tucker's ideas on the unlimited potential for growth, the presence of such constraints in Smith's theory were more to Hume's liking (Hont 1983; Elmslie 1995). What were these constraints? Smith did foresee the possibility that this ever increasing prosperity could be stalled by errors in a country's economic policy (e.g., his well known critique of Mercantilist doctrine). However, these errors are not a necessary constraint within a well managed economy and therefore not a satisfactory constraint by themselves.

There were two endogenous limits that Smith identified within his model of the economic process. The first is local, the second global. First, Smith envisioned economic growth as expanding into the natural advantages of a country. The idea was that a country would acquire "that full complement of riches which the nature of its soil and climate, and its situation with respect to other countries, allowed it to acquire" (Smith 1937[1776]:94). These limits to one country's opulence with respect to its neighbors is stated succinctly in the following quote:

A nation that would enrich itself by foreign trade, is certainly most likely to do so when its neighbors are all rich, industrious, and commercial nations. A great nation surrounded on all sides by wandering savages and poor barbarians might, no doubt, acquire riches by the cultivation of its own lands, and by its own interior commerce, but not by foreign trade. (Smith 1937[1776]:462)

This establishes a local maximum to which the self-reinforcing relations of economic prosperity are held in check, but does not set a global cap on prosperity. For this, we

need to turn to Smith's ideas concerning technological change and the advancement of knowledge.¹⁹

Although Smith undoubtedly believed that an increasingly refined division-of-labor caused people to mentally and morally degenerate over time (West 1964), this does not necessarily lead to a decline in the overall state of knowledge. As Rosenberg (1965) interpreted Smith, although intense specialization leads to the diminished mental capacity of the workers, it also leads to the increased mental capacity of the philosophers (specialists in thinking). Therefore, although the,

modal level of understanding is very low, the *highest* levels of scientific attainment permitted by the extensive specialization in the production of knowledge are quite remarkable. The *collective* intelligence of the civilized society, then, is very great. (Rosenberg 1965:137, emphasis in original)

The global constraint on economic progress is embedded within Smith's belief that the pinnacle of understanding is finite and relatively close on the historical horizon. Therefore, the philosophers' ultimate role will be to merely ensure that society's knowledge is not lost.²⁰ It has been argued that Smith saw the division-of-labor and technological knowledge as approaching some finite state, and that he was unable to envision "the growth of knowledge taking fundamentally new paths" (Elmslie 1994b:19). Therefore, the division-of-labor, and hence the economy itself, evolves into a steady state which has no further possibility for change, nor further novelty.

¹⁹ It has sometimes been contended that Smith did not have a concept of technological change (e.g., Rashid 1986), but if one views knowledge as an understanding of harmonious arrangement then the division of labor itself is a concept of technological change (see also Elmslie 1994a, 1994b; Reid 1987:92).

²⁰ This notion of an economic steady state is, in itself, a significant change from the popular ideas of Montesquieu which posited an inescapable natural decline of a country's success (Hont 1983).

From Smith to Marshall

In the past, Smith has frequently been seen solely through the filters of self-interested behavior and equilibrating, mechanical models (e.g., Hodgson 1993b). Such a perspective however, does not do justice to the richness of his economic insight. The interpretation presented here serves to broaden these narrow impressions of Smith's economic theories by emphasizing their evolutionary, in contrast to their equilibrating, dimension. Reid (1989:xi,) presented a qualitatively similar argument by emphasizing that Smith "thought in terms of process rather than equilibrium." He interpreted Smith as having theoretical stages of economic growth whereby the conversion from feudalism to mercantilism and mercantilism to industrialism involves "converting a state of stable but undesirable equilibrium into one of unstable but desirable growth" (Reid 1989:9). The only difficulty with this approach revolves around its need to sharply differentiate between different stages of civilization (i.e., stable equilibrium states) rather than allowing it to be a continuously evolving stream of relations.

What was done with Smith's ideas of complementary processes by the economic profession? Not much for many years. However, the complementary circularity between the accumulation-of-capital and division-of-labor, in coordination with the decision to invest rather than consume, began to be addressed as a single issue in economic theory. The individual firm began to embody this self-reinforcing process such that declining unit costs were seen to fall as the scale of production increased. However, if these circularities (soon to become known as increasing returns) are checked only by

the extent-of-the-market, then theoretically a market would become completely monopolized by a single firm.

Some, among whom Cournot himself is to be counted, have before them what is in effect the supply schedule of an individual firm; representing that an increase in its output gives it command over so great internal economies [an internal division-of-labor between labor and capital] as such to diminish its expenses of production; and they follow their mathematics boldly, but apparently without noticing that their premises lead inevitably to the conclusion that, whatever firm gets a good start will obtain a monopoly of the whole business of its trade in its district. (Marshall 1990[1920]:380, footnote 1)

Since the economy was not dominated by single firms within each trade, it was clear that the circularity between the division-of-labor and accumulation-of-capital needed further refinement. The profession had somehow misplaced the extent-of-the-market variable and the socio-political context.

Smith (and most other classical economists) presented the division-of-labor as a general *empirically observable* characteristic of the economy which provided a broad social benefit. However, once Marshall began to address these issues, the field of economics was in the process of establishing itself as a science. As a result, the broad theoretical brush strokes which classical economists had used to paint a picture of the economy were being held accountable to deeper levels of logical scrutiny. Along these lines, Marshall believed that the inherited theories of complementary processes were seen to lead "inevitably to things which do not exist and have no near relation to reality" (letter to A.W. Flux, March 1898, published in Whitaker 1975:51). As a result, Marshall engaged in a "Wanderjahre among factories" in order to discover the finer details of these relations. The theory of industrial organization in his Principles of Economics (1990[1920], 8th Edition) attempted to make finer theoretical distinctions

within the division-of-labor argument which would alleviate, to some extent, these problems. In exploring this path, he was the first economic theorist to implicitly analyze the *nested layers* of complementary circularities that exist within the economic system. Although these layers existed between individuals, towns, and regions in Smith's economic theory, Marshall's investigation refined them more fully. As a result, Marshall's theory stretched the assumptions of his *philosophical* framework to such an extent that these assumptions should have fallen under scrutiny. The fact that they did not caused a noticeable tension to arise within his writings. It is with this in mind that we proceed to Alfred Marshall's ideas.

Alfred Marshall

The first point to address when discussing the evolutionary dimension in Alfred Marshall's economic theory is his explicit acknowledgement of the biological quality of economic interaction *in contrast to* the fact that the majority of his theory was mechanical in form. It is important to note that he used the term *biology* in an organismic sense. In other words, he was appealing to a philosophy of organism: one which focuses on different levels of order (colloquially referred to as *organic wholes*) rather than merely the biological substructure of socio-economic phenomena. In order to see this, the distinction which Marshall made between biological (i.e., evolutionary) and mechanical (i.e., equilibrating) analysis will need to be explored. This can be done through the use of causal diagramming techniques (i.e., co-dependent and stabilizing circularities): theoretical concepts which would emerge later within the field of biology (e.g., von Bertalanffy 1968).

The evolutionary dimension of Marshall's economic theory begins with his distinction between different economic manifestations of the generic division-of-labor and accumulation-of-capital circularity based on the recognition of a differentiating and integrating dimension. This refinement informed Marshall's biological vision and led him to a developmental or ecological perspective on change which implicitly involved a hierarchy of *organic wholes* within the economic system. In support of this interpretation, three distinct levels of complementary circularities can be identified in

Marshall's economic theory, these being the internal and external economies found in industrial organization and the quality of labor. While such a perspective provides many insights into Marshall's work, it needs to be made explicit that I am not contending that Marshall used such notions consciously. Rather, I believe that Marshall's implicit use of these ideas reflects his sensitivity to the evolutionary dimension of economic systems and his explicit preference for biological models. Since a hierarchical nesting of circularities is a biological/ecological concept and since Marshall explicitly espoused the biological paradigm, the fact that Marshall's theory can be interpreted through such theoretical filters should not be surprising.

The coordination of these two facets of Marshall's thought (i.e., the distinction between differentiation and integration in coordination with the desire to develop a biological concept of economic interaction) created a tangible theoretical tension that exists within Marshall's major work, The Principles of Economics (hereinafter Principles). He unconsciously utilized a conceptual hierarchy for economic organization while explicitly maintaining the notion of a single level of theoretical analysis.²¹ Marshall's belief that "Natura non facit saltum" (Nature takes no leaps) was in direct conflict with the conceptual discontinuities found in the translation of his perceptions of the socio-economic process into theory. This inherent tension will be the last point explored within Marshall's theories.

²¹ A detailed discussion of the discontinuities inherent to hierarchical concepts is contained in the last chapter of this dissertation.

Biological Metaphor: Real or Rhetorical?

To begin with, a quick look at Marshall's work from a neoclassical perspective is interesting. These writers seem to be of the opinion that Marshall was vague, had a blurred vision, and that he derailed the progress of economic theory. The following list of headings from Samuelson's (1967:109,111,113) essay on monopolistic competition convey this attitude towards Marshall's work: "Exorcizing the Marshallian Incubus," "Retrogression in Monopoly Theory," and "Retrogression in Perfect Competition Theory." However, since Marshall's contributions to the field cannot be denied, he seems to come off as a heretical founder of neoclassical economics. For the purposes of this dissertation, the issue is not whether Marshall is guilty of "delaying the understanding of general equilibrium" (Samuelson 1967:113), but whether it was *his intention* to further such an biologically antithetical concept?

It is questionable whether there is an effective biological dimension within Marshall's economic theory. While the Principles grew out of the analytical foundations contained in Book III, "On Wants and their Satisfaction," and Book V, "General Relations of Demand, Supply, and Value" (Whitaker 1975:84), the only section which really used biological analysis was his discussion of industrial organization (Brinley 1991; Hodgson 1993a, 1993b). In fact, Brinley (1991:8,11) concluded that Marshall was "for the most part indulging in analogies or figures of speech" rather than providing biological analysis, and that "economic biology remained promise rather than substance."²² He went on to ask why Marshall never delivered the promised second volume to his

²² Currie and Steedman (1990) noted this same point.

Principles, which was supposed to extend his analysis more fully into the realm of economic biology.

Is it not probable that, in giving so much time to those Royal Commissions, the revising of his Principles and various professional activities, Marshall was really creating for himself a series of alibis? ... Could it have been that there were over-riding intellectual reasons why he could not accomplish the big task? (Brinley 1991:9)

He concluded that Marshall,

... had come to realize more and more that the study of organic growth necessitated *a break with his neoclassical system* as definite as the break he had made with the Ricardo-Mill system ... he would have to work out within him the foundations of yet another science - economic biology. (Brinley 1991:11-12, emphasis added)

In order to explore this insight fully, it is important to determine what *Marshall* meant by biological and mechanical concepts.²³ First of all, the words *mechanical* and *equilibrating* share similar meanings for him and are frequently used together. For example, note the following references to mechanical frameworks within his Principles: (1) In his discussion of firms, and as a precursor to his discussion of markets, he used the analogy of a "balancing of forces which corresponds rather to the mechanical equilibrium of a stone hanging by an elastic string, or a number of balls resting against one another in a basin" (Marshall 1990[1920]:269). (2) With respect to the distribution of income he used these same two examples (Marshall 1990[1920]:437) and a third example of "when two tanks containing fluid are joined by a pipe ... and thus the general levels of the tanks will tend to be brought together" (Marshall 1990[1920]:551). Both

²³ The use of the biological metaphor in Marshall's Principles has been investigated previously from many different perspectives (e.g., Brinley 1991; Foster 1993; Hodgson 1993a, 1993b; Levin 1983; Niman 1991a, 1991b).

of these examples correspond to equilibrating processes in which stable interrelations are reached.

Marshall's biological metaphors were different from his mechanical ones in two distinct ways. First, they involved the growth and decay of a process which is not in equilibrium, but rather constantly changing. Preceding the first mechanical metaphor presented above, Marshall spoke of "economic forces as resembling those which make a young man grow in strength; after which he gradually becomes stiff and inactive, till at last he sinks to make room for other more vigorous life" (Marshall 1990[1920]:269).

One of his most quoted statements also expresses this idea.

... we may read a lesson from the young trees of the forest as they struggle upwards through the benumbing shade of their older rivals. Many succumb on the way, and a few only survive; those few become stronger with every year, they get a larger share of light and air with every increase of their height, and at last in their turn they tower above their neighbors, and seem as though they would grow on for ever, and for ever become stronger as they grow. But they do not. One tree will last longer in full vigor and attain a greater size than another; but sooner or later age tells on them all ... And as with the growth of trees, so was it with the growth of businesses as a general rule ... (Marshall 1990[1920]:263)²⁴

This leads into the second distinction between mechanical and biological metaphors, the fact that this process of growth and decay was a characteristic of the firm for Marshall and that the industry (which is composed of a heterogeneous complement of

²⁴ This quote finishes with "... before the great recent development of vast joint-stock companies, which often stagnate, but do not readily die." This was added in the sixth edition of his *Principles* (Shove 1942:321). Although this biological theory of the firm may lose some of its credibility in an environment of extensive stock financing (e.g., see Penrose 1952), Marshall's vision does not stand or fall with this single point. Levine (1980) makes the point that a fundamental component of Marshall's theory of the firm involves the concept of time and the fact that change is not instantaneous: the firm is an *active* element within a larger process. This will be investigated later.

growing and decaying firms) continued on its own evolutionary path independent of, yet dependent on, the birth and death of these individual firms. For example, he stated,

... the rise and fall of individual firms may be frequent, while a great industry is going through one long oscillation, or even moving steadily forwards; as the leaves of a tree (to repeat an earlier illustration) grow to maturity, reach equilibrium, and decay many times, while the tree is steadily growing upwards year by year. (Marshall 1990[1920]:379)

So, not only did he use biological metaphors to characterize the process of growth and decay, but he also recognized the *nesting* of such concepts. This led him to implicitly use a theoretical model of complementary circularities which was applied discretely to different processes within the economy: therefore, he did not simply aggregate his conceptual model of the parts (e.g., individual firms) to form his concept of the whole (e.g., the industry). This point is addressed more thoroughly later on.

In coordination with these two specific characteristics of his biological metaphor, it is also possible to highlight the philosophical tenor of Marshall's thought which lent itself to a biological perspective. For example, he espoused mutual, rather than linear, notions of causality. He stated,

... it is necessary to face the difficulty of regarding the various elements of an economic problem, - not as determining one another in a chain of causation, A determining B, B determining C, and so on - but as all mutually determining one another. (Marshall 1990[1920]:viii)

Shove (1942:303, emphasis added) noted that the "principle of mutual determination *everywhere supersedes* the idea of a single determinant or a one-way chain of causes" in Marshall's Principles. From this philosophical emphasis on mutual causality emerges a more complex perspective on cause and effect which allows for self-reinforced endogenous change, a point that Marshall noted at times.

These ideas found expression within Marshall's theory of industrial organization through the productivity and capital stock variables (Beach 1982:61) and therefore have their historical roots in the complementary circular relations between the division-of-labor and accumulation-of-capital. It is perhaps this insight into endogenous change which led Marshall to anticipate economics being modelled along biological lines. As he stated in the preface to the 8th edition of his Principles,

The main concern of economics is thus with human beings who are impelled, for good and evil, to change and progress. Fragmentary static hypotheses are used as temporary auxiliaries to dynamical - or rather biological - conceptions: but the central idea of economics, even when its foundations alone are under discussion, must be that of living force and movement. (Marshall 1990[1920]:xiii)

For Marshall, the distinguishing quality of life is unquestionably the process of growth and decay.

Therefore, it seems that one can begin to address Brinley's question as to whether Marshall's theory contained an effective biological facet by asking whether there are any theoretical concepts useful in modeling such living/biological processes as described above and whether homologous concepts can be found in Marshall's economic theories? The theoretical concept of circular causality fulfills both these requirements. However, before turning to these theoretical ideas, it is necessary to explore one more facet of Marshall's biological vision.

As a final feather in his biological cap, one can point to Marshall's emphasis on organizational structure which materialized as a theoretical distinction between the

differentiating and integrative dimensions of the division-of-labor.²⁵ For Marshall, an increasing division-of-labor involves both a subdivision of functions, or "differentiation," and a more intimate connection between the specialized parts, or "integration" (Marshall 1990[1920]:200-201). As examples of differentiation, Marshall cited the development of specialized skills, knowledge, and machinery. For integration, he noted the increased security of commercial credit, the advances in communication (both physical and mental), and ethics/morality. While differentiation is a characteristic of the individual parts of the process as distinct from one another, integration is a characteristic of the interrelation of these parts as a whole process. These two concepts are linked by the fact that the advantages of the differentiation between parts must be realized through their integration into a single process.²⁶ In this way, the benefits of integration manifest themselves at many different levels of the economy (e.g., firms, industries, and regions). This concept of leveling can be used to better understand many difficulties which have been identified within Marshall's theories. Questions such as: What is the representative firm? What are the benefits of distinguishing between internal and external economies? And, most

²⁵ This is undoubtedly Spencer's influence. Spencer saw such a strong theoretical union between organisms and society that he openly appropriated biological ideas to talk about the development of society as a super-organism. Furthermore, he fought tooth and nail in support of a Lamarckian interpretation of evolution, even after such notions had been thoroughly rejected by academic biologists. Lamarck contended that the somatic changes of an organism could be passed on to its progeny: the inheritance of acquired characteristics. Unlike Lamarck and his followers, Spencer's focus on society rather than the individual allows for the possibility of Lamarckian evolution (e.g., knowledge). The fact that Lamarckian inheritance operates at the population rather than the individual level, a point missed by Lamarckian theorists, is critical to the integrity of this theory with respect to social phenomena (Bateson, 1979).

²⁶ In Smith's framework, the level of differentiation possible between markets is limited by the integration of these distinct markets into a single process of trading for needed commodities (i.e., the economy).

importantly, why did Marshall fail to develop a truly biological theory of economic change?

Three Conceptually Distinct Levels of Complementary Circularities

The following levels of complementary circularities which will be identified within Marshall's Principles represent the different integrative levels in his theory of the economy. While the first involves the quality of labor at the level of the individual or family, the second and third involve the notion of increasing returns at the level of the firm and between firms. More accurately, one could say that this third loop is at a higher level in his economic model than the individual firm and represents the integrative advantages which occur at the level of the industry, city, or region. As a result, it manifests as a constant or *external* economy from the perspective of the individual firm. This is in contrast to those integrative advantages which occur within the individual firm and are coined *internal* economies.²⁷

The Individual or Family.²⁸ The complementary relations active at the individual or family level (hereafter referred to simply as the individual) manifest themselves

²⁷ If we look at Marshall's discussion of wealth we find that he divided non-material goods with a homologous classification scheme. The first category consisted of qualities and faculties that lie within a consumer and were called internal, while the second consisted of "relations beneficial to him with other people," and were called external (Marshall 1990[1920]:45). An analysis of his discussion of industrial organization supports the contention that these terms continue to carry these connotations latter in his Principles.

²⁸ I am not sure which of these two levels is a more appropriate label for Marshall's thinking and therefore present them both.

through the interaction between the material wealth and productivity of the worker. Marshall's interest in this relationship reflects his concern for issues of economic poverty, an issue which gives "to economic studies their chief and their highest interest" (Marshall 1990[1920]:3). In coordination with his belief that economic systems could be consciously "modified by human efforts," the ultimate goal of all private effort and public policy became the improvement of the "well being of the whole people" (Marshall 1990[1920]:29,39).

While Marshall's account of general population growth is Malthusian in tone (i.e., a balance of countervailing forces), the growth of the individual possessed a complementary dimension. None would question the notion that an individual's wealth is dependent on his or her flow of income, which is dependent on that person's productivity. Marshall, however, also saw wealth as the means by which productivity is cultivated and sustained.

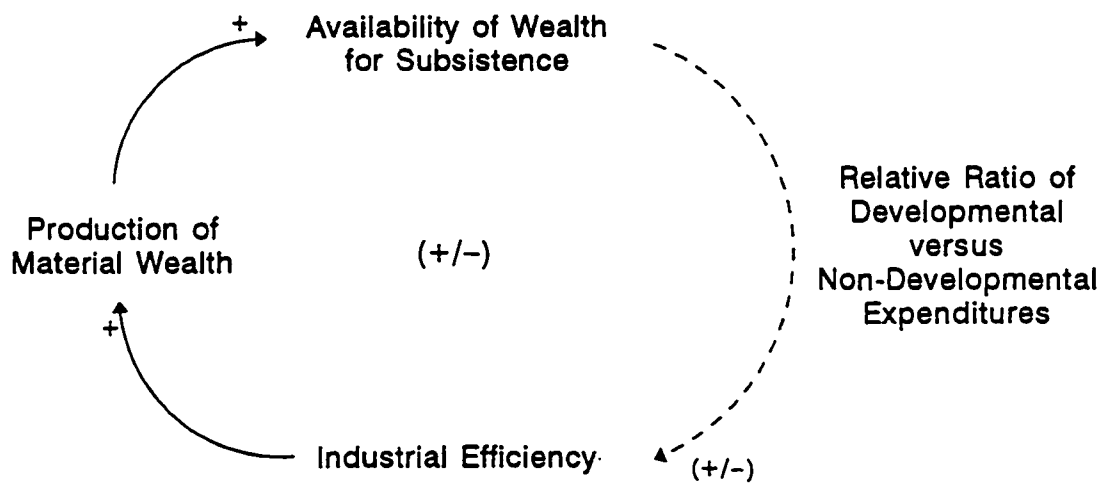
The production of wealth is but a means to the sustenance of man; to the satisfaction of his wants; and to the development of his activities, physical, mental and moral. But man himself is the chief means of the production of that wealth of which he is the ultimate aim. (Marshall 1990[1920]:144)

Wealth sustains and develops an individual, while this individual himself is the chief means of production for this holding of wealth. These ideas are restated in a later quote,

... consider the conditions on which depend health and strength, physical, mental, and moral. They are the basis of industrial efficiency, on which the production of material wealth depends; while conversely the chief importance of material wealth lies in the fact that, when used wisely, it increases the health and strength, physical, mental and moral of the human race. (Marshall 1990[1920]:161)

There are two points to consider here. First, there is a choice involved in the way that material resources are used. Second, that resources used "wisely" lead to increased industrial efficiency. This potentially complementary circularity is diagrammed in Figure 13.

Figure 13: Income and Individual Productivity



It is the ratio and quality of non-developmental to developmental expenditures that determines the degree of self-reinforcing growth within this circularity. The distinction between developmental and non-developmental expenditures is defined empirically as those which do and don't increase individual productivity.

Marshall partitioned a worker's health and strength into three parts: the physical, mental, and moral. It is the physical and mental aspects which have been emphasized by conventional economics, while the moral aspect or character of the individual has

been discarded.²⁹ However, this third aspect is significant within Marshall's economic theory since (1) the division-of-labor entails an integration of society and (2) ethics/morality is a quality of the individual which determines the atmosphere of human interaction. Ethical development corresponds to a deepening of one's ethical sensitivity, and its benefits are not solely limited to the individual who embodies them, but also helps to form an atmosphere for social interaction. In contrast, the development of an individual's physical and mental qualities allow for a much greater degree of private appropriability and can therefore be consciously withheld from society.

An understanding of this three-fold division of the individual is doubly important since Marshall believed that there was the possibility for hysteresis with respect to an individual's character. This postulated path dependency made fluctuations in an individual's income below some threshold level (i.e., the ability to buy adequate food, clothing, and shelter) an important consideration. If income falls below this minimum, there will be a corresponding decline in an individual's physical and mental, strength and health. However, this effect is fully removed if higher incomes are restored. In other words, the effects are not cumulative. In contrast to this, income fluctuations have a cumulative impact on the character of a worker. The visible effects of a decline in income,

²⁹ What Marshall meant by "character" is worth note. He commented at one point that "force of will, and strength of character" is "taken to be the strength of the man, as distinguished from that of his body, is moral rather than physical" (Marshall 1990[1920]:162). He continued, "this strength of the man himself, this resolution, energy and self-mastery, or in short this 'vigour' is *the source of all progress*: it shows itself in great deeds, in great thoughts and in the capacity for true religious feeling" (Marshall 1990[1920]:62). In a subsequent footnote he cited Leonardo da Vinci and Shakespeare as good representatives of strong character and tied his notion of character to *Heart* in Engel's three-fold division of the individual into Body, Reason, and Heart.

... end with the evil by which they were caused, [but] are not generally to be compared in importance with those that have the indirect effect of lowering the character of the workers or of hindering it from becoming stronger. For these last cause further weakness and further suffering, which again in their turn cause yet further weakness and further suffering, and so on cumulatively. On the other hand, high earnings, and a strong character, lead to greater strength and higher earnings, which again lead to still greater strength and still higher earnings, and so on cumulatively. (Marshall 1990[1920]:466)

The impact of this complementary relation is magnified since the rearing and educating of a child is done by someone who will receive very little of the price that is paid for his services in later years. Therefore, it is necessary that parents bridge this gap of self-interest. However, in the "lower ranks of society" these investments are not made and children "go to the grave carrying with them undeveloped abilities and faculties" (Marshall 1990[1920]:467). Most importantly, this social tendency is continually reinforced since these impoverished workers soon become parents themselves and the cycle is perpetuated.

... the point on which we have specially to insist now is that this evil is cumulative. The worse fed are the children of one generation, the less will they earn when they grow up, and the less will be their power of providing adequately for the material wants of their children; and so on to following generations. And again, the less fully their faculties are developed, the less will they realize the importance of developing the best faculties of their children, and the less will be their power of doing so. (Marshall 1990[1920]:468)

In contemporary terms, this is a poverty trap which prevents the flowering of human potential and represents a drag on socio-economic progress. Marshall wrote that "the distinction of the poor is their poverty," and that "the conditions which surround extreme poverty, especially in densely crowded places, tend to deaden the higher faculties."

The Orthogonal Nature of Increasing and Diminishing Returns. Before moving on, it is important to discuss Marshall's use of the increasing returns concept:

The law of increasing return may be worded thus: - An increase of labour and capital leads generally to improved organization, which increases the efficiency of the work of labour and capital. (Marshall 1990[1920]:265)

First, note that Marshall included *organization* as an explicit factor of production (Marshall 1990[1920]:115). Second, although most current economists would tend to think of increasing returns as a phenomenon occurring at the level of the individual firm, Marshall saw it as a general phenomenon inherent to many levels of the economy. This could be the aggregation of individuals to form a firm, firms to form a city, or cities to form a region. In support of this interpretation, Marshall frequently blurred the distinction between the firm and the factory (a common point of criticism by neoclassical theorists, e.g., Stigler 1941) and spoke of an industry's, region's, and nation's output as if all these different levels can display increasing returns (Marshall 1990[1920]:220). In doing so, he emphasized the general nature of organizational efficiency. It is his distinction between increasing returns inherent to the firm versus those which emerge from its interrelations with other firms that corresponds to a firm's internal and external economies. From this perspective, the representative firm is a conceptual bridge serving to represent individual firms within an industry level analysis (i.e., having average internal and external economies) and therefore a purely pedagogical device which has no physically manifest counterpart.

It is also important to note that Marshall did not view diminishing returns as the conceptual inverse of increasing returns, but as a distinct facet. For example, the role

of physical matter (i.e., Nature) shows a tendency to diminishing return, while human knowledge (i.e., Organization) shows a tendency to increasing returns.³⁰ These are not two poles of the same continuum, but distinctly different dynamic relations. Marshall (1990[1920]:266, footnote 1, emphasis added) explicitly stated this belief by quoting one of his contemporaries:

Increasing Returns are not of the same order as those that make for Diminishing Returns: and there are undoubtedly cases in which it is better to emphasize this difference by describing *causes* rather than *results*, and contrasting Economy of Organization with the Inelasticity of Nature's response to intense cultivation. (Bullock 1902, emphasis in original)

The Firm: Internal Economies. Marshall viewed the firm as an amalgamation of individual workers and capital which displays integrative qualities which cannot be attributed to the individual parts: although the firm is composed of these parts, this composition has a quality not reducible to the individual qualities of its components. However, since the firm's resources are generally under the direct control of a single owner (or possibly a small group of people), Marshall focused on this specific individual when talking about the firm.³¹ This is an unfortunate, but understandable error. It is unfortunate since it tends to give the impression that the business entrepreneur/owner is the critical component of the firm, and Marshall's discussion concerning the rise and fall

³⁰ What I find interesting here is nature's restrictive influence in contrast to the expansive influence of social organization and knowledge on production. In reading the Principles, one cannot conclude that Marshall saw nature as being at a higher level than the economy (as many environmental and ecological economists, myself included, would contend), but it is equally erroneous to assume that he viewed nature as subordinate to the economy (i.e., at a lower level). The conventional economic theory of production tends to take this latter perspective.

³¹ The reader will undoubtedly realize that the appropriation of the benefits of aggregation at this level was, and still is, a hotly contested debate in economics.

of firms reflects his attempt to operationalize this misperception in his theory. As a result, he directed an inordinate amount of attention to the historical individual rather than the services this individual provides (Levine 1980). This misplaced emphasis was fed by the empirical fact that in Marshall's time, ownership and management were synonymous with one another. These errors have been used to discount his theory of the firm (Penrose 1952). However, keeping in mind the focus that Marshall should have made explicit, we can look at the spirit of his ideas in a new light.

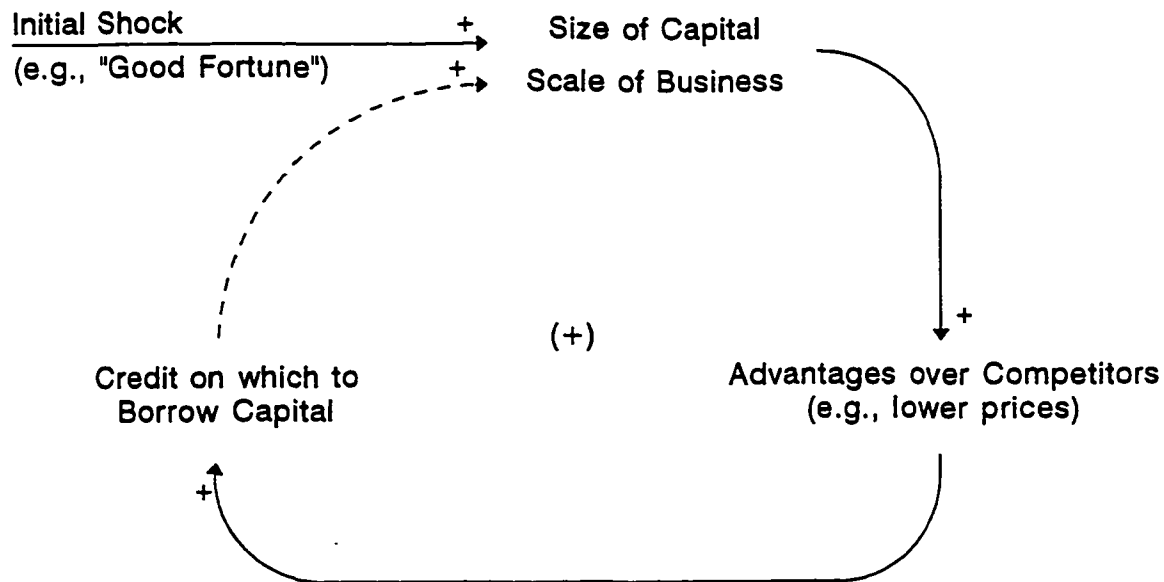
The general notion is that once a firm has acquired a small stake of capital, this capital affords it increasing opportunities to increase that stake.

An able man, assisted perhaps by some stroke of good fortune, gets a firm footing in the trade, he works hard and lives sparely, his own capital grows fast, and the credit that enables him to borrow more capital grows still faster ... success brings credit and credit brings success ... The increases in the scale of his business increases rapidly the advantages which he has over his competitors, and lowers the price at which he can afford to sell. This process may go on *as long as his energy and enterprise, his inventive and organizing power retain their full strength and freshness*, and so long as the risks which are inseparable from business do not cause him exceptional losses; and if it could endure for a hundred years, he and one or two others like him would divide between them the whole of that branch of industry in which he is engaged. (Marshall 1990[1920]:262-263, emphasis added)³²

This relationship is diagrammed in Figure 14.

³² See also Marshall (1990[1920]:238).

Figure 14: The Internal Economies of the Firm



In addition to the more conventional limitations of market size and marketing/transportation costs, Marshall introduced the quality of the individual managing the business as a limitation to this complementary spiral of success. The realization of internal economies is not a passive endeavor in Marshall's eyes, but an *active* pursuit that requires vigor, enthusiasm, insight, and mental strength. Furthermore, Marshall (1990[1920]:248-250) believed that these "leadership qualities" of the business owner are sparingly dispersed throughout the population and result from both the environment in which an individual is raised and their natural abilities. While such business skills are obviously found within the individuals who build a business, it is not necessarily these individuals who cause a firm to decay, but rather the people who take

over the business after these founding fathers have passed away. The individuals who inherit the business may lack the vitality and enthusiasm required for continued growth.

Although this theory of the firm has lost some of its credibility with the rise of joint-stock companies (i.e., a division-of-labor between owners and management), one can still see the importance of the active element of business management. A firm's vigor and enthusiasm within the competitive process is usually a direct reflection of its management. This emphasis is similar to Levine's (1980:271) view that Marshall's reconciliation of increasing returns with competition is, in part, accomplished by his recognition that *production is a process and all processes require time*. It takes time to expand markets, acquire capital, and realize the economies of large scale production. It is these qualities which determine the rate of expansion and the level of complacency within the *status quo*. Such issues are still important today in the study of firms and corporations.

Aggregate Industry: External Economies.³³ What Marshall sought to capture in his use of the external economies concept was an explicit acknowledgement that the organization of cities and broad regional economies may serve to integrate their composite parts into a synthetic whole just as an individual firm organizes its valuable resources (e.g., skills, materials, and machinery) in different ways to achieve greater

³³ Marshall thought of an industry as consisting of all the firms engaged in the production of a final consumption good (whether consumer or investment). Therefore, the industry was seen as a complementary array of vertically integrated "individual" parts or the division of labor amongst firms engaged in the production of the "same commodity."

productivity.³⁴ However, these economies will be external to an individual firm since they involve the integration of parts in which the firm is only one. An individual part can only create increased external economies in coordination with complementary changes in the other components of the integrated process (Marshall 1990[1920]:264). Therefore, one could say that this integration occurs at a level higher than the individual firm and thereby creates the environment which the firm acts within (e.g., city, region, or nation).

It is unfortunate that Marshall did not clearly articulate the idea that external economies include all those which manifest at a higher level of integration than the individual firm. As mentioned previously, this ambiguity has caused some (e.g., Stigler 1941) to conclude that he put forth contradictory definitions. For example, while one set of definitions involved those economies experienced due to an increase in the scale of production in a specific industry (Marshall 1990[1920]:220, 221, 262), another involved the collective economic organization of the district as a whole (Marshall 1990[1920]:xii, 220, 264, 380). This lack of clarity undoubtedly contributed to the subsequent dismissal of external economies from mainstream economics.³⁵

It is possible to identify three different references to the source of a firm's external economies in Marshall's Principles. The first referred to the pooling of skilled labor within a city or region.

³⁴ Prendergast (1994) has contended that Marshallian external economies are best considered within an evolutionary framework. See also Scitovsky (1954).

³⁵ Although the fields of regional and urban economics try to address such issues, they do so within a constraining philosophical framework (e.g., Hoover 1948; Losch 1939).

Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skills which they require; while men seeking employment naturally go to places where there are many employers who need such skill as theirs and where therefore it is likely to find a good market. (Marshall 1990[1920]:225)

This tendency was augmented by Marshall's belief that specialized skills were becoming grouped together such that differences within these groupings were becoming a less and less important factor in production. As the "iron fingers and iron arms" of machinery find their way into the most routine aspects of production, differences in the quality of labor become less distinct between some industries (Marshall 1990[1920]:217). For example, the laborers used in a watch factory are,

... not different in general characteristics from those which are used in any other of the lighter metal trades ... This is a good illustration of the fact that while there is a constantly increasing subdivision of labor, many of the lines of division between trades which are nominally distinct are becoming narrower and less difficult to be passed. (Marshall 1990[1920]:214-215)

However, these new jobs required "higher faculties than the old system" and "the person who minds it [machinery] must have an intelligence, and an energetic sense of responsibility" (Marshall 1990[1920]:214).³⁶ The qualities which make a "great industrial people" are the abilities to,

... bear in mind many things at one time, to have everything ready when wanted, to act promptly and show resources when anything goes wrong, to accommodate oneself quickly to changes in detail of work done, to be steady and trustworthy, [and] to have always a reserve of force which will come out in emergency ... (Marshall 1990[1920]:172)

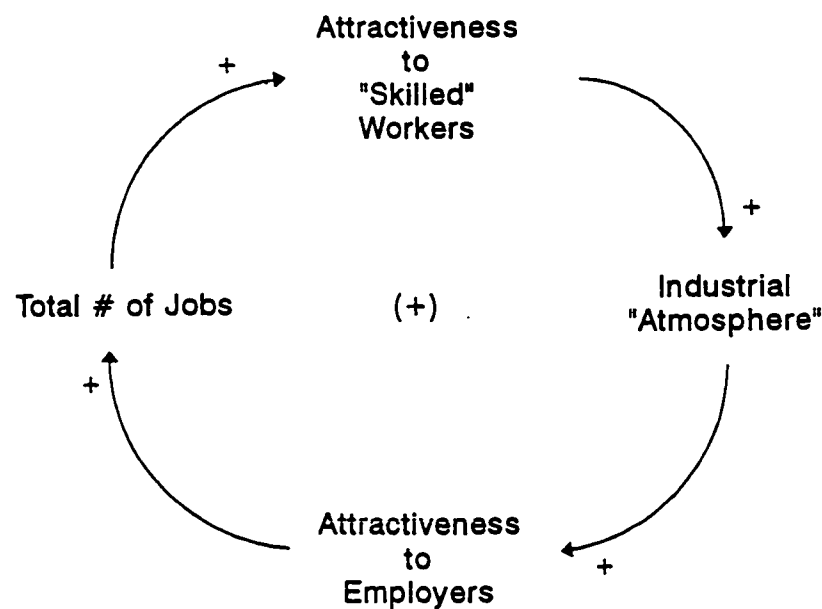
None of these qualities reflect specific manual skills, but rather a sense of flexibility.

In Industry and Trade, he referred to a pool of such skilled labor as an "acquired

³⁶ This addresses Smith's contention that the increased division-of-labor degrades the intellectual and moral stock of the "unskilled workers" who tend to machines.

industrial atmosphere," which cannot be moved (1915:284). In addition to the "industrial atmosphere" which individual firms create by locating in the same region, the extent to which they are diversified allows towns to weather market fluctuations more easily than single industry towns. This reduction in the uncertainty of employment serves as an added advantage for workers of even finely refined skills. This relationship is diagrammed in Figure 15.

Figure 15: Labor Pooling and Industrial Atmosphere



Marshall also believed that there were beneficial effects of labor pooling due to positively correlated labor markets. For example, industries that utilize only men are required to pay wages that support full families in the absence of other sources of income. However, if other industries which employ women and children locate in the area, these wages will supplement the family's income and allow the mens' wages to be

relatively lower (Marshall 1990[1920]:226). It is interesting to note that these external economies are experienced due to the correlation of resources through indivisibilities in the social norms and institutional structure.

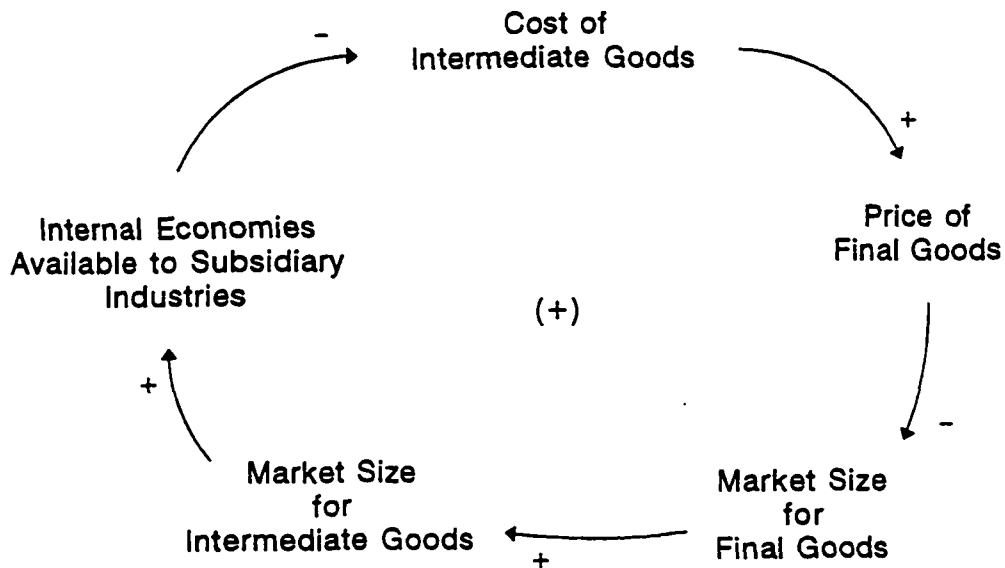
The second type of external economy contained in Marshall's Principles was the notion of "external-internal economies" (Pigou 1928; Robertson 1930). The idea is that as a given industry which contains firm "A" expands, the industrial use of inputs expands. This expansion may allow the producer of these inputs, subsidiary firm/industry "B," to enjoy greater internal economies. These benefits manifest themselves to firm "A" as an external economy.

... small producers can often buy particular components that have been made for open market by aid of larger economies of massive production than are at the command of any single business. (Marshall 1915:227)

It is this aspect of external economies which correlates external economies with industry size and issues of product standardization.³⁷ Figure 16 represents this relationship.

³⁷ The spatial extent of these external economies is dependent on transportation costs.

Figure 16: Internal-External Economies



Marshall's third type of external economy involved the broad class of what he called advancements in the means of communication. By this he meant both physical transportation (e.g., railroads, waterways, etc.) and the interchange of information (e.g., the printing press and telegraph). Although these economies are similar to the second type mentioned above, they have much farther reaching implications. In fact, they have the ability to influence the whole of civilization (e.g., see Harvey 1989:Part II). One way of seeing the potential of this third type of external economy is to distinguish between the 'natural' and human-determined dimensions. While natural facets are fixed in space from the very beginning (e.g., extensive river systems), the human-determined facet involves some element of *individual choice* at some point in time (e.g., highways or research & development). For example, the size, quality, and placement of public

infrastructure becomes spatially located based on human choice. Since this decision is undoubtedly made on the basis of some initial heterogeneity in the economic environment (e.g., existing industrial infrastructure or work force), there is the potential for a complementary circularity to emerge within economic development which includes an element of human valuation. This relationship could be diagrammed in a manner similar to the labor pooling external economies.

A tangible and contemporary example of this type of external economy involves the flow of information on the Internet.

For External economies are constantly growing in importance relative to Internal in all matters of Trade-Knowledge: newspapers, and trade and technical publications of all kinds are perpetually scouting for him and bringing him much of the knowledge he wants - knowledge which a little while ago would have been beyond the reach of anyone who could not afford to have well-paid agents in many distant places. (Marshall 1990[1920]:237)

Marshall saw advances such as newspapers and trade associations as benefiting the small business by creating an environment rich in information. Not only did technical knowledge become more accessible, but also market information.

Interestingly, Marshall did not comment much in his Principles on this third type of external economy. This may have been due to his inability to foresee the significance of the various technical and communication advances that would be made in the relatively near future (reminiscent of Smith).³⁸ For example, he commented in Industry and Trade that it is "assumed that aerial traffic will not supersede that on the surface of the earth ... the hold of railways ... seems not to be threatened" (Marshall 1915:770).

³⁸ Although theorists such as Marshall found it difficult to imagine the direction that technological advance would take us, some current theorists find it hard to imagine where technology *cannot* take us (e.g., Simon and Kahn 1984; Simon 1992; Simon and Steinman 1992).

Significance of Time.³⁹ There are many similarities between Marshall's use of complementary circularities (i.e., their leveling within the economy) and a theoretical framework of hierarchical composition. One of the distinguishing factors of hierarchical compositions is an explicit emphasis on the different temporal rates at which different layers of interactive process proceed. Therefore, Marshall's emphasis on time as the "chief difficulty of almost every economic problem" may serve to bolster an attempt to associate his thinking with hierarchy theory (Marshall 1990[1920]:vii). As will be demonstrated later, such an association leads to a better understanding of the apparent ambiguity or lack of cohesion which is frequently said to exist within his theoretical models.

Getting back to the role of time, Marshall believed that the problem results from the fact that change does not occur at a constant rate. Furthermore, while some causes work themselves out rather slowly, others act more rapidly. This temporal distinction means that slower causes are frequently interrupted as they ripple through the economy by their quicker counterparts (Marshall 1990[1920]:30, 275). For Marshall, the problem of time was overcome by utilizing *ceteris paribus* assumptions to analyze the economy "one bit at a time" and then to combine these "partial solutions into a more or less complete solution of the whole riddle" (Marshall 1990[1920]:304). While this technique inevitably led some theorists to develop general equilibrium concepts of the economy, Marshall would not have approved of such mechanical aggregations since they are devoid of the evolutionary dimension.

³⁹ This section borrows substantially from Currie and Steedman (1990).

It is interesting to note that Marshall used the *ceteris paribus* assumption to identify four different time periods for analysis in the economy. The *market* period is an analysis of temporary equilibrium during the course of a day, the *short* period involves a few months or a year, the *long* period involves several years, while the *secular* period lasts for a generation (see Currie and Steedman 1990:21-22). These are not the operational definitions of the theoretical short-run and long-run that one finds in current textbooks since they involve actual calendar time. The fixed nature of inputs results from the shortness of the period under discussion rather than serving to define it. In other words, Marshall used the *ceteris paribus* assumption to isolate his concept of a particular economic process from the host of other processes which occur simultaneously but at different temporal rates. For example, his long period was intended to be applied to the industry as a whole and permitted Marshall to disregard the oscillations which occurred from day to day and from year to year. There is also reason to believe that his short period was affiliated with individual firms since he connected it to the "cost of producing the commodity" (Marshall 1990[1920]:275).

The sheer fact that Marshall made temporal distinctions within his theory on the basis of socio-economic processes rather than distinguishing between these processes due to *theoretical distinctions* separates him from many of his contemporaries. To require that Marshall should have solved the problem of 'time' is an inordinately rigorous expectation. Given the importance of the temporal dimension to hierarchical concepts, it is significant enough that time was a major concern for Marshall and that he broke it down on the basis of different processes.

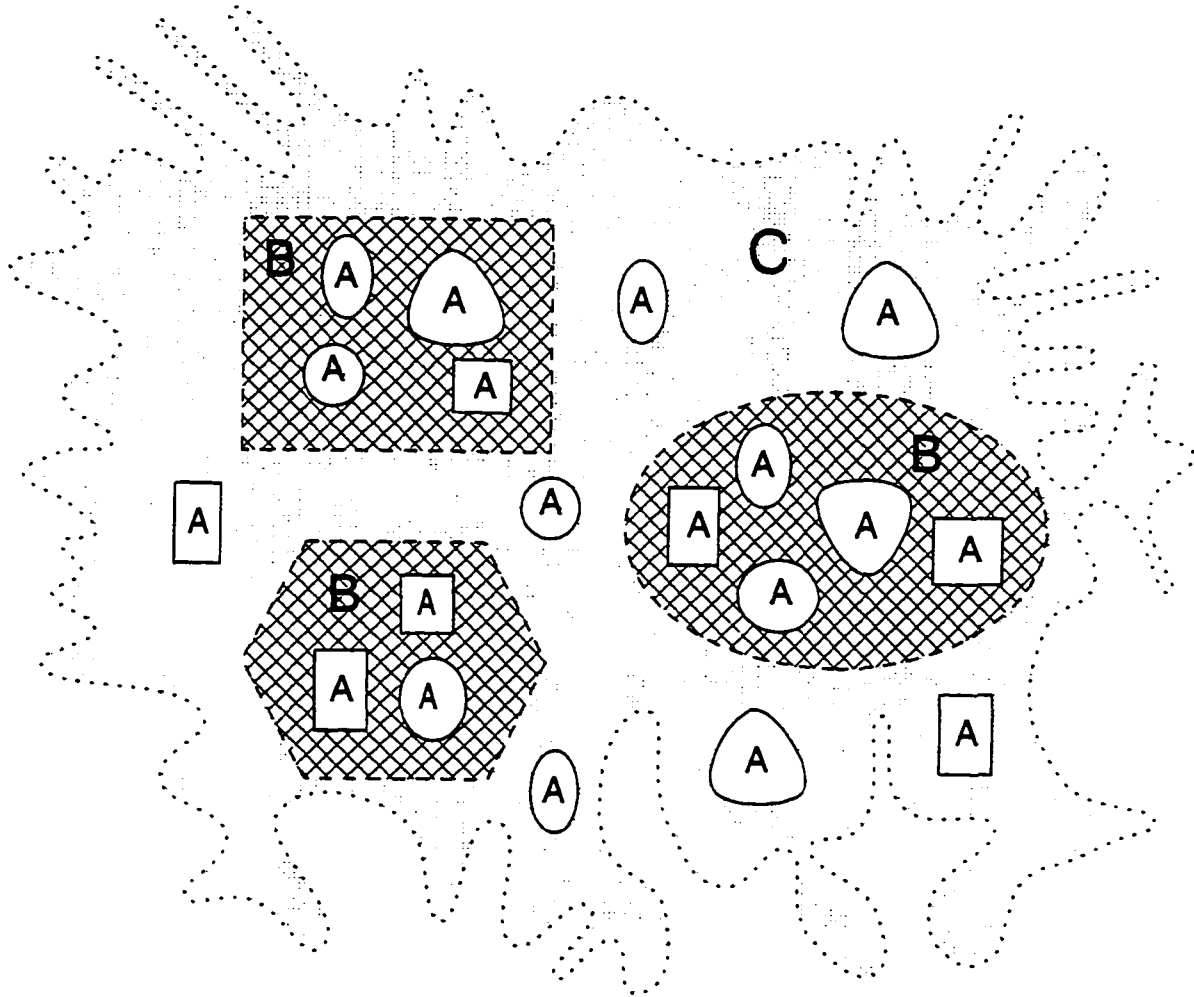
Nested Integration of these Levels. The previous three sections have presented the individual complementary circularities within Marshall's economic theory. It is possible to combine these into a single compositional diagram in which they appear as nested processes of ever greater levels of integration. In other words, the economic process of the individual is nested within that of the firm, and the firm's is contained within that of the industry or region. This nesting of processes, which is built up from the composition of his biological thoughts, provides a taste of Marshall's biological vision from a hierarchical perspective.

Figure 17: A Hierarchical Nesting of Complementary Circularities

A: Individual (see Figure 13)

B: Firm (see Figure 14)

C: City or Region (see Figure 15-16)



The Tension within Marshall's Thought

The final topic to be addressed is the fundamental tension which exists between Marshall's biological vision, which was a result of his empirical explorations of

economic processes, and his desire to make economics a science, which caused him to build theories conforming to the rules of classical logic (i.e., identity, difference, and excluded middle). Even though Marshall recognized that when the mechanical framework (the champion *par excellence* of logical thinking) is "pushed to its more remote and intricate logical consequences, it slips away from the conditions of real life," he was unable to overcome this obstacle (Marshall 1990[1920]:461). As a result, a tangible intellectual tension was created within his theories.⁴⁰ In concordance with this interpretation, Shackle (1972:286-287) has suggested that "the Principles is a relentless effort to bring into one fabric of argument the two incompatibles ... the mutually repellent strands of rationality and novelty."

An extremely fertile way to look at this tension is to see it as a result of Marshall's acceptance of the leveling he observed within the economic process, which would call for the use of a conceptual hierarchy within his economic theory (which can accommodate the emergence of novelty), while *concurrently* holding the belief that there are no discrete shifts in description. Inversely, one could say that Marshall sought to conceive of the economy as a single leveled process while concurrently accepting his perception that it was multilayered. This adherence to the notion of a single layered reality is reflected in the motto inscribed on the title page of his Principles: "Natura non facit saltum" (Nature takes no leaps). Although Marshall is perhaps right to contend that nature does not take discrete leaps, he did not realize that the descriptive concepts of the human mind do.

⁴⁰ This tension is also noted by Currie and Steedman (1990:11,21) and Niman (1991), although with different explanations.

A deeper look at how Marshall proposed to do his biological analysis is informative for this discussion. In the preface to his 8th edition, he wrote the following:

The Mecca of the economist lies in economic biology rather than in economic dynamics. But biological conceptions are more complex than those of mechanics; a volume on Foundations must therefore give a relatively large place to mechanical analogies; and frequent use is made of the term 'equilibrium,' which suggests something of statical analogy ... The forces to be dealt with are however so numerous, that it is best to take a few at a time; and to work out a number of partial solutions as auxiliaries to our main study ... We reduce to inaction all other forces by the phrase "other things being equal": we do not suppose that they are inert, but for the time we ignore their activity (Marshall 1990[1920]:xii-xiii)

This analysis of the parts through the *ceteris paribus* assumption, which was discussed earlier, then leads us closer to the whole.

In the second stage more forces are released from the hypothetical slumber that had been imposed on them ... and their complex mutual interactions begin to be observed. Gradually the area of the dynamical problem becomes larger; the area covered by provisional statical assumptions becomes smaller ... (Marshall 1990[1920]:p.xiii)

As the assumptions which provide the statical character of the analysis are dropped, the whole becomes more dynamic. But did Marshall mean that we have reached our "economic dynamics" and need further work, or has this whole undergone some metamorphosis which propels us into the field of "economic biology"? He seemed to hold the hope that mechanical models are distinguished from biological models merely by the greater complexity of the latter's interactive processes. But this is simply not the case, and perhaps, as Brinley (1991) has suggested, Marshall came to realize just how great a theoretical leap the move to "economic biology" would be. Even if Marshall had been able to garner the theoretical implications of his empirical observations of the

economy, he would have been forced to develop a new methodological approach for such an analysis.

The fact that Marshall made no attempt to formally model this economic biology with mathematics leads one to conclude that he saw the tools at his disposal as either inadequate or inappropriate for the task (Levin 1983; Leijonhufvud 1993:20-21; Colander 1995).⁴¹ Along these lines, Marshall quite succinctly stated that he refused to propose a theory which did not fit with the reality he witnessed (Whitaker 1975:51,94). In the appendix to his Principles, which is where the majority of his mathematical formulae are, he stated that,

For many important considerations, especially those connected with the manifold influences of the element of time, do not lend themselves easily to mathematical expression: they must either be omitted altogether, or clipped and pruned till they resemble the conventional birds and animals of decorative arts. (Marshall 1990[1920]:700)

Marshall's choice of metaphor suggests that mathematical embodiment reduces the quality of our representations to such an extent that they become hollow caricatures of the living processes they seek to represent. This drawback to mathematical modeling is augmented by the tendency to emphasize those elements of the economic process which lend themselves most easily to analytical methods. As a result of these two influences, one can easily create a skewed portrait of the relative proportions of driving forces within the economy. However, since Marshall was unable to foresee any theoretical alternative, he erroneously concluded that avoiding these problems would require the abandonment

⁴¹ Remember that Marshall's mathematical training was excellent for the times, as witnessed by his placing second Wrangler on his Mathematical Tripos in Cambridge (Whitaker 1975:4). Of similar, but slightly tangential importance in gauging Marshall's intellectual proclivities is the fact that he pursued studies in psychology and philosophy before settling into economics as a career.

of mathematics, which he believed was the "chief means of scientific progress" (Marshall 1990[1920]:700).

The alternative that Marshall required was a hierarchical representation of the economy which would have been able to embody many of the facets he observed: the emergence of novelty, a nesting of economic relations, the process of growth and decay, and both an integrating and differentiating dimension within the division-of-labor. However, since such an option was not available to him, he attempted to use an informal presentation which nested his biological insights within equilibrium concepts through the extensive use of organic metaphors. The subtlety of this insight escaped many of his contemporaries within economics, and the equilibrium dimension was later highlighted and expanded. When the precursor to hierarchical representations (i.e., general systems theory) was developed within Western science, it is noteworthy that it emerged within the field of biology, not economics (von Bertalanffy 1968).

Seemingly Irreconcilable Perspectives

The use of a hierarchical framework to interpret Marshall's writings clarifies his vision and allows us to see a cleaner structure behind his seemingly fragmented theory. From this perspective, Marshall's ideas should be affiliated with a developmental, ecological, and thermodynamic perspective (e.g., Foster 1993) rather than a framework of selective pressures between competing entities (e.g., Hodgson 1993a). This is not to

say that this latter perspective is absent from Marshall's theory, but merely that the former perspective highlights the evolutionary dimension within Marshall.

Marshall's inability to reconcile the biological and mechanical elements of his theories resulted in a tangible tension within his methodology. This tension spread like a contagious disease throughout the economics profession and remained asymptomatic for some time: some seemed to see the vision of Marshall's theory while others adhered to his mechanical/logical foundations. In the end, these seemingly mutually exclusive opinions surfaced within a series of articles published in the Economic Journal during the 1920's which will be referred to as the Increasing Returns debate. At this point in time, the economics profession faced what appears to be a bifurcation point: a choice between two apparently different and mutually exclusive approaches to economic theory. The first involved an evolutionary analysis along the lines of Marshall's biological vision, while the second was a more restricted analysis which utilized Marshall's partial and mechanistic methods. Succinctly put, the latter sacrificed the former's conceptual richness for analytic clarity and sharper focus. The failure to realize that discrete conceptual shifts, and hence logical inconsistencies, are a characteristic of hierarchical concepts created an apparent need to choose between these two approaches rather than work to integrate them into a coherent whole. Since it was Marshall's partial and mechanical methods which survived this battle, they served to set the future boundaries for acceptable thinking with respect to complementary co-dependent relations within economic theory.

The Increasing Returns Debates of the 1920's

One possible explanation for why Marshall was unable to reconcile his biological (i.e., evolutionary) and mechanical (i.e., analytic) perspectives is that he did not explicitly accept or use concepts of hierarchical nesting. Although the concept of hierarchically nested processes may seem to be a novel idea to many economists, it has been an implicit element of theory throughout the history of economic thought (e.g., Smith, Marshall, Marx, and Boulding).⁴² There was even a paper written by S.J. Chapman (1908) which explicitly used the language of hierarchical structure to investigate the law of increasing returns.⁴³ He stated,

I propose next by analysis of the actual production of commodities to elicit its forms with a view to determining the unitary factors in the several fields wherein the laws of increasing and decreasing returns are in operation. In all production of commodities the agents (of which there must be more than one, for there must always be at least labour and material or land) tend to be united in a hierarchy of systems. (Chapman 1908:55)

Chapman believed that this hierarchy consists of three layers of production: *systems of the first order* are individual businesses, *systems of the second order* consist of the many

⁴² One could even say that the layering of economic processes is implicit within current economic theory (i.e., consumer theory, theory of the firm, industrial organization, and macroeconomics). The reason why these nested processes are not investigated from an evolutionary perspective has to do with philosophical assumptions concerning the structure of reality and nature of cognition.

⁴³ It is important to note that Mr. Chapman (1871-1951) was a well-established member of the economic profession. He was a professor of Economics at the University of Manchester (1901-17), Secretary of UK Board of Trade (1918-27), and Chief Economic Adviser to the UK Government (1927-32). His early career included successful publications and the establishment of a "thriving commerce faculty at Manchester" (Blaug 1986).

businesses of various kinds (systems of the first order) concerned in the production of some one commodity, and *systems of the third order* are all the industries of the community. Chapman also extended his analysis into consumption, but the significance of his 1908 article is its explicit recognition of layered economic processes.

The question is, why were these theoretical distinctions not pursued further by the profession? The answer is twofold. First, there was a lack of formal modelling tools with which to theorize about circular causal relations, endogeneity, and the emergence of novelty (e.g., general systems theory). One could say that there were technical constraints which needed to be overcome before the theoretical vision could be embodied. Second, there existed (and still exists) an anthropocentric belief that the structure of human knowledge corresponds to the implicate structure of reality. Since logic is the tool *par excellence* of theoretical formulations and manipulation, and since there is no layering inherent to the rules of logic (i.e., Whole = Σ Parts), the *perception* of layers is downplayed as an aberrant fact which will undoubtedly yield to the militant advance of human knowledge. Therefore, appropriate theories of distinct processes (i.e., different layers of conception) are forcibly aggregated into a single layer of conception.⁴⁴ The combination of these two interrelated factors, the absence of appropriate theoretic tools and the assumption that reality/concepts are both single layered and equivalently structured, provided the technical and philosophical conditions from which the Increasing

⁴⁴ While a *unified science* based on the assumption that there is a single layered understanding of reality does not appear to be possible, a *unification of science* (which consists of a layering of distinct theoretical perspectives) based on an understanding of cognition is. An interesting point of note is that the possibility of a unified science can never be proved false, since it is a singular concept within a group of many. To borrow Popper's terminology, while one can never prove that all swans are white, one can also never prove that a black swan does not exist.

Returns debates emerged. Concepts appropriate to different conceptual layers of the economy were placed within a single layer of theory through the *indiscriminate* imposition of logical consistency. This effort resulted in the theories of perfect competition (e.g., Pigou 1927, 1928) and imperfect competition (e.g., Robinson 1933; Chamberlin 1933). While it is the abandonment of the evolutionary dimension which is the subject of this dissertation, it is through an understanding of the emergence of these two theories of competition that this decline becomes clear (see also Foss 1994).

The articles of the Increasing Returns debate can be divided into three groups in order to identify the three major stages of debate. The first group consists of a discussion concerning the practicality of sorting industries into the theoretical boxes of diminishing, constant, and increasing returns (Clapham 1922; Pigou 1922; Robertson 1924). It presents the initial intellectual landscape, the framing of the relevant questions, from which the Increasing Returns debates unfold. The second group concerns the theoretical reconciliation of increasing/decreasing returns and competitive equilibrium (Sraffa 1926,1930; Pigou 1927,1928; Robertson 1930). The conceptual perspective which emerged from this second group established the direction and structure of future economic theory: one which dismissed the evolutionary dimension of Marshall's theory in favor of theories characterized by stable equilibrium and logical consistency. The last group may not really merit being called a group since it consists of a single article written by Allyn Young (1928). The significance of this essay is that it extended the evolutionary flavor of Marshall's vision by pursuing a higher level theoretical model of the economy, one which made no direct reference to individual firms. Although an

implicit ally of the Marshallian advocates within the Increasing Returns debate (i.e., Robertson 1924, 1930), Young's analysis shifted the perspective by drawing an explicit connection between increasing returns, division of labor, and economic development.

This second group presents what appeared to be two mutually exclusive directions for economic theory: the first logical consistency and stable equilibrium, the second evolutionary. Although Young's essay was the clearest and most explicit presentation of an evolutionary perspective within the Increasing Returns debates, it was Robertson who served as the champion of the Marshallian evolutionary vision since it was Robertson who was pitted against Sraffa in the Economic Journal symposium of 1930. A bifurcation interpretation of the Increasing Returns debate is interesting since it is not too far of a stretch to contend that Sraffa's 1926 article encouraged the emergence of a formal theory of the firm, perfect/imperfect competition, and eventually general equilibrium theorizing, by representing a dynamic process with static equilibrium and laying the groundwork for a shift from the heuristic representative firm to a reified equilibrium firm. Whereas Robertson's articles *represent* Marshall's ideas and thereby preserved his ambiguity, Young's article *developed and clarified* the spirit of Marshall's work.

Empty Analytical Boxes

Clapham's 1922 article was the initial spark of the Increasing Returns debates since it questioned the practical value of the conceptual distinction between increasing and

diminishing return industries.⁴⁵ To embellish his argument, Clapham painted a rather colorful portrait of all industries being placed in boxes on the "shelves" of our mind labelled diminishing, constant, or increasing return industries. He then asked whether the increment of product due to the increase by a unit in the quantity of resources occupied in producing a good is smaller (decreasing returns) or greater (increasing returns), the greater is the quantity of resources so employed. Although he conceded that theoretically sound policy arguments can be made under the assumption that conditions of diminishing or increasing returns prevail in an industry, he asked that these boxes be filled by the "Great Analytics" with empirical observations.⁴⁶

We are building a framework into which we hope facts may in time be fitted. If those who know the facts cannot do the fitting, we shall regret it. But our doctrine will retain its logical - and, may we add, its pedagogic - value. And then you know it goes so prettily into graphs and equations. (Clapham 1922:312)

Clapham questioned whether economists can identify specific industries as being either increasing or decreasing return industries. How is one to conceive of an industry? How are units of resources to be conceived? Or increment of product? He concluded,

I think a good deal of harm has been done through omission to make it quite clear that the Law of Returns have never been attached to specific industries; that the boxes are, in fact, empty ... Unless we have a good prospect in the near future of filling the boxes reasonably full, there is, I hold, grave danger to an essentially practical science such as Economics in the elaboration of hypothetical conclusions about, say, human welfare and taxes in relation to industries which cannot be specified. (Clapham 1922:312)

⁴⁵ This article is written in response to Pigou's Economics of Welfare (1920). This explains why Pigou, rather than Marshall, answers the criticism a few months later in the Economic Journal. It is notable that the theoretical structure of economic thought was well accepted within the profession and few had dared to question its fundamental assumptions in the past (Shackle 1983:5). Things were changing.

⁴⁶ For example, Pigou talks in his book about the subsidization and taxation of certain industries based upon their being either increasing or diminishing returns industries.

The interest in Clapham's analysis from our perspective is simply his questioning the possibility of translating these theoretical concepts into practical insights which can guide policy. He focused less on increasing returns as an evolutionary concept and more on policy issues (as noted by Pigou 1922:458-459). In other words, his article was concerned with the empirical and practical possibilities of the current theoretical use of the law of returns.

Pigou's reply to this article addressed both methodological and empirical concerns. After making a distinction between the "pure" knowledge of implications (e.g., he cited mathematics) and a "realistic" knowledge concerned with subject-matter presumed to be actual (e.g., he cited physics), he noted that "knowledge of implications is just as much knowledge as knowledge of matter of fact" (Pigou 1922:459). Therefore, determining the mathematical implications of theoretical assumptions is a source of knowledge. However, he added that the ultimate goal of such theories should always be subject-matter presumed to be actual, which he calls realism. While realism need not entail the presence of practical usefulness for Pigou, he does say that he pursues economic theory under the belief that it will provide practical insight at some point in time. Pigou also believed that the law of returns was "an organic and inseparable part" of the whole of economic theory (Pigou 1922:462). He warned that "to take the categories of increasing returns and diminishing returns out of their setting [the established theoretical framework of economics] and to speak of them as though they were a thing that could be swept away without injury to the whole *corpus* of economics is a very perverse proceeding" (Pigou 1922:461, emphasis in original).

In addition to these arguments for the organic significance of the law of returns within economic theory, Pigou altered the empty boxes metaphor to include a measurement of the degree of returns experienced by each industry. The theory is thereby expanded into an "intricate collection of little cases" within the larger boxes, which Pigou claimed would have greater practical use when filled. Whereas Clapham feared that these boxes, and hence Pigou's little cases, were destined to remain empty, Pigou believed that such a conclusion was "premature" (Pigou 1922:464). He believed that the economics profession merely needs more people who are equally at home in the fields of theoretical and statistical analysis in addition to detailed case studies of particular industries. It is interesting to note that Chapman, who was cited earlier for his explicit use of hierarchically nested concepts, fits Pigou's criteria rather well according to Blaug's (1986) biographical description.

Both Clapham and Pigou theorized about a static world and implicitly constrained the concept of increasing returns to mechanical theories of linear input-output for firms and industries rather than allowing it to have an evolutionary flavor. Although Pigou mentioned external economies once, neither man seemed to realize that the symbolism of empty boxes is an inadequate and possibly misleading metaphor. It implies that everything is placed on one of three shelves (i.e., increasing, decreasing, or constant returns). Pigou's alteration of this metaphor is merely a recognition of the mess that still remains and an attempt to straighten up these boxes by arranging them by relative size. In response to this, Robertson (1924:16) wrote that there exists here,

... a tendency to discover a simplicity of parallelism where none exists, and to submit disparate materials to an identical logical process. The boxes, if I may

make free with the metaphor, are not in my view properly to be loaded upon the same cab. It is almost as though one were a hat-box, and the other a monstrous compound of a box at the opera and a box growing alongside a garden path.

This "monstrous compound" represents Robertson's attempt to introduce external economies into the discussion. While the music of the opera enhances one's experience of the garden, the fragrance of the garden's flowers enhance the ambiance of the opera. Although neither the opera nor the garden may, in and of itself, be properly called an increasing returns industry, the two industries may display increasing returns through their *complementary* expansion: a higher quality opera and garden are created simultaneously.

Robertson believed that increasing returns arise for two reasons. The first involves the "lumpy and discontinuous" nature of capital (i.e., natural monopoly framework). This is merely a surface-volume relationship in which the presence of a prime element in production will create episodes of increasing/decreasing returns as the optimal technical combinations in production are approached/ surpassed. The second reason is implicitly evolutionary since it involves the *passage of time* by which "methods of technique and of organization are capable of improvement" (Robertson 1924:18). Robertson noted that interference in the market of an industry which enjoyed this second type of increasing returns (e.g., selective subsidization or taxation) represents an attempt to substitute for time, and can only have limited effectiveness.

It is worth noting that one year later in the Quarterly Journal of Economics, an article appeared by the well-known Russian economist N.D. Kondratieff (1925).⁴⁷ Kondratieff made three important points which did not filter into the Increasing Returns debate, but do shed an illuminating light on the different positions contained within these three articles: (1) A distinction is drawn between static and dynamic conceptions of the economy. The former seeks an "understanding of the equilibrium of unchanging elements and of their inter-relations," while the latter considers "economic phenomena in the process of changes in their elements and in the inter-relations of the latter." Both consider change, but one is the mechanical interaction of fixed elements (quantitative change) while the other concerns compositional/organic/qualitative change. Kondratieff believed that these two views are *not* cleanly separable: conclusions reached through static theory play an auxiliary, but necessary, role in dynamic theory and vice versa. (2) Kondratieff also believed that only the dynamics of phenomena as a whole exists, and "it is not the statics and the dynamics of *phenomena themselves* but the *static view* as against the *dynamic view* of them that should be treated in contrast to each other, as two different theoretical conceptions." (3) There are two forms of dynamic processes, these being evolutionary or non-reversible and "wave-like" or fluctuating. He stated,

Regarded as a whole, economic reality represents a non-reversible process, in which progress is accomplished by stages. But the individual economic elements, while they are thus subject, as parts of the whole, to a non-reversible process of variation, in some cases develop, when considered separately, through a reversible process. (Kondratieff 1925:582)

⁴⁷ A few other articles which were important for the Increasing Returns debates proper, but not pertinent to this dissertation, appeared in the Quarterly Journal of Economics (e.g., Graham 1923; Knight 1925).

In other words, while an economy or industry evolves in a non-reversible fashion, the individual elements which compose it may experience repetition, reversion, and cyclical behavior.⁴⁸ As examples of non-reversible dynamics, Kondratieff cited population, volume of production and trade, and the amount of capital.

Kondratieff's distinctions can be used to highlight the differences between the methodological perspectives of Pigou/Clapham and Robertson's within the Increasing Returns debate: while the former espoused/questioned the use of certain concepts within a static equilibrium view of the economy, Robertson advocated a dynamic view and thereby presented a distinct alternative to the former perspective. However, this distinction between the methodological perspectives inherent to these three articles are veiled by the metaphors of hat factories, boxes, and religious folklore. In contrast, Kondratieff's essay contained little of this verbal fencing, presented the issues in a clean and concise manner, and is an eerie precursor of current distinctions drawn along the same lines. It is due to this clarity that he is cited here.

⁴⁸ Since different moments within this "repetitive" dynamic of the parts will represent different points in time and different combinations of economic factors, "the statement that the process is subject to reversion and repetition is not to be applied in an absolute sense, but is to be used only to distinguish this class of change from the other [i.e., evolutionary], which admits of no repetition or reversion" (Kondratieff 1925:582). In other words, the statement that a process is subject to repetition highlights a particular aspect of its dynamic change rather than serving to contend that it experiences no evolutionary change whatsoever.

Building Sturdy Shelves and Stronger Boxes

Sraffian Dilemma. The second group of articles begins with one by Piero Sraffa (1926) which has been called the Sraffian Manifesto in Shackle's (1983) The Years of High Theory.⁴⁹ Addressing the "one dark spot" which disturbs the harmony of the current theory of value, this being the law of increasing and decreasing returns, Sraffa delivered a scathing critique of the conceptual unification of increasing/decreasing returns into a single law of non-proportional returns which is used to yield an industry supply curve. This supply curve is then used to build a theory of value based on exchange within the context of a partial equilibrium analysis and under the assumptions of perfect competition.⁵⁰ My discussion shall focus on Sraffa's analysis of the logical consistency of the assumptions underlying such an analysis and its residual effect on the evolutionary dimensions of Marshall's theories (subsequently defended by Robertson 1930).

To set the historical stage, one must realize that earlier conceptions of perfect competition did not possess the clean theoretical structure which contemporary economists have come to expect. Instead, it was a more loosely defined set of assumptions whereby each individual firm within a collection of firms produces an object which is physically and technically indistinguishable from that produced by other firms (see Shackle 1983:25-26). Therefore, no potential buyer has the least preference for one firm's product over another's. Economists therefore reasoned that if the number of firms

⁴⁹ These years being 1926-1939.

⁵⁰ This argument had been developed in a previous article by Sraffa (1925) and has been thoroughly explored by many historians of economic thought (e.g., Maneschi 1986; Panico and Salvadori 1994; Roncaglia 1978; Shackle 1983).

is so great and their size so small that no practicable change in the output of any one firm can noticeably affect the output of this collection of firms as a whole, then the product can be called a commodity, the collection of firms an industry, and the price a firm receives for its product will be given exogenously by the industry's market for the commodity. This provided a basis for the law of demand. In addition to this, although earlier economists had used diminishing returns to discuss distribution and viewed increasing returns as a characteristic of economic progress in general, a *Law of Returns* had come into being which included both diminishing and increasing returns under the same heading. Through a "radical transformation," these two forces of "profoundly diverse nature" were united into a single explanation for the link between an individual firm/industry's scale of output and production costs (Sraffa 1926:537). Within the then current interpretations of perfect competition, this Law of Returns was used to yield a law of supply, which in coordination with the above mentioned law of demand provided a theory of exchange value which permits one to infer output from the knowledge of price alone. An equilibrium is achieved in a particular market when the amount of a commodity supplied is equal to the amount demanded at a given price.

Sraffa questioned many aspects of this conventional formulation. First, he wondered whether the laws of decreasing, constant, and increasing returns could be combined into a single law of non-proportional returns and then used to construct a supply curve for an industry, given their unique origins. Furthermore, he augmented Clapham's practical concerns by noting that this single law creates difficulties "when it is sought to classify the various industries according as they belong to one or the other

category" (Sraffa 1926:538). From a theoretical perspective, the problem involves setting the boundaries which define an industry. If an industry is defined by its use of a given *factor of production*, it would presumably experience decreasing returns (increasing costs). In contrast, if an industry is defined by its *commodity of production*, with each industry employing only a small amount of the productive inputs, then it would presumably experience increasing or constant returns (decreasing or constant costs). Therefore, Sraffa reasoned that the classification of industries as experiencing increasing or decreasing returns will depend upon the boundaries one uses to define what an *industry* is. In addition, he believed that the element of time presents problems since the short-run is associated with decreasing and the long-run with increasing returns.

Sraffa's talent as a theoretician shined most brightly at this point, for he proceeded to demonstrate that the assumptions necessary for the partial equilibrium analysis of a single commodity (i.e., perfect competition) are such that only in exceptionally restrictive cases can either increasing or decreasing returns be involved. Since non-proportional returns are the basis on which the supply curve of the industry is derived, the logical inconsistency of increasing and decreasing returns within a partial equilibrium, competitive framework was deadly to a theory of value based on exchange. His argument questioned the extent to which economic theory can abstract from the interdependencies between different markets whose absence is essential within the logic

of partial equilibrium analysis.⁵¹ At issue is the *ceteris paribus* assumption which Sraffa believed was blatantly false.

While the details of Sraffa's criticism are not fundamental to this discussion, two important points are his explicit exclusion of external economies and the fact that his argument is levied against the logical contradictions inherent to the conventional set of assumptions being used in economic theory. His conclusions are well summarized by Maneschi (1986:10, emphasis in original),

Sraffa makes *conditional* statements to the effect that if returns to scale are variable, then a partial equilibrium analysis of a particular industry under perfect competition is inappropriate; if, on the other hand, returns to scale are constant, then such a partial equilibrium analysis is appropriate, but then the Marshallian symmetry between demand and supply is destroyed, and one is left with a classical theory of prices being determined by cost of production.

This statement reflects Sraffa's understanding that the assumption of constant costs is "necessary for *logical* consistency in a partial equilibrium setting under perfect competition" (Maneschi 1986:10, footnote 3, emphasis added). This focus on the logical implications of the assumptions was also noted by Shackle (1983:19),

⁵¹ Sraffa's argument proceeds like this, all internal economies must be removed from consideration since a firm experiencing such economies could expand output at a lower cost and would therefore not be in equilibrium by definition. He also excludes all external economies except those external to the firm but internal to the industry as being outside the scope of partial equilibrium analysis; This one type of external economy permitted being dismissed by Sraffa as one which is practically never witnessed in the real world. With increasing returns out of the way, he then proceeds to explain how decreasing returns are also incompatible with partial equilibrium analysis under the assumption of perfect competition. If one assumes that an industry uses a large portion of a fixed productive factor, then increases in output will increase the price of this productive input which will influence other commodities prices and therefore, very likely, the demand in the original industry. Therefore the independence assumption is highly likely to be broken. If one assumes that an industry uses only a very small portion of a fixed productive factor, then an increase in output will have no appreciable affect on the input price and the unit cost of production will remain the same. One is then left with constant costs. Therefore, an upward and downward sloping relationship between unit production cost and output cannot be isolated within a partial equilibrium analysis of perfect competition with non-proportional returns. If the assumption of constant returns is made, cost is independent of output, it is also independent of demand and the theory of value based on exchange collapses to one based on production costs.

Let us again notice that what this argument concerns is a method of analysis, a set of assumptions, namely the 'particular equilibrium' analysis of an industry operating in competition.

Therefore, it is not increasing returns *per se* which Sraffa objected to, but the reconciliation of non-proportional cost curves and the partial equilibrium analysis of perfect competition.

After skillfully dissecting the body of assumptions underlying conventionally accepted economic theory, Sraffa had four theoretical alternatives to choose from (three which he noted himself and the last an evolutionary alternative). First, to assume generalized constant returns to scale and retain the concept of perfect competition. Second, to explicitly acknowledge the interdependencies and pursue a "general economic equilibrium" concept. Third, to reject the assumption of perfect competition in favor of variations on the monopolistic theme. And, lastly, to reject the necessity of a single layered static equilibrium in favor of a hierarchically layered dynamic process which possesses an evolutionary dimension.⁵² Sraffa (1926:542) rejected the second option as a "well-known conception, whose complexity, however, prevents it from bearing fruit, at least in the present state of our knowledge," and chose to forsake the "path of free competition and turn in the opposite direction, namely, towards monopoly." Anyone even roughly familiar with this period of time in the history of economic thought will know that this decision by Sraffa represents the beginnings of imperfect competition. It is important to note that the last alternative was not really an option for Sraffa since the

⁵² This last perspective has been used to dismiss Sraffa's (1926, 1930) and Robbins' (1928) criticisms, which were based on equilibrium assumptions, as "irrelevant to the Marshallian system because a Marshallian firm is seldom, if ever, in equilibrium" (Beach 1982:60).

analytical tools for such a complex analysis were not available, and his rejection of the second option seems to imply a rejection of the fourth also. However, this technical constraint was not great enough to prevent other economists (e.g., Schumpeter 1928 and Young 1928) from exploring this route.

Years of High Theory. Sraffa's Manifesto of 1926 was the first link in a long chain of theoretical advances within the economics profession (Shackle 1983). Obviously, it led to Robinson (1933) and Chamberlin's (1933) work on imperfect competition, but before these works came Pigou's (1927, 1928) essays which introduced the concept of the equilibrium firm.⁵³ While it is common folklore that imperfect competition "filled in the middle ground" between existing theories of perfect competition and monopoly, a convincing argument has been made for the creation of the theory of perfect competition from monopolistic competition theory. This argument was developed by Moss (1984) and is paraphrased below.

Marshall had insisted that the representative firm did not actually exist and Pigou had explicitly stated his belief that no actual firm was likely to be an equilibrium firm. However, by characterizing the equilibrium firm as having *fixed* marginal and average cost curves which are not affected by changes in the firm's activities, Pigou makes the firm's technological production relations exogenous. And it is this formulation which allows the firm to be equated to its production function. However, whereas Pigou derived his equilibrium firm from the laws of returns experienced within a particular

⁵³ It is notable that Robinson went on to reject this form of analysis she had helped to found.

industry, Robinson and Chamberlin stood this concept "on its head" by "defining the industry on the basis of a population of equilibrium firms" (Moss 1984:314). As a result, the industry becomes a population of firms characterized by identical cost curves with each firm facing identical demand curves under the assumption that each of n firms would meet one- n^{th} of the industry demand.

What does this historical tale of the inversion of definitions have to do with evolutionary theory? Its significance is that Moss contends that Friedman's 1953 essay, and the rise of Positive economics in general, was necessary to "save the [new] theory of value and distribution as a logically consistent and widely applicable central core of economic theory and basis for applied economics" (Moss 1984:316). The reason for this is that the representative and equilibrium firms were *not previously believed to actually exist*, but when the industry came to be *defined* by a population of such firms it becomes reasonable to survey businessmen and ask whether they behave as they are assumed to under the new theory. A negative response to such a survey could be interpreted as evidence that the assumptions of this theory are not realistic, and hence that it provides spurious predictive value. Moss speculated that since conclusive survey methods and data are highly unlikely to be accepted by everyone, the methodological status of these new theoretical foundations could be continually called into question.

[Robinson and Chamberlin's] contribution was to give the analysis of these issues an axiomatic foundation. In so doing, they took from the theory of value and distribution a robustness that had previously been unaffected by a methodological stance in which the realism of the assumptions of a theory constitute its conditions of application. Once the effects of this lack of robustness became apparent, it was re-established by the adoption of positive economics. (Moss 1984:317)

The positive methodology which Friedman introduced to economics, which was accompanied by a host of subsidiary arguments which were antithetical to an evolutionary perspective, allowed the realism of theoretical assumptions to be replaced by instrumental efficiency as a methodological criterion for 'good' theory. Therefore, the new theories treated firms *as if* they were identical rather than contending that they actually were identical. This can be quite fruitful as long as the heterogeneity between firms is not significant and heterogeneity is not de-emphasized simply for the sake of conceptual simplicity.

The fact that Moss was even able to make this connection between the Increasing Returns debates and the rise of positive economics serves as a witness to the *pivotal juncture* at which economics found itself. The evolutionary overtones in Marshall's vision were lost as the profession turned to the greater analytical clarity afforded from this new theoretical vantage. This is not to say that Sraffa intended for economics to go in this direction. In fact, his Production of Commodities by Means of Commodities (1960), which is believed to be a direct extension of his 1925 and 1926 essays, has no trace of imperfect competition, returns to scale, or demand relationships (Maneschi 1986:11).

Increasing Returns Symposium. Before moving to the third grouping of articles in this sequential stroll through the Increasing Returns debates, it is important to note that it is not the logical structure of Sraffa's argument, but rather the absence of the evolutionary dimension that is of interest. How was this evolutionary dimension

expressed within these debates? It was embodied within a parts-to-whole relationship in which the quality of the whole is not seen to be reducible to the quantitative sum of its parts. And it is in trying to express these thoughts, under the unforgiving onslaught of logical consistency, that Robertson (1930) finds himself. However, to the extent that such concepts implicitly embody a notion of systemic layering, they will not be reconcilable with the theory of perfect competition in a logically consistent manner (as per Sraffa). Robertson's failure to fully understand the philosophical assumptions underlying these debates (as compared to , e.g., Kondratieff 1925; Schumpeter 1928; Young 1928) and therefore his inability to present his arguments in a concise and clear manner resulted in the apparent defeat of the evolutionary dimension within Marshall's theoretical legacy.

Although Robertson was not an explicit exponent of the evolutionary dimension within economic theory, the fact that he publicly opposed Sraffa's 1926 criticisms in the Increasing Returns symposium implicitly made him its defender. Robertson had an excellent reputation in the profession and was considered a capable theoretician by his contemporaries: if his defense of these views failed, then they would lose respect within the profession. Although he understood enough about the evolutionary dimension to use parts-to-whole metaphors to convey a sense of their inherent layering, he never directly challenged Sraffa's pervasive retreat to logic. As a result, an indiscriminant use of logic as a criterion of theoretical validity was never called into question, even though the transition from the parts to the whole defies logic. Robertson's failure to understand these facets of the discussion, perhaps due to a lack of genuine interest or philosophical

finesse, crippled the strategic position of the evolutionary perspective during and following these debates. In addition, Robertson's tendency to adopt a "many-sided eclectic approach" which led him to genuinely believe that "there was some element of truth in most theories" (Presley 1983:236) did not allow him to take a definitive stance in this argument with Sraffa and hence weakened his presentation. The stronger position in a debate does not guarantee a win, especially if someone does not fully understand or capitalize on the strength of his or her position.

How was the evolutionary perspective represented in these debates? What are the various metaphors and similes used by Robertson as illustrations of parts-to-whole layering? There were four metaphors used, these being: (1) The well known trees in the forest metaphor which was originally used by Marshall. (2) A collection of water drops which form a wave. (3) The individual bones and aggregative skeleton of a growing baby. (4) The concept of the representative firm which forms a link between a *dynamic* theory of the firm and *static* theory of industry (Moss 1984:309). With respect to this latter symbol, although firms are seen to compose the industry, the industry cannot be reduced to these firms. The concept of the representative firm was therefore invented to conceptually represent the firm from the perspective of an industry and hence appease Marshall's strong desire for analytic continuity (i.e., the characteristics of the industry being used to form a concept of an individual firm).

Why must one use metaphors and similes to communicate nested structures? Chipman's (1965:744) comment that the disturbing aspect of economies which are external to the firm but not internal to any other sector (e.g., industry) involves "a

fallacy, or at least an old paradox, of a whole being greater than the sum of its parts" provides an answer. *Metaphor is required to transcend logical fallacy* (see Polyani 1975). The use of metaphor helps one to bridge the gap in one's understanding of a process which is not experienced directly, by appealing to relationships which are experienced directly. This is what Robertson (1930:87) wished to communicate in his statement that metaphors "assist the reader in making a more violent effort of the imagination."

The evolutionary flavor of Robertson's arguments was not missed by Sraffa, who does us the favor of explicitly restating the argument in less flowery, but none the less evolutionary, terms.

Suppose that a change in the environment produces a change in the colour of an animal species, say from brown to white, through the operation of natural selection. We may say that "the representative individual" has changed his colour, although not a single individual has changed colour during his lifetime. (Sraffa 1930:91)

It is significant that Sraffa's comments frame the discussion in terms of a natural selection process which involves stabilizing circularities and engenders an equilibrium between an entity and its environment.⁵⁴ This alteration is only a slight compromise on Sraffa's part, and he correctly believed that such a reframing of the question does little to reconcile the contradiction.

If the new firms can turn out a larger output at a lower cost than the old firms, why didn't they come into existence before? Why in the new, and not in the old position of equilibrium. (Sraffa 1930:92)

⁵⁴ See Bateson (1988:44) for a discussion of Darwin and Wallace's theory of evolution along these lines.

It should be obvious that these two men were speaking past one another as they used similar language but expressed differing perspectives. Although Robertson did not explicitly emphasize *time* as a factor, and hence establish an explicit plea for an evolutionary perspective on these grounds, he did seem to allude to the temporal in his response to Sraffa. He stated,

... it does not require a sense of poetry, but only of human nature and of history, to refrain from asking - as in effect Mr. Sraffa asks in this section - why slavery was not abolished or the Channel Tunnel built at the earliest moment at which the world would have been better for the change. (Robertson 1930:93)

To which Sraffa responded,

We seem to be agreed that the theory [competitive equilibrium and increasing returns] cannot be interpreted in a way which makes it *logically self-consistent* and, at the same time, *reconciles it with the facts* it sets out to explain. Mr. Robertson's remedy is to discard mathematics, and he suggests that my remedy is to discard the facts; perhaps I ought to have explained that, in the circumstances, I think it is Marshall's theory that should be discarded. (Sraffa 1930:93, emphasis added)

This is a clear statement of the belief that Robertson was unable to deal theoretically with the facts he perceived and therefore chose to fudge the theory, while Sraffa's alternative proposal was to discard the theory and begin anew (i.e., Sraffa 1960).

Allyn Young's Alternative Blueprint

Although Robertson failed to recognize that Sraffa's implicit rules for the Increasing Returns debate were restricting the concept of increasing returns to the arena of equilibrium analysis, Allyn Young's 1928 article ("Increasing returns and economic progress") argued within an explicitly different context, the process of economic growth

as a whole, and was thereby able to develop the Marshallian vision further.⁵⁵ While it is common to note the ancestral link from Smith to Young, there is little recognition of the affiliation between Young and Marshall. However, the fact that Young's article was listed as being within the Increasing Returns debate (Increasing Returns symposium, Economic Journal 1930), which resulted in part from the tension between the analytic and organic perspective within Marshall, lends support to this connection. It is not that Young explicitly aligned himself with the evolutionary perspective, in which the whole is greater than the sum of the parts. Rather, his interest in a general understanding of increasing returns places him on the same side of the theoretical watershed as Marshall (via Robertson) in these debates. Both men share an emphasis on the importance of time, the endogeneity of economic change, and the impossibility of reconciling the richness of increasing returns with a single leveled theoretical concept of the economy. In this way, both theorists limit the degree to which they are willing to abstract from their experiences of economic reality. In other words, Smith and Young could be said to be united vertically, Marshall and Young are united horizontally by a common approach and vision, or using a genealogical simile, as brothers rather than father and son.

⁵⁵ This article is a reproduction of his Presidential Address before Section F (Economic Science and Statistics) of the British Association for the Advancement of Science. While it is unlikely that many economists will be familiar with Young's work, Schumpeter (1959:875) once referred to him as a "great economist and brilliant theorist ... in danger of being forgotten." A prophesy that has come true. His professional reputation in his own times was adequate enough to land him a position as one of the economic advisors to President Wilson at the Paris Peace talks (1918-1919), a similar role to that which Keynes served for the British government. Although Blich credited Young with having an impressive publications record, it consisted largely of sources other than professional journals. It is also worth noting that Young's "main focus in university work was graduate teaching" (Bitch 1983:1). As witness to this, he chaired the dissertations of Edward H. Chamberlin (1933) and Frank H. Knight (1921), both of whom made significant contributions to the field.

Choice of Approach. Although Young agreed with Sraffa's conclusion that partial equilibrium analysis is not an appropriate framework for discussions of increasing returns, he chose to forsake equilibrium theorizing in favor of a *dynamic process perspective*. While Sraffa chose in 1926 (and 1925) to simply abandon the assumption of perfect competition, Young (1928:527) believed that a theoretical framework of industry/firm equilibrium stood in the way of a "clear view of the more general or elementary aspects of the phenomena of increasing returns." Young focused on the inappropriate use of equilibrium methodology rather than the logical inconsistency between the various conceptual components of a firm level equilibrium analysis. He emphasized, in the graduate economics course he taught at the London School of Economics between 1927 and 1929, that partial equilibrium analysis and increasing returns would never be fully reconcilable phenomena since "supply and demand analysis does not see things in their togetherness" (Blitch 1990:451). The alterations of increasing returns, which were made with a view towards the development of a coherent theory of exchange value, are quite different from their classical ancestors. Young believed that the classical economists used increasing returns as a general "characteristic of manufacturing industry taken as a whole," which was thought to be a "natural phenomena, like the precession of the equinoxes" (Young 1928:528-529). It is this classical concept of increasing returns, which possesses a dynamic flavor, from which Young chose to build his understanding of economic progress.

In particular, Young went back to a "simpler and more inclusive view" of increasing returns that is based on the division-of-labor. In doing this, he implicitly

expands the level of structural detail beyond that of individual firms. What were, from an individual firm's perspective, properly considered external economies become the internal economies of particular productive processes collaboratively engaged in the economic process as a whole. This analysis singled out a distinct level of structural detail from Smith's general division-of-labor and extent-of-the-market relationship by differentiating within the industrial infrastructure which had evolved since Smith and thereby shared a theoretical perspective with Marshall. As Blitch (1990:451) has noted, although Young realized that this circular relationship between the division-of-labor and extent-of-the-market is active at many levels of the economy, the particular perspective which he chose to take focused on the final products.

Methodological Foundations of Young's Perspective. Young used Marshall's distinction between internal and external economies to explain his objections to strict equilibrium theorizing.⁵⁶ It is not that an equilibrium framework lacks heuristic value, but that it will always be a partial view which has limited use when investigating the phenomenon of increasing returns in its full richness. It is at this point that we get the first comments by Young associated with a conceptual hierarchy of parts and wholes: The contention that all external economies cannot be accounted for by summing the internal economies of all the separate firms and his recognition of the stability of these

⁵⁶ A little known article written anonymously by Young in 1929, "Big Business: How the Economic System Grows and Evolves Like a Living Organism," and published in The Book of Popular Science, is an explicit investigation of the internal and external economies of a firm, industry, and the economy. It has been reprinted in the Journal of Economic Studies (Young 1990).

internal economies relative to external economies. It is worth quoting his description of internal and external economies at length.

When we look at the internal economies of a particular firm we envisage a condition of *comparative stability*. Year after year the firm, like its competitors, is manufacturing a particular product or group of products, or is confining itself to certain definite stages in the work of forwarding the products towards their final form. Its operations change in the sense that they are progressively adapted to an increasing output, but *they are kept within definitely circumscribed bounds*. (Young 1928:528, emphasis added)

In other words, the internal economies of a firm pertain to the relative efficiency of a diversity of productive techniques available to make a specific product, whether intermediate or final. One could say that the firm's internal economies result from its successful/unsuccessful adaptation to a particular niche within the economic process.

Young continued,

Out beyond, in that obscurer field from which it derives its external economies, changes of another *order* are occurring. New products are appearing, firms are assuming new tasks, and new industries are coming into being. *In short, change in this external field is qualitative as well as quantitative*. No analysis of the forces making for economic equilibrium, forces which we might say are tangential at any moment of time, will serve to illumine this field, for movements away from equilibrium, departures from previous trends, are characteristic of it. Not much is to be gained by probing into it to see how increasing returns show themselves in the costs of individual firms and in the prices at which they offer their products. (Young 1928:528, emphasis added)

One could say that external economies represent the environment, and therefore determine the niche in which individual firms find themselves. However, Young seemed to imply that this environment experiences dynamic qualitative change due to the emergence of *new niches and new products which change the nature (i.e., quality) of existing niches*.

Although Young recognized that "one who likes to conceive of all economic processes in terms of tendencies towards equilibrium" may wish to imagine that the realization of increasing returns are spread through time so as to secure an equilibrium of costs and advantages, he believed that,

This would amount to saying that no real economic progress could come through the operation of forces engendered within the economic system - a conclusion repugnant to common sense. (Young 1928:535)

The appropriate concept, he believed, is one of *moving* equilibrium since the declining costs of increasing returns are not those which can be figured into a static equilibrium of costs and advantages. This can be interpreted to mean that the individual firm/industry finds itself within a context of relative stability which allows for some degree of equilibrium corresponding to firm level qualities. However, the forces which contribute to systemic stability at the level of the firm are dwarfed by the external economies that act on the firm's environmental context. These slower, but more powerful contextual forces determine the underlying trend of an individual firm's moving equilibrium.

In trying to reconcile these ideas within a partial equilibrium analysis, the representative firm concept is used as an expository device which caters to the discrete nature of human concepts and is not a 'real' entity. As the economy develops and the division-of-labor expands, what were the internal economies of the representative firm dissolve into the "internal and external economies of the more highly specialized undertakings which are its successors," but these economies are also "supplemented by new economies" (Young 1928:538). Like Robertson (1930), Young (1928:538)

contended that the representative firm "loses its identity" as the division-of-labor expands within the economy. From this perspective, he expressed the belief to his graduate students at the London School of Economics that Robbins' (1928) article, which lambasted the representative firm concept, was overcritical and "hardly worth wasting an article on in the Economic Journal" (Blitch 1990:451).

In his 1928 analysis, Young focused on the division-of-labor among and within the complementary patterns of firms which contribute to the production of a final consumer good. For example, the production of books involves the production of wood pulp, different kinds of paper, printing blocks, printing presses, different inks, et cetera. As each of these particular steps becomes its own specialized industry, the division-of-labor is expanded. The economy experiences simultaneously a differentiation of tasks along with a greater level of integration between these component parts. Although this increased differentiation will obviously reap the advantages gained through using capitalistic methods of production (i.e., the factory system), which is the conventional explanation for economies of production, it will also take advantage of new economies. Young cited three examples of these new economies: (1) A higher degree of specialization in management services. (2) A more efficient geographical distribution of industrial operations, i.e., a more efficient combination of productive advantages can be realized with a smaller element of compromise.⁵⁷ (3) A greater access to the economies of indirect or roundabout methods of production whereby previously produced capital

⁵⁷ The advantages which Young cited were nearness to raw materials, accessible and inexpensive power sources, proximity to other industries and/or cheap transportation, and access to a large center of population and/or inexpensive marketing channels.

goods are used to produce consumer goods through specialized processes. For example, the use of hammers, saws, and lathes in the production of furniture and buildings represents an indirect method of production.

Of these three, Young (1928:531,539) believed that indirect or roundabout methods of production make the greatest contribution to the productivity of the economy as a whole.⁵⁸ As the division-of-labor unfolds, new industries emerge to take advantage of indirect methods of production which were not economical when the aggregate output of the whole industry was smaller. There is a slight problem here since the concept of an industry is used ambiguously, due to the symbiotic linguistic relation between the concepts of an industry and the goods market.⁵⁹ Young's emphasis, when referring to the whole industry, was on the market for the *final product* and therefore on all the firms engaged in the process of producing a particular consumer product from beginning to end, rather than merely markets in general.⁶⁰ Although it has become more difficult to empirically disentangle the interconnections between industries in the economy using this criterion, by viewing the productive process in its entirety Young implicitly internalized the individual firm and dissolved the logical inconsistencies that occupied Sraffa and were dispelled through ancillary assumptions by Pigou. While Robertson's failure to recognize the logical paradoxes inherent to the parts-whole perspective caused him to argue with futility within the logical arena established by Sraffa, Young preserved

⁵⁸ These ideas find analytical expression in Georgescu-Roegen's (1971: Chapter 9) conception of the production process even though Georgescu-Roegen fails to mention Young's work.

⁵⁹ This linguistic difficulty is directly related to the circularity between the DOL and EofM.

⁶⁰ This perspective was also taken by Chapman (1908) with respect to his systems of the second order.

the evolutionary dimension of the increasing returns concept by explicitly shifting the perspective.

Endogeneity of Economic Progress. What is wrong with exploring increasing returns solely from the perspective of an individual firm? Young felt that the use of increasing returns as an explanation of a firm's ability to achieve significant economies, rather than as a quality of the economic process as a whole, is "in a way" true, but also "misleading." He commented that one should not,

... try to make of *large-scale* production (in the sense of production by large firms or large industries), as contrasted with *large* production, any more than an incident in the general process by which increasing returns are secured. (Young 1928:531, emphasis in original)

He elaborated on this in relation to the extent-of-the-market.

The scale of their operations (which is only incidentally or under special conditions a matter of the size of the individual firm) merely reflects the size of the market for the final products of the industry or industries to whose operations their own are ancillary. (Young 1928:539)

This interdependence between the realization of economies and the extent-of-the-market, which was a central theme of Smith's economic theory, needed to be emphasized in contemporary expositions since,

the economies of large-scale operations and of 'mass-production' are often referred to as though they could be had for the taking, by means of a 'rational' reorganization of industry. (Young 1928:531)

This comment addressed the belief that if increasing returns exist in potential, they will be appropriated by the individual firm. Conversely, if they are not appropriated there exists a logical contradiction within the conditions of the situation, as if a ball was

suspended three feet above the floor without falling and without support. It was the reinstatement of the extent-of-the-market constraint, the recognition of the prevalence of indirect and roundabout methods as the primary manifestation of increasing returns, and the shift from individual firms to the industrial *process as a whole* which alleviates this apparent contradiction.⁶¹ Economic progress involves the unfolding of an existing web of relations through time, which does not preclude conscious participation as an active element (e.g., rational re-organization), but nor does it make this element primary. Although Young did concede that rational reorganization might be necessary to break through the procrustean layers of routine and inertia within industrial operations, he believed that one should not expect too much from such reforms (Young 1928:531). In contrast to Young's beliefs, an extreme notion of rational reorganization implies a conscious ability to simply re-arrange the parts, pretty much disregarding the complementary relations of the existing web of relations and the necessity of time, in order to reach greater efficiency.

As empirical support for his ideas, Young cited the productivity differences between British and American industry. After accounting for a country's economic endowments, he believed that the most important single factor in determining the effectiveness of its industry is the extent-of-the-market as manifest through its effect on the feasibility of indirect methods of production. Therefore, the high productivity in America is largely due to the size of its domestic market rather than any entrepreneurial

⁶¹ It is perhaps a recognition of these facts which led subsequent literature to abstract away from external economies in analyses at the level of the firm (e.g., Sraffa 1930; Harrod 1931).

advantages *per se*. There are productive techniques which are profitable in American industry but would not be in other countries. He stated,

But just what constitutes a large market? Not area or population alone, but buying power. This trite observation, however, at once suggests another equally trite, namely, that capacity to buy depends upon capacity to produce. In an inclusive view, considering the market not as an outlet for the products of a particular industry, and therefore external to that industry, but as the outlet for goods in general, the size of the market is determined and defined by the volume of production. (Young 1928:533)

Young believed that this division-of-labor and extent-of-the-market relationship has greater implications for economic theorizing than was commonly believed.

Adam Smith's dictum amounts to the theorem that the division of labor depends in large part upon the division of labor. This is more than mere tautology. It means, if I read its significance rightly, that *the counter forces which are continually defeating the forces which make for economic equilibrium are more pervasive and more deeply rooted in the constitution of the modern economic system than we commonly realize*. Not only are new adventitious elements, coming in from the outside, but elements which are permanent characteristics of the ways in which goods are produced make continuously for change. Every important advance in the organization of production, regardless of whether it is based upon anything which, in a narrow or technical sense, would be called a new 'invention,' or involves a fresh application of the fruits of scientific progress to industry, alters the conditions of industrial activity and initiates responses elsewhere in the industrial structure which in turn have a further unsettling effect. *Thus change becomes progressive and propagates itself in a cumulative way*. (Young 1928:533, emphasis added)

The economic process contains "pervasive and deeply rooted" complementary co-dependent relations which cause changes to cascade through the entire system: endogenous structural change is established as a fundamental characteristic of Young's theoretical conception of the economic system.

There are only two qualifications which Young made to this cumulative process of change. The first involved the idea that "different productive activities must be

proportioned one to another" within this aggregate volume of production. This seems to be a direct reference to the fundamental co-evolution between the productive and consumptive dimensions of human civilization. The interaction between consumption needs/wants and technological abilities will determine the degree (i.e., horizontal dimension) and depth (i.e., vertical dimension) of specialization in particular production processes and hence the resultant size of the industrial infrastructure.

Second, Young explicitly noted the importance of recognizing the temporal character of this expansive process.

If, under these hypothetical conditions, progress were unimpeded and frictionless, if it were not dependent in part upon a process of trial and error, if the organization of industry were always such as, in relation to the immediate situation, is most economical, the realizing of increasing returns might be progressive and continuous, although for technical reasons, it could not always proceed at an even rate. But it would remain a *process requiring time*. (Young 1928:534, emphasis added)

He continued these thoughts by stating two reasons why an "industrial dictator, with foresight and knowledge ... could not achieve an Aladdin-like transformation of a country's industry" (Young 1928:534). The first is institutional since the human element is not perfectly malleable with respect to the geographical distribution of population and its cultural traditions. This rationale is obviously similar to ideas within the American Institutional school of economic theory.⁶² The second involves the accumulation of productive capital which plays a fundamental role in the realization of indirect methods of production. Not only does the investment process take time, but Young also felt that

⁶² Young's early academic affiliations included many connections to Institutional theory (see Blich 1983). He received his doctorate from the University of Wisconsin (1902) and had academic relationships with Richard T. Ely, Wesley Clair Mitchell, and Thorstein Veblen (during his tenure at Stanford from 1906-1910).

the realization of significant improvements will not happen until "a certain quantum of prospective advantages has accumulated" (Young 1928:535). This is interesting since it posits discrete change resulting from thresholds within the economic system. Due to these two reasons, attempts to accelerate the rate at which increasing returns are realized face increasing costs of both a psychological and technical character which may be discrete rather than continuous.

Young did cite four factors which aid in the economy's realization of increasing returns. These consist of the discovery of new natural resources, new uses for known resources, the advancement of science in general, and the growth in population. These influences are commonly accepted and conventionally assumed to be exogenous factors of economic growth. While recent theoretical models have endogenized knowledge and discovery as the dynamic of growth (e.g., Romer 1986, 1990), Young made no such move in his theoretical model. One might conclude that knowledge, as a singular gauge for dynamic economic development, lacked the heterogeneity that Young sought to include in proposing a complementary pattern of economic processes.

Speaking the Native Tongue of the Econ. Although Young believed that supply and demand analysis diverts attention towards "incidental or partial aspects of a process which ought to be seen as a whole", he did attempt to express his ideas within such a framework (Young 1928:533). He reasoned that if a good is produced competitively under conditions of increasing returns and demand is elastic, in the special sense that a

small increase in its supply results in an increase in the amount of other commodities which can be had in exchange for it, then,⁶³

Under these conditions, an increase in the supply of one commodity *is* an increase in the demand for other commodities, and it must be supposed that every increase in demand will evoke an increase in supply. The rate at which any one industry grows is conditioned by the rate at which other industries grow, but since the elasticities of demand and of supply will differ for different products, some industries will grow faster than others. Even with a stationary population and in the absence of new discoveries in pure or applied science there are no limits to the process of expansion except the limits beyond which demand is not elastic and returns do not increase. (Young 1928:534, emphasis in original)

This process of expansion for a particular product continues until the conditions of demand elasticity and/or the possibility of increasing returns in production change. Economic expansion as a whole is seen to depend on the complementary and competitive interplay between individual production processes, as conditioned by their individual possibilities.

In order to get a clearer picture of what Young proposed, one must recognize that human valuation knows no thermodynamic limitations (i.e., obeys no laws of conservation). Therefore, whereas one could contend that the increasing production of one good (e.g., X) must draw productive resources from another good (e.g., Y), the demand for additional X may possess the same degree of valuation as previous units without necessarily reducing the value of any other units of consumption.⁶⁴ Demand

⁶³ Note that he was not directly interested in the profit margins and costs of individual firms, but with a flow of goods within the economy as a whole.

⁶⁴ If one allows imperfect information to exist, additional X may even find itself in markets which possess a higher degree of valuation than previously tapped consumer demand. Furthermore, economies of scale resulting from indirect methods of production associated with marketing and transportation may open markets with high consumer valuations.

and supply analysis is a particular formulation of this insight that aggregate patterns of individual consumption needs/wants are in a dynamic interplay with the technological productive pattern of the economy in such a way that each exerts a force to pull the other in alignment with itself. An expansion in the production patterns of the economy are conventionally assumed to be brought into alignment with consumption through a conservative re-alignment of spending patterns as mediated through the price system. However, the alternative possibility which Young appealed to was that the *other productive endeavors in the economy are expanded* to create the means by which the desire for the initial good can be met. Young's criteria that demand is elastic and production experiences increasing returns represents the conditions under which the *expansive* forces latent within these two co-evolving patterns of the economic system possess mutually re-inforcing tendencies through which a complementary expansion can theoretically continue indefinitely.

The key to understanding this argument rests in Young's theory of money, his main research interest from 1920 to his death in 1929, since it is money rather than price which functions as the mediator between the complementary patterns of production and consumption. He believed that money, through the flow of bank credits, provided "precision and determinateness" to the economy (Mehrling 1994:5). Young attempted to formalize this belief by building a new monetary theory from the theory of banking, the manuscripts of which have unfortunately been lost. As a result, one must not fall prey to the temptation to complete Young's theoretical model of the economic process by imposing one's own monetary bias, especially when such components possess a

distinctively different philosophical perspective (e.g., a Keynesian model based on national income accounts which lack the heterogeneity of a monetary theory based on the dynamic interplay of individual banking operations).

One can summarize the contributions of Young's article with three main points. The first involves his choice of analytic perspective, in that the individual firms and industries which compose the economic process need to be seen as an interrelated whole for an integral understanding of increasing returns. Within this division-of-labor for the economy as a whole, indirect methods of production are the foremost manifestation of increasing returns. Second, the complementary co-dependence between the division-of-labor and extent-of-the-market is re-instated as the fundamental constraint on the progressive evolution of the economic system. Last, through such circular relationships, the possibility that economic progress can occur endogenously in the absence of novel productive methods, new resources, or population growth is put forward as a viable theoretical possibility.

A Bifurcation Point in the History of Economic Thought

Is it appropriate to call the Increasing Returns debates a bifurcation point in economic theory? To the extent that the two methods of approaching economic analysis which dueled within the Increasing Returns debates were both viable alternatives which appeared to be mutually exclusive, perhaps it is. This apparent exclusiveness can be established in two different ways when coupled with a philosophical assumption

concerning the ability to reduce all phenomena to their constituent parts without doing damage to a concept of the whole (the host of ideas which accompanied the methodology of positive economics). First, these two methods analyze the system at different levels. Whereas the work that stemmed from Sraffa's 1926 piece concentrated on the level of the firm, Young was concerned with the economy as a whole. Second, these two groups proposed different concepts of change. The first group utilized an equilibrium analysis, while Young and Robertson used a process analysis. Although Kondratieff contended that static and dynamic concepts are complementary but not reducible to one another, this irreducibility was not appreciated and frequently explicitly denied.

While neither Young nor Sraffa openly criticized the other's perspective, they both recognized the problems associated with restricting the increasing returns notion to the level of the firm. Sraffa fought this tendency on its own terms by contending that there exist interdependencies which make partial analysis flawed while Young chose to reject the appropriateness of this perspective outright. Young did not believe that increasing returns are completely absent from the level of the firm, but contended that their most important aspects are not amenable to this level of analysis. However, the emergence of imperfect competition allayed Sraffa's criticisms by reconciling increasing returns with some sense of competition. In doing this, he appeared to solve the dilemma and thereby legitimated a tendency to focus on the firm, a focus which was further buttressed by a more rigorous theory of perfect competition. Robertson's attempt to keep a process-oriented approach alive at the level of the firm was doomed since he failed to see the need for a hierarchical nesting of concepts which provide the ground for such

evolutionary arguments within an arena of logical consistency. By trying to work within a single level, he crippled his own theoretical position.

Why was Young's work ignored by the profession? There are a few obvious historical reasons. First of all, Young died from pneumonia within a year of writing his 1928 article. He was therefore not able to bolster, refine, or extend his argument. If one notes that the ideas he proposed were "not understood even by professional economists of the day" (Blitch 1990:453), this fact takes on real significance. Another factor is simply the theoretical success of the other lines of economic inquiry. Robinson and Chamberlin's work set off a flurry of activity. To the extent that advances are made in proportion to the amount of attention given to a specific field, a positive circularity is established and advances lead to progress which, in turn, leads to greater attention.

Whereas delusions concerning physical reality are checked as soon as one attempts to fly off a bridge, delusions concerning social reality are more easily self-perpetuated and less quickly rebutted (present author included). This theoretical expansion was therefore self-reinforcing until critical junctures surface, either theoretical snags or empirical discrepancies, which impede the continued unfolding. The third and perhaps most notable event is the Great Depression. Professional attention was drawn towards explaining this problem and Keynes' General Theory was released in 1936. In the wake of the Keynesian Revolution, there arose a split in economics between the fields of macro and microeconomics. Therefore, Young's analysis could be simply dismissed as a contribution to this former field, rather than one having much broader and explicitly distinct implications. For example, the explicit focus on failures of effective demand

within the macroeconomy abstracted away from the heterogeneous process of endogenous growth and decay also found within Young's ideas. It is not until Nicholas Kaldor brought some of Young's ideas into a Keynesian framework that they received significant attention.

CHAPTER 3

THE TRANSITION TO CONTEMPORARY ECONOMIC THEORY

Following the debates of the 1920's, not only were Marshall's evolutionary and biological proclivities dismissed, but even the very possibility of increasing returns was removed from certain topics of mainstream economics (e.g., general equilibrium theory). Hahn and Matthews (1964:833) speculated that it was the inability to logically reconcile increasing returns with a theory of value based on exchange, in the wake of Sraffa's 1926 criticisms, that explains why the concept of increasing returns received so little attention within economic literature during the 40's and 50's. And due to this historical neglect by the field as a whole, most economists were able to shy away from exploring the full implications of such a concept with a clean conscience.

However, if the economy does have such an evolutionary dimension and if economists were actually searching for an accurate representation of the economy, it would make sense that this element would continually creep back into economic theory.⁶⁵ Although the evolutionary paradigm apparently disappeared from mainstream economics, one could argue that it merely remained dormant within the Keynesian system through the multiplier-accelerator relationship which represents the first formal embodiment of a complementary circularity in economic theory. However, while

⁶⁵ From such a perspective, attempts to eradicate the evolutionary dimension are equivalent to trying to empty the sea of its water by transferring buckets of water into mountain streams.

Keynes' savings-investment multiplier received the most attention, the foreign trade multiplier which sits at the core of many cumulative causation models of economic development (originally developed by Hicks 1950, and extended by Kaldor 1955, 1957, 1967, 1968), was given relatively little attention by mainstream economics. These two multipliers were used to explain different economic phenomena: stagnation and prosperity. Kaldor (1975:354) commented that,

... it may have been unfortunate that the very success of Keynes's ideas in explaining underemployment in a depression--essentially a short-period analysis--diverted attention from the 'foreign trade multiplier,' which over longer periods is a far more important principle for explaining the growth and rhythm of industrial development.

The circularity between the division-of-labor and extent-of-the-market which had been passed down from Smith to Young can be seen as the general phenomena to which this language of multipliers is applied. The similarity of these theoretical currents pose several fundamental questions for economic theory. Are economic stagnation and prosperity merely theoretical inversions of one another? Or is it that the principles of growth and decay share similar structural relationships?

The next three sections present different threads of economic theory which shared a common ancestry in evolutionary theorizing characterized by their attempts to understand both stagnation and prosperity from an evolutionary perspective. These theoretical models frequently extended the realm of variables in order to include complementary circularities which were not included in conventional economic theory. Of additional interest is the fact that the Increasing Returns debates empowered a dominant equilibrium methodology which was antithetical to evolutionary theoretic

approaches. As a result, all of the theorists presented in the following sections have felt the need to actively criticize this equilibrium theoretic bias. Even though the evolutionary perspective may not have been extremely well formulated in their minds, these theorists knew what they did not believe. Their criticisms may even attest to the bifurcation in economic theory hypothesized earlier in this dissertation.

The first critic discussed here is Gunnar Myrdal. Not only did Myrdal explicitly use concepts of "circular and cumulative causation" to address the problems of economic development and race relations, he also has a sincere appreciation of the methodological dilemmas intrinsic to socio-economic theorizing. As a result, he embedded his theories of complementary co-dependent relations within divergent co-dependent relations that possessed a tangible psycho-social dimension.

The second section presents the ideas of Lord Nicholas Kaldor on economic growth and uneven development. His work used Young's 1928 essay, Myrdal's "circular and cumulative causation" concept, and Keynesian theories of investment to model the economy as a "continually evolving system whose path cannot be predicted any more than the evolution of an ecological system in biology" (Kaldor 1985:12). His models are some of the most complete within the theoretical lineage of evolutionary thinking laid out by this dissertation. A significant feature of Kaldor's writings is his initial attempts to formalize his thoughts through mathematics and then his subsequent retreat to a literary presentations in his later works.

The last section of this chapter presents the accepted notion of what evolutionary economics is and the incorporation of an explicitly hierarchical perspective. This is

augmented by some formal mathematical models of increasing returns phenomena (Arthur 1989) which highlight the unique characteristics of such systemic relations relative to systems which embody the conventional equilibrium assumptions. Not only does this last section stand as a testament to the growing awareness and attention being directed towards the evolutionary paradigm, it also demonstrates a growing ability to formally embody such ideas by employing contemporary mathematical models.

Gunnar Myrdal

Gunnar Myrdal's credentials are not as well established in economics as the theorists presented previously in this dissertation. In fact, Myrdal is considered by many economists to have done the work of a sociologist even though he shared the 1974 Nobel Prize for economics with F.A. Hayek and was honored as one of ten "pioneers" in economic development by the World Bank. Part of the reason for this lack of professional standing is his emphasis on institutions, attitudes, and political atmosphere in conjunction with his explicit rejection of equilibrium assumptions. As a result, his theories have exerted only a minimal influence on mainstream economic thought. In contrast, Myrdal's ideas are highly respected in the other social sciences. For example, he was cited by the U.S. Supreme Court in the historic *Brown vs. Board of Education* case of 1954 as a "modern authority" on race relations (Southern 1981), and was awarded the 1975 Bronislaw Malinowski award in Applied Anthropology.

With respect to real world experience, Myrdal was politically active in his home country of Sweden and served as the executive secretary of the United Nations Economic Commission for Europe (ECE) from 1947-1957. His theories of economic development were formulated during this time at the U.N. (Myrdal 1956, 1957) and founded on an intimate acquaintance with developing regions and their problems. As the executive secretary of the ECE, Myrdal was given the opportunity to travel frequently to South Asia and was in frequent contact with other U.N. Commissions for Asia and Latin

America. His two major case studies, the analysis of race relations in the United States (Myrdal 1944a, 1944b) and economic development in South Asia (Myrdal 1968), embody a clear methodological position which he continually refined and applied throughout his career.

Although Myrdal started out as a neoclassical theorist, he soon came to the conclusion that the tools of conventional theory were inadequate for the study of social phenomena. He therefore chose to develop alternative tools while concurrently holding to the belief that his ideas were an extrapolation of the *spirit* of his conventional training. Two main facets of Gunnar Myrdal's writings will be explored in this section. The first involves his commitment to making values explicit in economic analysis. His work along these lines is very similar to contemporary work in the sociology of knowledge and postmodern philosophy, although he demonstrates modernist leanings with respect to his expectations concerning the power of human reason. The second theme is Myrdal's notion of *circular and cumulative causation*. These ideas first appeared in a footnote to Monetary Equilibrium (1939), but were not developed fully until he wrote An American Dilemma (1944a, 1944b). Kapp (1976:217) held Myrdal's concept of circular and cumulative causation in such high esteem that he placed it at the "core of Institutional economics" and claimed that although similar ideas were implicit in the works of Malthus, Thunen, Marx, Veblen, and Wicksell, it was Myrdal who developed them in a systematic way.

Embedded Theoretical Perspectives⁶⁶

Myrdal believed that answers to problems should never be limited to using only the variables within established disciplinary boundaries. Rather, the problem itself should dictate which factors are relevant and which ones irrelevant to one's understanding. He stated,

... in reality there are no economic, sociological, or psychological problems, but just problems, and they are all mixed and composite. Our separate disciplines in the social sciences had come into existence only to serve the convenience of specializations in research and teaching. They had no logical justification, only a practical one ... In dealing with a problem, it could never be a legitimate excuse that certain facts or causal relations between facts lay outside one's own field of knowledge. (Myrdal 1975:327)

Many of the problems that Myrdal was concerned with, e.g. economic development and race relations, required the inclusion of variables which were normally shunned by economic theory. When addressing problems such as these, he believed that the empirical boundaries for economic theory should be the "total cultural situation" which includes "practically all human relations" (Myrdal 1975:327-328).⁶⁷ Along these lines, his criticism of mainstream economic theory was not a critique of abstraction, but that irrelevant variables are selected and relevant ones ignored (Streeten 1992).

One reason why it is important to fit the discipline to the problem rather than vice versa involves endogenous change. Although the economic process has evolved into

⁶⁶ The information in the following three sections of this chapter have been repeatedly stated by Myrdal (1956, 1964, 1969, 1973). In addition, a wealth of insight from Dykema (1986), which is based on his 1984 dissertation entitled "Methodology and Scope in Gunnar Myrdal's Economics," has been liberally drawn from.

⁶⁷ The one exception to this rule was the imposed exogeneity of government policy, which was consciously done to "preserve a freedom for development planning" (Myrdal 1975:328).

greater levels of complexity, theories of such change have eluded us. For example, formal theories of economic development must frequently appeal to changes in exogenous variable (e.g., technology or population growth) to simulate development within the model. One possible explanation for this lack of endogenous change within economic models is that important circularities have been amputated due to a sectarian proclivity to include only economic variables. When non-economic variables which complete a circularity are included, progressive or degenerative change may emerge within the theoretical model. For example, Myrdal believed that *democracy* and *political freedom* along with *education* are key components to economic development in this sense. If one is interested in evolutionary change, then the inclusion of previously excluded variables which serve to complete a causal loop and thereby endogenize change becomes a methodological criteria for 'good' evolutionary theory.

Myrdal believed that conventional economists work with narrowly closed models that limit their analysis to too few conditions. By restricting this list of variables even further to those that can be quantified, it becomes possible to use impressive mathematical models. Although this "sharp restriction of vision" should require a clear statement of abstractive assumptions made, such a disclaimer is usually not forthcoming and frequently "not even consciously perceived" as being necessary (Myrdal 1982:314). As a result, these theoretical models become more and more removed from the empirical reality they are attempting to understand. It is not that Myrdal is hostile to models and theories, but that he wants:

the models and theories - regularly conceived by us as systems of questions that are logically integrated to the empirical reality around us - to be more adequate to this reality. (Myrdal 1982:315)

This lack of concordance with reality led Myrdal to predict that Institutional economics was "destined to gain ground at the expense of conventional economics" in order to deal effectively with practical and political problems. Furthermore, he believed that much of "present establishment economics, and in particular those very abstract theoretical constructs that up till now have enjoyed highest prestige among economists," will be "left by the wayside as irrelevant and uninteresting" (Myrdal 1982:315-316).

While Myrdal believed that theoretical modelling should explicitly include cultural variables in order to accurately represent the economic process, he also held the more radical belief that the cultural conditioning of the theorist lays hidden *within the theoretical model itself*.⁶⁸ This cultural conditioning manifests itself in an individual's values and ideals which form the foundation of their particular theoretical viewpoint. And, it is the theoretical viewpoint (e.g., the equilibrium bias) which not only directs the questions asked, but also determines which questions are deemed legitimate.⁶⁹ In this way, an initial structure for the answers is provided. This co-dependence between theory and revealed fact is captured in the following quote:

Scientific knowledge never emerges by itself, so to speak, from empirical research in the raw, but only as solutions to problems raised ... Theory,

⁶⁸ He commented, "Biases in research are much deeper seated than in the formulation of avowedly practical conclusions. They are not valuations *attached* to research but rather they *permeate* research" (Myrdal 1962:1043, emphasis in original).

⁶⁹ A wonderful discussion of the values implicit within the equilibrium viewpoint can be found in "Appendix 2: A Methodological note on facts and valuations in social science" of Myrdal's American Dilemma.

therefore, must always be *a priori* to the empirical observations of the facts. Facts come to mean something only as ascertained and organized in the frame of a theory. Indeed, facts have no existence as part of scientific knowledge outside such a frame. Questions must be asked before answers can be obtained and, in order to make sense, the questions must be part of a logically coordinated attempt to understand social reality as a whole. (Myrdal 1957:164)⁷⁰

The importance of values/ideals is that they provide this *a priori* theoretical viewpoint from which the perceptual unfolding of reality proceeds. In summary, our perceptions are flavored by our theories, as our theories are flavored by our values.

Focusing on the interaction between theory and revealed fact, it is this co-dependent relationship that forms the logical crux of science, since science,

assumes in all its endeavors an *a priori* but its ambitions must constantly be to find an empirical basis for this *a priori*. (Myrdal 1957:167)

Streeten (1958:xi) has characterized Myrdal's beliefs in an evolutionary sense as,

the continual encounter - sometimes constructive, sometimes destructive - between the *a priori* and the *a posteriori*, between vision and experience, in which each, in the process of shaping the other, is itself shaped by it.⁷¹

The fact that this continual encounter can be either constructive or destructive recognizes the fact that this co-dependence between fact and theory is not a complete symbiosis. Myrdal believed that although theory is *a priori*, facts are sovereign. Theory is merely a hypothesis whose criterion for truth is its effectiveness in bringing our observations of facts into a meaningful and noncontradictory system of knowledge (Myrdal 1957:165).

⁷⁰ It has been contended by Dykema (1986) that Myrdal literally meant that there is nothing to 'see' in the absence of *a priori* conceptual structures used to make sense out of chaos. For example, Myrdal (1944b:1057) commented that "scientific facts do not exist *per se*, waiting for scientists to discover them," but that they are a "construction, abstracted out of a complex and interwoven reality." Furthermore, Myrdal (1953:240) was fond of quoting a friend's comment that, "without valuations we have no interest, no sense of relevance or of significance and, consequently, no object ..."

⁷¹ See also Myrdal (1967:36).

How do facts exercise this sovereignty? If a theory is composed of "inadequate categories," Myrdal believed that the facts will "kick" and that scientists will thereby know that their theories are somehow misspecified. In this manner, there is a self-healing capacity within scientific research (Myrdal 1973:146). It should be noted that Myrdal differed significantly from the contemporary sociology and psychology of knowledge schools of his day. Although these details cannot be explored in detail here, suffice it to say that Myrdal emphasized the conscious *choice of viewpoint* rather than a difference due to observer's being "children of different times and place," and that he had confidence that "every researcher is fully rational ... if only he wants to be" (see Dykema 1986:148). This inherent potential for scientific rationality, in coordination with sovereign facts, is then used to uncover the unconscious biases which have become lodged within our inherited viewpoints. In opposition to these ideas, Myrdal believed that people were frequently guilty of being *opportunistically ignorant*.

Myrdal qualified this circularity between fact and theory by making a clear distinction between the natural and social sciences. For example, while theoretical conflicts between competing theories within the natural sciences usually result in one theory being refuted (e.g., the Copernican concept of the universe, Newtonian physics, or the phlogiston theory in chemistry), the same cannot be said of the social sciences. Conflicting theories may actually co-exist in the social sciences, and the advance of social research does not usually result in new and more commonly accepted knowledge. Myrdal's explanation for this persistent lack of theoretical clarity and progress within the social sciences has two facets: (1) Social research is more dependent upon value premises

than the natural sciences. (2) Social scientists have ignored this fact and attempted to present their findings as factual and independent of valuations.

In order to address these two points, it is important to note that Myrdal (1944b:1047) distinguished between beliefs and valuations.

A person's beliefs, that is, his knowledge, can be objectively judged to be true or false and more or less complete. His valuations - that a social situation or relation is, or was, "just," "right," "fair," "desirable," or the opposite, in some degree or intensity or other - cannot be judged by such objective standards as science provides.

While there are close similarities between these thoughts and the conventional positive/normative distinction, there is also a distinct difference. Whereas Myrdal used this dichotomous classification to highlight a dialectic truth, conventional economics has reified these two poles and privileged *value-free* over *value-laden* theory. Once Myrdal realized that such a clean positive/normative separation was a naive and impossible dream, he began to express the belief that value premises should be explicitly declared. He came to realize that *all* scientific work, and more generally any viewpoint adopted or question raised, involves valuations. When valuations are not made explicit, they do not cease to be active but rather are merely concealed. In this manner they constitute "a fraud, even though an unconscious one" (Myrdal 1956:337). For example, Myrdal (1978:777) believed that contemporary welfare theory sought to "conceal and forget" that its foundations are founded on a "now obsolete moral philosophy and an even equally obsolete hedonistic psychology." Such selective amnesia allows welfare economics to appear to be outside the domain of morality and values.

Whereas the valuations in the field of natural phenomena are "simple, evident, and so mostly *a priori*," valuations in the social sciences are "immensely diversified and anything but self-evident" (Myrdal 1973:147). What does it mean to say that values are *more a priori* in one field than in another? Myrdal would contend that the *ends* or *objectives* of the natural sciences are more easily identified and defined within the scientific process than the ends of the social sciences. For example, medical science may aim at the prolongation of life through the proactive prevention or the reactive response to disease. Although the choice between the different *means* to achieving the prolongation of life may involve a more explicit valuational dimension, the objective itself is definitive. In contrast, the ends embodied within the social sciences involve a less explicit valuation dimension from the very beginning. For example, the Gross National Product (i.e., GNP), which is used to model and index economic growth and development, involves implicit valuations concerning the meaning and quality of life (Myrdal 1973:Chapter 10). Should one factor in leisure time, household production, police protection, natural and biological resources, literacy rates, infant mortality, or income distribution, one might ask?

Myrdal's emphasis on the primacy of *value-laden* perspectives within the social sciences, a term coined by Dykema, has caused at least one economist (Bauer 1959) to contend that Myrdal's methodological position inevitably leads to the destruction of economics as a systematic-discipline. This erroneous conclusion is based on the implicit assumption that there are an infinite diversity of correct values and hence an infinite

number of possible co-dependent factual-theoretical composition.⁷² However, Myrdal was definitely not contending that *all* values and *all* theories are equally valid. Nor was he expressing the view that there is no common ground between individuals from which shared values and theories can emerge. Instead, his comments are a pointed rejection of the entrenched opinion that theories can be independent of values. Although Myrdal had made qualifications to the extent that all values were not equally valid, conclusions such as Bauer's may have been what led him to make an explicit list of criteria for acceptable value premises in the social sciences (Myrdal 1967: Chapter 13 and 14). First, they should be explicitly stated, specific and concrete in terms of factual knowledge, and purposefully selected.⁷³ In addition, value premises must be founded on actual experience and it is this requirement of "realism" within a subjective world which Myrdal felt was "the main reason for difficulties." Furthermore, it should be consciously recognized that the particular set of values chosen have been given a *strategically favorable* position within one's research (Myrdal 1962:1063, 1967:71). And lastly, once a set of values has been accepted, they should remain hypothetical and subject to revision.

The actual choice of perspective emerges from a theorist's personal ideals for human existence and from an examination of what other people actually desire. However, since peoples' desires are "to some extent regularly founded on erroneous

⁷² This argument aligns Myrdal with a radical postmodern stance. However, it is evident from his work (e.g., Myrdal 1967:Chapter 15) that his ideas have a greater affinity with those of Thomas Kuhn and the sociology of knowledge or even Habermas (see Dykema 1986; Peltier 1992).

⁷³ This last quality introduces a volitional element to research.

beliefs about facts and causal relations," the correct value premises which reflect what people "would desire if their knowledge about the world around them were more perfect" is relevant for Myrdal (1956:336). While this belief obviously reflects Myrdal's exposure to racism, it introduces an obvious difficulty. Who is to play Philosopher King and dictate the "more perfect" knowledge of the world from which values can be judged? Myrdal escapes this snare by positing a hierarchy of human valuation in which the 'higher' values are by definition in greater concordance with reality (i.e., informed by a full and accurate knowledge of the facts). As Dykema (1986:153) stated, for Myrdal:

The common man is caught up in the environmental web, but MAN, epitomized by Western, Enlightened, social scientist MAN, is the agent that stands outside of the underdeveloped environment and can thus function as its savior.

It is from this angle that Myrdal has been openly criticized for imputing Western values to developing countries (e.g., South Asia) and for assuming that the rational foundations of Enlightenment reasoning are the singular basis for a human ideal of rationality (e.g., Goonatillake 1978).

However, Myrdal's ideas are more refined than they might appear to be after a quick glance due to his emphasis on the conscious act of *choosing a viewpoint* and the necessity of neutralizing the unconscious biases embedded within this perspectives. He demonstrated a touch of Rousseau in his belief that biased viewpoints are not inherent to human understanding, but are due to "social institutions and to opportunistic ignorance when living in them" (Myrdal 1957:301). His confidence in the power of human rationality and the belief that every researcher is "fully rational and in control at all times" allowed Myrdal to avoid many sticky philosophical issues by preserving the

possibility for scientific consensus (Dykema 1986:148). This modernist leaning becomes much more pronounced from this point forward in Myrdal's methodology.

Once an ideal has been chosen, it becomes possible to prescribe policy since the ideal establishes a criterion by which different means to achieve this ideal can be judged.

Reality is always studied from the viewpoint of the ideal. The practical problem is how - by what policy changes - reality can be made to approach the ideal. It is recognized that reality is very far from the ideal. In this situation a move towards the ideal is assumed to be desirable, while a move away from the ideal is undesirable. (Myrdal 1956:12)

For example, the recognition that the price mechanism serves to reflect society's values and influence socio-economic behavior, coupled with an explicit declaration of society's ideals and scientific insight (e.g., with respect to environmentally sustainable development), would allow an economist to judge the appropriateness of this incentive structure for achieving our stated ideals. Without the clear declaration of what one wishes to achieve, it is impossible to say whether progress is ever being made. The lack of an explicit ideal does not mean that society will not change, but merely that it will lack vision and purpose as a whole.

Equality of Opportunity as an Ideal

Based on this discussion, it is obviously important to identify Myrdal's ideals which are based on a "more perfect" knowledge of the world. Lalonde (1992) epitomized these

ideals using the motto of the French Revolution: liberty, equality, and fraternity.⁷⁴ The two terms that Myrdal himself used were "economic integration" and "democracy." What is economic integration? It is not merely the connection of different economic processes but also their synthesis through "the realization of the old Western Ideal of equality of opportunity" (Myrdal 1956:11-12). Myrdal defined equality of opportunity as,

the loosening of social rigidities which prevent individuals from choosing freely the conditions of their work and life. The economy is not integrated unless all avenues are open to everybody and the remunerations paid for productive services are equal, regardless of racial, social, and cultural differences. (Myrdal 1956:11)

However, it is not only the freedom to make such choices but also the power to exercise such choice that Myrdal is concerned with. The power to exercise choice emerges from the co-evolution of economic prosperity and political democracy.

... only under democratic rule will people's innermost strivings be protected and a basis laid for attaining the distant goal of a 'free world' of liberty, equality, and brotherhood, and, therefore, peace. (Myrdal 1956:176)

Although Myrdal believed that economic prosperity and political democracy are intimately related by logical necessity, the realization of social reform and democratic ideals emerged "almost as a incidental by-product of the rising levels of productivity and income" which were experienced by Western countries during their development (Myrdal 1956:20). While democracy had historically emerged in these countries via the *individual's quest* for personal expression (which Myrdal coined a "one man, one gun"

⁷⁴ It is tangential, but very interesting, to note that this motto, which is proudly displayed on French coins, was changed during the German occupation of France during World War II. It was changed to travail, famille, patrie (i.e., work, family, and fatherland). This change represents a shift in meaning from an expansive to an introverted view and provides a vivid contrast for Myrdal's ideals.

mentality), recent advances in both warfare and mass communication technologies have destroyed the simplicity of this possibility (Myrdal 1956:325). As a result, undeveloped countries face distinctly different challenges than the currently developed countries faced, and theoretical models of the latter's development will shed only limited light on the former's.⁷⁵

Since these ideals that Myrdal aspired to are so far ahead of world realities, he acknowledged that it is a *faith* in democracy and equality of opportunity which is the ultimate source of his inspiration.

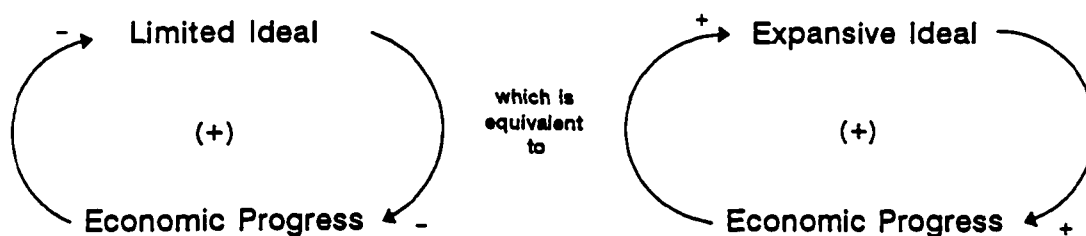
Only when all these underprivileged nations, with their great multitudes of peoples with different facial features, color of skin, religions, folklores, and cultural heritages, have risen to equality of opportunity will the world become integrated. Faith in this principle is the real content of our value premise. (Myrdal 1956:320)

The recognition that faith is the ultimate basis on which his ideals rest is a heroic confession for a scientist to make: it is heroic because it is both a conscious acceptance of uncertainty and ignorance in addition to being an explicit statement concerning how he sees the world. However, Myrdal does not seem to believe that this faith is a blind faith, untethered to reality, but one based on a rational extrapolation of his own experiences.

⁷⁵ Myrdal did not believe that the free play of market forces, in isolation, would be able to achieve any significant improvement in the equality of opportunity. Instead, he believed that it is necessary to institute policies which "cut right across market forces" (Myrdal 1956:13). In support of this view, he noted that the United State made positive steps towards achieving greater equality among its citizens not through the "unhampered operation of an automatic price mechanism and abstention from discriminatory interventions on the part of the state and other collective units of the community," but through a conscious "political and social process aimed at organizing, controlling, and changing the conditions for the functioning of the price mechanism ... determined largely by the ideal ... of achieving an ever-greater equality of opportunity for all their citizens" (Myrdal 1956:119).

The importance of ideals is that they guide action. The belief that "history is man-made and never a blind destiny, determined in advance" gave Myrdal the strength to continue with his work even when he found it "impossible to end with any other conclusion than that, short of a number of near-miracles, few underdeveloped countries will succeed in attaining their [Myrdal's] essential goals" (Myrdal 1956:314). This already pessimistic outlook darkened as Myrdal came to realize the social inertia existing within underdeveloped countries and the widespread corruption in many of their governments (Myrdal 1984). Social institutions may reproduce inherent social values which complement a limited ideal (e.g., caste or national allegiance) and thereby preserve the *status quo* institutional context and limit the realization of 'higher' ideals (e.g., equality of opportunity or peace). In this way, these institutions will engender the preservation of the socio-economic *status quo* rather than its transcendence. However, this self-reinforced stagnation can be converted into a process of progressive development if society shifts from limited to more expansive social ideals (e.g., away from caste relations and towards equality of opportunity). Figure 18 represents this relation in a causal diagram.

Figure 18: The Co-Dependence between Social Ideal and Economic Progress



Myrdal believed that small changes in the socio-economic process hold much greater potential than commonly realized due to these endogenous relations which can create a self-reinforcing spiral of social progress. It is towards these ideas on circular causality that this dissertation now turns.

Circular and Cumulative Causality

The genesis of Myrdal's circular and cumulative causation ideas began with his rejection of the conventional assumption that social systems reside in a state of stable equilibrium and that shifts in this position are simply the impact of exogenous shocks. Instead, he chose to accept the possibility of both stable and unstable states of balance. For example, a pencil can theoretically be placed on its tip, eraser up in the air, and balanced in a state of equilibrium. However, any perturbation to this state of balance will cause the pencil to fall. It was Myrdal's belief that there exists an interrelatedness within the socio-economic process which engenders instability. The idea of cumulative effects refers to the fact that change within this interrelated pattern of complementary elements will reinforce itself: an initial change in a single facet of the social pattern can thereby have ramifications on the whole social process which appear to be quite out of proportion to the magnitude of the initial change. These ideas challenged (1) the common acceptance of equilibrium as the 'natural' state of things and (2) the belief that small changes have small effects while large changes have large effect.⁷⁶

⁷⁶ The latter idea has recently fallen prey to research into the dynamic behavior of chaotic and path dependent systems while the former has been a topic of discussion albeit without any formal resolutions.

In fact, the social process was seen to be in constant flux, with "no equilibrium in sight" (Myrdal 1978:774). As witnessed by his repeated and varied appeal to circular and cumulative causation, Myrdal believed that it was a pervasive and predominant characteristic of social processes in general. Although his expression of these concepts would remain verbal throughout his career, he did identify three characteristics which could be used to identify circular and cumulative relations (Myrdal 1974, 1975). First, he explicitly stated that they are those relationships in which an initial change in one condition results in the secondary changes of other conditions which proceed in the same direction. Although this rules out equilibrium relations from consideration, it includes both complementary and divergent relations of the co-dependent and adjustment variety.⁷⁷ Second, whether a change of one condition is going upwards or downwards must be determined from the point of view of whether it contributes to a movement towards or away from our ideal (e.g., economic integration and democracy). This serves to definitively sign the circular relations and highlights the role of values in providing the poles of judgement. Last, even though the positive or negative signs of the causal interrelations between the elements of these socio-economic circularities may be known, the actual coefficients are not known with certainty and our knowledge of them will remain "utterly imprecise."⁷⁸

⁷⁷ This was not initially appreciated by Myrdal, and formed the basis of Swan's (1962) criticism of his concept of circular and cumulative causation.

⁷⁸ My initial attempts to formulate a formal simulation model of Myrdal's theories fell prey to this point. However, with the proper computer simulation software and hardware, it is possible to 'fit' the dynamic behavior of a simulation model to socio-economic time series data. Towards this end, Clark, Perez-Trejo, and Allen (1995:123) distinguish between two types of simulation variables: (1) *Substantive Variables* for which actual data are available (e.g., initial conditions) and (2) *Intermediary Variables* that represent the simulation models internal logic rather than actual empirical quantities. Within this

While obvious similarities exist between Myrdal's concept of circular and cumulative causation and General Systems Theory, it does not appear that he was aware of the latter's existence. In addition, Swan (1962) criticized Myrdal on the grounds that his ideas were not refined enough and therefore gave an oversimplified account of the endogenous relations within social relations. One is led to wonder why Myrdal did not refine the methodology of his conceptual framework further or search out similar approaches? Although I can offer no explanation for the latter part of this question, there are two possible answers to the first. First, Myrdal (1984) expressed the feeling that he merely repeated his arguments over and over again with little alterations. The ideas he did propose, however simple they may be, were not listened to by the vast majority of the economic profession anyway. Why complicate a story that no one listens to? Second, if no one acknowledges your theoretical ideas, you spend your time collecting data which you believe "fits" into this framework. Even though you may lack the tools required to bridge this gap between fact and theory, a time may come in the future when these case studies will be invaluable to researchers (e.g., Myrdal 1944a, 1944b, 1968). One thereby builds up a storehouse of revealed facts from a *distinctly non-neoclassical perspective*.⁷⁹

These case studies would consist of generalizations since precise information was seldom, if ever, available for the "coefficients of interrelation." Myrdal (1978:775) commented that,

framework for analysis, Myrdal's caveat remains untarnished.

⁷⁹ It is significant that Marshall's Industry and Trade represented a similar turn towards case studies and away from theoretical speculation.

our analysis of development problems often must end in tentative generalizations and mere plausible hypotheses, built upon limited observations, discernment, and conjectural judgements ... the widening of the perspective, implied in this institutional approach, will regularly destroy the neat simplicity of both analysis and conclusions in conventional economics.

Kapp (1976) shared Myrdal's viewpoint but expanded this general pessimism to explicitly include the inability to capture such complex causal relations within a manageable mathematical formulation. Although I would tend to agree that the precise coefficients of interrelation may eternally evade our grasp, a system's dynamic behavior does not defy our current technical ability to embody such theories within a formal computer simulation model. The continuing rise of affordable and powerful computers has made simulation a viable option, something not as readily feasible in the 50's, 60's, and 70's (e.g., Costanza and Maxwell 1991). Computer simulation models have already been proposed as a technique for socio-economic modeling along Institutional lines (Radzicki 1988, 1993; Carrier 1992).⁸⁰ However, the current chapter is concerned with the actual embodiment of these circular and cumulative causation ideas within Myrdal's thought and therefore turns to the manifestation of these relations within his socio-economic research.

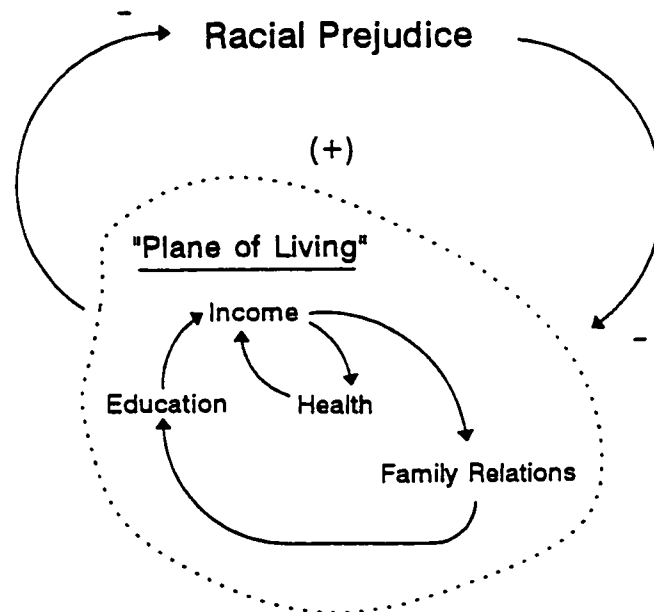
Self-Reinforcing Prejudice. A simplified version of the argument in An American Dilemma (1944a, 1944b) will serve as a nice example of Myrdal's theory of circular and cumulative causation.

⁸⁰ A caveat is in order since computer simulation techniques will need to make substantial advances with respect to bridging the gap between playful simulation programs that are easily accessible to users and the calibration and arraying tools necessary for serious social science use. The juxtaposition of straightforward theoretical models and complex formal techniques is demonstrated in Clark, Perez-Trejo, and Allen (1995) and Costanza, et. al. (1991).

In its simplest form the explanatory model can be reduced to two factors: 'white prejudice,' causing discrimination against the Negroes in various respects, and the 'low plane of living' of the Negro population. These two factors are mutually interrelated: the Negroes' low plane of living is kept down by discrimination from the whites while, on the other side, the Negroes' poverty, ignorance, superstition, slum dwellings, health deficiencies, dirty appearance, bad odor, disorderly conduct, unstable family relations and criminality stimulate and feed the antipathy of the whites for Negroes ... White prejudice and low Negro standards thus mutually cause each other. (Myrdal 1957:16-17)

Myrdal viewed this set of positively related characteristics, i.e. health, education, family relations, etc., to form some sort of *plane of living* matrix. It was recognized that there may be temporal delays, inertia, and therefore possibly no immediate response within the changing interrelations between these variables, but he believed that they generally move together. This plane of living matrix finds itself in a divergent relationship with white prejudice. One could postulate a causal diagram as follows:

Figure 19: Self-Reinforcing Prejudice



This concept of a plane of living index which is negatively related to a psycho-social variable within a positive loop is used repeatedly in Myrdal's development work and represents a nesting of the individual characteristics of human existence within a socio-economic context which is similar to the relations Marshall highlighted. The importance of these ideas is that they establish a positively related social matrix which impinges upon the economy whether explicitly modeled or not, and appear to be used by Myrdal as a proxy for equality in the sense that low levels give limited opportunities for economic advance. Remember that it is not only the right to economic opportunities, but also the ability to exercise this right that Myrdal was concerned with.⁸¹

Self-Reinforcing Economic Inequalities. Myrdal spent most of his later years writing on the subject of uneven development (1956, 1957, 1960, 1968, 1970, 1973). There are two homologous levels of analysis pursued here, one at the national or regional level and the other at the international level. Although he frequently limited his analysis to national issues, this emphasis served as a stepping stone to international issues and the self-proclaimed arena for his thought was *humanity as a whole*. The method which Myrdal used to transition between these levels was to build up the circular causal links

⁸¹ See Smith and Welch (1989) for an empirical exploration of the economic progress of African-Americans from 1940 through 1980. Based on their data, which are average incomes for racial groups categorized by age, it is questionable whether Myrdal's theories are supported by the data. For example, they found that income equality was beginning to occur before both the publication of Myrdal's 1944 study and the passing of Civil Rights laws. One important question is whether this statistical grouping which Smith and Welch employed is appropriate for the assessment of Myrdal's ideas, or whether a more detailed geographical categorization (e.g., by neighborhood or city) should have been used.

of the regional system first and then apply this framework to national and international relations through the addition of international trade considerations and currency flows.

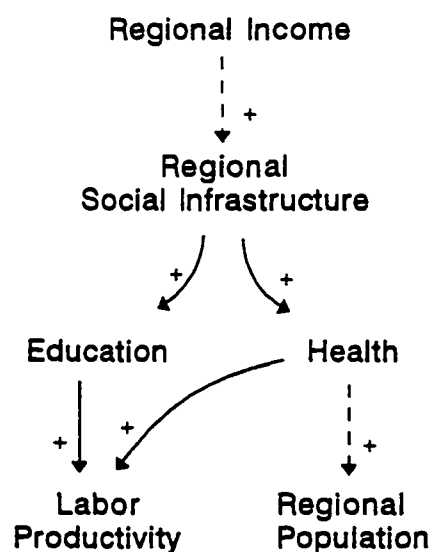
The following section shall unfold Myrdal's theoretical model in a similar manner: from a regional/national to a international perspective. The system's flows are taken as trade (products and services), capital (investment), and migration (labor). Although natural resources were included in his writings as primary products which are traded, the environment was not given an explicitly distinct role in Myrdal's model.⁸² These factor flows represent the throughput from which the cumulative process of economic progress feeds. Between interrelated socio-economic regions, it is the relative attraction of the developing region in comparison to an underdeveloped region which influences these flows. A divergent co-dependent relation was thereby posited to exist between the developed and underdeveloped regions, leading to greater development of the former region coupled with stagnation or decline in the latter. This endogenous widening of the development gap then fuels further development of the developed region. All three of the above mentioned flows will continue to favor the region which developed itself first through manufacturing, commerce, et cetera.

However, the foundation of Myrdal's development theory is built around the postulate that the social and public infrastructure of a region (i.e., a return to his *plane of living* concept) are positively related to the process of economic development. For

⁸² The fact that natural resources are not considered as a separate flow is due to Myrdal's focus on development issues. To fully incorporate this fourth flow into his model would have unnecessarily expanded his research and hence deflected the thrust of his argument by including the interface of the economy with the environment. The stabilizing circularity between the economy and the environment would have complicated Myrdal's conclusions on global development.

example, a prosperous region is able to invest in public infrastructure such as transportation and communication systems. Higher regional income and wealth is also assumed to result in more medical care and superior education. In contradistinction to developed regions which have moved to more instrumentally based systems of belief, the indigenous populations of underdeveloped regions are seen to be, on average, "believers in the more primitive variants of religion, sanctioning traditional mores by taboos and functional magic, and they would be more superstitious and less rational generally" (Myrdal 1957:30). For that matter, the system of valuation in less developed regions take on an air of poverty and backwardness to such an extent that they become "less susceptible to the experimental and ambitious aspirations of a developing society" (Myrdal 1957:30). These variables are believed to be the main influence within the complementary co-dependent process of change since they are completely endogenous to the system and self-reinforcing.

Figure 20: The Socio-Economic Matrix of Endogenous Co-Dependence

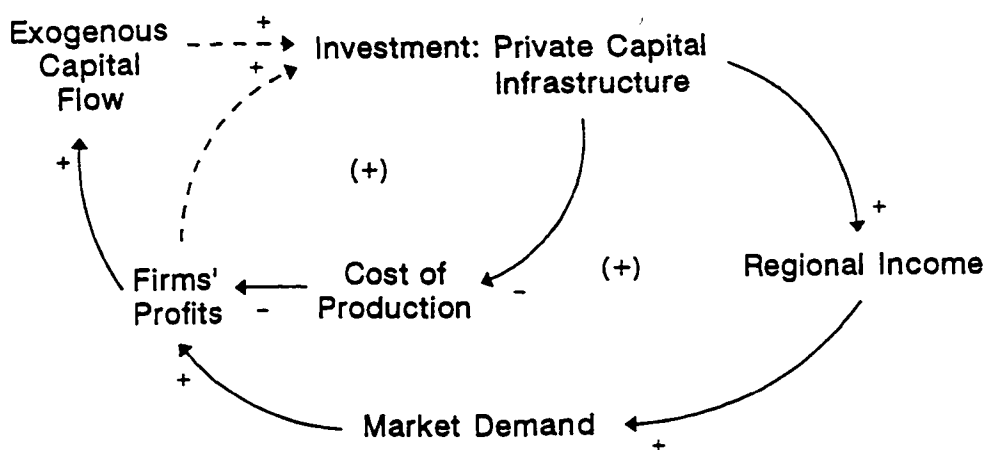


Like Smith, Myrdal's initial conditions for development are geographical advantages such as natural ports or rivers favoring commerce and the location of coal and iron favoring heavy industry. The choice between equally attractive geographical locations is viewed as the result of historical accident (Myrdal 1957:27). These initial advantages establish the conditions from which the circular and cumulative process of increasing internal and external economies provide the continuing drive for economic expansion. Within this expansion, there are two simultaneous effects experienced between regions. The first Myrdal coined the "backwash effect," and the second, the "spread effect" (see Myrdal 1957:26-33). The former are divergent and the latter complementary co-dependent relations between regions.

The backwash effect refers to the adverse changes experienced by one region as a result of the economic expansion of another spatially proximate region. For example, capital will flow into a developing region in response to the greater profitability resulting from an increasing demand via larger regional income. Since Myrdal believed that one of the reasons for increasing regional incomes is the productivity increases due to an expanding production infrastructure, the causal loop becomes circular. The decline of the proximate region is conditioned by his belief that investment in the developing region may exceed endogenous savings and that the difference could be drawn from other regions based on the relative profitability of investment opportunities within the unfolding economic process as a whole. The divergent character of this relationship is due to the fact that the flow of capital into one country represents its flow from another. The

following diagram seeks to represent these endogenous relationships within a given region.

Figure 21: External Regional Economies

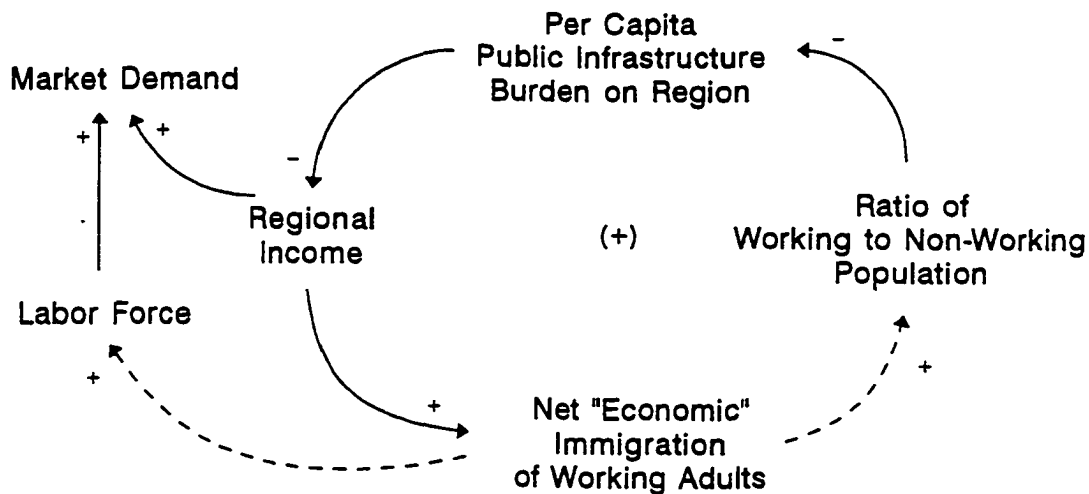


Another backwash effect is worker migration to the developing region which is driven by better employment opportunities (see Myrdal 1956:Chapter 7). Since the immigrants responding to these economic differentials tend to be working adults, this migratory pattern alters the population distributions between regions.⁸³ The relative ratio of working to non-working people in the population (e.g., young children, the elderly, and the sick or disabled) therefore decreases where emigration occurs and increases where immigration occurs. Since the per capita public infrastructure necessary to support this increasing proportion of non-working individuals within the socio-economic system has increased due to emigration, there will exist a heavier per capita public expenditures burden on an underdeveloped country's government. The alternative,

⁸³ Even "political" immigrants may show a tendency to be young and relatively healthy adults since the elderly and ill may not be able to make the trip frequently required under such conditions.

of course, is a decline in the per capita level of public infrastructure which would feed further socio-economic decline. The following diagram augments the previous diagram to reflect these additional causal links.

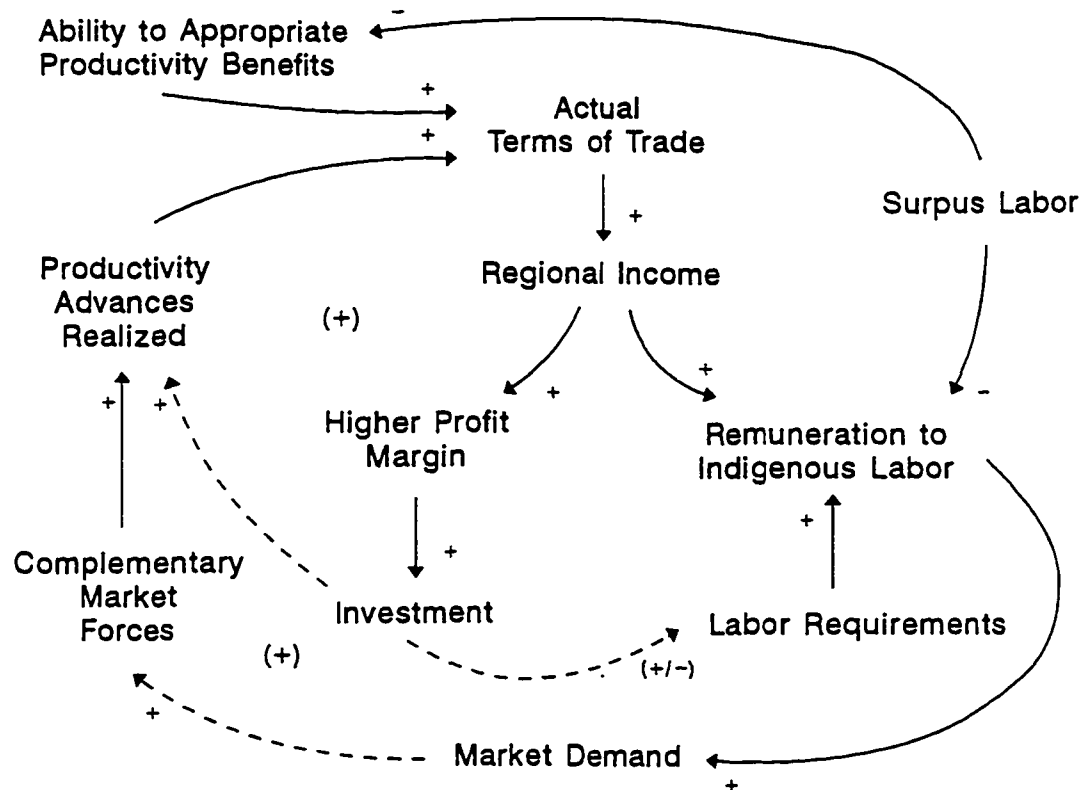
Figure 22: Immigration and Population Composition



A third backwash effect involves the terms of trade between regions (See Myrdal 1956:Chapter 13). Although Myrdal does not appear to propose a concise theoretical explanation for the unsatisfactory terms of trade which underdeveloped countries experienced, a task left to Kaldor, he considered it an empirical fact that the terms of trade favored developed countries. In support of this belief, he cited the findings of a United Nations study by Prebisch (1950) that found a downward trend in the prices of primary goods which underdeveloped countries export relative to the prices of the manufactured goods that they import. Although this could be attributed to low productivity and productivity growth rates in underdeveloped regions, Myrdal believed that productivity is an endogenous characteristic of the socio-economic system.

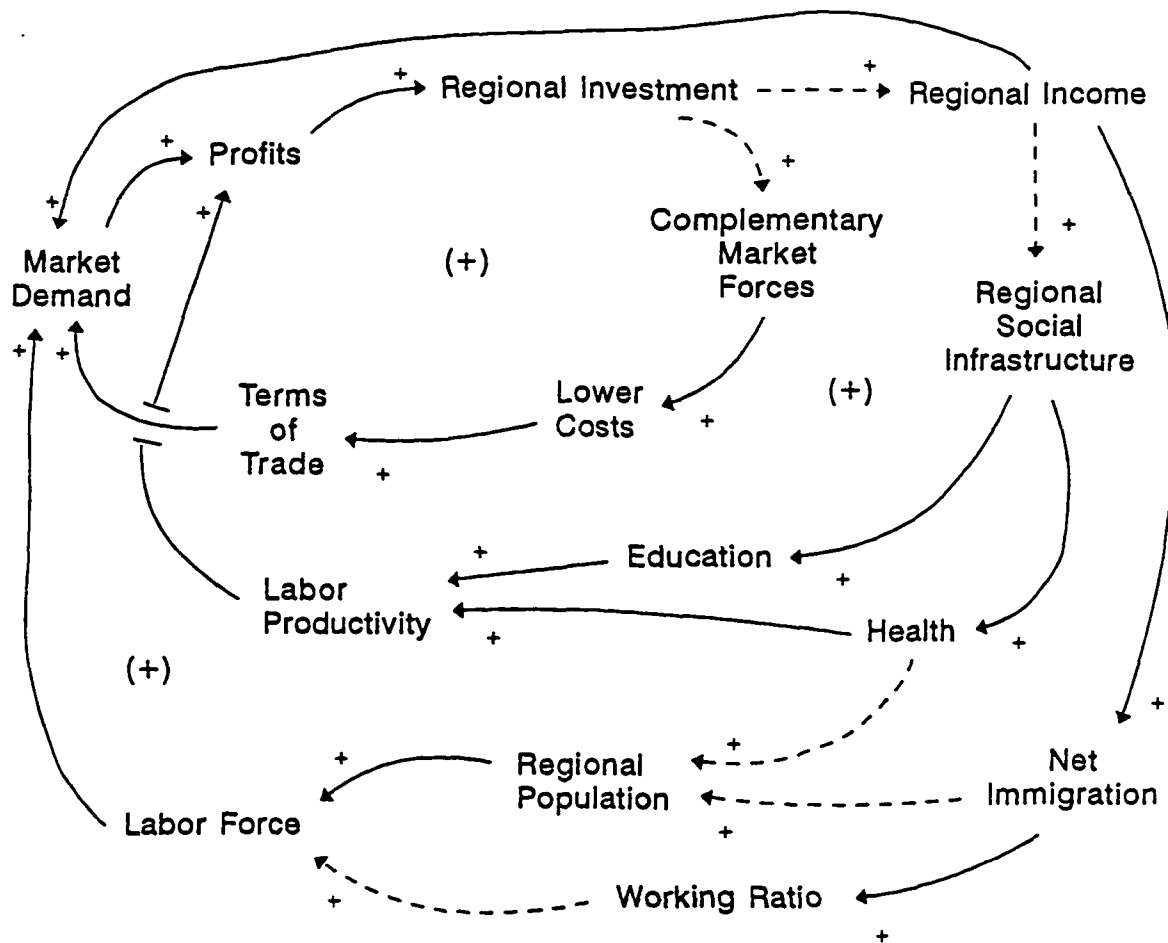
Furthermore, Myrdal was immune to the hypnotic appeal of theoretical rationales for free-trade since he believed that developed regions tended to appropriate both the entire benefits of their own productivity increases which manifest interregionally through a changing terms of trade *in addition to* the scant productivity increases experienced by the underdeveloped regions (Myrdal 1956:232). This ability to appropriate the advantages of a changing terms of trade is attributed to population pressures and the existence of surplus labor in underdeveloped countries, characteristics which are not shared by developed regions. Within the larger pattern of socio-economic relations, these advantages fuel economic development by widening their markets through lower costs (i.e., primary goods prices relative to, e.g., manufactured consumer electronics) and therefore further improvements in the terms of trade. The following diagram shows these postulated causal linkages.

Figure 23: Terms of Trade



These last four diagrams can be combined into a single diagram (Figure 24 which is located on the following page) which represents the complementary socio-economic relations within a given region. The one facet that is noticeably absent from this diagram is Myrdal's emphasis on the cultural and traditional beliefs of the region. These variables would influence the strength of the circularities which loop through the regional-social-infrastructure variable with respect to its overall impact on economic development: a more limited social ideal would inhibit these links while a more expansive ideal would allow them to feed into the expansion of the economy.

Figure 24: The Complementary Dimension of Myrdal's Socio-Economic Model



The spread effects represent a centrifugal expansionary momentum, which becomes manifest due to the expansion of nearby agricultural and more distant primary product markets which feed the process of economic growth in the developing region. These expanding subsidiary markets have the potential to set in motion complementary forces within their respective regions. The spread effect can therefore be viewed as a sort of diffusion effect which is a function of geographic and economic proximity (i.e., direct

trade relationships). Myrdal also associated spread effects with the general enhancement of the various social infrastructure variables influencing human well-being (e.g health, education, values, and beliefs) which he believed would naturally spread across regional boundaries. Along these lines, Myrdal appears to believe that the allocation of the gains from trade are more readily shared intra-nationally as opposed to inter-nationally (due to, e.g., a strong bias along ethnic and religious lines). Of special note is the fact that the strength of the spread effect increases as a function of increasing development (Myrdal 1957:34).⁸⁴ This allows the backwash effects to be more easily overcome in the proximate regions of highly developed areas, thereby resulting in higher development rates in these regions. Although spread and backwash effects are generic to all regions, the actual coefficients of interrelation may be different between regions due to specific historical, cultural, or geographical differences.

Myrdal also mentions a few intra-regional forces, as distinct from the aforementioned interregional backwash and spread effects, which can inhibit this self-reinforcing development cycle he foresaw. For example, increasing population and industry concentrations, inflated and non-competitive prices for productive inputs, the existence of large and technically defunct capital stocks, and a tempering of the entrepreneurial spirit will all have a negative influence on development (Myrdal 1957:35-37). Likewise, there are forces which counteract decline and thereby set a minimum level to which socio-economic integration can fall, e.g. the inability of the wage rate to fall below subsistence levels of living without triggering a Malthusian population decline.

⁸⁴ This complementary relation between a magnitude (i.e., level of development) and a 1st order derivative (i.e., the strength of the spread effect) represents a higher order functional relationship.

Expectations, Myrdal believed, play an ambiguous role since they can be either supportive or countervailing depending upon the situation. He concluded a discussion of these counteracting forces with the qualification:

Nevertheless, I believe that when main trends over somewhat longer periods are under consideration the changes will in the main support each other, and thus tend to be cumulative in their net effects. (Myrdal 1957:37)

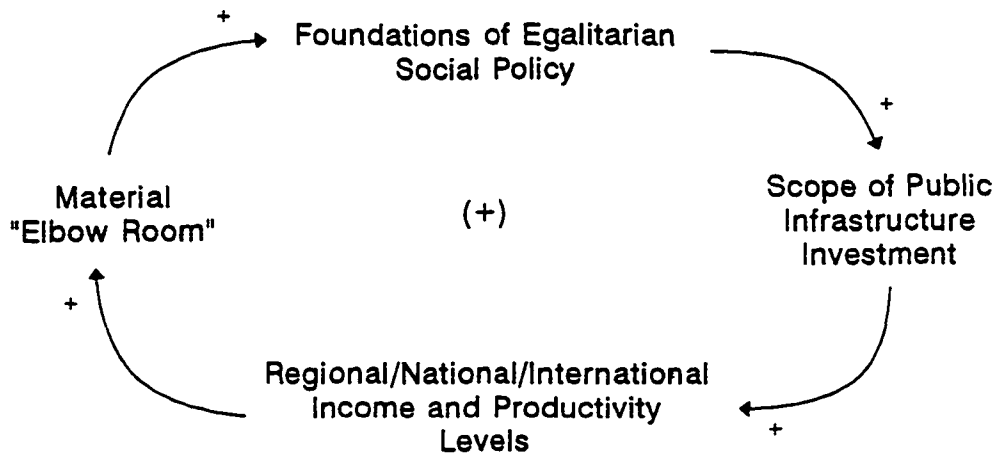
Myrdal's analysis of the international economic process is very similar to his regional and national analysis up to this point. One addition that he does make is to note that migration can be safely ignored as a factor of importance at the international level (Myrdal 1957:54). This was based on his belief that while immigration to an underdeveloped country does not occur due to internal population pressures, emigration from such countries into more developed regions is not freely allowed by the latter. National restrictions which inhibit such immigration flows have the potential to aggravate the loss of skilled/educated labor in a more pronounced fashion since such labor is more likely to slip through the restrictions.

While immigration restrictions are an overt manifestation of a bias towards and against certain groups of people, such biases may also lay hidden in a more discrete fashion within the public infrastructure of a socio-economic system. After a certain level of development is attained, a progressive political dimension (i.e., the pursuit of egalitarian state policy) is believed to amplify the spread effects in a region by actively expanding the public infrastructure.⁸⁵ Such policies would include national welfare

⁸⁵ Recent empirical work has found a statistical correlation between both democracy and economic growth (see Sirowy and Inkeles 1990) and civil/political liberty and economic growth (Scully 1988; Barro 1989).

systems (e.g., income and medical) and the provision of minimal levels of certain services to all regions (e.g., telecommunications, utilities, education, and postal service). Support for such egalitarian policies emerges from a sense of solidarity and kinship between countrymen. Myrdal believed that the degree to which people are willing to support egalitarian policy, which requires a redistribution of income/wealth between individuals and from the individual to the group, is directly related to the amount of economic "elbow room" these individuals perceive they have. Therefore, a rising level of income is more conducive to such policy maneuvers while decline and stagnation are not. Along these lines, an underdeveloped region's citizens are not materially comfortable enough or generally willing to support such egalitarian aid within their own regions. Any redistribution that does occur will mitigate the backwash effects by de-emphasizing the causal link between regional income and regional social infrastructure. Social infrastructure becomes linked to the *national* income, rather than regional income. In a similar manner, an expanding sense of solidarity within humanity as a whole would further decouple these causal interconnections regionally and nationally in the hopes that they will re-emerge at the global level. These relations are summarized in Figure 25. Note that two of the variables are psycho-social.

Figure 25: Egalitarian Policy and Economic Development



The absence of egalitarian policy at the international level was a notable facet of international economic analysis for Myrdal. Although individuals may not perceive themselves as having sufficient economic "elbow room" to afford global egalitarian policy, there also usually exists more distinct personal differences between nations than between regions (e.g., cultural and physical attributes).⁸⁶ In contrast to this, one could add that the world was a large place before the age of advanced transportation and communication technology. As a result, underdeveloped countries may have laid outside the realm of the world as perceived by the citizens of developed nations. For whatever reason, there has not been much of a push by the developed countries to acknowledge the common goal (e.g., happiness) or ancestry of the human race. These cultural differences are really at the heart of what alienates groups of people from one another

⁸⁶ One should note that political boundaries imposed on the world by the Western mindset have frequently been insensitive to cultural differences (e.g., Western Africa) and that egalitarian ideas have frequently been imposed through legislation and military force. This mind-induced delineation of boundaries and imposition of human ideals which deny the actual dynamics of the socio-economic system (e.g., the individuals it is composed of and their beliefs) is therefore doomed to failure.

and thereby hinders the spread effects which might otherwise occur through international channels.

The Significance of Myrdal's Theory

Although Myrdal did not speak in evolutionary terms, except to the extent that he was quite consciously affiliated with the Institutionalist tradition, he was nevertheless deeply sympathetic to the evolutionary paradigm. As a result, his work made significant contributions to the clarification of what an evolutionary concept of the socio-economic process might entail. There are three major points which can be drawn from this last section. First, Myrdal explicitly emphasized the role of institutional variables (i.e., psycho-social and political) within the process of economic development. This interdisciplinary methodology preceded a growing contemporary trend. Second, he did not limit the impact of the aforementioned variables to the socio-economic process, but believed that they play an active role in social science itself. This stance highlights the importance of explicit human ideals to evolutionary theory and annexes the ivory towers of theory to consciously serve, rather than unconsciously dictate, society's goals. Last, Myrdal brings to our attention the socio-economic relations which exist between sets of complementary relations. To the extent that these divergent relations possess a conscious dimension in the shape of attitudes towards others, we are forced to concede that there is a volitional element to socio-economic progress.

Nicholas Kaldor: A Keynesian Injection

There are two lines of Kaldor's thought that I would like to explore. First, his well constructed criticism of general equilibrium theorizing (1972, 1975, 1979, and 1985:Chapter III). Second, the complementary economic relations which form the backbone of his formal and informal models of economic growth and development (1957, 1962, 1967, 1968, 1970, 1981, 1985).

The Irrelevance of Equilibrium Economics⁸⁷

The crux of Kaldor's criticism centers around his belief that the prevailing theory of value, which he calls "equilibrium economics," has become an intellectual exercise that does not constitute a scientific hypothesis (Kaldor 1979:277). By "equilibrium economics," he is referring to the general equilibrium model originally devised by Walras, expressed in von Neumann's 1945 paper, and subsequently developed by the mathematical economists of "our own generation" (e.g., Debreu and Arrow). And by "science," he means a theoretical model which is based on assumptions that are *empirically derived from observations* and which produces hypotheses that are capable

⁸⁷ This is the title of Kaldor's 1972 essay published in The Economic Journal.

of verification with respect to both the assumptions and predictions.⁸⁸ The reason for the failure of equilibrium economics to provide a valid scientific hypothesis is that its basic assumptions are "axiomatic and not empirical, and no specific methods have been put forward by which the validity or relevance of its results could be tested" (Kaldor 1979:277). In fact, its fundamental assumptions have not been empirically observed within the economy, but chosen in order to develop a "logically watertight system," or mathematically pure "crystal." As a result, such models give a "misleading impression of the nature and the manner of operation of economic forces" (Kaldor 1975:347).

A common rebuttal of this line of criticism has been that equilibrium models of the economy are merely the starting point (albeit frequently thought of as the only valid one) from which a truly comprehensive model will spring. However, the necessary process of removing the scaffolding which such a justification implies, i.e. the relaxing the unrealistic assumptions, had not yet begun in Kaldor's eyes. In fact, he even went so far as to contend that it would be truer to say that the fascination with the equilibrium model has caused some economist's *views of reality to become increasingly distorted*, "so as to come closer to the theoretical image rather than the other way around" (Kaldor 1985:60-61).

Where had economic theory gone astray?⁸⁹ In his first three papers which explicitly addressed this question, Lord Kaldor (1972, 1975, 1979) stated the belief that

⁸⁸ "In other words, contrary to the prevailing trend, one should subordinate deductions to induction, and discover the empirical regularities first" (Kaldor 1985:8).

⁸⁹ Some researchers trace Kaldor's thoughts on this matter back to his 1934 papers on static equilibrium concepts and the emerging theory of the firm (e.g., Harris 1991). I shall restrict myself to his more explicit explorations which occurred later in his career.

this misdirection began with the rise to prominence of the theory of value and the idea that the essence of economic activity is an *allocation problem* (e.g., Robbins 1937). In his 1972 essay, this was rather tersely identified as an emphasis on the allocative function of the market as opposed to its creative function. These insights were later refined by Kaldor as he began to see the root of the problem as the elevation of the *principle of substitution* to THE central principle from which both the price system and production are explained. He felt that this approach glossed over the *essential complementarity* that exists between different factors of production and different types of economic activities. For example, labor and capital do substitute for one another, but they also complement one another in the production process. In addition, the different sectors of the economy (i.e., agriculture, industry, and services) also complement one another. These facets of complementarity are "far more important" for understanding the process of economic growth and development than their allocative counterparts, and it is their de-emphasis in equilibrium models of the economy which make these models "so lifeless" (Kaldor 1975:348).

One of the fallacies of the allocation perspective that Kaldor emphasized is the idea that industries compete with one another for identical capital and labor resources. Even when industries do use identical resources, these resources are not in any meaningful sense allocated between them, argued Kaldor. Instead, he believed that each "sector generates its own capital [i.e., the ability to purchase capital] in the course of its own expansion" (Kaldor 1979:279). In other words, the growth of output and the growth of capital are "merely two different facets of the same process; neither is prior to the other

nor a precondition of the other" (Kaldor 1979:279). Following this line of thought, Kaldor believed that different capital accumulation rates between different sectors of the economy are not primarily the result of an allocative flow of capital between sectors, but rather the result of a complementary relationship which exists between the rate of capital accumulation and the rate of return enjoyed by different sectors. Sectors experiencing higher rates of return will expand production faster than other sectors through an *endogenous* process of capital accumulation rather than by being allocated from some great aggregate pool of savings.⁹⁰

Continuing with this evolutionary theme of endogenous sectoral growth and explicitly borrowing from Young, Kaldor noted that the expansion of any one sector will tend to stimulate the expansion of others. In this way, change becomes a chain reaction which, under suitable conditions, harbors the possibilities for self-sustained growth between complementary sectors. This expansion was not *ad hoc* in Kaldor's eyes since the profile of different sectors' rates of expansion tended to approach a "structurally determined pattern," determined by the technical relationships within each sector and the income elasticities of consumer demand for that sector's produce.⁹¹ Under such circumstances, the use of an equilibrium concept is inappropriate since every change creates fresh opportunities for further change and the distinction between changes in the

⁹⁰ As early as 1955, Kaldor was expressing these ideas through his contention that theories of economic growth which account for uneven rates of development based on thriftiness or the occurrence of important inventions are "quite inadequate." He believed that these factors are endogenous manifestations of the process of economic development rather than its underlying cause (Kaldor 1955:718-719).

⁹¹ This complementarity between the patterns of technical and consumer relations within the economy is a promising field of study which has been empirically explored by Boyer and Petit (1991) and Boyer (1988).

quantity and quality of resources can easily become blurred (Kaldor 1975:355). Therefore, the market should not be thought of as an instrument for allocating resources, but rather as one for "transmitting impulses to change." It would be more accurate to say that the market mechanism *creates* and *generates* resources than that it allocates them (Kaldor 1975:280).⁹² However, in addition to these criticisms, Kaldor believed that there is a *basic truth* which equilibrium theoretic models attempt to capture. The crux of the problem is whether or not,

... the manifestly absurd or unreal assumptions of equilibrium theory can be abandoned while still preserving the 'core' of the theory - which I take to be the proposition that the movement of relative prices of commodities and labor enables us to have enough fresh bread baked every morning, that people enter the profession in such relative numbers as are necessary to ensure that there is no penury of dentists nor plethora of doctors or a superfluity of lawyers, and the same is true of street cleaners, sewage workers, motor car mechanics, and so on. (Kaldor 1985:21)

Although Kaldor's 1985 essay also dealt with these issues, it did not share the previous essays' explicit emphasis on allocation. Rather, he suggested that in order to exit the present impasse of the equilibrium theoretical bias, economists must construct models which recognize *time* as being a continuous and irreversible process. In addition, he stated a belief that it is impossible to assume the constancy of anything over time and that the forces which create economic change are endogenous rather than exogenous to the system. The only truly exogenous factor is whatever exists at a given moment of time as "the heritage of the past" (Kaldor 1985:61). This is perhaps one of the most radical statements concerning the presence of interdependence within the economy ever

⁹² This idea has also been explored by DeGregori (1987).

made by a prominent economist. Furthermore, Kaldor goes on to couple this statement with one concerning the fundamental indeterminacy which exists within the economy:

The heritage of the past is the one truly exogenous factor, and its influence will determine future events to an extent that varies *inversely* with the distance of the future period from the present. Thus our ability to predict what *can* happen or what is likely to happen becomes progressively less as we consider the more distant future as against the nearer future. (Kaldor 1985:62, emphasis in original)

What is significant about this passage is that it expresses a belief in endogenous change which seems to evade our ability to predict in both a quantitative and qualitative fashion and is thereby reminiscent of the earlier theoretical positions of Smith and Tucker in the 1700's.

In contrast to his own beliefs, Kaldor contended that equilibrium theory assumes a context for economic activity determined by a set of exogenous variables which remain stable over time. This assumption allows one to identify unique equilibriums to which the theoretical system will gravitate. The problem is not that *some* variables are taken to be stable, but that a *broadly conceived* set of such stable environmental variables is utilized to create an economic theory which is practically independent of historical heritage (e.g., exogenous technological, psychological, and sociological facets). In other words, the set of relevant variables has been misspecified. These criticisms reflect an appreciation for *path-dependent* processes and lead naturally into Kaldor's second criticism of equilibrium economics: the conscious exclusion of increasing returns.

Increasing Returns

It is his emphasis on increasing returns which explicitly aligns Kaldor with the complement of economists explored previously in this dissertation. Just like these earlier theorists, Kaldor believed that increasing returns are an empirically observable fact. In support of this, he cited the Verdoorn Law (following Beckerman 1965) which identified a positive statistical relationship between productivity growth and output growth (Kaldor 1967:15).⁹³ This "stylized fact," a term coined by Kaldor to signify broad historical tendencies which avoid a great deal of individual detail and statistical fuss, was one of six proposed as characteristics of economic change and development in capitalist societies. A full list of these stylized facts is as follows (Kaldor 1968:178-179):⁹⁴

- (1) The steady growth of output and labor productivity with no recorded tendency for falling productivity growth rates (i.e., the Verdoorn Law).
- (2) A continued increase in the capital/labor ratio.
- (3) A steady rate of profit on capital.
- (4) Steady capital/output ratios.
- (5) A high correlation between the share of profits in income and the share of investment in output (i.e., investment coefficient).

⁹³ Conway and Darity (1991:747) note that Verdoorn (1949) identified a strong positive statistical *association* between the rate of growth of GDP and that in manufacturing output while Kaldor (1967) contended that there is a close positive *relationship* between the rate of growth of productivity (and employment) in manufacturing and that in manufacturing output: the difference being one of a strictly correlative versus causal connotation. See McCombie (1983) and Bairam (1987) for a review of the literature concerning this statistical 'law' and the arguments that have been advanced in support of and against Kaldor's theoretical explanations (e.g., Thirlwall 1983; Rowthorn 1975, respectively).

⁹⁴ Wulwick (1992:36) noted that some of these generalizations have been called into question by recent empirical research, but stated that the "consensus of opinion is that Kaldor's stylized facts are accurate broad generalizations."

(6) A noticeable difference and absence of convergence in the growth rates of labor productivity and total output between different capitalistic societies. This is associated with differences in the investment coefficient and the share of profits in income, however, capital/output and the rate of profit on capital are remain steady between different countries.

The cornerstone of Kaldor's theoretical explanation of these stylized facts is an expanding market (i.e., increasing demand) which allows for large-scale production and thereby a production process which utilizes more specialized techniques. These techniques, by assumption, increase labor productivity through the utilization of more specialized capital per worker than previous techniques (i.e., both quantitative and qualitative changes). In attempting to achieve lower costs per unit of production (i.e., higher labor productivity), entrepreneurs employ an ever increasing amount of specialized capital which is made profitable through larger markets. Therefore, the resulting capital/labor ratio involved in production is not primarily due to the relative scarcities or relative prices of labor versus capital and has "nothing" to do with the marginal productivities or marginal rate of substitution concepts of a constant cost framework (Kaldor 1985:67). Rather, it is a matter of using the cheapest production method *relative to the size of the market*.

These increasing returns consist not only of economies of scale experienced by an individual firm, but also include Marshallian external economies which are realized by a region as a whole. For example, opportunities for the development of skill and know-how, easy communication of ideas and experience, increasing differentiation of production processes, and specialization in human activities are all regional externalities that Kaldor cited (1970:340). Due to these regional external economies, industries will

tend to develop near one another. As with Myrdal before him, Kaldor (1979:284) used this relationship to explain the polarization of rich and poor countries with respect to economic development,

The country which became rich and attained higher incomes per head was a country which became "well endowed" with capital and in which therefore the capital/labor ratio became very high. But this capital was largely accumulated out of reinvested profits in consequence of increasing demand, and the ability to use so much capital in relation to labor is very largely a reflection of the scale of activities and not of the relative price of capital and of labor.

As empirical support for this theoretical relationship, Kaldor repeatedly noted the stylized fact that while the capital/labor ratio increases dramatically during economic progress and differs between rich and poor countries (30:1 or 50:1 ratio), this difference is not correlated with a difference between the capital/output ratios which are frequently very similar between rich and poor countries (Kaldor 1979:285, 1985:67). While the acceptance of increasing returns provides a "simple" explanation for these empirical observations concerning the capital/labor and capital/output ratios, the simultaneous association of rising labor productivity and capital productivity is not compatible with a constant cost, allocative perspective.⁹⁵ As a result, a theoretical explanation attempted via neoclassical value theory "clearly goes out of the window" (Kaldor 1979:286).

⁹⁵ The attempt to introduce the concept of neutral exogenous technological change whereby technological change is represented by the residual shift in output growth after factor input changes have been accounted for is incapable of being independently measured and was therefore judged "untestable and vacuous" by Kaldor (1979:285).

A Model of the Macroeconomy

The framework that Kaldor chose for the analysis of economic development is a simple model of a closed world economy with two sectors: one being agriculture/mining and the other industry (i.e., primary and secondary sectors). More complex situations involving economic relationships between non-self-sufficient regions with open borders (e.g., regional, national, and international economic development) can then be explored from this starting point. This two-sector model is sometimes referred to as a North-South model due to the archetypal polarization that occurred after the economic unification of the Northern and Southern halves of Italy. At the time of unification, Northern manufacturing was sufficiently advanced relative to Southern manufacturing (20-25% higher industrial productivity) that free trade resulted in accelerated industrial growth in the North while concurrently inhibiting such development in the South (Kaldor 1981:597).

Before presenting a causal representation of this model, it is important to note that Kaldor was constantly revising, refining, and deepening his ideas to correspond with what he perceived to be empirical observations. For example, Kaldor's thinking concerning the operation of monetary forces underwent significant revisions over the years (see Lavoie 1991). Likewise, Kaldor's theoretical explanations of economic development were also revised and expanded over the years (beginning in the 1950's and continuing through the 1980's). In a 1986 lecture in honor of Sir John Hicks, Kaldor noted approvingly that Hicks never felt constrained by his past utterances. This was

accompanied by a quote from Hicks' Capital and Time which reflects on the different research themes Hicks had pursued:

... it is just as if one were making pictures of a building; though it is the same building, it looks quite different from different angles. As I now realize, I have been walking round my subject, taking different views on it.

Kaldor respected this quality and it was expressed in his own research. However, whereas Hicks employed a spatial metaphor, it is more appropriate to use a temporal metaphor for Kaldor. In other words, Kaldor's models attempted to capture the operative relations responsible for the dynamic evolution of the economy while concurrently taking account of the shifting dominance of various cultural and economic forces.

Although Kaldor's earlier essays (1955, 1957, 1962, 1968) presented formal mathematical models of economic development, his later essays (1970, 1972, 1981, 1985) focused on the more significant theoretical themes without his feeling a need to embody them in formal models.⁹⁶ Perhaps Kaldor came to recognize the difficulties inherent to mathematically modeling path-dependent processes and chose to invest his time in forging the significant theoretical cogs rather than fiddling with teeth size, gear ratios, and lubricant grade.

The following presentation abstracts from much of Kaldor's thought and leaves some facets (e.g., the monetary system) noticeably absent in order to continue our focus on the general phenomena of increasing returns in production. Only the facets assumed critical to this issue are included in the following discussion and diagrams. There are

⁹⁶ Hahn (1989:47) commented that Kaldor found precise models "too constricting and settled for a more literary and narrative style." Kaldor himself (1986:187-188) commented that he "never had the patience to learn mathematics."

three main structural themes that compose the complementary dimension of the Kaldorian model: (1) The presence of increasing returns in manufacturing coupled with its absence in agriculture. (2) An asymmetry between the agricultural and industrial sectors of the economy due to the flex-price and fix-price nature of their respective markets which manifests in their terms of trade. (3) The endogenous nature of capital accumulation and induced consumption.

Technological Progress and The Productivity of Labor. Kaldor did not believe that one could devise a satisfactory measure for capital as distinct from technology. Rather, it is the assumed stability of money within some index of prices which gives the *appearance* of income or capital as being a *real* magnitude. He believed that technological change is embodied in capital equipment and that this creates a serious problem in any attempt to distinguish between the quantity and quality of an ever changing stream of capital investments. For example, it is a relatively arbitrary process to compare two different points of time on a production curve and isolate that portion of the change due to shifts along the curve (i.e., quantity change due to capital productivity) and shifts in the curve (i.e., quality change due to technological change) since the differentiation will be determined completely by one's definition and measurement of capital stocks. And this capital stock variable is conceptually elusive and difficult to measure. Insensitive to this caveat, technological change is sometimes defined as the residual of the change in measured output *not* associated with quantitative changes in measured factor inputs (e.g., Solow 1957).

Due to these difficulties, Kaldor completely rejected the theoretical use of production functions and production frontiers. Instead, he attempted to develop a Technical Progress Function (Kaldor 1957:595-598, 1962, 1968). This formulation was one in which the rate of growth of output/laborer was posited to be a declining function of the rate of growth of capital/laborer, under the assumption that there exists a constant flow of new ideas over time. In his 1962 essay this formulation was simplified, and the growth of output was posited to be a function of the value of gross investment which increased labor productivity through the introduction of innovative capital equipment. While these formalizations attempt to capture dynamic increasing returns, it is not altogether clear that they accomplish their task or that they represent a clear break from conventional production functions (Hahn 1989).⁹⁷

If technology is embodied in capital, then there are two factors which determine the productivity growth in a given sector. First, the level of possible technology relative to the technology actually embodied within the existing capital infrastructure. For example, one can copy existing factor relations to increase output, but as output increases the opportunity for novel factor relations may also present itself. At a given level of output, the introduction of innovative production relations may preserve/increase output at lower/equal cost than the maintenance of previously existing capital.⁹⁸ The second factor is the sector's ability relative to its willingness to close this gap through the

⁹⁷ Arrow's (1962) essay which attempts to endogenize technological change through "learning by doing" and Georgescu-Roegen's (1971) theoretical model of production appear to be alternatives.

⁹⁸ It is important to note that Kaldor's tendencies to endogenize technological change led him to conclude that the "production frontier" will shift as one moves towards it. This differentiates him from the technological gap literature which presupposes a static ideal to which the economy converges.

accumulation of innovative capital. Kaldor believed that a sector's ability to accumulate capital was endogenously determined by its level of output.⁹⁹ However, it is the entrepreneur's willingness to invest in innovative capital processes which determines which investments will actually occur. This entrepreneurial willingness has both a psycho-social and economic (e.g., expected profits) dimension. While the latter is readily accepted by economists, Kaldor (1968:207) supported the former by noting that,

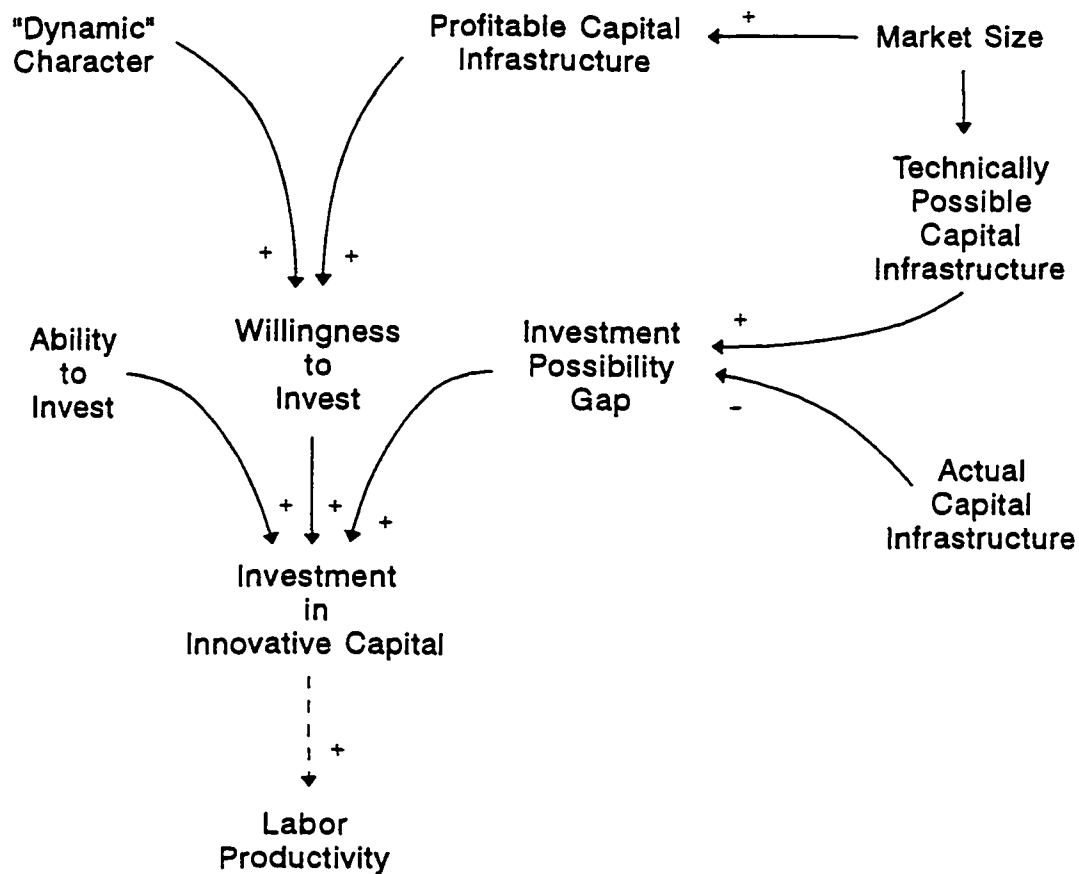
The more 'dynamic' are the people in control of production, the keener they are in search of improvements, and the readier they are to adapt new ideas and to introduce new ways of doing things, the faster production (per man) will rise, and the higher is the rate of accumulation of capital that can be profitably maintained.¹⁰⁰

Therefore, given a gap between possible and actual technology, it is a region's capacity to accumulate capital relative to its willingness to innovate and infuse innovations into the economic system which will determine the rate of growth of output. These relationships are embodied in Figure 26. Although this particular diagram does not present a circular relation, this characteristic will emerge as we build up Kaldor's concept of the economy as a whole.

⁹⁹ If one were to graph output as a function of capital, the "rate of shift of the curve will itself depend on the *speed of movement* along the curve" (Kaldor 1968:207). This is a higher order relationship.

¹⁰⁰ This dynamic quality which Kaldor attributes to the "people in control of production" is an institutional variable similar to the property rights component of Adam Smith's framework, Marshall's emphasis on the enthusiasm and character of a business's owners, and Gunnar Myrdal's inclusion of civil liberties. See also Hodgson (1989).

Figure 26: Technical Progress



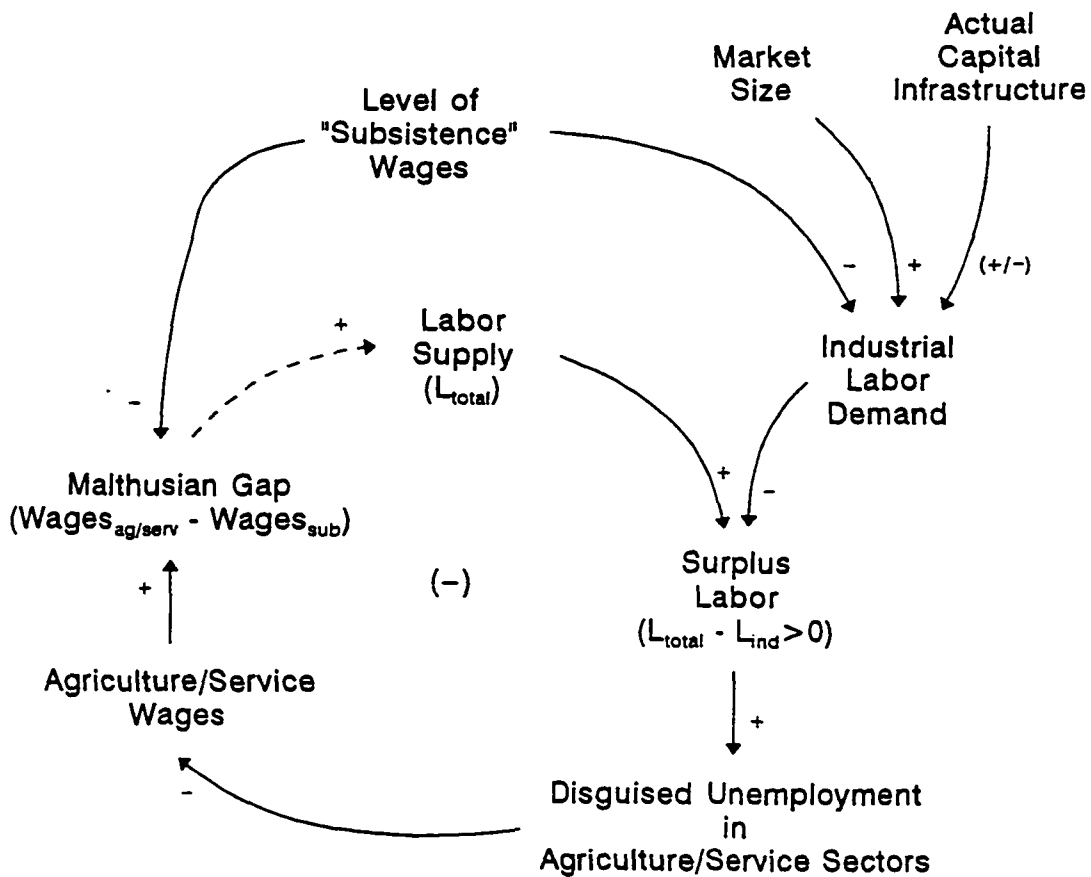
Terms of Trade: Flex-Price versus Fix-Price. Kaldor believed that the price of industrial goods is essentially fixed while that of agricultural goods is flexible. This is based on the idea that there is a minimum and relatively fixed real industrial wage rate in terms of agricultural products which displays resistance to downward movements. This minimum is not merely biological, although such a lower bound undoubtedly exists, and may be determined by custom or convention to such an extent that it bears "no recognizable relationship to subsistence in some biological sense" (Kaldor 1979:352, see also 1975:352). Due to this constraint, the markup price in the industrial process will face the constraint that the value added above primary material costs must be equal to

or exceed this labor cost, or else no industrial production will be forthcoming. As a result, the industrial labor market may not clear in the conventional sense since labor supply will exceed demand. This surplus labor will be absorbed by low-earnings subsistence sectors which allow laborers to earn subsistence wages without effectively contributing to output, a phenomenon which Kaldor called disguised unemployment. Therefore, the employed industrial labor force is endogenously determined by consumer demand rather than exogenously by population growth.

The sector which harbors this surplus labor force is agriculture (and services in his later models). Agricultural production is usually constrained by the productivity of the soil (i.e., productive agricultural infrastructure), rather than the productivity of labor. Kaldor believed that however essential labor is to agricultural activities, there is usually more labor than can be effectively employed on any given area of land. This excess labor is due to a Malthusian relationship whereby population density is a function of agricultural productivity (i.e., surplus over subsistence).¹⁰¹ While agricultural output could theoretically be limited by labor supply, Kaldor believed that only one production constraint would "bite" at any given time (i.e., soil or labor), and assumed that agricultural infrastructure is the predominant limiting factor for development purposes in the majority of rural areas of developing countries. Figure 27 represents these interrelations in a causal diagram.

¹⁰¹ This assumes that subsistence is the dominant factor in procreation and that the population is always pushed back to subsistence conditions. However, many developing countries have experienced a decline in population growth as per capita incomes grow above subsistence (see Meadows 1973). Kaldor did not explore the implications of this demographic transition.

Figure 27: Subsistence Wages and Disguised Unemployment



Kaldor noted that industrialists might find it in their best interest to increase industrial wages above subsistence in order to increase labor productivity (e.g., through education and health care). However, this possibility has been suppressed in the above diagram for simplicity.

In the face of this unlimited supply of labor to industry and assuming a constant profit margin, the actual labor employed is determined by the technical relations of the

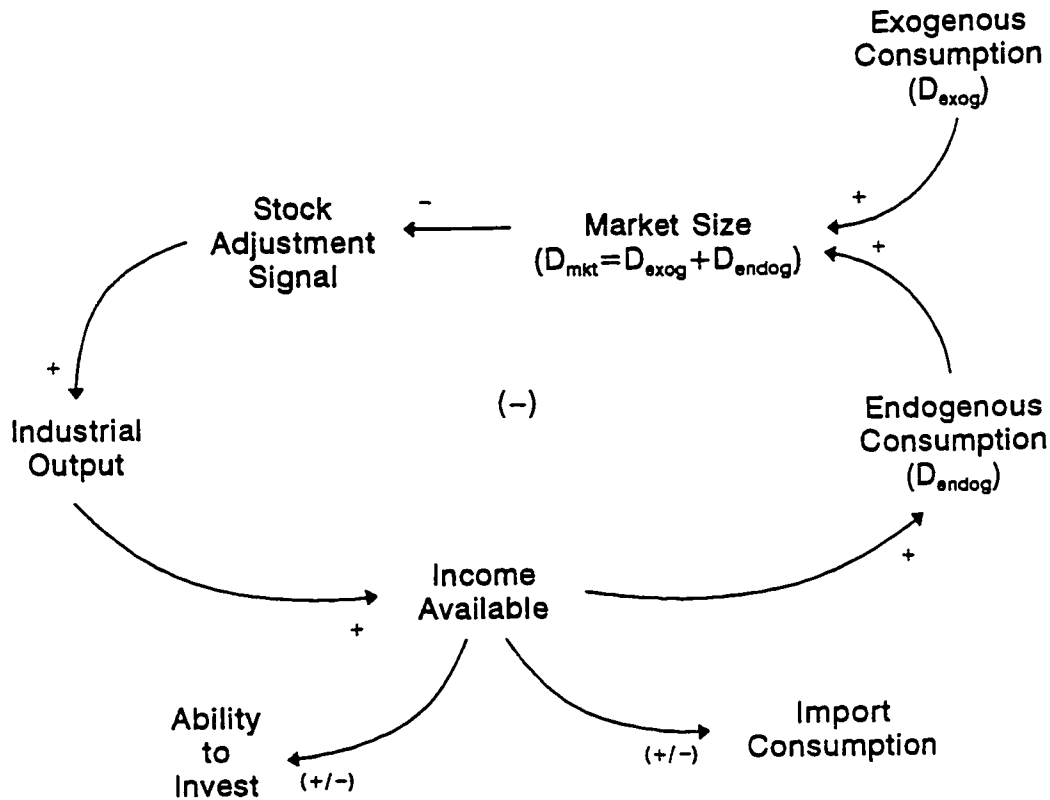
particular production process (i.e., the productivity of labor), the level of market demand, and the conventional minimum wage required by workers. Kaldor believed that since contractual costs form an "important independent element" in the determination of prices within industrial markets, sellers are more likely to set price and accept quantity, and therefore competition will by necessity be imperfect (Kaldor 1970:341). Practically speaking, quantity signals provide entrepreneurs with more information than price signals since they give some indication of *how much* a producer's market has expanded through sales and inventory figures (Scitovsky 1991:117). If producers respond to quantity signals rather than price signals, they are assumed to be willing to supply more at the prevailing price in response to any increased demand. Therefore, changes in industrial demand are assumed to cause shifts in the level of production rather than shifts in price.

This fix-price situation divorces the price of industrial goods in terms of agricultural goods from the supply/demand situation in agriculture. Whereas in agriculture markets the relative price of agricultural commodities will closely conform to changing supply/demand conditions as predicted by the accepted market adjustment process, industrial markets respond to different signals. For example, if the demand for tomatoes exceeds their supply in a given local market, prices will rise and thereby induce the importation of tomatoes from an adjacent region. However, the supply of industrial products within this region is flexible and an increased demand will elicit increased production rather than a price increase. Kaldor (1979:282) summarized these beliefs in the following statement,

If agricultural output is limited by the scarcity of land and not by the availability of labor, and the price of industrial goods in terms of agricultural products is

increased production will result in increased sales receipts if prices are permitted to decline with falling costs. This assumes, of course, that these increased sales do not come at the expense of other sectors of the economy. Recognizing this qualification, Kaldor distinguished between demand which originates from outside the economy and that which originates from inside the economy. The former would be represented by agricultural demand for industrial products or exports in general, whereas the latter represents a Keynesian component of endogenously created demand within the economy. It is this addition which led Kaldor (1968, 1972) to characterize his work as a Keynesian growth model. In the final analysis, the internal or endogenous component of industrial demand is dependent on surplus primary sector production as the initial condition for economic development. These relations are diagrammed in Figure 29.

Figure 29: Endogenous Demand and Induced Investment



Notice that the accumulation of capital in industry is funded endogenously out of profits resulting from expanding markets: however it is also this very accumulation which determines productivity. The extent to which the industrial sector consumes (i.e., agricultural imports and endogenous industrial consumption) versus exports and invests will determine its future growth rate (Kaldor 1981). An increase in demand thereby sets up a self-reinforcing process of industrial growth which is not necessarily experienced by the agricultural sectors. Although capital accumulation can occur in agriculture and thereby increase productivity in that sector, this potential is far less than the dynamic returns experienced in industry. Furthermore, due to the flex-price nature of agricultural

markets, productivity advances in this sector of the economy are passed on directly to customers via the market rather than being retained by producers (e.g., in industry) through higher wages and profits. Therefore, Kaldor concluded that the terms of trade will always move in favor of the industrial sector whenever technological change occurs in *either* sector of the economy (Kaldor 1986:197).

The sectors of the economy which experience increasing returns, whether these be firms, industries, regions, or nations, will evolve spontaneously through endogenous relations. Although this growth must initially be sparked by external stimulation, this life-line may diminish in size relative to other relations. For example, following one line of thought on the topic, although the imperialistic relationship between industrial and agricultural-primary products economies may have provided the initial impetus for the former's growth, these former economies may continue to experience increasing prosperity even as their relations to the latter diminish due to reciprocal trade relations with other industrial economies.

The four previous diagrams can be combined into a single representation of the industrial sector of the macroeconomy in order to highlight the positive causal loops within a Kaldorian model, see Figure 30. Within this industrial sector, there are two stabilizing circularities which equilibrate the quantity signal of *inventory-stock* and *industrial-output*.¹⁰² (1) The *willingness-to-invest* circularity which connects *industrial-output* to the *profitable-capital-infrastructure* variable through the *inventory-stock* of this

¹⁰² Italics are used in the following discussion to identify the different variables within the causal diagram.

particular market (i.e., industrial output in general as opposed to agricultural output).

(2) The *capital-utilization* circularity between *industrial-labor-force*, *industrial-output*, and *inventory-stock*. The first of these circularities reflects a capital adjustment response to changes in industrial output while the latter reflects a labor adjustment response to such changes. Kaldor's emphasis on quantity signals within a fixed-price rather than the traditional flex-price framework is represented by the use of an inventory variable rather than a profit variable.¹⁰³

The most important complementary circularity in this diagram is that between the *size-of-the-market*, the *technically-possible-infrastructure*, and then through to *industrial-output*. This relationship represents the traditional division-of-labor and extent-of-the-market circularity first proposed by Smith two centuries earlier. However, this circularity is augmented by two additional complementary loops formed by inserting the *size-of-the-market* between *industrial-output* and *inventory-stock* in the two aforementioned negative loops. The resulting circularities are usually assumed to be of the adjustment variety (i.e., traditional Keynesian analysis with $MPC < 1$) although the addition of *exogenous-consumption* provides an additional factor which is not endogenously constrained. This consumption dimension of Kaldor's model could include the division of *industrial-output* between re-investment and consumer spending, although we will not explore this possibilities here.¹⁰⁴

¹⁰³ Although it is assumed that quantity and price signals are just two sides of the same coin, the theoretical inclusion of one rather than the other has practical implications for the dynamic behavior of the system even without fixed-prices (e.g., inducing oscillations; see Mass 1980).

¹⁰⁴ Kaldor's (1949) interest in advertising can also contribute to this facet of the model.

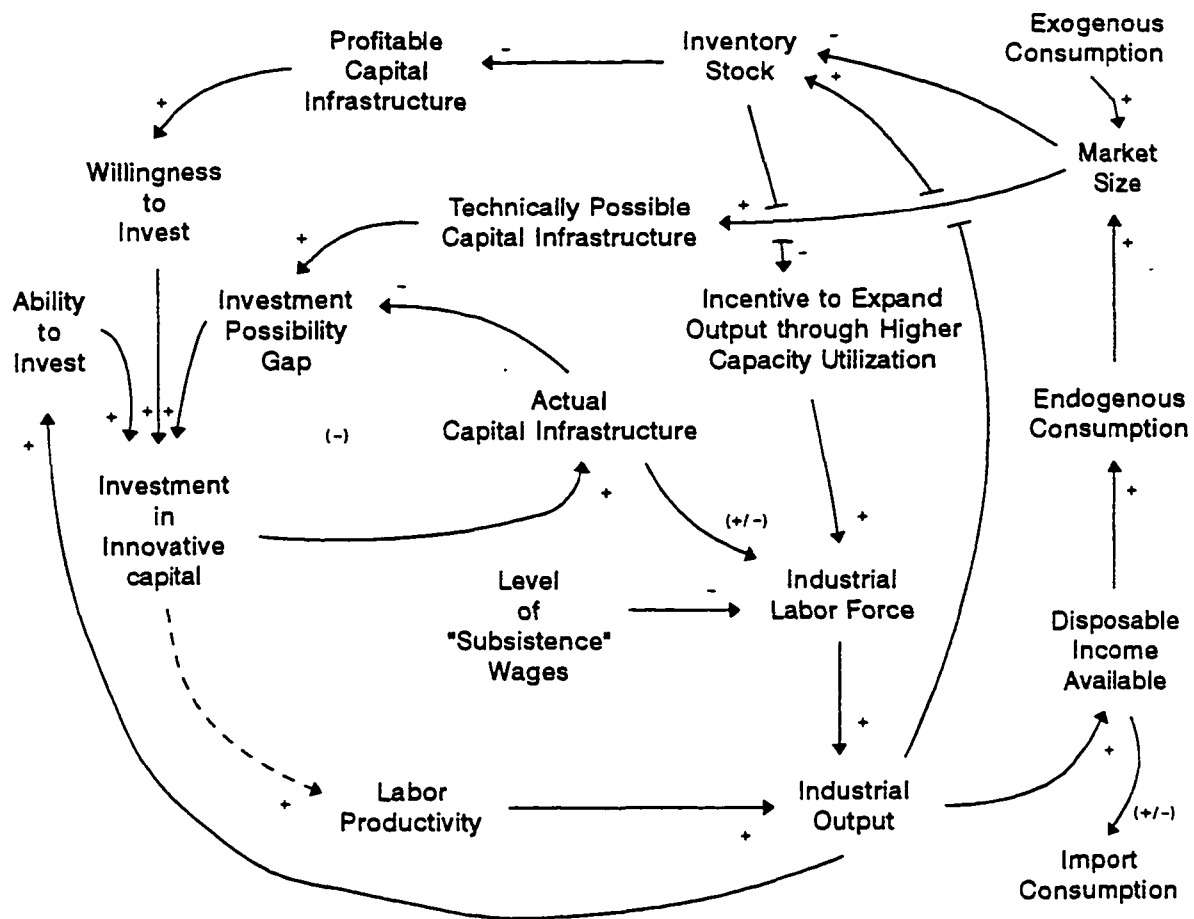
This causal representation of Kaldor's model is completed by two auxiliary relationships: (1) The complementary circularity between *ability-to-invest*, *industrial-output*, *investment*, and *labor-productivity*. This represents Kaldor's notion of endogenous investment. (2) The stabilizing circularity between the *investment-gap*, *investment*, and *actual-capital-infrastructure* recognizes the fact that when the technically possible division of labor is actualized within the capital infrastructure of the economy, there is no incentive to invest in additional innovative capital equipment.

Kaldor's concept of disguised unemployment is not reflected in Figure 30 since its inclusion would require an agricultural sector (experiencing diminishing returns). However, the *industrial-labor-force* variable reflects the pull of a portion of the total labor supply into industry and away from agriculture (or services). It is therefore around this variable, through the inclusion of the causal loops of Figure 27 and an explicit agricultural sector, that the model could be expanded to represent the divergence between industry and agriculture.

It is important to note that on at least one occasion, Kaldor noted *diseconomies* associated with excessive industrialization such as "environmental problems in housing, public services, congestion, and so on" which he believed would be caused by fast rates of population growth into industrialized regions through immigration (Kaldor 1970:344). Areas which experience industrial decline will experience the opposite, which is the existence of under utilized social infrastructure. From this analysis, he established a role for policy by concluding that if the market process were left alone, there is reason to

believe that regional concentration of industrial activities will proceed further than socially preferable.

Figure 30: The Complementary Dimension of a Kaldorian Macro Model



Limits to Growth

It has already been noted that the endogenous limits to industrial expansion will be determined by the technological relationships and demand elasticities. Due to this fact, the basic requirement for continued economic expansion is that the different sectors in

the economy expand "in due relationship with one another" such that "bottlenecks" not occur in key sectors (Kaldor 1986:196). Therefore, future development is continually dependent on balanced development in the present. Of course, the very possibility of balanced growth is an intriguing and unsolved problem. While Kaldor (1986:195, footnote 11) recognized that the natural resources of the earth are finite and could pose a constraint, he appeared to be an optimist (or perhaps devil's advocate) with respect to substitute resource creation through technical innovation.

Kaldor's contribution to the evolutionary dimension of economic thought involves his formidable criticism of equilibrium economics on both the theoretical and empirical front. By emphasizing broad statistical generalizations which could be addressed with a model including complementary relations but not the contemporary neoclassical approach, he developed a strong refutation of equilibrium economics within the field of economic development. In addition, his work as an economist, as opposed to Myrdal, lent credence to his thinking and led to the development of detailed models of economic interrelations.

Contemporary Evolutionary Literature: A Characterization

Whereas one can focus narrowly on the seminal theories of individual economists for long spans of history without doing injustice to the whole, a different approach is required during the critical stages of theoretical development when no obvious route for advance is visible (e.g., the Increasing Returns debates). The history of economic thought becomes the history of economic *thoughts* when the profession moves into periods of what Kuhn (1970) would call revolutionary science. It is this author's belief that the contemporary evolutionary paradigm is participating in just such a conjuncture. One of the reasons for this is that the literary presentations which have been employed by all the aforementioned theorists of this dissertation are no longer acceptable. Why is this so? Simply put, it is a consequence of the growth of computer technology and empirical research on nonlinear systems and hence on the ability to formally embody the evolutionary dimension through computer simulation. However, as with all mathematical models, the conclusions will flow from the assumptions in a *strictly logical fashion*. As a result, it is necessary to have a theoretical perspective which guides the modeling exercise, and it is the historical and philosophical foundations of this theoretical perspective which is the primary concern of this dissertation.

What does contemporary evolutionary theory consist of? Although Darwinian themes of competitive selection are frequently appealed to, this is merely a negative feedback relation between a fluctuating system and its static context: nothing more than

a dressed-up reinterpretation of equilibrium economics. However, this Darwinian theme merely needs to be expanded to include the influence that the system has on its context. In other words, a system and its context will be co-dependent. Many contemporary evolutionary theorists have realized this and have therefore proposed a more general evolutionary theory which contains, but is not limited to, the particular details of a simple Darwinian perspective. In addition, they have realized that there is a mental and volitional dimension to socio-economic evolution which distinguishes it from purely biological systems.¹⁰⁵

A common definition of the evolutionary paradigm within the economics literature is that it is concerned with *becoming rather than being* and the emphasis is on process rather than structure (e.g., Allen 1988; Dosi and Nelson 1994). A dynamic independence is rejected in favor of explicit and thorough interdependence (Clark 1990; Freeman 1991). It is concerned with change which leads to qualitative difference (i.e., the emergence of novel patterns), in contrast to merely quantitative change (e.g., Allen 1988). When dealing with quantitative change, the dynamic characteristics of path dependency and multiple equilibria are stressed (e.g., Arthur 1988). There is the implicit dismissal of closed systems which restrict the flow of resources across the system's boundaries (i.e., conservative systems) in favor of open systems which permit the throughput of energy, matter, and information (e.g., Costanza et.al. 1993; Norgaard 1985, 1987). Along these lines, whole books have been written (e.g., Dosi 1988; Nelson and Winter 1982), collections of essays compiled (e.g., Anderson et.al. 1988; England

¹⁰⁵ This reference to biology is in the conventional sense of the words.

1994; Hodgson 1995; Witt 1993), and a new Journal of Evolutionary Economics founded.

The general approach of all this research has emphasized three "concrete principle building blocks of an evolutionary theory" (Dosi and Nelson 1995). These are: (1) Units of selection which can be the "loose equivalents of the genes in biological theory." These can be thought of as the constituent elements of the system under observation (e.g., technology, behavioral patterns, and cultural traits). (2) The process and criteria of selection by which the spatio-temporal continuity of the aforementioned units is determined. (3) The endogenous process of adaptation, learning, and self-transcendence (i.e., the emergence of novelty) displayed by a given system. These three building blocks can be synthesized through a hierarchical representation, the causal details and philosophical foundations of which are developed in the next chapter.

Although the majority of contemporary work in the field of evolutionary economics is being conducted along Schumpeterian lines (e.g., Freeman 1982), this dissertation has stressed a distinctly different lineage in order to highlight a different historical and methodological facet of the evolutionary perspective within economics. In particular, this dissertation has attempted to establish a broader concept of the socio-economic system that includes psycho-social and political variables in the hopes of developing the foundations from which a truly progressive model of socio-economic development will emerge. In order to do this, it has explored theorists who were interested in the field of economic development as a whole rather than a more narrow economic focus. One of

the disadvantages of taking this approach has been the de-emphasis of the hierarchical dimension as presented in the last two sections.

Returning to these hierarchical ideas, I would like to elaborate on the aforementioned qualities of the evolutionary paradigm. The endogenous process of adaptation, learning, and self-transcendence is comprised of a dynamic flux between conservative and expansive/degenerative forces. These forces have been conceptualized in this dissertation as stabilizing and co-dependent circular relations. Co-dependent circularities have the potential to be explosive, but can be "contained" when nested within stabilizing relations. This nesting of circularities is captured in concepts of the socio-economic process which present different layers of circular relations. It seems logical to propose the use of a hierarchical concept of the socio-economic system based on the expansive and conservative dynamic of these nested circularities. However, these relations will not always be *given* to our perceptions. They are highly nonlinear and all novelty that emerges is experienced *after* the fact. Therefore, an evolutionary theory must explicitly accept the emergence of novel qualities. At the heart of the evolutionary perspective is an attempt to *describe the emergence of qualitative distinction through the act of understanding systemic relations*. Towards a clarification of the evolutionary paradigm, a mathematical formulation of the general phenomena of increasing returns is presented below in order to highlight the characteristic qualities of nonlinear systems

A Formal Model of Complementary Relations

W. Brian Arthur's (1988, 1989, 1990) model of increasing returns phenomena provides a clear and concise presentation of the quality of complementary/divergent systems which will complement the literary presentation of the previous theorists discussed in this dissertation. His model involves two new technologies which are competing for the same unfilled niche in the consumer market. These technologies are assumed to be fully developed in a technical sense but incompatible with one another. While one could make this an increasing returns model by simply allowing the price of the consumer product to fall as production expands, Arthur chose not to rely on scale economies inherent to production. Instead, he proposed that the benefits to purchasing a given technological standard were dependent on the availability of complementary products, which thereby results in the co-dependence of these complementary markets.

As a historical example, Arthur presented the market for VCR tape players in which the consumer originally had a choice between VHS or Beta technologies: Which one does she choose? If the two VCRs are of equal quality, price, aesthetics, etc., then the decision may come down to something like the availability of rental tape outlets (i.e., a complementary product). Therefore, if one lives in an area that has numerous VHS tape rental stores and few Beta tape rental stores, one would tend to favor buying a VHS tape player. What determines the ratio of VHS to Beta tape rental stores? Obviously, the size of their respective markets. But the size of the tape rental market is heavily influenced by the number of people who own the respective tape players. Therefore, under the assumption that tape rental availability is correlated with the current ratio of

tape players in use, one could model the probability that a consumer chooses to purchase a VHS rather than Beta tape player as equal to the number of VHS tape players divided by the total number of tape players in current use.

This scenario was formalized by Arthur, Ermoliev, and Kaniovski (1987) and labelled a Polya Urn problem.¹⁰⁶ Imagine the setting ... one has a big urn which contains two equally sized but different colored balls: one red, one black. The dynamics of this model involve the removal of one ball from the urn which is subsequently returned to the urn *along with* an additional ball of matching color and size. Therefore, additional balls will be added to the urn sequentially with a probability equal to the proportion of red and black balls in the current population.

$$\text{Probability (Next Ball Added is Red)} = \frac{\# \text{ of Red Balls}}{\text{Total \# of Balls}}$$

$$\text{Probability (Next Ball Added is Black)} = \frac{\# \text{ of Black Balls}}{\text{Total \# of Balls}}$$

$$\text{Prob (Next Ball Added is Red)} + \text{Prob (Next Ball Added is Black)} = 1$$

¹⁰⁶ See also Katz and Shapiro's (1985, 1986) work on consumption externalities whereby, for example, consumers value a product more highly when it is compatible with other consumers' products. Although their model reaches identical conclusions and is more noticeably economic in structure, it lacks the penetrating simplicity of the Polya Urn framework.

Such a system will display three interrelated characteristics: multiple equilibria, path dependency, and the tendency to lock-in to a particular color ratio of red to black balls. The first of these means that the system has the potential to settle into more than one stable equilibrium in the long run. With the Polya Urn, many different final color ratios are possible. Although it will start at 1:1, it will soon be 2:1 in favor of one color, and will more likely reach 3:1 than 2:2 in the next period, and the situation continues to unfold. In the VCR scenario, the market settled into a complete standardization in favor of VHS technology. However it may have initially possessed the potential for a great variety of stable outcomes. One could imagine both complete Beta standardization or an East Coast/West Coast split where each region adopts a different technological standard.

What determines which outcome the system actually settles into? While there may obviously be significant factors which cause the system to evolve in a particular direction, *path dependency* refers to the idea that the particular historical path a system follows will help determine its current state.¹⁰⁷ In contrast to systems that settle into specific equilibrium states regardless of their historical antecedents (e.g., a marble spinning around a bowl), this implies that the temporal arrangement of events, even seemingly insignificant events, may be very important. With the Polya Urn scenario, the first few balls selected have a greater impact on the final ratio than later selections. With respect to our VCR market, one might be led to believe that the decisions of the first wave of consumers, and perhaps the advertising efforts and support services aimed at

¹⁰⁷ Other words frequently used to represent this characteristic are *hysteresis* and *ergodicity*.

them, exerted a larger influence on the final market outcome than the choices of later consumers. So what? The economy standardized in favor of VHS instead of Beta tape players, but they both serve the same purpose and the fact that one dominates the market makes little difference, right?

Perhaps. However, the tendency to *lock-in* to a particular systemic relation (i.e., stable equilibrium) presents an obstacle to future change. What this means is that the support which the different elements of the system provide to one another is so strong that this complementarity may inhibit the successful introduction of innovative alternatives. Turning to the Polya Urn problem, once the ratio of black to red balls has become established at 9.9% red (e.g., 12345:1357), a significant shift in this ratio is unlikely to occur.¹⁰⁸ With VCRs, it is believed by many electronic engineers that Beta technology is superior to VHS, but a switch from VHS to Beta technology would now be extremely difficult since standardization has already occurred.

A more vivid example of how standardization can result in the continued use of a recognizably *inefficient* technology is typewriter keyboard layouts (David 1985).¹⁰⁹ When mechanical typewriters first came out, typists were experiencing a problem with typewriter keys jamming since the rate at which they could type was faster than the rate at which the typewriter could register the letters. As a result, a keyboard layout was designed which purposefully slowed down the rate at which someone could type by

¹⁰⁸ Notice that 'stability' remains relative to the unit of measure. Although the tens decimal place may be stable at 9, the thousands or hundred thousands decimal place may still display a high level of unpredictability until an even larger population of balls exists.

¹⁰⁹ See also Cowan's (1990) exploration of the lock-in of nuclear power reactor technology.

placing the most frequent letters in the more difficult places to reach, i.e., the QWERTY layout. This solution was an ingenious way to increase efficiency by decreasing typing speeds and hence decreasing the probability of the typewriter keys jamming. However, in the contemporary world of word processing software and Pentium microprocessors, the problem of people typing faster than the "typewriter" can register the letters is non-existent. Yet even though a U.S. Navy experiment in the 1940's on the DSK (Dvorak Simplified Keyboard) demonstrated that the increased efficiency of retraining a group of typists "would amortize the cost of retraining within the first ten days of their subsequent employment" (David 1985:332), the complementary relations between QWERTY keyboards and existing human capital prevents the economy from making the transition: this is what is meant by inefficient technological lock-in.

The possibility of inefficient technological lock-in is unequivocally antithetical to laissez-faire politics and free market ideology.¹¹⁰ The principal concern will involve the depth of and accessibility to information concerning the long-range feasibility, both technically and financially, of competing and complementary products (Farrell and Saloner 1985; Cowan 1987, 1991). However, even when individuals are fully informed, the probability that society might lock-in to an inefficient technology or market relation is far from zero when private and social benefits diverge and self-seeking behavior is primary (e.g., a prisoner's dilemma situation). Cowan (1991) also concluded that although governments can overcome coordination problems due to divergent private and

¹¹⁰ While this increasing returns scenario could simply be labelled an imperfect market, it is obviously *not* amenable to an equilibrium formulation. Therefore, while there are similar issues within mainstream theory, the following ideas form a distinct subset of imperfect markets which has not been significantly explored.

social benefits, the ambiguity of the future still remains. Inefficient lock-in resulting from uncertainty is inescapable and the goal must be to increase information flows and decrease coordination barriers. This idea of open communication to overcome inertia and generate progressive change is a prevalent theme of social existence as a whole.

The literature on technological lock-in has centered around a hypothetical dogfight between similar products that satisfy the same consumer need (or want). The presence of complementary relations implies that an inefficient technology may gain a dominant position due to historical circumstance rather than objective superiority. In the case of competing technologies, this usually means the technique which minimizes the energy, material, time, or cost of production. However, these criteria for determining what is an inferior solution are heavily influenced by the current values and priorities operating in the economy (e.g., labor costs and discount rates), and one cannot speak of inferiority and superiority unless one has such a standard from which to judge. When we speak of chemical and physical processes (i.e., engineering problems) these standards may be easily ascertained, e.g. steel is stronger than wood. When issues of human welfare (both cross-sectional and intergenerational) are involved, the demarcations between good and bad, efficient and inefficient, or superior and inferior are not always very clear. Furthermore, no portion of contemporary social existence is free of valuation: even the de-valuation of values is a quite significant value to hold. While values have the potential to change, the conservative inertia inherent to complementary relations may resist this change. Yet this web of past actions which is based on past values forms the economic heritage of current social existence.

CHAPTER 4

PARTS, WHOLES, AND HIERARCHIES: A PORTRAIT OF REALITY

The Language of Conceptual Hierarchies

The goal of science should be to pierce the veil of delusion, to go beyond mere appearance and apprehend Truth. From a human perspective, the world seems to consist of certain forms which "stand out" against the backdrop of their surroundings and present themselves as being relatively stable through time. Such forms are conceived of as 'wholes,' 'things,' or 'entities,' in recognition of this perceived autonomy and stability. In looking more deeply at the internal organization of these things, one finds that their inner dynamics consists of the interaction of 'parts,' which may themselves appear as a single entity when viewed from a more detailed perspective (e.g., from molecular to atomic systems). The word *system* is used to emphasize the idea that these entities are not immutable and self-existent *per se*, but the interrelations of parts which may appear as a single entity due to their spatio-temporal continuity in relation to a given perspective. This *process metaphysics* was described by David Bohm at a conference on theoretical biology (paraphrased by Platt 1970) as:

the idea that the universe should not be regarded as made up of "things" but of a complex hierarchy of smaller and larger flow patterns in which the "things" are invariant or self-maintaining features of the flow. The shape of a waterfall or a match flame, or the shapes of clouds, which have a certain constancy even

though masses of moist air are flowing through them and continually condensing and evaporating, would be "things" of this type.

The particular "flow pattern" which is the focus of our attention at a given point in time will be referred to as the *focal system*. What is perceived of as the parts and wholes will depend on the spatio-temporal dimension of perception relative to the spatio-temporal flow pattern or interactive process of the observed system (i.e., the relationship between the observed and the observer). More accurately, one could say that things manifest in accord with the existence of the observer. One of the concerns of this chapter is the definitive placement of human awareness within the spatio-temporal flux of reality and the resulting decomposition of experience into a hierarchy of parts and wholes.

It is obvious that the perception of a distinct system *per se* will require that a system maintains a semi-autonomous dynamic consistency relative to the observational frame; in other words, random relations between elements are not considered to be a *systemic* interaction even though they may influence one another. This homeostatic property permits one to conceive of the system in the first place. But, the essential aspect of *being a whole*, as opposed to merely a logical aggregation of parts, is the presence of a *synthetic quality* which emerges due to a *meaningful pattern formed by the different parts*. This idea is captured in the commonly made statement that the whole is greater than the sum of its parts.

There is, however, a logical paradox within this contention that the whole is greater than the sum of its parts since what appears to be continuous from the vantage of sensory perception has become discrete from a conceptual perspective. In the language of mathematics and logic, individual elements are existentially independent of one another

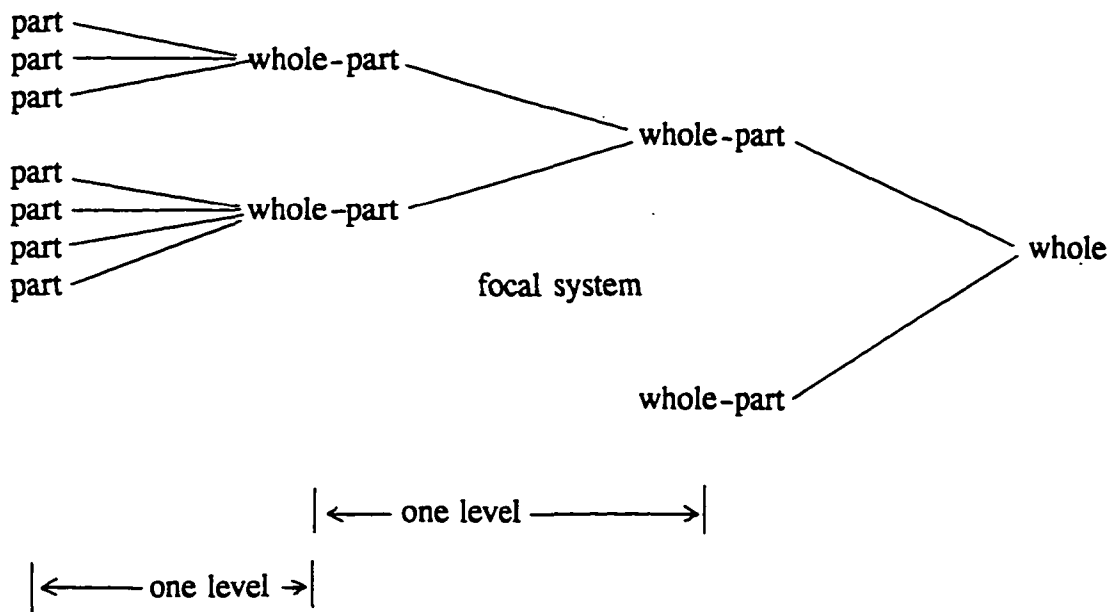
and qualitatively static: the quantity of these elements can change, but it is impossible to capture a qualitative leap from the parts to the pattern within this conceptual framework. In order to conceive of a synthetic quality, one must accept *discrete jumps* within one's language which define a new qualitative level: one could say that the whole transcends the "logic" of its parts. In this chapter I accept the presence of such qualitative leaps and proceeds to build from this point. This acceptance is never reified, but remains contingent on the continued effectiveness of this framework in the problem-solving process.¹¹¹ However, the burden of empirical proof is placed on aggregative concepts rather than this hierarchical alternative.

The representation of a pattern which possesses different qualities from those of its individual parts involves the notion of conceptual leveling. As one increases the spatio-temporal dimension of perception (i.e., larger resolution and longer time span), the decomposition of experience changes. Things which were semi-autonomous systems become the parts of a larger interactive process. As the spatio-temporal perspective is increased further, these systems become the parts of an even larger interactive process. If a synthetic quality appears within a system, then it can be called a whole to signify this new level of integrity. Each shift from the parts to the whole, and then to the whole as a part (i.e., parts-whole and whole-part relationships), can be spoken of as a change of level within the conceptual hierarchy (i.e., a different order of things). Wholes which appear as the parts of the focal system will be identified as *lower level systems*. The

¹¹¹ The problem-solving process is defined as the human endeavor to cope with, understand, and possibly transcend the state of human existence. This conceptual framework does not correspond to a hierarchy of power, but a nesting of conditional relationships which exist simultaneously and manifest to perception through variations in the spatio-temporal decompositions of perception.

larger whole, of which the focal system is a part, will be identified as a *higher level system*. When all these levels are conceived together, they form a nested hierarchy of structural order. This is diagrammed in Figure 31.

Figure 31: Hierarchical Leveling



It must be remembered that hierarchical organization is a conceptual framework used to represent *simultaneous* decompositions of experience rather than being a characteristic of some ultimate reality. As a result, there will never be an ultimate hierarchical representation, but only variations around major qualitative themes determined by spatio-temporal perspective.

As an example of such conceptual levels, neoclassical microeconomic theory conceives of individual consumers (i.e., the process of consumption) and individual firms (i.e., the process of production) as the fundamental wholes of the macroeconomy (i.e.,

regional market process): these three processes occur simultaneously.¹¹² The quest for microfoundations is an attempt to mathematically aggregate these individuals and firms to get the macroeconomy. If the macroeconomy displays patterns which are *important in and of themselves* (e.g., cities, industries, regions, or nations), such a theoretical aggregation will be inappropriate and the derived macroeconomic model will be conceptually biased. In other words, it will not accurately represent the qualities which compose the macroeconomy through their interaction. While the microeconomic parts do form the material substratum of the macroeconomic system, our compiled perception of this physical continuity does not translate into the necessity for conceptual continuity. This is due to the fact that qualities not present in a purely physical or biological process are present in the socio-economic process, notably, self-consciousness.

Since self-consciousness is a distinctive characteristic of human existence and hence a structural quality active in social existence, it is important to address the strict independence which is commonly assumed by many scientists to exist between concept and experience.¹¹³ It is not altogether clear that this assumption is *universally*

¹¹² While the *quality* of this economic agent is not an issue here, it should be noted that the neoclassical concept of "economic man" possesses few significant synthetic qualities above a hedonistically conceived animal. In denying human beings their distinctiveness, concepts of the socio-economic system built on such sterile foundations are stripped of their distinguishing synthetic quality. In addition, individual consumption and firm production decisions are frequently assumed to be made completely independent of one another. The relationship within these processes is one of strict competition. Few *complementary* interactions are allowed since they destroy the logic of the aggregation (e.g., Marshall's external economies). As will be explored later, competition is only one facet of evolutionary change.

¹¹³ An important event in the genesis of the assumption that concept and reality are independent was the Enlightenment (e.g., the ideal of rational human thought and Cartesian metaphysical assumptions). Nature begins to be thought of as a machine which can be directly known. Many of our conceptions of nature have been built on such foundations through the emphasis on empirical fact, objective reason, and logical coherence. However, this particular method for discovering the relations manifest in Nature originated from a more fundamental and radical assertion concerning an individual's ability to experience

warranted. If one's concept of 'what reality is' guides actions which participate in the creation of one's experiences, and if these experiences inform perception, it is theoretically possible for the situation to arise in which one's concepts lead to actions which create a perception of experience which *supports and hence reinforces* the initial conception. For example, Myrdal (1944a, 1944b) postulated that racial prejudice may result in the withholding of social services (e.g., medical care and education) from specific groups deemed inferior. However, this denial of services meant that this 'inferior' group tended to actually be less educated, less healthy, and less affluent. This low state of socio-economic being subsequently serves to reinforce the prejudicial concepts that went into its creation. While one could contend that the prejudicial concepts of social reality are true, this truth has no ultimate validity outside the complex interdependencies in which it participates.

This chapter will investigate the possibility of a complementary co-dependence between concepts and perception as it relates to the formation of socio-economic theory. By explicitly including such epistemological dimensions, one can garner new insights which correct misconceptions concerning the academic community's relationship with social reality and which, therefore, inform future action. Keynes (1936) once commented that politicians are frequently slaves to the theories of defunct economists,

and understand reality directly for one's self. At its heart, the Enlightenment was a reaction to the Catholic church's claim to a monopoly on Truth. No longer was it accepted that Truth flowed selectively through particular institutional and cultural channels. Instead it was seen to be accessible to all who applied themselves towards its discovery. Unfortunately, these foundations have become blurred. Intolerance has shifted through time from a particular individual's ability to know Truth towards strict adherence to a particular *method of inquiry* which is sanctioned as *universally valid*. This claim that the methods of gathering knowledge are singular and universal is ironically reminiscent of past claims by the Catholic Church that, "Holy thought can be expressed only in Latin" (Georgescu-Roegen 1971:50).

and Mirowski (1988) could be interpreted to say that many economists have been slaves to the theories of defunct physicists. To the extent that these defunct physicists were slaves to the theories of defunct philosophers, the deepest assumptions of socio-economic theory are open to investigation.

If such a co-dependence between concept and perception exists, one is led to questions of academic responsibility. Do our concepts of society drive social evolution? Or does social evolution create our concepts of society? Are these two separable? If our concept of socio-economic interaction influences the way society evolves, then this influence needs to be explicitly acknowledged. What is the risk involved in assuming a strict independence between concept and perceived reality, as opposed to their dependence? If one assumes that concepts influence social evolution and they do, one must take some responsibility for the way the world is. If concepts do not influence social evolution, then whether one takes responsibility or not is unimportant. However, if one assumes conceptual independence when such an assumption is false, one divorces the artisan from his or her work under the illegitimate jurisdiction of objectivity. This game is diagrammed in Figure 32.

Figure 32: Assumptions on the Relation Between Concept and Perception

	Assumption of Conceptual Influence	Assumption of Strict Conceptual Independence
Concepts Influence Social Evolution	Responsibility Necessary	Lack of Accountability
Concepts Do Not Influence Social Evolution	Cost of Time	Responsibility Not Necessary

The following discussion presents a philosophical foundation for socio-economic theory which accommodates these ideas through the open espousal of an evolutionary perspective. The goal is not to provide a new economic or social theory, but to propose a new manner of conceiving of the socio-economic process which will, in turn, allow a truly evolutionary theory to emerge. In particular, a systemic perspective is proposed which emphasizes complementary co-dependent relations which are constrained by their participation in both divergent and stabilizing relations. From this perspective, an embodied complementary co-dependence would serve as a metaphorical engine fueled by lower level relations (e.g., photosynthesis with plants and the Krebs cycle in cellular respiration) and motivates higher level structures. The application of this idea to the socio-economic process will require substantial background work and is not attempted until the final section of this chapter.

Furthermore, by introducing this philosophical alternative many economic insights which were previously thought to be in logical opposition to one another can be integrated into a coherent whole. For example, neoclassical economics with its emphasis on individual decision can be coupled with the Institutionalist's emphasis on culture/technology and a Marxian emphasis on class struggle. This feat is accomplished through the recognition that each of these different perspectives addresses a different layer of structure within the conceptual hierarchy of socio-economic interaction as a whole. Although differences of opinion and boundary conflicts will undoubtedly lead to the possibility that the insights of one perspective may improve another perspective or even cause the latter to be absorbed into the former as a simple logical extension or reduction, these perspectives should primarily *complement* one another. To argue that one is absolutely true and the others absolutely false is similar to three blind men who are groping an elephant in different places (e.g., the trunk, ear, and leg) and claiming simultaneously to know what *the* elephant is.¹¹⁴

This discussion starts by exploring the assumptions surrounding the mediation between human concepts and 'what the world is' by the process of perception. Next, it explores the analytic framework with which theoretical concepts are built. These ideas will allow us to develop a static hierarchy concept which will consist of two complementary components: the structure and process dimensions. Structural elements are the qualitative variables engaged in an interactive process, a process which may create a pattern with meaning in and of itself. This is amenable to formulation within

¹¹⁴ This metaphor is adapted from The Udana (Ireland 1990:Chapter 6.4), which is a collection of discourses attributed to the Buddha.

a conceptual hierarchy of synthetic qualities. By exploring the concept of process using the notions of positive and negative circular causality, a further refinement of the conceptual hierarchy is possible through the recognition of synthetic processes. This hierarchy concept can then be used to identify the differences between the natural and social sciences due to both the *fixed position* and *process* of human perception within it.

Interrelations between Concept, Perception, and Experience

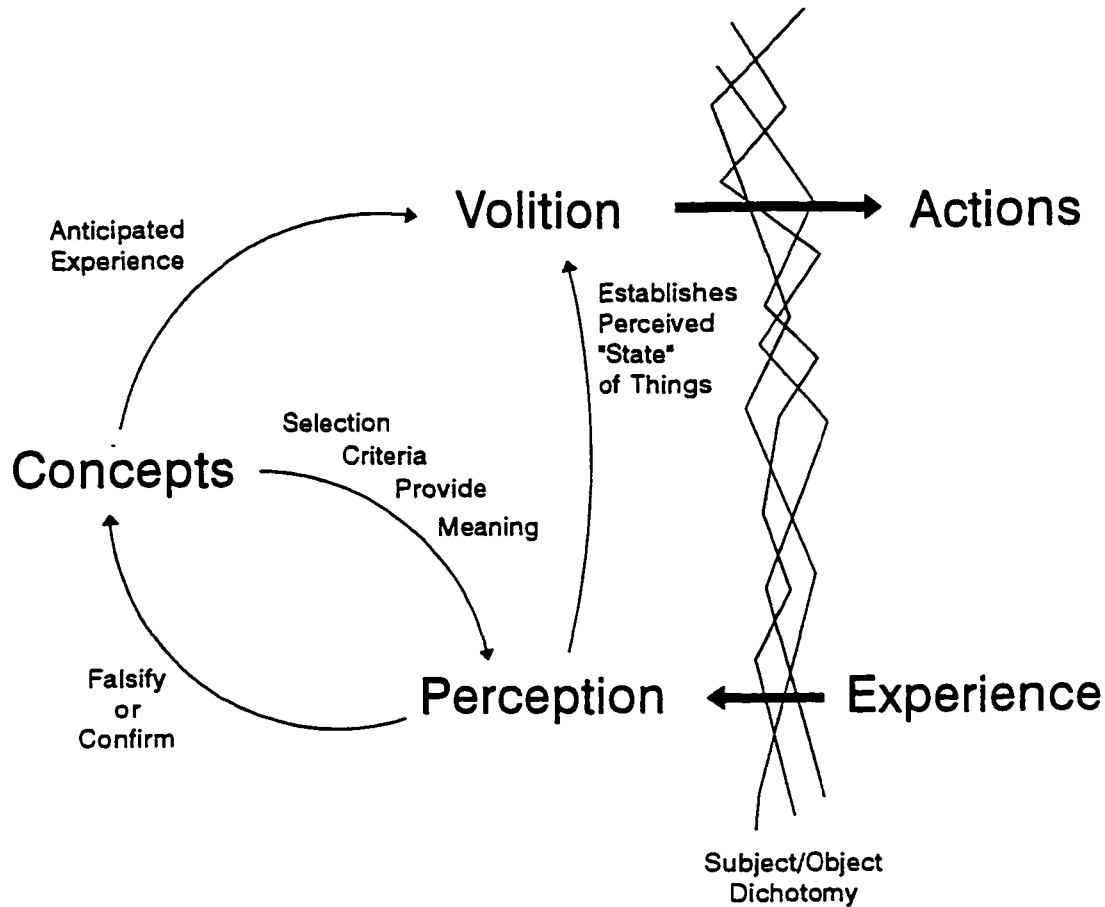
The assumption of *absolute* independence between concepts, perception, and experience is not made in this dissertation. The view adopted here is that the process of sensory perception is relative by its very nature and that concepts and experience may be complementary and co-dependent. While the use of one's perceptions in the confirmation/falsification of one's concepts is an accepted fact, the influence that one's concepts assert in the determination of which variables are relevant within one's field of perception is not widely appreciated. If the focal system *per se* is outside the influence of individual actions, which are guided by one's concept of the situation, then the co-dependence between concept and experience is attenuated and the phenomenon will display a *relative* fixity when observed. However, as individual action begins to participate more fully within the focal system *per se*, concepts begin to influence phenomena in a more subtle fashion (e.g., the socio-economic process). One is to some degree placed within a "Which came first?" paradox. In other words, an individual's actions are the expression of their volition or will.¹¹⁵ This expression of one's will through the choice of what action to take is informed by two things. First, concepts of 'what reality is' which serve to anticipate the experiential response to one's actions. And second, perceptions of the current 'state of reality' from which this experience is

¹¹⁵ Although I have avoided the topic of human will and volition, which would lead into a philosophy of existence, I would appeal to Buddhist insights in any such discussion. The interested reader is referred to Sangharakshita (1957, 1967).

presumed to flow. These individual actions or inaction determine one's experience, which is then filtered through perception and thereby brought into comparison with one's original concepts. When the concept of how reality *should be* is in agreement with how it *appears*, the concept of 'what reality is' is taken as having some degree of validity (i.e., not falsified). In other words, our original conjectures are not refuted and thereby continue to serve as guides to our actions: the trial and error process of knowledge accumulation has not resulted in error.¹¹⁶ This process of validation and falsification is complicated by the fact that perceptions are not simply given to observation and individual actions may actively participate in the focal system *per se*. This postulated interrelationship is diagramed in Figure 33.

¹¹⁶ Although the *Problem of Induction* will not be addressed in this discussion, the reader should be aware of its presence. What is the Problem of Induction? It involves the attempt to draw conclusions regarding the future, based on one's knowledge of the past. In doing this, it presupposes that a generalization, or law, that has been found to hold in the past will continue to hold in the future (see Pheby 1988; Blaug 1994). However, the use of this inductively derived idea, that there is a uniformity between the past and the future, cannot be used to justify induction itself: such a justification would be circular. Therefore, one can never confirm a theory as 'true' through inductive methods since the future will always be outside of one's field of knowledge. As an alternative to induction, Popper (1972, 1983) has suggested that we think of the growth of knowledge as a process of trial and error, or *conjectures* and *refutations*, in which our concepts are continually being tested against our perceptions. In this way, acceptable theories *fail to be falsified*, rather than verified, through experience.

Figure 33: Interrelation of Concept, Perception, and Experience



While all interactive processes may not be in a co-dependent relation with human concepts, it is highly likely that socio-economic systems are. The concepts which individuals hold with respect to 'what reality is' play an active role in the spatio-temporal stability and evolution of technology, tradition, culture, religion, and ethics. Such notable economic and social theorists as Marx (1844), Veblen (1899), Weber (1904-1905), Tawney (1926), and Ayres (1944) have all espoused such a view, albeit with

differing twists.¹¹⁷ A recent theorist who included such a co-dependence in his economic theory was Gunnar Myrdal. Succinctly put, Myrdal (1944) believed that prejudicial views as to the superiority and inferiority of different classes of people could result in either easy or restricted access to certain social services (e.g., health care and education). The denial of these services, however, caused some people to be less educated and less healthy, thereby providing a perceptual reinforcement for the original beliefs (see Figure 19). In other words, these concepts of 'what reality is' provide the conditions whereby a reality which is perceived to be in accordance with these original concepts emerges. It is not that these concepts are necessarily false, in the sense that they are at odds with perception, but rather that they participate in a co-dependence which has no ultimate validity; one's concept of 'the way the world is' contributes to the conditions for that world's emergence. What makes Myrdal such a notable proponent of these ideas is his general recognition of the complementary relationship between an expanded social ideal and socio-economic progress (see Figure 18). The prevalent way of life will either suppress or encourage the endogenous process of socio-economic development.

Although the vast majority of economists do not normally address such questions, the contention that an individual's working concept of social existence plays a significant

¹¹⁷ Although this may seem to be the reverse of what these theorists proposed (i.e., the individual determining the evolution of culture), one must remember that only individuals possess concepts. Since culture is no more than a shared belief in the 'way things should be,' a collection of statistical individuals can lack true individuality (e.g., characterized by forming their own beliefs) to such an extent that the group begins to exert a homogenizing influence on the world views of the individual. In this way, culture and tradition begin to influence socio-economic evolution through the sanctioning of acceptable belief. These issues are dealt with more thoroughly in the last section of this chapter.

role in creating society is a viable proposition which begs to be fully explored.¹¹⁸ For example, Frank et. al. (1993) has found that people trained in neoclassical economic theory *act differently* from those who lack such training. In fact, they act in a notably more self-interested manner. Is this behavior 'natural' or a result of concepts of what is natural? Furthermore, does this concept of what is natural help to recreate its own reality? This is not to argue, of course, that the doctrine of self-interest is universally false. However, it is not *universally true*, unless we define all actions as being self-interested, in which case the concept of self must be addressed.

In opposition to the possibility of a co-dependent relationship, the conventional assumption is twofold: (1) one's experience is independent of one's concept of 'what reality is' and (2) the way we conceptually embody our experiences is somehow related to the actual structure of some reality *per se*. These two assumptions create a competitive relationship between our concept of 'what reality is' and our experience. In other words, in attempting to conceptually embody our experience, any deviation of perception from concept signals a discrepancy, discrepancy is taken as evidence of poor fit, and poor fit leads to the rejection of the previous conceptual framework and the formation of a more accurate representation. This corresponds to saying that there is a

¹¹⁸ Of course, the *act of knowing* cannot be sterilized through one's theoretical assumptions. For example, Muth's proposal of the rational expectations hypothesis, originating from his work with Charles Holt, Franco Modigliani, and Herbert Simon on "satisficing" behavior under uncertainty, served to cut the Gordian knot. Simon (1979:505) commented that, "instead of dealing with uncertainty by elaborating the model of the decision process, he [Muth] would once and for all - if his hypothesis were correct - make process irrelevant" (see also Colander and Guthrie 1980). What RE does is remove the human dimension from the socio-economic process by asserting the primacy of a particular structural foundation. The RE hypothesis effectively robs "the coordination of economic activities as an economic issue of its most fundamental significance" (Wible 1984:93).

stabilizing circularity between one's concept of 'what reality is' and some reality *per se*. Within this framework, experience is given the status of being ontologically primary, and concepts are taken to be secondary.

Since concepts have no influence on this reality, but *are* in perfect structural correlation with its implicate order, epistemological concern is restricted to the empirical discovery of 'what reality is' and the clearing up of confused concepts about such a reality through their lack of concordance with experience. For example, a model which is able to describe the current situation or predict the future course of events (determined through perception) is deemed to be of a higher quality than one which cannot. Models which describe a wide range of phenomena are preferred to those which describe a smaller range. In addition to these direct tests against experience, a model can have aesthetic value which is reflected in its internal logical consistency and simplicity of form. Along these latter lines, one is permitted and encouraged to investigate 'what reality is' vicariously through logical extrapolations of one's concepts. The verification of such pen and paper theories rests in their confirmation with the actual phenomena they attempt to describe or predict.¹¹⁹

To begin to discuss these philosophical proclivities, it is necessary to explore the entrenched working assumption that our experience of tangible things represents the ultimate objective existence of some reality *per se*. Such an assumption is frequently supported through a plea to common-sense or simple thought experiments which testify

¹¹⁹ Although my choice of the criterion of verification rather than falsification may seem philosophically immature, it is made because human actions are typically guided by what is believed to be true rather than what is known to be false.

to the 'real' existence of things or entities. For example, a book which is used to thump you on the head *exists*. The puddle of water you step in *exists*. The person you hug with compassion is witness to the *existence of things*. *You perceive yourself to exist*. It is this appearance of individuated existence coupled with the concept of independence which is the starting point for formal logic, theoretical science, and hence all scientific perspectives on human experience.

However, rather than assuming an inherent quality to things *per se*, an alternative and less demanding assumption would be to contend that this *quality of thingness* results from the interactive spatio-temporal relationship between human beings and the conditions being observed. In other words, that appearances and concepts are not of a reality which exists independent of what we are. Yet, the idea that things have an independent and inherent existence has been directly woven into our concepts of what it means to know something. One might assume that their sense organs (i.e., sight, hearing, smell, taste, and touch) perceive the world *as it is*, and that they conceive of it *as it is*, but this merely demonstrates a strong anthropocentric bias.¹²⁰ Furthermore, it might not be assumed that everyone *can* perceive this independent reality in an opportunistic sense, but that everyone *does* perceive this reality: not an equality of opportunity, but one of actuality. Not only is it possible that our perception of the world is imperfect, but also that the things we conceive of may have only a relative existence derived from our own spatio-temporal placement within the dynamic flux of reality.

¹²⁰ Bartley (1987:34-38) presents the limitations of a frog's visual perception to demonstrate its crudeness with respect to human perception and then bluntly asks whether it is appropriate to assume perceptual perfection in humans.

From this perspective, the issue is not the existence of an absolute and unified ontological being, but the epistemological relationship between human perception and the concepts it engenders.

It is possible to see how the inclusion of an observer introduces the necessity for epistemological considerations, for if the observer is outside reality *per se*, and thereby able to perceive it as a whole, any resultant concept of this reality will not be fully accurate since it fails to include the observer. In other words, the presence of a knower *divides* reality by entering into it from a particular perspective. The operational effectiveness of this *relative concept of experience* will depend on the degree to which the systemic interaction of interest has been divorced from associated variables which play a significant role in its behavior. A *complete concept* of reality is a logical impossibility.¹²¹ Paradoxically, the 'ultimate' concept of reality can only exist in the complete absence of any epistemological dimensions: all concepts are by their very nature relative concepts as long as the duality between the knower and the known persists.

This chapter assumes that one's concept of reality is the cumulative impression of a personal sensory experience through time and space which can ultimately stake claims to only relative validity. One might be tempted to say that we all live in our own worlds to some extent. This does not mean that different individual's perceptions and experiences do not correlate: such a contention would be ludicrous, we are all human. To the extent that we all exist as human beings within a context of physical, chemical,

¹²¹ John von Neumann's conclusion that the degree of complexity in a predictive model must be equal to or greater than the phenomenon being modeled is relevant here (see Aspray and Burkes 1966).

biological, and psychological conditions, our concepts of the world will be similar to one another. However, most individual's concepts and perceptions of social existence will differ from one another through different twists (e.g., differences in physique, cultural heritage, and life experiences). Therefore, two identically placed observers could have identical concepts of physical interaction while concurrently demonstrating a large divergence between their concepts of social interaction (e.g., a Chinese and an American engineer).

The Decomposition of Experience through the Process of Perception¹²²

While the process of perception seems to be enjoyed to various degrees by many different biological organisms (e.g., plants, insects, animals, and humans), the particular structuring of perception can be quite distinct between different forms of life (e.g., see Wachtershauser 1987). These different decompositions represent arrangements which have significance relative to the perceiving organism: perception is the process of discriminating between gradients which are relevant to the organizational continuity of the perceiving system (e.g., seeing predators and detecting dinner). While one cannot present all potential perceptual distinctions, since the variations are infinite, one can talk about how the addition or alteration of existing sensory modalities alters the structural decomposition of experience.

Varela et. al. (1991:165) used the perception of color (i.e., what they call the "color space") to illustrate this variation in perceptual sensitivity. They noted that while the dimensionality of visual perception in humans is trichromatic (3-dimensional sensitivity), other organisms possess tetrachromatic (e.g., goldfish and turtles) and even pentachromatic perception (e.g., diurnal birds such as pigeons and ducks). Although it is possible to translate the differences inherent to a three dimensional color space into

¹²² These issues have also been addressed by Hayek (1976). Weimer (1982) serves as a nice introduction to Hayek's thought in general, and his theory of perception in particular. In addition, Popper and Eccles (1977) present both philosophical and neurobiological perspectives on the nature of perception and the existence of the self.

four dimensions *if* three dimensions are shared by both perspectives, the distinctions possible within a four dimensional space can *never* be translated into a three dimensional framework without loss of information. For example, a 3-dimensional experience of yellow might be fast-yellow, and slow-yellow (using time as a qualifier we all understand) within a 4-dimensional framework. While the distinctions possible within the former framework are possible within the latter one, the inverse is not true (Varela et. al. 1991:183).

While animals may be restricted to one set of perceptual decompositions, human beings are able to augment their inherited sensory modalities through the use of instruments which translate particular spatio-temporal characteristics of otherwise unobservable phenomena into observable ones. For example, the frequency of a neuron's action potential is translated into auditory clicks and visual curves. Through the use of these observational instruments, the set of possible structural decompositions of reality increases. However, it must be remembered that this augmented perspective is *actively* constructed, translated into our native perceptual language, and then synthesized into concepts. The following section presents the epistemological limitations inherent to the process of perception in order to provide a foundation for later discussions concerning the concepts of circular causality and synthetic qualities which emerge from the aggregation of elements. It presents the biophysical foundations which decompose experience into an observation set characterized by the spatio-temporal dimensions of perception. Although this observation set will be dialectic in nature, this quality will be abstracted from and the set will be generically labelled the *inherent structure of*

perception. Once the field of potential perceptions to which attention may be directed is identified, the discussion can turn to the conceptual construction of a "unified" perception through the criteria of significant and meaningful patterns within the observation set.¹²³

The Limitations of Sensory Perception

When a human being has experiences via sensory perception, there are characteristic dimensions of time and space inherent to particular sensory modalities which structure the maximum detail available, beyond which the demarcation between 'things' is not possible. In discussing this notion of perceptual structuring, the human eye will be presented as a representative sensory modality.¹²⁴ The following discussion is intended to establish the fact that the process of human sensory perception presents a set of dialectically discrete signals which are merely a subset of all such possible decompositions. This discussion is intentionally a terse, general introduction to the insights available within the psychological field of sensation and perception.

¹²³ This task is simplified through the recognition that the majority of unobservable phenomena are translated into a visual language through symbolic concepts (e.g., numbers, letters, and words) and representations.

¹²⁴ The following discussion, which derives from three primary sources (i.e., Clark 1993; Comsweet 1970; Levine and Shefner 1991) will hopefully provide the reader with a general understanding of the structuring that occurs within the process of perception. The visual system is chosen since it has been intensively investigated for over 200 years and current debates center around the "proper explanation of the facts" rather than the facts themselves (Evans 1974:4).

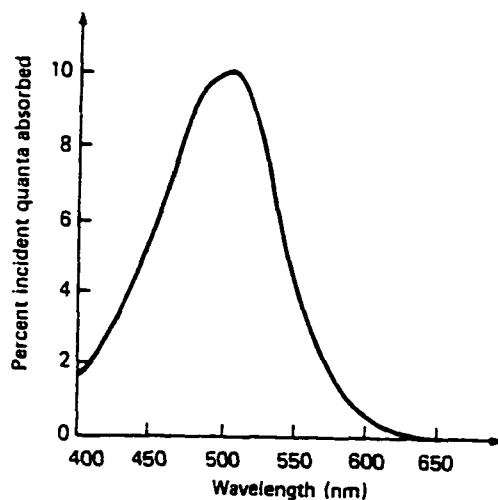
What is the inherent structure of perception? The *temporal dimension of perception* represents the fastest rate of spatial fluctuation (i.e., temporal difference) that is perceptible to a human being by means of a particular sense. For example, at what rate (i.e., flashes per second) does a blinking light go from being perceived as a blinking light to a light which is constantly on? One can also investigate different facets of the perception of spatial qualities. How bright must a light be relative to its context before it becomes perceptible? This question alludes to the fact that perception is not solely determined by the object of perception itself, but by the contrast between the object and its background. A small bright light which is imperceptible during the day is easily seen at night. Affiliated with this is the resolution of spatial perception; how large must a light be relative to one's field of view in order to be perceived? These two questions concerning the *spatial dimension of perception* are obviously inversely related: large objects (i.e., those which subtend a large area of visual perception) will require less contrast to be perceived while small objects will require more. Furthermore, the questions concerning the temporal and spatial dimensions are interrelated: large objects of high contrast which subtend a large area of the perceptual window will be distinguishable at smaller temporal intervals than objects of low contrast which subtend a smaller area.

The discussion of visual perception will begin with the spatial dimension of perception. There are two varieties of light receptive cells found in the retina of the human eye (i.e., the physiological screen onto which images fall). These are known as *rods* and *cones*. All rods contain a single type of light sensitive pigment, rhodopsin,

while cones are divided into three distinct types on the basis of three different light sensitive pigments (i.e., each cone has only one of these pigments present). It is the interplay of multiple receptors of different sensitivities which provides the perception of color. While the cones are concentrated at a high density in the very center of the retina directly behind the lens (i.e., the fovea), the rods are distributed around this area with their density declining as one moves further into the periphery. Therefore, when we direct our eyes to a particular object, its image falls predominantly in this central area of the retina which is composed almost exclusively of a high density of cones. This gives the image we perceive greater resolution since the density of receptors is high, and provides more acute color perception since there are three different photoreceptive sensitive pigments present. This distribution of rods and cones is particular to humans and some other primates and is not a general characteristic of visual systems in biology (Levine and Shefner 1991:92). Thus we can conclude that humans have a peculiar mode of visual perception, one contributing to a particular sense of reality.

Each of these four types of receptor cells is most sensitive to a particular wavelength of light (i.e., the spatial quality discriminated for) and display a decreasing sensitivity to light of increasing and decreasing wavelengths around this particular wavelength of peak sensitivity. As a result, each type of receptor responds differently to different visual stimuli. The following figure plots the proportion of light quanta absorbed by a rod versus stimulus wavelength to yield what appears to be a slightly skewed almost-normal distribution (from Levine and Shefner 1991:101).

Figure 34: The Spectral Absorption of Rhodopsin



From this graph, it is easy to see that in order to find out how many quanta of light a rod actually absorbs one must not only know the wavelength of light, but also its intensity (i.e., the total number of quanta involved in the stimulus).

The translation of this absorption of light quanta into a neural signal is accomplished through what is known as an *action potential* (i.e., the basic unit of information in the nervous system). The physiological process underlying this event is not as important as the resulting structure the signal takes, since it is the frequency of the action potentials rather than their size and shape which changes as a function of stimulus strength.¹²⁵ Therefore, stronger stimuli produce more action potentials in a given time

¹²⁵ From a hierarchical perspective it is interesting to note that action potentials result from the multi-level interaction of electrical, chemical, and organic processes. In particular, a balance between electrical and chemical gradients is mediated by a change in the neuron's membrane which selectively alters its permeability to certain ions. This organic alteration of the axon membrane lasts for a period of less than four thousandths of a second. See Levine and Shefner (1991:Chapter 3:46-47) for a textbook discussion of neurophysiology.

period than weaker stimuli. However, since the process by which action potentials are propagated requires time, the frequency response of these potentials is limited. This establishes a temporal dimension inherent to the process of visual perception.

One of the ways that receptors overcome this inherent limitation is by responding to stimuli change and contrast rather than absolute levels of stimulation.¹²⁶ By holding the stimulus' context intensity (I) constant while varying the stimulus intensity, one can start to ask questions concerning the intensity differential above background required to elicit a response from the visual receptors. Beginning with a context of darkness, one finds is that rods have a lower *threshold of sensitivity* to stimuli intensity than cones.¹²⁷ In other words, the rods are sensitive to lower levels of stimulus intensity, relative to a dark context, than cones. Since it is the synthesis of different visual receptors' responses to a stimulus that provides the perception of color, and since the threshold for cones has not been exceeded, there is actually a range of stimulus intensity above a dark background that will be *colorless* (i.e., perceived in black, white, and grey) to human perception. It is not that the stimulus lacks color, but merely that humans are unable to *perceive* these differences at such low intensities.

¹²⁶ It is said that a frog placed in a pan of slowly heated water will not be able to sense the impending doom before it is too late. In other words, perception is not transitive.

¹²⁷ "Threshold sensitivity" is defined as the level of stimulus above ambient levels which is detectable with experimental probabilities greater than chance. For example, a subject is asked to respond whether a light is seen or not seen. There are four possibilities (1) that a stimulus is present and seen, (2) present but not seen, (3) not present but seen, and (4) not present, not seen. Chance is defined as the point at which the subject responds correctly to the presence/absence of the stimulus fifty percent of the time. If the subject is able to discriminate at a rate greater than this fifty percent level, they are said to be able to discriminate the stimulus from its context. It is interesting to note that subjects will display discrimination rates greater than chance even when they claim that they are unable to perceive any stimulus differentials.

As the intensity of the stimulus above background, ΔI , increases, the threshold of sensitivity for cones will be exceeded, but the sensitivity of the rods loses its responsiveness and the signal becomes saturated. In a binary framework, one could say that rods come to be continually "on" and hence provide no information on signal variability within this range. In a similar manner, as the context illumination (I) increases, rods will cease responding to signal variability (ΔI) since the context itself will dominate their response. This results in two dialectically distinct ranges of visual sensitivity which respond to low (scotopic: rods) and high illumination (photopic: cones), the former being perceived as colorless. Note that this difference will also result in different perceptions of color brightness within high and low illumination contexts. This is demonstrated by the fact that in the dim light of early morning reds look the blackest of all colors: as light increases the blues emerge as the brightest only to be overtaken by yellows and greens in full sunlight. This is known as the Purkinje Shift (Levine and Shefner 1991:146-147). Although this combination between stimulus and context creates a host of interesting sensory phenomena, only a general stimulus-context intensity relationship is investigated here.

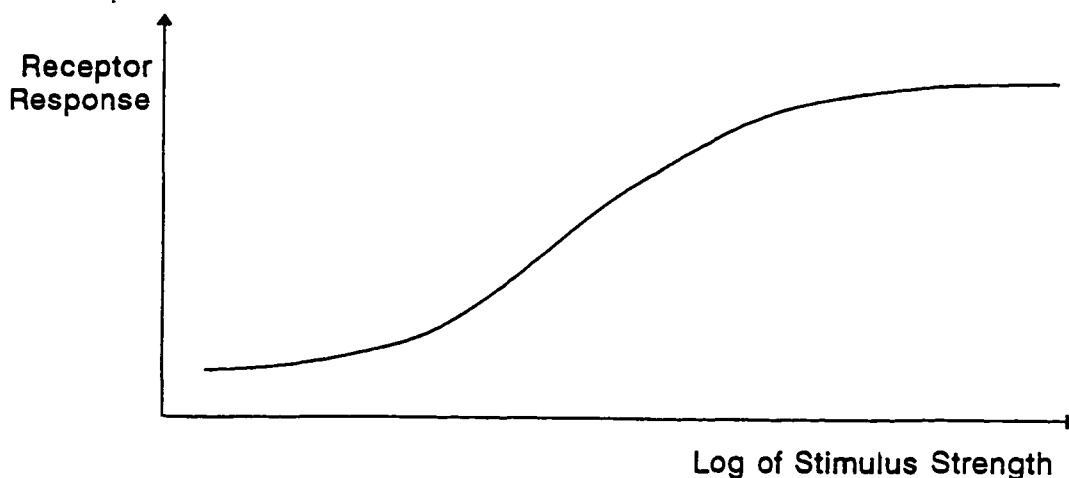
The issue of determining the stimulus intensity differential (ΔI) necessary for stimulus detection is captured in *Weber's Law*. This general relationship states that ΔI is in constant proportion ($k < 1$) to the average level of background intensity (I).

$$\textit{Weber's Law} \quad \Delta I = kI$$

It is important to note that receptors will lose their sensitivity below threshold and their signal will be saturated at high stimulus strengths. Therefore, this law breaks down at

both low and high levels of intensity. As stated earlier, at low levels there is a minimum ΔI necessary to stimulate the receptor. And at high levels, the time period required for the sensory receptor to reset the signaling process places an upper bound on the range of different signals it can send. In other words, the frequency of action potentials per second is limited by the time necessary for the receptor to create such a signal. One is left with the following qualitative relation.

Figure 35: Receptor Responses versus Log of Stimulus Strength



Such limitations are also highlighted through a discussion of color perception (i.e., the photopic sensitivity range) which involves the synthesis of three different receptor signals (i.e., the three types of cones) into a single perception. While past scientists have attempted to identify distinct colors with distinct wavelengths of light (i.e., a 'pure' color stimuli), such a simple correlation has been found to be inaccurate. In fact, color is merely the psychological labelling of a physiological event which has a one-to-many character; in other words, impure stimuli composed of different wavelength lights can yield *identical* color perceptions to a pure stimulus consisting of only a single wavelength

of light. Two physically different stimuli result in identical receptor responses. Such a match is called a *metameric* match. One can begin to understand this perceptual phenomenon by using the spectral absorption of rhodopsin (see Figure 34), the visual pigment found in rods.

For example, photons at 450 nm and at 550 nm both have approximately a 5 percent chance of absorption. Approximately the same number of absorptions will occur in response to light of 450 nm as of 550 nm, so whatever effects are produced by one can be produced as well by the other. The receptors cannot discriminate between those wavelengths. (Clark 1993:31)

When one includes the intensity of light, the problem of non-uniqueness becomes even more complex since different absorption rates can be compensated for through different intensities.

To match the effect of 100 quanta at the 500 nm wavelength, one simply needs to increase the intensity of the stimulus at 575 nm, to make up for the lower rate of absorption. (Clark 1993:31)

The solution to this non-uniqueness problem is to have multiple receptors with different absorption spectra and then to compare their individual responses for a given stimulus. Since there are three distinct types of cones which have three different spectral absorption distributions, corresponding to short, medium, and long wavelength photopigments, different light stimuli which have identical effects on the medium wavelength photoreceptor will have different effects on its short and long wavelength counterparts. The discrimination made possible through these varied responses is the perceptual phenomenon we call color. However, it still remains possible to adjust the

intensity of three arbitrarily chosen reference light sources to get a metameric match with a pure source (Clark 1993:43).¹²⁸

The most important point to extract from this discussion of color perception is the recognition that perception is a structuring process which possesses an inherent trade-off. If this structuring is so narrow as to make the receptors sensitive to only a unique wavelength, i.e., a spectral absorption distribution with only a single peak rather than a range, the problem of multiple stimuli yielding identical perceptions is removed. However, one would need an infinite diversity of such specialized receptors to compensate for an individual receptor's lack of sensitivity to other stimuli. The receptor has become too specialized. Expanding an individual receptor's realm of noticeable stimuli expands the problem of non-uniqueness in exchange for broader sensitivity. The extent to which one suffers from non-uniqueness is determined by the spectral absorption distribution around its peak (i.e., its variance); higher variance corresponds with a greater breadth of sensitivity but a decreasing ability to easily differentiate between similar stimuli. The trade-off which evolves between the breadth and focus of sensitivity will be reflected in the parameters of this spectral absorption distribution. Since this distribution will taper off at both ends, two proximate quality stimuli which fall within the outlying range of the different receptors will be indistinguishable from one another.

¹²⁸ There are stipulations that must be met for this to be true, but these qualifications do not detract from the fascinating fact that physically distinct stimuli produce identical perceptions. These stipulations are as follows: First, none of the three reference lights can be a linear combination of the other two. Second, we allow for the match to include negative values of the reference lights: this translates into an *addition* of this particular reference light to the pure source, thus matching this new combination with the combination of the remaining two reference lights. Third, we assume that the experiment is conducted against a neutral background in order to nullify the affects of stimulus/context interaction since intensity and color contrast can alter such matching exercises. And finally, one must note that the size of stimuli relative to the visual field can complicate the situation.

Therefore, the synthesis of varied signals to yield color perception will have a limited range of function.

A fascinating parallel can be drawn between this trade-off and the construction of conceptual categories (i.e., mental representations of spatial qualities and temporal continuity). Within the process of conceptual embodiment, one is also faced with a trade-off between uniqueness and similarity; extremely narrow criteria for a spatial quality will allow a unique mental discrimination, but reduce the general applicability of the concept within theoretical relationships. To the extent that different things possess qualitative similarities which result in similar interactions with other things, much can be gained by de-emphasizing their uniqueness and highlighting their similarity to yield theoretical generalizations. In contrast, excessively broad criteria of similarity reduce the uniqueness of individual qualities and hence have the potential to dilute the power of theoretical understandings.

This simple presentation is not intended to address the idiosyncracies of visual perception and those interested in a more detailed analysis are referred to sources such as Cornsweet (1970) and Levine and Shefner (1991). For example, the adaptation of receptors to light and darkness is a fascinating feat of physiological magic, as is the synthesis of these base level signals through higher level neurons to create the perception of vertical and horizontal lines. However, what the current presentation does do is provide a brief introduction to some of the spatio-temporal limitations inherent to the process of perception. Through this brief discussion, one is introduced to the presence of threshold effects and non-uniqueness. Prior to this point in the discussion, the stimuli

might have been taken as obvious and unambiguous. It is therefore important to address the question of how one determines what the important stimuli are within a setting.

Concepts as Guides to Perception

The process of sensory perception involves the recognition of difference: without difference there is no perception. In other words, differences which have *absolutely* no bearing on a system cannot be said to exist within that system's perceptual world view. In fact, the visual process incorporates a slight endogenous unsteadiness to accommodate the physiological need for difference within the perception process. Within this set of perceptions, concepts and mental images represent the retention of patterns of perception which make a *meaningful* difference, and thereby represent a process of distillation which occurs within the possible scope of perception. Allen, O'Neill, and Hoekstra (1987:67) comment that the limits to perception are "what it is possible to see: within these limits, transformation and analysis further confine what is seen to something commensurate with human comprehension." An old Arabian proverb takes this even a step further in stating that, "the eye is blind to what the mind does not see" (Evans 1974:20).

This dissertation uses the words *perception* and *concept* instead of *fact* and *theory* to ground the discussion in the realm of human experience and shift it away from the subject/object overtones of the latter pair of terms. While the word fact is frequently taken to mean 'the state of things as they are,' perception is explicitly 'the state of things as they appear.' Everyone should realize that to assert that facts (i.e., perceptions) exist

in dependence on theory (i.e., concepts) is *far from radical*. Many social scientists and philosophers have contended that fact and theory can be tangled up in a paradox of first movers when it comes to social theorizing (e.g., Myrdal, Kuhn, Kant, Foucault, Heidegger, Nietzsche, etc.).

The identification of meaningful patterns in perception is a question with which Gestalt psychologists have grappled for years. Although many assume that stimuli are self-evident and that one must merely identify when they are present, the task of perception will also include identifying what the relevant stimuli are. It is not the relative size, intensity, or color of a stimulus which is important here, but the establishment of the stimulus/context distinction. For example, what do you see in the following illustration?

Figure 36: Multiple Equilibria in the Perception of Form



What one perceives will depend on whether one chooses to make black or white the background. If white is chosen, then the image of two faces will appear. If black, then the image of a vase. Is it possible to see *both* pictures at one time? This question is not an issue of whether one can conceptually understand that both perceptions are possible, since this is obviously true, but whether one can truly perceive in both ways

simultaneously. Although I know of no experimental results which address this phenomenon, my inclination is to contend that such an act is impossible since it would imply the division of awareness within a single focal point of perception.¹²⁹ In other words, the uniqueness of the vase must be sacrificed to increase one's perception of the faces, and vice versa: to be aware of both simultaneously is to be aware of neither one fully.

The identification of the elements of the focal system becomes more complicated when one realizes that perceptions frequently inform one another through both temporal sequence and spatial context. For example, what do you see in this next illustration?¹³⁰

¹²⁹ Please see Kruse and Stadler (1993) for supportive research.

¹³⁰ This is from Barlow and Mollon (1982:118).

Figure 37: Concept as Guide for Perception



The eye will survey the different parts of this scene in order to compose a concept of what it represents as a whole. The horizontal line, a small "ship" in the "distance," the light versus darker surface, and the "trees" all help to create a distinction between water and land which then lends meaning to any further perceptual survey. Such a mental composition might be more difficult for the layman to construct out of Picasso's *Friendly Nude* and other such early cubist art work which require a more specialized pre-conception. However, the general rule is that pre-conceptions of phenomena and form (e.g., cubist art: the presence of different perspectives in a single perception) allow us to order the perception and extract an appropriate concept of 'what it is.' In this way,

concepts lend a predisposition to perception. For example, while the above illustration is easily perceived as a beautiful shore, one can also find another image within this scene: that of Napoleon standing between the two trees. Barlow and Mollon (1982) go even further than this by interpreting this space as representing Napoleon in particular, an interpretation which may say more about these authors than the picture itself.

These perceptual phenomena are possible since the eye does not see the whole scene in its totality, but builds up this totality from a compounding of the details.

The image of a room, or any other situation, is in the mind. Any details in that image, except the very broadest, have been built up by successive glances directly at these details; both the details and the broad image are retained by the mind for as long as they are wanted and then as quickly erased ... (Evans 1974:21)

This composition of the whole image from the perception of its constituent parts is influenced by conceptual expectations and is done in a similar manner to the scientific method.¹³¹ For example, the following figure is ambiguous:

¹³¹ Studies have also found that translation differences exist due to cultural and experiential factors. For example, one experiment presents the capital letter "T" constructed in such a way that the vertical and horizontal lines which compose it are identical in length. Subjects are then asked which segment is longer? Of course, since both are of equal length, one would assume that the response rate would be 50:50. However, it was found that people from mountainous regions tend to see the vertical segment as longer while people from desert regions tend to see the horizontal segment as longer.

Figure 38: Conceptual Referencing within Perception



The observer may begin with the hypothesis that the loop to the left is a face; which means the triangular projection on the far left is a nose, the black band below is a necklace, and so on. As each part falls into place, no hypothesis need be rejected, and the young lady is seen. Alternatively, if the first hypothesis was that the loop to the left is a nose, then the triangle is a wart on it and the band is a mouth. No hypothesis need be rejected, and the old lady is seen. There are no details drawn completely enough to cause the rejection of any particular hypothesis. (Levine and Shefner 1991:285-286)

Therefore, as long as the string of conceptual hypotheses goes unchallenged within the process of organizing the constituent pieces of perception into a conceptually coherent whole, there is no reason to question the translation process (see Kruse and Stadler 1993). In a statistical language, given the confidence intervals of the observer, there is no reason to reject the initial concepts used to translate perception.

Another illustration of such a concept-perception filtering is witnessed in psychological experiments where individuals were briefly presented with arrays of four letters, and then asked to determine whether a particular target letter had been present (Johnston and McClelland 1974). The experimental population is divided into two groups: the first group is asked to look at a central position and read the word, while the

second group is told the position that the target letter will be in and asked to watch only that position. What is surprising is that the first group was more successful than the second at performing this task.

That is, it was easier to read an entire four letter word and deduce whether it contained the target letter anywhere within it than to find the target letter in a forewarned position. One would think we recognize letters in order to read words, but in this experiment the words were read to identify the component letters. (Levine and Shefner 1991:259)

Similar findings have been obtained with identifying lines imbedded in coherent versus incoherent figures (Weisstein and Harris 1974; Wong and Weisstein 1982). Therefore, one must conclude that perception is not merely a passive process of receiving impressions of dynamic reality, but requires the observer to consciously identify what 'the' perception is.

This potential co-dependency is made more complex when instruments (e.g., microscopes and photographs) are introduced which allow us to perceive the otherwise hidden differences within reality. For example, one way that the human nervous system signals stimulation is through a discrete change in its polarization which is transmitted along the length of the neuron's axon (i.e., an action potential). This phenomenon is unobservable to human perception without the use of instruments.

The amplified nerve signals must be displayed in a way that the experimenters can understand. If the signal consists of action potentials, it can be fed to a loudspeaker, just as the output of a stereo amplifier goes to a loudspeaker. Each time an action potential occurs, the loudspeaker produces a click. The experimenter can often get *an idea* of how various stimuli are modulating the rate of firing by listening to the signal. (Levine and Shefner 1991:59, italics added)

It may also be helpful to have a written account of this signal as a function of time, but such a graph cannot be drawn by hand with a pen and paper. Such a technique would be *much too slow*.

The only kind of pen that can obtain speeds high enough to trace an action potential that is completed in a fraction of a millisecond is a 'pen' consisting of a beam of electrons 'writing' on a phosphor screen [i.e., an oscilloscope]. (Levine and Shefner 1991:59)

The concepts which calibrate these instruments, and thereby focus our senses which peer through them, introduce a more explicit conceptual dimension to our experiences. The choice of significant elements within and between different observation sets is influenced by one's concept of the problem. In other words, one's *pre-conceptions* serve to lend direction to the admissible perceptions which confirm/falsify one's concept of the situation.¹³² One *chooses* the spatio-temporal qualities which are highlighted and frequently even the orientation of the observational instruments (e.g., optical, infrared, radar, etc. involved with images of the Earth from satellites). Effective translations (i.e., capable of accurately informing the observer's operational concept of the system under investigation) will, by necessity, pair the spatio-temporal dimensions of the observation process with those of the phenomenon under investigation. In other words, a phenomenon must be observed on *its own terms* in order to be conceived with accuracy. However, to the extent that the augmented perceptions are not tailored to the

¹³² For example, American geneticist Barbara McClintock's theory that genes can jump from one place to another within a cell (i.e., transposable elements) was rejected by her colleagues in biology and genetics for thirty years *since it was at odds with the received wisdom*. McClintock was awarded the 1984 Nobel Prize for her work along these lines. Another example is the theory of Apoptosis in molecular biology (i.e., programmed cell death) which is now heralded as a *fundamental biological mechanism* which offers much promise in cancer research (Meyn 1994).

phenomenon they seek to observe (e.g., quarterly economic data based on the orbiting of the earth around the sun which is used to assess the dynamics of a manufacturing economy), attempts to build concepts from this observation set may not accurately embody the process under observation.

Although all phenomena will not be significantly influenced by the conceptual dimension, it is important to appreciate when this co-dependence must be accounted for theoretically. One can begin to address this issue by realizing that although human concepts can roam freely through a mental universe, the biophysical process of perception *fixes* one's perspective. For example, a human being will either see through the eyes, hear through the ears, smell through the nose, taste with the tongue, or feel through the skin.¹³³ Unless one transcends the human condition, one's concepts are from a distinctly *human* perspective which is derived within the process of *human* perception. By acknowledging this fixed nature of observation rather than allowing it to arbitrarily roam through phenomenal space, tangible differences appear between observing relatively lower (e.g., physical, chemical, and biological) versus higher level systems (e.g., self-consciousness). This creates unique difficulties for conceptualizing the latter as opposed to the former, leads to a richer understanding of the relative success of the natural sciences as opposed to the social sciences, and identifies avenues of future social research which may prove fruitful.

¹³³ The number of different sensory modalities is not as important as their existence as *modalities*. The inclusion of additional sensory modes would not change the quality of the argument presented here, although the hierarchical arrangement of synthetic qualities might be significantly altered.

The Observation Set

From this presentation of visual perception in humans, the following characteristics of a given process of perception are posited:

(1) Perception is a process which identifies a particular *spatial dimension* (i.e., quality) within a context. However, there exists a trade-off between sensitivity to multiple stimuli versus the identification of a unique stimulus. To the extent that receptors possess a range of sensitivity, there will be a many-to-one correspondence between the phenomenon being observed and the resulting perception.

(2) Given a receptor's sensitivity to a particular spatial quality range, there will be a threshold of sensitivity above ambient distributions required for detection. Stimulus intensity above this threshold will contribute a quantitative dimension to a given spatial quality. Saturation occurs when marginal increases in the stimulus intensity no longer produce a noticeable change.

(3) The process of perception is a nesting of physical, chemical, and biological conditions that requires the duration of time. The temporal interval between perceptual 'moments' is a characteristic of a particular perceptual process and contributes a *temporal dimension* to any observational set.

(4) Perceptions which do not change will cease being attended to in time. Therefore, if one is to remain aware of constant differences, the perspective must be shifted to create the perception of change.

(5) Perceptions can and are physiologically integrated into composite perceptions (e.g., color vision). This process of integration results in a multidimensional perception which possesses the four aforementioned characteristics.

These individual observation sets of distinct sensory modalities (i.e., vision, olfactory, auditory, tactile, and gustatory) can also be compiled into a master set which informs a mental concept of the phenomenon (as per #5). The most fundamental

composition of multiple modalities into a mental concept is the emergence of the concept of self versus other. It is from this reference point, the central "I" of existence, that observational and conceptual extensions are made. For example, instruments are placed between "I" and experience in order to change the spatio-temporal decomposition of perception and hence the apparent structure of 'what reality is.' From this evolutionary perspective, humanity's ability to use external instruments to augment the process of perception supports the claim that economic development is a continuation of biological evolution (Georgescu-Roegen 1971:11).

An interesting aspect of this use of instruments to augment perception, which is aided by concepts which compile the new perceptual extensions into an overall vision, is that it must literally begin at our feet (i.e., that which is known) before ascending to the heavens of planetary interaction or descending into the depths of atomic structure. In other words, our concepts and instrumentally augmented observation set must co-evolve. The acceptability of these augmented perspectives is dependent on one's ability to incorporate them into one's overall world view through either a conceptual understanding of the process of translating unobservable to observable phenomena (e.g., the Hubble telescope) or the final perceptual orientation (e.g., visions of God). The individual pieces of the concept-perception circularity must "fit" one another, and an isolated knowledge of either perceptual direction without a corresponding knowledge of the perceptual translation process, or vice versa, is a dangerous ledge to rest one's faith on. Crystal balls whose perceptual process and orientation are unknown must have one of these chasms breached or face dismissal as mere kaleidoscopic toys.

Therefore, while the five aforementioned characteristics form the latent potential within one's observation set, one must also include the influence of an observer's conceptual framework and expectations when considering the actual observation set acceptable to that observer. As a result, the following concept-perception filtering characteristics are included.

(6) A mental aggregation of individual spatio-temporal qualities can occur in such a way that a tendency for temporal co-variance and spatial proximity results in these qualities being conceived of as related. The perception of such an aggregation is referred to as a mental perception of form.

(7) Since indirect observation via instrumentation creates a characteristic spatio-temporal decomposition, conceptual priors and expectations are frequently used to orient augmenting instruments. These guided perceptions are then used to confirm and falsify the very concepts which contributed to their initial selection.

(8) The degree of coherence believed to inhere within the resultant percept-concept correlation is determined by one's tolerance for ambiguity. Some degree of ambiguity will always exist since no perception can ever serve as a *full* representation: all concepts are ultimately false.

It is to the structure and process of mental conception that this discussion now turns.

The Internal Coherence and Incoherence within Mental Conception¹³⁴

Sometime in the past, humans gained the ability to compile their perceptions into a coherent, unified whole. The senses were somehow "pulled together" and the concept of an external reality emerged from this unification (see Appendix D). This synthetic ability to conceive of a separate reality allows one to manipulate and anticipate one's experiences, and therefore live more effectively than those who lack such working understandings. Furthermore, it was discovered that learning from others was easier and safer than discovering for oneself. This opportunity to learn vicariously led to a building of communal knowledge. To aid in this endeavor, *taxonomic science* evolved as a system of classification for the filing of descriptive propositions. In such a system, an object is characterized by a unique set of spatial qualities and the interactions between such objects are remembered as particular events. Since each particular piece of knowledge has to be remembered individually, in its uniqueness, the extensive use of taxonomic science was limited by memory.

It was at this stage of human development that *theoretical science* emerged from taxonomic science as an "economy of thought" (Georgescu-Roegen 1971:15).¹³⁵

¹³⁴ The ideas of this section are heavily influenced by the work of Georgescu-Roegen.

¹³⁵ It is interesting to note that Georgescu-Roegen (1971:22) saw theoretical science as a living organism which has a "genesis and evolution". It "emerged from an amorphous structure - the taxonomic science - just as life emerged from inert matter." It possesses a purposeful mechanism in the quest for knowledge, for the sake of knowledge. It reproduces itself since any "forgotten" proposition can be rediscovered from the logical foundations. It grows since the same foundations continually produce new propositions. And lastly, it preserves itself since destructive contradictions are automatically removed from

General relations between different classes of qualitatively similar objects could be established. Instead of memorizing all knowledge directly, it was only necessary to memorize the principles of interaction, the criteria for similarity, and the rules for *unfolding* the whole of knowledge from this base. Knowledge is thereby relieved of the "burden of singular instance, the tyranny of the particular" (Medawar as cited in Georgescu-Roegen 1971:27). This recognition of recurring tendencies in the covariation of stable qualities reaches its conceptual climax in the mechanistic conception of nature. Spatial qualities such as mass, malleability, and form (e.g., springs versus gears) are taken to be general characteristics of physical objects such that the relationships between objects become generalized. One abstracts from the uniqueness of objects in favor of their similarities. An object is then represented by a variable whose magnitude represents either an intensity or its proliferation in space. Georgescu-Roegen believed that within such theoretical models, the constant and quantifiable nature of the relationship between objects is a consequence of the fact that they display no qualitative change over the course of their variation (Georgescu-Roegen 1971:102). The fact that the quantitative relationship between the first set of variables is qualitatively identical to that between the hundredth creates an indifference to scale which manifests itself mathematically as homogeneous (first degree) linear relationships. Relations which are not indifferent to scale represent the presence of qualitative change and a stretching of the effectiveness of that particular theoretical concept of experience.

the structure.

Theoretical Science

Georgescu-Roegen's analysis of theoretical science begins by establishing two classes of propositions: α -propositions and β -propositions.¹³⁶ One can think of α -propositions as the qualitative elements of a process and β -propositions as the quantitative elaborations, combinations, and extensions of these categorical foundations through the rules of logic and causal reasoning. In other words, α -propositions represent the building blocks and β -propositions the buildings of theoretical concepts. A notable quality of β -propositions is that they always preserve the integrity and individual identity of the α -propositions they are composed of. Due to this fact, β -propositions will be referred to as *aggregations* of their α -class constituents.

The three laws of logic which establish the discrete individuality of α -propositions are identity, contradiction, and excluded middle. The law of identity states that a thing (referred to as \mathfrak{S}) is always equal or identical to itself (\mathfrak{S} equals \mathfrak{S}). This law formulates "the material fact that definite things, and traits of things, persist and maintain recognizable similarity amidst all their phenomenal changes. Wherever essential continuity exists in reality, the law of identity is applicable" (Novack 1971:23). The law of contradiction is the negative formulation of the law of identity. If a thing is always equal or identical to itself, it cannot be unequal or different from itself (\mathfrak{S} is not non- \mathfrak{S}). This individuated exclusiveness is completed in the third law, that of excluded middle. A thing cannot be parts of two opposing classes simultaneously. From these three laws,

¹³⁶ Although Georgescu-Roegen proceeded from a model of theoretical science to phenomena, others have proceeded from phenomena to scientific understanding (e.g., Hayek 1967d; Popper 1972). To do this, they have frequently begun their discussions by categorizing phenomena, e.g., as clouds and clocks in Popper's case.

difference and identity are "completely different, utterly disconnected, mutually exclusive characteristics of both things and thought" and "the correctness of one judgement invariably implies the incorrectness of its contrary and vice versa" (Novack 1971:21). These formal laws of logic establish the basic rules by which theoretical science maintains individual distinctions within the class of α -propositions.

Geometry is one of the champions of theoretical science and its process of logical extrapolation. The α -propositions might be: (1) assume that one is given a triangle (sum of all angles is 180°) which (2) possesses one right angle (90°). Then the β -propositions would include: (1) the sum of the other two angles is 90° , (2) the area of the triangle is equal to one half the product of the lengths of the two sides adjacent to the right angle, and (3) the sum of the square roots of the two sides adjacent to the right angle is equal to the square root of the hypotenuse (i.e., the side opposite the right angle).¹³⁷ Therefore, one can extrapolate from a small set of initial conditions to various aggregate relations and a diverse set of actual experiences (i.e., all triangles which share the α -class assumptions corresponding to these β -class rules).

If an α -proposition is not accessible to direct experimental verification (e.g., the self-interested character of human nature), it is assumed to be indirectly verified if the logically derived β -propositions agree with observation. There are three qualifications

¹³⁷ The Pythagoreans, who have this geometric theorem named after them, developed a whole philosophical world view based on whole numbers. It is rumored that once while at sea, one of the Pythagoreans discovered the square root of two (i.e., $1^2 + 1^2 = 2$) as a possible length for the side of a triangle. Since this value cannot be expressed by the ratio of two whole numbers (i.e., an *irrational* number), this created such chaos within their neat world that they threw the person who discovered this "new" number overboard and everyone who knew of this aberrant fact was pledged to secrecy (Kline 1959:45).

to be made along these lines: (1) If β -propositions derived from α -propositions are found to disagree with observation, or conversely if β -propositions *not* derived from the α -propositions are found to agree with observation, then as long as the logical extrapolations of these theoretical constructions are sound, the α -propositions will fall into doubt. (2) If ω -propositions are discovered from which the α -propositions can be logically derived (i.e., more elemental propositions), one simply replaces the old α -foundations by the newly discovered ω ones. (3) If two or more sets of α -propositions yield β -propositions which do not contradict perceptual experience, then the basis on which one chooses between these two sets of elemental propositions is *not* a matter of theoretical science but rather a matter of taste.

The first of these three points establishes the role of perception in confirming and falsifying the axiomatic foundations of a theory. Little needs to be said about this. The second point highlights the economy of thought inherent to theoretical science: the old α -foundations are *replaced* within the theoretical structure by the more elementary ω -foundations rather than being retained. This substitution will (1) simplify the theoretical model by decreasing the number of elemental spatial variables necessary (i.e., similar to removing the lowest common denominator in fractions) and (2) increase its structural accuracy and possibly its breadth of application. A retention of these α -foundations in full knowledge of the existence of deeper ω ones is a *categorical simplification* within one's theoretical concept *only when the logical bridge between these two levels has been built*. For example, not using a fully detailed concept of a car when attempting to drive one represents a categorical simplification: an aggregative model of

the car built from its basic elements is possible, but very cumbersome. However, if this logical bridge does not exist, the use of ω -foundations in coordination with α derived β -propositions in aggregate analysis represents an unsubstantiated metaphysical assumption. To the extent that such aggregative structural assumptions are inappropriate, the effectiveness of one's concept of the focal system will decline: metaphorically speaking, these concepts could be said to be *out of focus*.¹³⁸ The third point is perhaps the most interesting since it allows for different theoretical concepts to co-exist to the extent that the focal system's apparent structure and relations *per se* do not allow for judgement between these alternatives. The rules of theoretical science (i.e., logic extrapolation) are inert as principles by which to re-align the spatial-temporal dimensions of the observation set in order to make such a judgement. This latter point has implications for the social sciences since concepts may influence actions which help shape experience, and thereby feed one's perceptions which informed the initial concepts.

To the extent that the α -propositions accurately capture the qualitative elements of a system, and as long as these qualitative dimensions remain relatively consistent, one is able to quantitatively extrapolate from them. For example, Michael Polanyi (1967) attributes the success of engineering to the consistent and well-known qualitative physical/chemical conditions which are embodied in a theoretical model to deduce favorable arrangements. It owes its success as a manipulative art to these non-changing foundations. This caused Georgescu-Roegen (1971:36, emphasis added) to claim that

¹³⁸ It is interesting to note that the metaphysical assumption that "what reality is" has a single leveled implicate structure (i.e., that *the way we conceive of the world is the way the world is*) cannot be falsified. The quest for "the proper" decomposition of experience which can be effectively embodied in a theoretical model is a never-ending one.

theoretical science is "thus far the *most successful device for learning reality* given the scarcity pattern of the basic faculties of the human mind." It has fostered significant advancement in the knowledge of inanimate matter, served as a check on literary thinking, and helped free humanity from the indiscriminate application of animistic habits of thought. However, it has also fostered the impression that it offers the only sound method for the expression and cultivation of knowledge.¹³⁹ The essence of this flaw resides in the *failure to acknowledge the limitations of theoretical science* and the attempt to apply it indiscriminantly and universally. This failure to acknowledge the limitations of theoretical science is related to the belief that the way we conceive of the world is the way the world is; that reason and logic are synonymous.

The strength of theoretical science resides in the fact that for a given set of α -propositions, the corresponding β -propositions are uniquely determined through the rules of logic. What are the limitations of theoretical science? Since theoretical science uses the rules of logic to derive β -propositions from α -propositions, it is susceptible to the same limitations as logic itself: this being that one must posit a *cardinal measurability* for the qualitative elements contained in the theoretical concept. Cardinal measurability implies the specific property of existence as a quantum or elementary unit which displays qualitative consistency in the face of subsumption and subtraction (Georgescu-Roegen 1971:98). There are phenomena, however, which elude such prerequisites and therefore

¹³⁹ This emphasis of a singular method of knowledge is reminiscent of the Enlightenment during which the Church's self-proclaimed monopoly on truth was challenged. In opposition to this, some individuals contended that they possessed the ability to discover *for themselves* (see Cassirer 1951). It is the ossification of this creative individual urge to know into a *static and universal method* of knowing that is challenged in this dissertation.

elude the grasp of a purely aggregative theoretical concept. To the extent that such phenomena are present, a logically continuous and universal theoretical science is not possible.

Quantity versus Quality: The Spatial Dimension of Concepts

A *quality* is defined as that which makes something what it is, while *quantity* is the exact amount of a particular thing. The essence of this distinction between quantity and quality is related to the perceptual distinction between parts and wholes. There are two types of qualities, those which can be logically reduced to more elemental qualities and those which cannot without destroying their uniqueness. The former is merely a categorical simplification. In the latter case, a composition of elements will possess a *synthetic quality* which is not present in the theoretical aggregation of its qualitative elements (i.e., distinctive characteristic of the parts as whole). While quality is essentially related to the perception of a discrete whole (i.e., parts as whole), quantity is the conceptual manipulation of constant quality (i.e., whole as part).

Bateson (1979) has highlighted this distinction between quality and quantity using the notion of a *pattern*. While it is impossible to create a pattern with a single quantity, a ratio between two quantities is the very beginning of a pattern.¹⁴⁰ However, a pattern will only possess a synthetic quality if it makes a *difference as a whole* within the

¹⁴⁰ An interesting point to note is that whereas multiple rabbits or multiple turtles *per se* can form only a limited pattern, a group of human beings can form a much more complex pattern due to the conceptual dimension of human existence. People who are biologically identical can be mentally distinct. It is this intangible diversity which provides an intangible heterogeneity to individual human existence.

observer's concept of the process. In other words, a pattern warrants individualized attention and conceptual embodiment only if it has meaning *as a pattern* within the process under observation. Patterns which do not make a difference do not need to be conceived of as being distinct from their quantitative aggregations. For example, individuals who come together to form a firm establish a pattern of relations which is important *in and of itself*. Therefore, economists model a firm as an individualized whole (hence the black box model). In contrast to this, a perfectly competitive market is a pattern of firms and customers which is not significant *per se* and can therefore be modelled through a simple theoretical aggregation of more elemental parts.

Along these lines, Polanyi's (1962, 1967, 1975) work concerning tacit knowledge involves the implicit recognition of meaningful patterns in perception.¹⁴¹ The idea is that the description of some phenomena is not necessarily expressible in a language of their constituent parts, but involves a leap of understanding which allows for the comprehension of a system *per se*. Polanyi (1967:18) even argues that to delve into the particulars of a pattern may actually destroy the understanding one has of it as a whole. He qualifies this by noting that an engineer's understanding of a machine may go much deeper than that gained through its routine use by the factory worker without necessarily hindering the engineer's understanding of the machine as a whole.¹⁴² However,

¹⁴¹ See also Hayek (1967c, 1978).

¹⁴² This is obviously connected to the temporal rate of interaction between the laborer and machine which dictates a limit to the complexity of one's active concept of this ongoing interaction. For example, one does not "think" about all the discrete motions involved in driving a car nor the process of the car *per se*. Yet, a car is amenable to a high degree of logical reduction into its pieces without doing violence to "what a car is."

machines are the pinnacle of theoretical conception and with many other phenomena this act of logically integrating the relations between an entity's particulars to yield the whole still leaves something out. For example, although grammar is composed of words, it involves the interrelations between these words and an isolated knowledge of words provides no insight into the structure of grammar.¹⁴³ These intuitions lead Polanyi to conclude that the "ideal of eliminating all personal elements of knowledge would, in effect, aim at the destruction of all knowledge. The ideal of exact science would turn out to be fundamentally misleading and possibly a source of devastating fallacies" (Polanyi 1967:20).

Remember that in Georgescu-Roegen's analysis of theoretical science, the elementary meaningful patterns (i.e., synthetic qualities) which form the foundations of our theoretical concept are denoted by α -propositions. All concepts (β -propositions) built from these fundamental blocks are the result of the logical aggregation of these elemental foundations. Through comparing these qualitative foundations and their theoretical aggregation with the corresponding phenomenon which actually appear to human perception, Georgescu-Roegen divides phenomena into three distinct *orders of rationality* to implicitly acknowledge that some patterns present a synthetic quality.

Phenomena of the 1st order of rationality are those which can be discovered with "the tip of the pencil doing some algebra or logistic calculus on paper as is the case in mechanics" (Georgescu-Roegen 1971:116). There is no synthetic quality that arises and

¹⁴³ Along these lines, although *Cajun* and *Creole* were originally thought to be simply local dialects of the same language, linguistic research has discovered that they represent the mixing of French grammar with English words and English grammar with French words respectively.

therefore a logical extrapolation of the constituent qualities provides an accurate concept of composite phenomenon. It is this class of phenomena which allows itself to be investigated vicariously through theoretical extrapolations and reductions. The discovery of the planet Pluto through pen and paper calculations is a wonderful example of the rich possibilities offered by theoretical science when dealing with such phenomena.

Phenomena of the 2nd order of rationality are those which must first be observed before they are known. However, this novel quality of a pattern is predictable given "identical" conditions (i.e., an identical quantitative pattern of qualitative parts). Since such qualitatively unique events are properly categorized as α -propositions, a *hierarchical series* has established itself within the class of α -propositions through a given pattern of α -class elements which produce a synthetic quality. This new α -proposition corresponds to a pattern of lower level α -class elements such as the β -class propositions do, but it has a uniqueness about it which goes beyond the theoretical aggregation of its foundations.¹⁴⁴ For example, when a chemist combines elements (e.g., hydrogen and oxygen) in some novel fashion, she may discover new qualities (e.g., wetness) which will continue to emerge when identical combinations of these conditional elements are recreated. However, in the first instance, she is unable to predict the quality of a novel pattern by simply considering the qualities of its constituent parts.

¹⁴⁴ Logic has always had a difficulty with distinctions between elements of a class and the class itself. The fact that theoretical science's first victory was geometry helped to cover-up this difficulty since geometric relations involve only being, no aggregative qualitative distinctions, no class distinctions, and no becoming. Note that three prominent philosophers who proposed the universal validity of logic (i.e., Russell, Whitehead, and Wittgenstein) *all* abandoned such aspirations in later works (Barrett 1979).

Phenomena of the 3rd order of rationality have pointed implications for socio-economic theorizing. The basis on which Georgescu-Roegen draws this last distinction concerns the *predictability* of the synthetic quality that emerges from the pattern. While 2nd order phenomena present identical results in identical conditions, phenomena of the 3rd order of rationality will elude one's attempt to predict the outcome after repeated "identical" combinations. Georgescu-Roegen believes that such systemic inconsistency is prevalent in the organic and super-organic domains. For example, a hostile natural environment may spawn both a highly peaceful culture as well as a highly aggressive one (Georgescu-Roegen 1988). Another example he cites is the diverse traditions of marriage which include buying the bride, the bride bringing a dowry, or no transaction at all (Georgescu-Roegen 1971:117). These phenomena display a multiplicity of solutions which are not witnessed in 2nd order phenomena. Since such events are typical in the realm of the social sciences, Georgescu-Roegen believes it is therefore necessary that such sciences rely more heavily on *sui generis* methods as a "logical necessity" when dealing with 3rd order phenomena (Georgescu-Roegen 1971:119).

These conclusions concerning the non-predictable nature of 3rd order phenomena result from Georgescu-Roegen's failure to recognize the conceptual dimension of human existence (i.e., self-consciousness). What is the meaning of "identical" conditions in a social context? When Georgescu-Roegen says that an adverse environment can spawn both a peaceful and aggressive culture, the basis by which he equates these two situations is materialistic. In other words, both instances involve an adverse environment and a group of people. Likewise with respect to marriage, all three possible situations involve

a man, woman, cultural group, and environment. However, one potential difference within both of these examples is the conceptual models that the individual participants possess. In other words, the relationships between different individuals and those between individuals and their environment may have different meanings to the participants. One should be talking about 3rd order phenomena as possessing a conceptual dimension which is mental, not material, and therefore tacit and intangible from a material perspective. Therefore, one can dismiss this third classification in favor of the explicit recognition of self-consciousness (i.e., a synthetic quality which introduces the conceptual dimension) which may evade materialistic attempts at measurement.

Returning to the hierarchical nesting implicit within 2nd order phenomena, the synthetic quality of a pattern does not appear within an aggregative theoretical concept built from its constituent qualities. Therefore, such patterns will not have individual meaning unless one assigns them such meaning within the categories of logic. But, the law of contradiction requires that a pattern of elemental qualities cannot simultaneously be equated to both a *sum of its parts* and *more than the sum of its parts*. There are two representations of a single phenomenon which are both accurate: this cognitive discrepancy is similar to the ambiguous figures of perception presented earlier, except for the fact that the former has a spatio-temporal depth not present in the latter. For example, a human being is perceived to be both a biological animal and a self-conscious individual. From one perspective, a human being can be conceived of as a biological organism; we engage in all the activities that other biological systems do, such as eating, defecating, sleeping, and reproduction. Yet, however complex an understanding one has

of these biological processes, such a concept will provide very limited insight into self-consciousness. In other words, a theoretical aggregation built from biological qualities and biological interactions provides only a limited understanding of human existence, one that abstracts from its most significant feature.¹⁴⁵

Georgescu-Roegen calls such phenomena *dialectical* and argues that reality appears to be dialectic in nature. When coupled with the assertion that mental conception is analytic in character, this proposition denies the possibility of an ultimate theoretical conception of reality. However, since it is the poles of our dualistic concepts which define the dialectic interstices, one begins to realize that this dialectic character of phenomena is co-dependent with the analytical structure of conception. This recognition of a dialectic experience in light of humanity's analytic orientation is the most philosophically significant theme of Georgescu-Roegen's The Entropy Law and the Economic Process (Neidhart 1992).¹⁴⁶

Two points need to be addressed immediately. First, the presence of dialectical concepts (such as young/old, night/day, and life/death) still allows for definitive meanings since the overlap of "S" and "not-S" is not "throughout the entire range of denotations" (Georgescu-Roegen 1971:47). For example, while the question, "What is

¹⁴⁵ One might contend that some humans "live" more in the realm of biology and simple stimulus-response psychology than others. Note, however, that this is an individual choice and that self-consciousness is an individual quality.

¹⁴⁶ The aversion to complex philosophical problems has led this particular idea to be virtually unexplored within the economic profession while Georgescu-Roegen's own emphasis on thermodynamic concepts has received the most attention. Since his later works focused primarily on entropy as the ultimate constraint on the expansion of the economic system, his work has been aligned with the first two laws of thermodynamics and may rise and fall with their popularity (i.e., notions of out-of-equilibrium thermodynamics).

the quality of being alive?" may not lend itself to a distinct boundary between life and death, the qualities of life and death are nevertheless distinct. Second, it must be stressed that the presence of this "S" and "not-S" logical paradox is a result of the analytic nature of the human thought process and the relativity of perception, *not* of imperfect measurement. While imperfect measurement may result in conceptual difficulties, it is unsubstantiated and anthropocentric vanity to argue that all conceptual difficulties are the result of imperfect measurement.

While Georgescu-Roegen's insight into the analytic/dialectic relationship inherent to conception is quite profound, he failed to explore these ideas to their full depths. One might say that his ideas remained tethered to the human perspective. This discussion unfolds the implicit richness of these ideas by developing a conceptual hierarchy which provides a dialectic depth through the interaction of parts to form wholes. While I would not contend that such a vertical dimension is completely missing from Georgescu-Roegen's work, it is not explicitly drawn out. The difficulty is that since these hierarchical relations collapse relative to the spatio-temporal dimensions of human perception (i.e., one always perceives an interaction of parts which form the focal system), this depth must be intuited through one's concept of meaningful patterns and the synthesis of varied, but simultaneous, perspectives.¹⁴⁷

An exploration of Georgescu-Roegen's use of the term *dialectics* is worth while. In general, he defines dialectic concepts as those which are "surrounded by a penumbra

¹⁴⁷ This is similar to the fact that even though vision is only two-dimensional, we intuit a third dimension through the synthesis of two distinct perspectives (i.e., eyes) and three dimensional geometric concepts (e.g., shadows and relative shifts in spatial position). See Levine and Shefner (1991:Chapter 12) and Bateson (1979).

within which they overlap with their opposites" (Georgescu-Roegen 1971:45). For example, the quality of being alive is distinct from not being alive, but the point at which a process goes from being inanimate to living is not easily demarcated in practice, as current debates in medical ethics attest. This could be said to be a vertical application of the concept of dialectics since life *emerges* out of non-life and emphasis rests on the emergence of a synthetic quality within a pattern. In contrast to this use, two patterns can be classified as possessing the same quality while remaining quite distinct at the *same conceptual level*. For example, the concept of democracy has a dialectic nature since both the United States and Mexico can be called democracies even though they remain very different politically. This could be called a horizontal dialectic since the synthetic quality is given, and two systems are equated on the basis of their possession of this quality. Therefore, these two examples represent different types of dialectics, a distinction which is not made explicit in Georgescu-Roegen's work.

One can clarify this distinction by noting that the concept of democracy is dialectic in the sense that it is used to characterize a structural quality within the political process. Democracy is perhaps a synthetic quality within the political process (i.e., from monarchy, to oligarchy, to democracy), but it does not symbolize the emergence of an autonomous and novel process. Therefore, there is a linguistic ambiguity or lack of precision involved in the categorization of a political process as simply democratic. In contrast, the concept of life is used to characterize an autonomous and novel process. In order to perceive its dialectical nature, one must alter the spatio-temporal dimensions of the observation set to reveal the non-livingness of its physical and chemical

foundations. It represents not only the emergence of a synthetic quality, but also the potential for novel interactions. One could say that life is a *process dialectic* which involves the synthetic quality of being alive while democracy is a *structural dialectic*. This distinction, however, should not be reified. For example, life is frequently used when talking about ecosystems as being living processes. Within this latter use of the term, our perspective has expanded such that the quality of being alive becomes one of many structural characteristics of the process and many different processes can be referred to as being alive just as many different political systems can be referred to as being democracies.

These ideas are captured by introducing a hierarchical leveling within our concepts which provides a "depth" to our overall representation. The fixed perspective of human perception is complemented by altering the spatial (e.g., microscope) and/or temporal (e.g., photographic exposure) dimensions of observation to create an array of simultaneous structural decompositions of interactive processes. For example, a cell will appear as an individual entity from one perspective and as an interactive process from another (e.g., mitochondria, cellular membrane, protoplasm, etc.). From an even faster temporal and smaller spatial perspective, these interactive parts will appear as individual entities themselves, and even this viewpoint gives way to the interactive process between organic and inorganic molecules. In other words, as the spatio-temporal dimensions of the process of perception are changed, the structural qualities and the interactive process which manifest itself to perception will change.

The Meaning of Hierarchy

Let's take a few steps backwards and ask what is meant by a *hierarchy*? Although the word hierarchy is commonly associated with the class structure of society or the administrative structure of a firm, this idea of ranking structurally identical elements on the basis of authoritative power is not used here.¹⁴⁸ Instead, the word hierarchy is taken to symbolize a nesting of simultaneous conditional relationships which manifest to perception through variations in the spatio-temporal decomposition of reality. A conceptual representation of phenomena will therefore involve *levels of contemporaneous* structural parts-whole relationships. The ordering of these levels is only useful in coordination with the ability to intervene in this hierarchically conceived process. Self-consciousness represents just such a quality in that *one appears to exist independently* of the situation, whereas stimulus-response psychology represents a non-reflective mental existence. Therefore, the emergence of self-consciousness as an active participant in the greater system is *necessary* for hierarchical ordering to have any meaning.

Herbert Simon (1969) provides a speculative rationale for the evolution of hierarchically nested patterns through a thought experiment involving an environment which displays random perturbation. These perturbations destroy any unstable configurations by returning them to their dissociated elemental components. In order for a particular configuration to persist, its unit assembly time must be lower than the time between subsequent perturbations. For example, assume that there are 1000 pieces needed to assemble a watch and two different techniques. The first technique is to

¹⁴⁸ For a discussion of the varied use of this term over the years see Wilson (1969) and Grene (1988).

assemble all 1000 parts in a single step, while the second technique breaks the assembly process into ten 100 part stable sub-units which are then combined to form the watch. If we assume that total assembly time is a linear function of the number of components involved in each step of the process, we could conclude that the first technique (1000 parts, one step) would be slightly faster than the second (10 times 100 parts and one step of 10 parts). However, in an environment of uncertainty and chance fluctuations (e.g., phone calls and visits by customers), perturbations which occur more frequently than the sub-unit assembly time will undermine production. As long as this perturbation frequency is slower than the sub-unit assembly time of the second technique but faster than that for the first, the second methods use of nested stability patterns will prove superior. In accordance with this theoretical mindwalk, one finds that the difference between the temporal rates of development for different processes will frequently serve to identify the different levels within the conceptual hierarchy.

For a given spatio-temporal perceptual anchor, the conceptual hierarchy will involve three parts.¹⁴⁹ If one defines the structure and interaction that one is concerned with as the *focal* level, this will be bounded by a *higher* and *lower* level. These higher and lower levels will influence the focal level dynamics through constraint. The lower level provides the *structural elements* from which the focal dynamics evolve while the higher level provides *boundary constraints* which set the context for the focal dynamics. Since these divisions abstract from the simultaneity of phenomena, it is important to remember that higher level phenomena are partially composed of focal level dynamics,

¹⁴⁹ This triad has been identified by many different theorists (see Salthe 1985:75-77).

and that the focal level helps to create the context for systems at lower levels than itself. This pervasive, nested interdependence between levels highlights the co-evolution between a system of elements and its context, e.g., as with economy-environment interactions (Norgaard 1984, 1985).

The apparent discreteness, and hence non-transitivity, between these different levels is due to the fact that their interactive processes occurs at different homeorhetic rates (i.e., the time period required to fully propagate a given change through the causal links of the system).¹⁵⁰ In other words, given a particular focal level process, the interactive process of higher level phenomena move significantly more slowly while those for the lower level phenomena move at a much faster pace. Therefore, both of these bordering levels will appear to be constant *relative to the focal level* (e.g., geological and atomic interaction rates relative to that of human existence) and will behave like "rigid bodies" in their relation to one another (Simon 1973:10). However, this conceptual separation of distinct levels should not be taken to imply a complete absence of dynamic interactions among these levels. It is always possible for high level "events" or low level "amplifications" to play a more direct role in a focal system's dynamics (Salthe 1985:138).

Since these directly contiguous levels define what cannot happen rather than what will happen, one could say that an *open dimension* exists for the focal system. While it is possible that the lower and higher levels define a unique range in which the focal system must exist (i.e., representing a mere aggregation problem), such a deterministic

¹⁵⁰ This idea is espoused by Simon (1969,1973), Allen and Starr (1982), Bateson (1972), and Salthe (1985, 1989).

interpretation abstracts away from the non-transitive nature of synthetic qualities and the co-evolutionary interplay between levels.¹⁵¹ Since this hierarchy is a conceptual compilation of simultaneous perceptions, the historical record should bear witness to the evolution of particular classes of systems which traverse the levels of our overall conceptual representation as they develop and unfold, while concurrently presenting us with an existing continuum of such systems. During this process of unfoldment, the middle of the hierarchy (i.e., the cutting edge of qualitative distinctions) is continually within the context of lower level possibilities and higher level constraints, even though these relations are co-evolving within the interstitial systems themselves.

Although our language would need to distinguish between these distinct levels by necessity, it also makes sense to use words as an economy of speech (i.e., to represent a mechanical process such as a personal computer). However, whereas an economy of speech is amenable to theoretical reduction, synthetic qualities are not. In both instances the configuration of parts is represented by a unique label. To add further complexity, the fact that *language* has evolved dictates that although it will trace the evolution of emergent meaning through time, this relation between language and meaning has the potential to become locked-in to ineffective forms of representations. In other words, certain words which symbolize significant relations may be retained in a language even after their significance has disappeared.

¹⁵¹ Resnick and Wolff's (1993) ideas on overdeterminism are a critique of mainstream neo-classical theory on these grounds. They contend that the neoclassical concept of the economy is placed in a dynamic straightjacket by theoretical assumptions which leave no open dimension and is therefore sterile with respect to creativity by assumption.

Hierarchies and the Evolutionary Perspective

There are two different ways to differentiate between the levels of interactive process within the conceptual hierarchy. The first of these highlights the *complementary interaction* between parts which create patterns with synthetic qualities: the parts-whole transition. From this perspective, a representative hierarchical order might consist of individuals interacting to form families and firms, families and firms interacting to form local neighborhoods or cities, cities interacting to form regional economies, and regional economies interacting to form the national or world economy. The analytical emphasis is on the structural interaction of the parts to form the synthetic qualities of the whole. If such a synthetic complementarity does not exist between the parts, the whole would be a simple sum of its parts and a distinct analysis would be unnecessary.

An alternative emphasis highlights the interactive competition between similar parts for participation in the larger process: this facet corresponds to the competition of wholes as parts. In other words, it concerns itself with *functionally similar wholes* and establishes the range of *competitive interaction* between these structural elements. It is this aspect of hierarchical organization which has traditionally been stressed in evolutionary theory (e.g., Darwinian selection of the fittest) and involves an individual's competition within the group. Although it is erroneously assumed that the viability of a synthetic quality (e.g., a new organism) is determined solely within this competitive interaction, such a view does not fully understand the interplay between complementary and competitive interactions.

The different emphases between these two orderings is critical: the first corresponds to complementary circular relations, and the second stabilizing ones. Neither one is *the* evolutionary theory, rather it is their *combination* which provides coherence and clarity to a theory of evolution. Both contribute to the structural identity of the elements, one addresses the competitive interaction which serves to define functionally homogeneous individuals while the other presents potential individuals as the complementary interaction of lower level elements. From a different perspective, one could say that the higher level complementary ordering provides the selection criteria or niche from which the process of lower level competition proceeds. In addition, it is the lower level competitive ordering which identifies the qualitative elements which participate in the higher level compositional ordering. The synthesis of these two criteria is established within the growth and development of a *particular* system which traverses our conceptual hierarchies through time.¹⁵²

This duality of language can also be explored at a more fundamental level through the concepts of structure and process. For example, while it has already been contended that things have only a relative or conditional existence, this thought leads naturally to the affiliated idea that *things are defined by their relations*. If one were to then contend

¹⁵² This distinction has direct relevancy for economic thought. One should be aware of the fact that Marshall's use of the term *biology* emphasized the *spatio-temporal continuity of an entity and its interactive parts* rather than the inter-individual or inter-firm competition for survival which is typical of Darwinian evolutionary thinking. In fact, the biological dimension to Marshall's writings centered on organizational efficiency, and was concerned with an evolving whole rather than competing parts. This observation explains Hodgson's (1993) rejection of Marshall's evolutionary perspective in favor of Darwinian foundations and Foster's (1993) attempt to tie Marshall, Georgescu-Roegen, and the dissipative structure literature (e.g., Prigogine 1976,1980; Allen 1988; Allen and Sanglier 1978,1979,1981) together into a single evolutionary conception.

that only relations existed, she would not be completely wrong but could be asked, relations between what? Upon close examination, it becomes obvious that there is a difficulty in proclaiming the primacy of process (i.e., interactive relations) over structure (i.e., things) since without structure there can be no coherent concept of process. This is the paradox involved with the process/structure dichotomy inherent to conception. One must therefore conclude that neither an exclusive emphasis on relations nor things is accurate. Rather, *both* are required within our thought process and these two modes of conception are complementary. The over emphasis of one over the other will ultimately result in either nihilism (process) or essentialism (structure).

A similar appeal to a dual method of conception is made in Bohr's formulation of the complementarity principle to explain the wave/particle duality of quantum physics. Bohr noted that,

... classical explanation was achieved through the representation of conceptually disjoint systems [waves and particles] by one, unified and coherent mode of description; whereas complementarity achieves explanation of conceptually unified coherent systems by disjoint modes of description. (cited in Pattee 1978:193)

This complementarity perspective is based on the idea that the perceived duality does not have ultimate existence, but is a residue of *the subject/object dichotomy inherent in the act of perception*. It is human consciousness which distinguishes an object from within the flow of time to establish the characteristic of sameness and structural quality. In contrast, a classical theorist would claim that our level of knowledge has just not advanced far enough, but that as it does advance, this duality will be resolved.

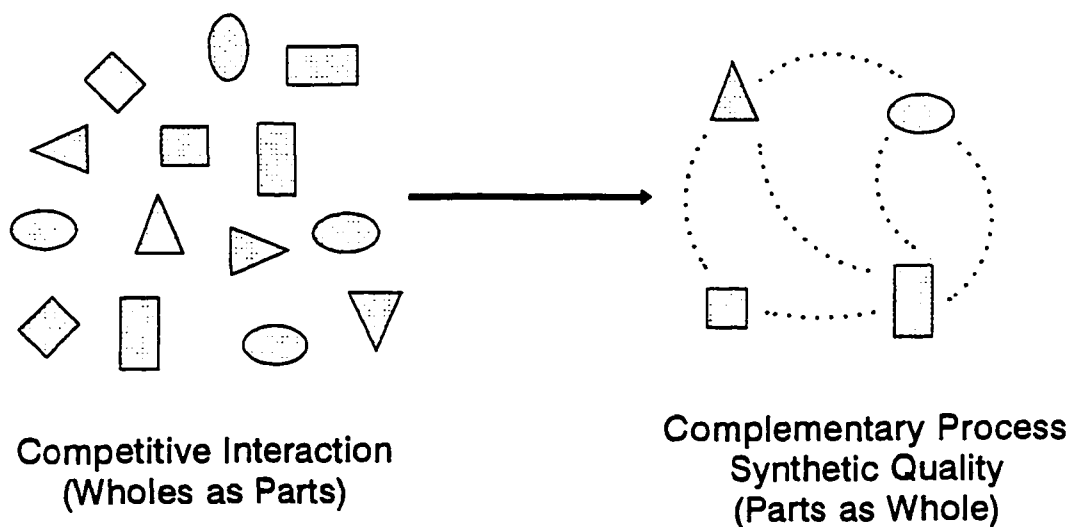
In brief, the skeleton of our epistemological portrait is one in which flow patterns which are relatively consistent become the structural dimension of one's concept of

reality. These structural dimensions are then used as the different elements of the interactive process under observation. As synthetic qualities emerge from these elemental substrata, they will require individual embodiment within our concept of the process but will not change the fundamental essence of the interaction. For example, new species introduced into an ecosystem may change its structural composition but will not necessarily change the process of ecological interaction (e.g., a forest after the introduction of a novel plant species). One could say that the new structural components will compete for a position within the existing ecological interaction. Although the process may not remain the same structurally, the relations between its compositional elements will embody the same limitations and potentials as previously.

While it could be said that the process of interaction never changes, but only actualizes latent possibilities, when these latent possibilities are sufficiently unique within our hierarchical concept, we embody them in a new template of structural interaction. Since our hierarchical concept is one of simultaneous phenomenal interaction, these novel processes represent a *leveling of interactive process*. It should be noted that although the emergence of a single, isolated synthetic quality may not signal an observable change in the process of structural interaction (since it represents an isolated innovation), the emergence of a host of such structural qualities may. For example, life is a synthetic quality which presents a significant shift in the potential interactions of the emergent system. However, a singular instance of life may not be sufficient to fully manifest the interactive potential that such a quality harbors.

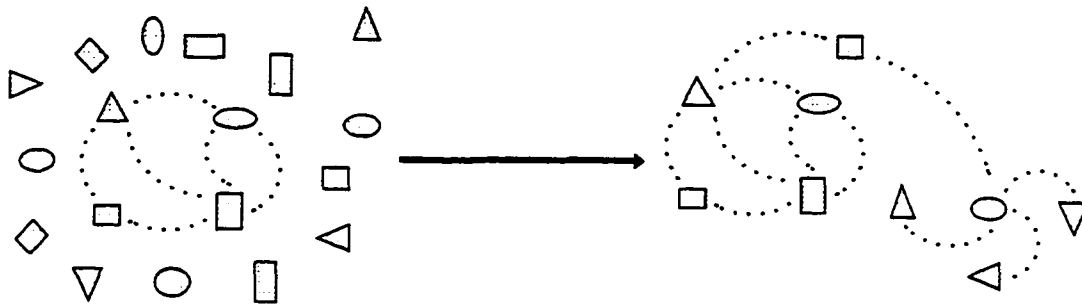
In order to better understand this conceptual complementarity between structure and process, one can utilize the distinction between complementary and competitive orderings. Beginning with a competitive ordering, imagine functionally similar parts vying for participation in a stable synthetic structure which forms spontaneously (i.e., an initially complementary relation which becomes stabilized) within the interactive process between the elements. This is diagrammed as follows (dotted lines represent the complementary process):

Figure 39: From Individuated Parts to Synthetic Patterns



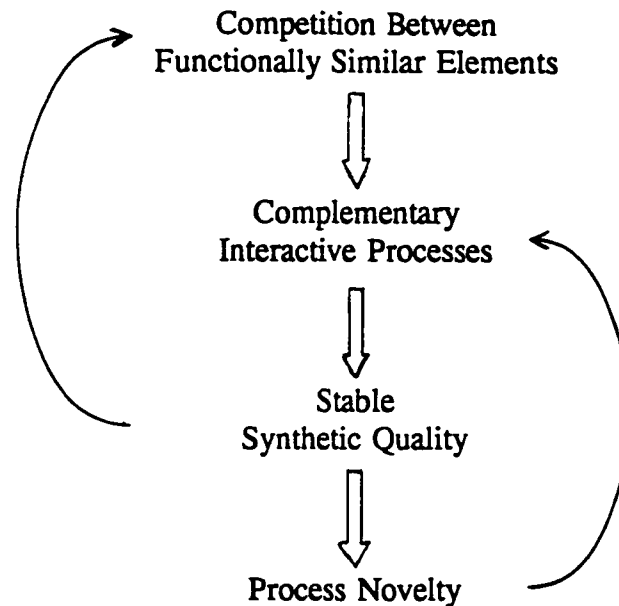
These *synthetic qualities* may continue to compete within the dynamic context they emerged from and may even represent an intermediate step in the formation of a more elaborate pattern novelty, as in Figure 40.

Figure 40: The Concatenation of Structural Novelty



However, it may also be the case that a synthetic quality no longer competes with these other elements on their own level *per se*, but transcends the limitations of these previous interactions by displaying the potential for unique interactions. It is this transcendence which will be called a *process novelty* or *synthetic interaction*. By combining the ideas of a *synthetic quality* and *process novelty*, the hierarchical concept becomes much more complex (see Appendix E for an application of this theoretical framework within existing economic theory). This nesting of static and dynamic relationships is depicted in Figure 41.

Figure 41: Synthetic Qualities and Process Novelty

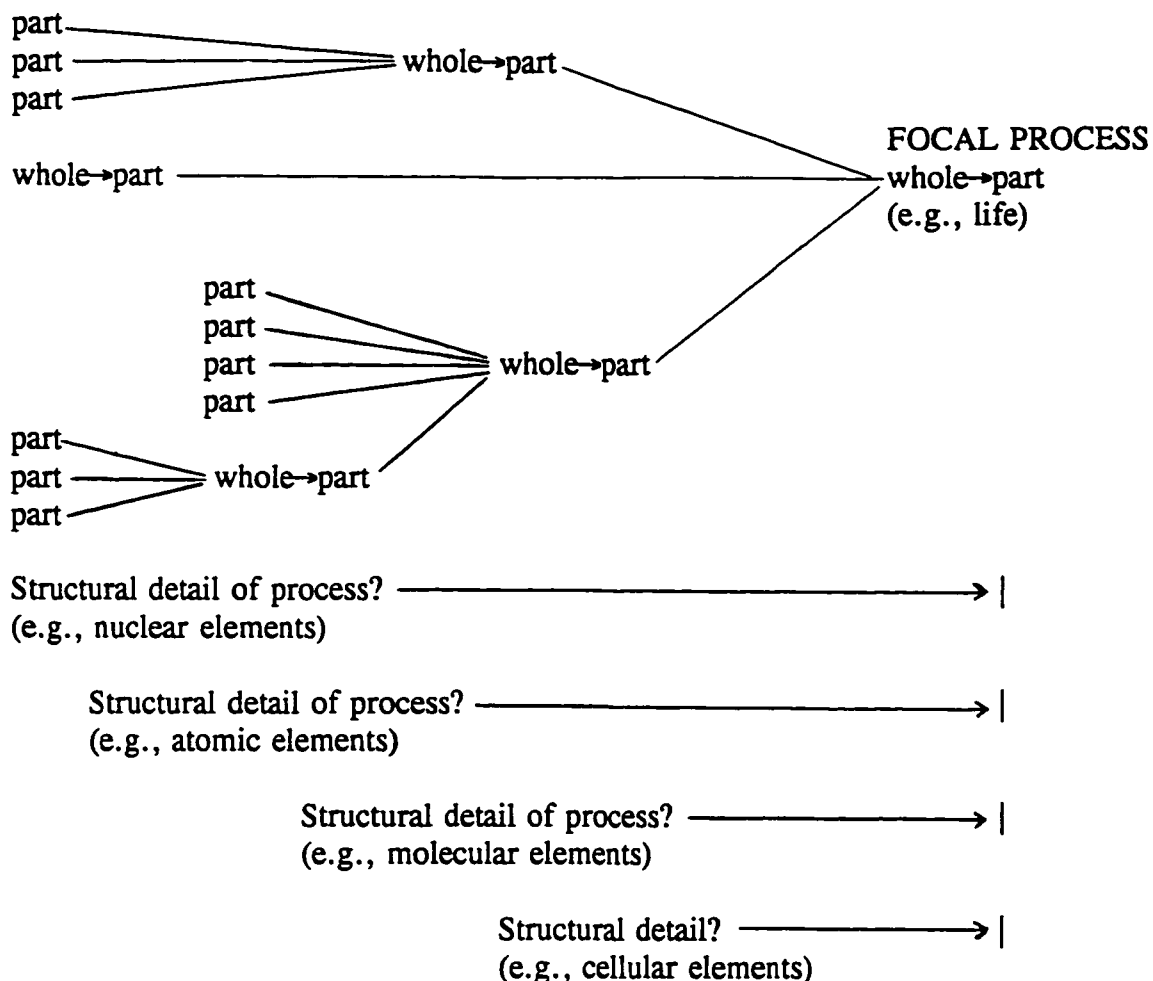


This diagram should be read as follows. As functionally similar elements compete to participate within the complementary processes occurring, a synthetic quality may stabilize within the overall process (i.e., a structural novelty). This synthetic quality will then re-engage in the ongoing process of interaction from which it emerged. However, this synthetic quality may also transcend this competitive and complementary process *per se* by introducing novel interactive possibilities (i.e., a process novelty). This latter example represents leveling which is affiliated with the idea of different *laws of interaction* (e.g., physical versus biological).

Although this discussion of the interplay between synthetic process and structure has been analytic, it is best thought of as being dialectic. The emergence of novelty is not a uniform transition in which, e.g., a "complete" set of synthetic qualities emerge

together to form the distinction between the concepts of a purely chemical versus biological process. Rather, the emergence of synthetic qualities and novel interactions is the slow climb of individual systems. The emergence of a synthetic quality or process novelty signals a distortion of the previously appropriate theoretical concept such that the particular theory under consideration becomes an inaccurate representation of the focal system. I will contend that a given theoretical concept will lose its effectiveness as the difference between the spatio-temporal dimension of perception and the homeorhetic rate of the focal system widens. Although this hypothesis seems to hold in lower level interactive processes since increased spatio-temporal dimensions shift one between the purely physical, chemical, and biological realms, the synthetic qualities of mind and self-consciousness alter this trend. The essence of the problem seems to be that the very space-time continuum is *revealed by* self-consciousness and hence there is a significant nonlinearity which signals a further order of qualitative change which is occurring. Without exploring this apparent nonlinearity in more detail, one might simply say that the structural decomposition and interactive process are co-determined in such a way that progressively deeper levels of structural detail used in combination with a fixed focal process will diminish the effectiveness of one's understanding.

Figure 42: Appropriate Structural Detail within Concepts of the Focal Process



A similar conclusion holds with respect to progressively deeper levels of interactive process used in combination with a fixed decomposition of structural detail. For example, if one wishes to describe the interaction of molecules one might consider using the concepts of quantum, atomic, chemical, biological, or psychological interaction. However, chances are that a "template of chemical relations" would prove most fruitful.

A Classification for Structural Elements

In order to formulate a concept of interactive process, one must establish the different types of structural elements which are possible. To address this issue, I wish to expand upon three types originally suggested by Georgescu-Roegen (1971:Chapter 9). First, there are those elements which appear only as a *Stock/Flow*, such as many of the raw materials used in economic production. Such structural parts are absorbed by the process in such a way that they apparently cease to exist (i.e., input) or come into being (i.e., output) as the interactive process unfolds. As an example, imagine a box which contains twenty pieces of candy. We can use this candy to make twenty people happy now or twenty people happy tomorrow with the qualitative identity of the candy being completely consumed in the process.

The second type of structural elements are those which are significant within the process but are transformed due to participation only after prolonged interaction. Georgescu-Roegen (1971:224) calls such elements *Funds of Services*. An example of a fund is a light bulb that lasts five hundred hours. This bulb cannot be used to light five hundred rooms for an hour, but involves a service of lighting one room for five hundred hours: roughly speaking, one can refer to this as a measurement of systemic lifetime.

The last type, which I shall call *Systemic Elements*, consist of those elements which undergo noticeable qualitative change during the interactive process but are able to restore their previous state of qualitative existence given the necessary period of time. In other words, Systemic Elements can be thought of as Funds of Services which are noticeably degraded as they participate in the process, but have the ability to return to

their previous state which gave them meaning within the process. An example of such a structural element in economics is the rested laborer as opposed to a tired laborer. Since a theoretical concept of the process allows only monotonic qualities which vary quantitatively, one must either represent these two states of a systemic element as distinctly different (i.e., treat them as a Stock/Flow), ignore this systemic degradation (i.e., treat them as a Fund of Service), or add a quantitative continuum from rested→tired.¹⁵³

These classifications identify the significant quality which the different types of elements contribute to the process under observation and are determined by the homeorhetic rates of the different structural elements relative to the focal system. Structural elements which appear as Funds in lower level processes will appear as Stocks in higher level processes (i.e., longer time periods). This distinction finds expression in the spatio-temporal dimensioning of the structural concepts. Stocks/Flows are consumed in the process and it is not necessary to note their lifetime or homeorhetic rate as a system, but only the spatial density of this consistent quality. As a result, they are quantified as a Stock (Units) of potential Flows (Units/Time).

In contrast, Funds of Services provide a consistent spatial quality which is not significantly consumed in the process, but has a limited temporal existence. Their importance within the process is as a catalyst and it is their effective life span in this capacity which must be noted. Unlike a Stock, Funds are not saved and spent, but

¹⁵³ In economics, laborers are usually typified as a Fund of Services with respect to production. However, if there happens to be a hysteretic effect such as psychological impairment due to episodes of unemployment, this simplification is inappropriate (e.g., see Darity and Goldsmith 1993).

require a duration of time in which they are either used, decay, or lay idle. Furthermore, their rate of use is restricted by their inherent systemic structure. The dimensions of a Fund of Services is (Quality x Time), which can be aggregated in order to appear as a Stock of Funds (Units of *Quality x Time*) from which the services provided are dimensioned as a set number of qualitative units which have a definite lifetime. For example, a machine represents a fund of services which persists for a specific number of machine hours. The service provided to the process is one machine. Note that if one has a fund of identical elements, then as this aggregative fund becomes larger and the systemic lifetime of its elements smaller, it can be represented as a stock with an input/output flow based on the lifetime of a representative element. However, if the qualitative nature is changing between successive additions or if their systemic lifetime changes significantly, such a categorical simplification may break down. One example of this dilemma is the measurement of capital within economic models. This provides insight into the relationship between Funds of Services and Stocks of Flows: what are Funds from one perspective can be conceived as Stocks from a broader spatial and longer temporal perspective.

Systemic Elements possess both spatial and temporal variations which are significant to the process. One could say that systemic elements enter the process as a Fund which experiences a noticeable qualitative change in its systemic state due to participation in the process ($Units_t \neq Units_{t+1}$). Once again, it seems as if systemic elements will make a transition into the conceptual category of a fund as the spatio-temporal dimension of one's perspective is broadened and extended. In other words, as

the temporal dynamics of the process under observation becomes slower, the adjustment of the Systemic Element will occur at a *relatively* faster rate and these transitional periods will become *relatively* shorter. At some point, the element will begin to be perceived as a Fund. Therefore, how an element is classified depends on its homeorhetic rate in relation to that of the interactive process under observation.

In addition to these three structural elements, there will also be environmental parameters which form the context, atmosphere, or setting for a systemic process. The fundamental difference between an environmental parameter and the previously mentioned classifications is that the former pervades the entire context of the process and displays no spatio-temporal change as the process unfolds. This is not to say that there is no interdependence or co-evolution between the focal process and its context, but rather that the focal process occurs at a speed significantly faster than its environment. As a result, the qualities of higher level and aggregative phenomena display no meaningful quantitative or qualitative variation relative to the focal level process. For example, the mass of the earth provides a gravitational parameter which is constant *relative to* the process of human existence. However, the earth has not always had a constant mass when viewed from the perspective of the evolution of our galaxy; nor does the earth exist independently of human civilization. Another example is that while one can speak of culture/tradition as being constant relative to an individual's daily life, if the focal process becomes one of a human lifetime or generations of families, this culture/tradition context may be perceived to change (if not qualitatively, at least quantitatively). These four types of structural elements are presented in Table 3.

Table 3: Types of Structural Elements within the Interactive Process		
Element Type	Significant Variable Quality	Dimension
Stock/Flow	Spatial	Quality
Fund of Services	Temporal	Quality X Time
Systemic Element	Spatio-Temporal Interaction	$unit_t \rightarrow UNIT_{t+1}$
Environmental	Spatio-Temporal Constancy	Parametric

An example of the shifting classification of structural elements relative to a systemic process is nicely captured within the distinction between public goods and common property resources within economics. This classification of resources does not represent a quality of the resources *per se*, but of the resources in relation to the economy. As the economy expands, what was once considered to be an Environmental parameter becomes a Systemic element in danger of becoming a Fund of Services. Therefore, we observe the fact that resources previously thought to be public goods (e.g., clean air and water) have become common property goods and may degenerate completely or become some form of a club good or private good in the future.

Concepts of Interactive Process

The concept of an interactive process can be thought of as a template of relations in which the aforementioned structural elements are pieces of a dynamic puzzle.¹⁵⁴ This template must be able to accommodate the systemic behavior of stability, development, and degeneration. In addition, it should attempt to understand the emergence of synthetic qualities, even if this understanding is fated to remain *ex post facto*. This chapter uses a derivative of General Systems Theory and the conceptual dichotomy between positive and negative circular relations, which was presented in the first chapter, to develop a qualitative analysis of process within a conceptual hierarchy of systems.

The Heuristic Value of Causal Loops. Although causal loop diagramming represents a loss of structural detail within one's concept when compared to formal differential equations, whether this loss of structural resolution also represents a decline in meaningful content is not so obvious. While the ability to predict the dynamic behavior of a particular system through differential equations has visible merit, this dissertation is concerned with the general quality of dynamic interaction within the conceptual hierarchy. Thus, the value of causal loop diagrams within this dissertation resides in their use as heuristic tools. One caveat: although these circular relations are frequently labelled positive and negative, which then leads to a comparison within the

¹⁵⁴ If the structural element is purely categorical with no dynamic interactive quality, then science remains taxonomic. The move to theoretical science and the notion of generic process involves the categorization of dynamic interactions.

semantic dichotomy of disequilibrium and equilibrium, this is not an accurate appraisal of their difference. A more appropriate term for positive loop relations would be evolving, developing, or, conversely, degenerative: these words embody a sense of unfolding. This shift to the language of evolving and equilibrating relations (i.e., complementary/divergent versus stabilizing), prevents one from drawing hasty conclusions regarding the necessity of choosing one of these facets over the other since they are no longer mere inversions of one another, which is not true of the language of positive/negative or equilibrium/disequilibrium.

Whereas a metaphysical bias towards equilibrium templates has served to exclude the use of most evolutionary templates from the intellectual arena, the inclusion of the latter *requires* the former in order to make any sense. In an equilibrium process, change involves a preservation of the quantitative relations between elements and a balancing of forces: like weights on a scale, the template of relations remains consistent and the quality of these interrelations is preserved. Therefore, equilibrium allows for the recognition of systems *per se*. The fact that stabilizing circular relations are the conceptual counterpart of perceptual stability, in coordination with the assumption that 'things' exist, has led many theorists to propose the primacy of stabilizing loops within scientific models of the world. However, the problem is not equilibrium relationships *per se* but rather their universal application. In contrast, the inclusion of complementary circular relations does not lead to the exclusion of equilibrium concepts. Rather, it expands these notions to accommodate our perception of multiple equilibria, path dependency, persistent asymmetries, inefficient lock-in, and the emergence of novelty.

For example, the economic concepts of external economies, economic development, technological change, and increasing returns are due to *complementary relations between heterogeneous elements* and have therefore escaped the equilibrium lens which emphasizes stable structure. Their inclusion within the overall concept of an interactive process creates a richer theoretical description of the nature and possibilities of change.

One must not think that the inclusion of these complementary circular relations completes one's conceptual models in a logical sense. They are not missing links which will fill-in the holes of our scientific concepts while leaving their metaphysical foundations standing. Concepts of reality built from the assumption of the *inherent existence* of structure and things cannot simply incorporate the concept of an evolving process without calling into question these first principles it holds dear: novelty and inherent existence will clash. However, it is so alluring to extrapolate the relative truth of stable processes into the absolute truths of inherent existence that it is difficult to accept an evolving co-dependence without attempting to fit it into a theoretically continuous whole of static being. One could contend that such ideas go against our mental and emotional conditioning. Perhaps an analogy from the history of thought in physics will be helpful. While the geocentric models of the universe proposed that the earth was at the center, the heliocentric models refuted this in favor of a belief in the sun being at the center. Going beyond these views, the cosmological picture derived from Einstein's General Theory of Relativity posits that there is *no* center of the universe (Mook and Vargish 1987:178). To think in terms of the complete absence of *a center*

is extremely difficult. What does it mean to be without a center? Similarly, what does it mean to ultimately have only conditional existence?

Circular Causality and the Conceptual Hierarchy. What is the relationship between circular causal relations and conceptual hierarchies? Circular causal loops allow the interactive processes that take place between structural elements to be elaborated on and thereby provide a platform from which a deeper exploration of the conceptual hierarchy can be launched. Recall that the inability to theoretically aggregate the qualitative pieces of a pattern into an appropriate concept of the pattern itself creates a layering of parts-whole relationships. This layering has been coined a conceptual hierarchy within this dissertation.

Stabilizing circularities make an obvious contribution to this qualitative layering since they engender stability within the pattern of interrelations (i.e., the stability of parts as a whole). In addition, divergent circularities represent the competitive process between elements for a specific niche (i.e., the competition between wholes as parts). What role do complementary circularities play in this hierarchy? As one surveys the synthetic qualities which appear to perception, they seem to involve the entrainment of a complementary circularity within a context of stabilizing circularities through an active management of its conditional elements (i.e., environmental constraints in general). In this way, complementary circularities seem to be associated with the interstices of the structural hierarchy and play a role within the *particular* evolution of an interrelated set

of variables.¹⁵⁵ One might say that they represent the endogenous process of conditional transcendence, a transcendence which reflects the system's transition into more refined levels of conditionality. For example, life transcends physical conditionality by becoming more than mere matter and hence opening a previously closed window of interactive possibilities.

Complementary relations are the evolutionary dimension of concepts of process, and the laboratory for investigating them is the *realm of the particular* rather than that of the general: evolutionary growth is a transformative process of the individual.¹⁵⁶ For example, in a very concise exploration of the nesting of complementary and divergent co-dependence, Arthur (1987, 1988b, 1989) demonstrated the presence of path dependency, multiple equilibrium, and configurational lock-in: characteristics which all point to the potential for a unique transformational process. The most interesting of these characteristics is configurational lock-in since it implies that the stability of a pattern is not determined solely on the basis of the efficiency of the pattern relative to its context, but also on the relative efficiency within the pattern itself. For example, David (1985) discusses the continued use of the relatively inefficient QWERTY keyboard layout due

¹⁵⁵ Because of this fact, it is not possible to predict the actual trajectory of evolutionary development in any quantitatively precise manner: it represents an unfolding of a co-dependent circularity which will display multiple-equilibria and path dependency. However, while the particulars may evade us, an explanation of the principles underlying the evolutionary process need not. This distinction between an *explanation of the particular* versus an *explanation of the principle* has been developed and used extensively by (Hayek 1967a, 1967d).

¹⁵⁶ This fact has frequently been lost sight of since it is in competitive interaction with the general that the particular finds itself. What is the general? It is the niche in which the particular unfolds. Therefore, the particular finds itself affiliated with the "group" to the extent that it unfolds into a similar niche or is a complementary facet of a mutually constructed niche.

to its complementary relation with other facets (e.g., labor and capital infrastructure).¹⁵⁷ Although QWERTY was efficient relative to its context at one time, the context has changed. Such frameworks have also been used extensively to discuss the geographic distribution of industry and urbanization (e.g., Allen and Sanglier 1978, 1979, 1981; Arthur 1988a; Kaldor 1981; Krugman 1991c; Marshall 1898; Myrdal 1956, 1957, 1968). From such a perspective, the current configuration of economic activity and infrastructure is partially dependent on the historical concatenation of conditions and may possess inbred inefficiency which resists change.

Change between the variables of a complementary co-dependent relations is self-reinforcing. While this expansion is explosive with respect to the current context, the context itself will change. The evolving system begins to interact with relatively different elements which create different constraints and alter its previously expansive tendencies. The system may expand into stabilizing circularities which did not previously exert themselves (e.g., the economic development of Japan and an international extent-of-the-market constraint). Or, this expansion may be dependent on a divergent relation with a systemic element whose spatio-temporal integrity may limit the expansion of the focal system. For example, underdeveloped countries (or workers) cannot go below subsistence standards of living without losing the systemic quality on which developing countries (or capital owners) depend.

In order to clarify these concepts of evolutionary processes, circularities which include only Stocks, Funds, and Systemic Elements without involving any higher layer

¹⁵⁷ See also Cowan (1987) and David (1985).

elements (i.e., environmental parameters) will be called *horizontal circularities*.¹⁵⁸ *Vertical circularities* will be those which nest these horizontal circularities (i.e., lower level relations) within the higher level variables such as parameters of atmospheric quality, context/setting, or mood. This distinction allows me to conceive of the evolutionary change of a system by the predominance of a horizontal complementary co-dependent relation which either (1) expands *within* the limitations provided by lower level elements which are themselves anchored by stabilizing circularities, or (2) expands *into* restraints provided by higher level stabilizing relations. Therefore, there can be both internal and external restraints on change, respectively.

The evolution of a particular system can be conceived of in a few different ways. For example, one could imagine that it is stable in only a roughly probabilistic fashion rather than manifesting a strict point equilibrium or limit cycle. This is easily conceived by including chaotic relations which display quantitative randomness and therefore provide a stochastic element to the system.¹⁵⁹ Such systems will deny us the ability to predict the exact quantitative dynamics of the system since infinitesimally small errors in initial conditions will engender completely different quantitative interrelations. Furthermore, these periods of unpredictable dynamic behavior may be interspersed within relatively consistent behavior (i.e., transitive chaos). However, whereas the quantitative detail of the system may be elusive, the quality of the system may not. For example,

¹⁵⁸ Discussions of *isolated* horizontal circularities are done merely for convenience under the implicit recognition that such independent existence is never fully accurate.

¹⁵⁹ Along these lines, see Cesar das Neves (1988) for a basic introduction to the process of poverty equilibrium based on the work of Nurkse, Myrdal, Galbraith, and Leibenstein. In addition, the seminal papers by Lorenz (1963) and May (1976) may be of interest.

a predator-prey interaction may display chaotic behavior while the quality of the relation and the greater forest ecosystem remains stable. It is possible that these chaotic tendencies could provide oscillations within the system which engender a change in its quality. One could imagine that a system possesses complementary relations which are presently inactive. If the system's perturbations happen to exceed some critical threshold, which is likely to be multidimensional, this circularity reinforces the deviation and the relations expand.¹⁶⁰

These ideas can also be expressed through the notion of a *key* variable, or pattern of variables, which connects the system to lower level phenomena. If this key is bordered by two negative links, these links may place the reinforcing elements of the focal system in the position of being suppressed (see Figure 5). Unless this variable changes, which is dependent on the current relations within the unexpanded system, these potentially expansive relations can not manifest themselves fully. This scenario addresses *contingent* evolutionary change since structural variations within the current system may be necessary to initiate further development. However, once this spiral of growth has begun, the momentum behind continued development may far surpass what one might expect from the small deviations of the key variable.

There are many empirical complementary co-dependent relations, some of which seem to be accepted as synthetic qualities, which exist within economic theory. For

¹⁶⁰ This is similar to ideas developed by Prigogine (1976, 1980) and Prigogine et. al. (1977) within the field of out-of-equilibrium thermodynamics, which have subsequently been extended into economic growth theory by Allen and Sanglier (1978, 1979, 1981) and May (1989). In Prigogine's work, a change in the flow of energy causes systemic re-organization, while Allen and Sanglier's work substitutes an increasing population (i.e., labor and goods flow).

example, a black box theory of the firm acknowledges the synthetic quality which emerges from a pattern of human beings, technical know-how, and capital equipment engaged collaboratively in production. If this firm were to gain a monopoly or monopsony position in a given region, it would become much more, qualitatively, than a firm which merely employs resources to produce products: it will possess a social and political significance which may influence the *regional* socio-economic process. One can make this evolutionary distinction more pronounced by considering multinational firms which experience multifaceted complementarities much more complex than the economies of scale associated with single commodity production. It is not so easy to delineate neat economic boundaries within which such entities participate since they frequently become meaningful within a broader context of national or even global social relations. Some of the larger multinationals are a more significant force at the global level of socio-economic analysis than are some political unities (e.g., Coca-Cola versus Nicaragua).

Moving outside the conceptual confines of the notion of a firm, one could present industrial networks (e.g., the computer or automotive industry) which possess complementary co-dependent relations which foster the expansion of the industry as a whole. Such ideas are contained in Marshall's Principles of Economics (1990[1920]) and were the theoretical foundations for his Industry and Trade (1915). It should be noted that the stabilizing circularity within which these industrial networks evolve includes the ecology of consumer preferences for the products available to society (Young 1928). Therefore, the emergence of novel products will influence the process of social

interaction (e.g., the Internet).¹⁶¹ In support of this claim, note that the socio-economic context we live in now is distinctly different from what it was even twenty years ago.

Smith's (1937[1776]) exposition on the emergence of the market system, through an unfolding division of labor made possible by institutional changes within English society, is another example of such an unfolding evolutionary process. The rich possibilities for the economy could not manifest themselves until the ability of peasants to effectively hold property had changed. These initial changes in private property rights opened up the opportunity for and increased the motivation to expand the division of labor. These unfolding economic relations possessed an internal momentum which caused institutional changes that the existing social relations were unable to arrest. The significance of these changes is captured in the emergence of a new field of study dealing with structural elements which had not manifest themselves fully in the past (e.g., in Antiquity and the Middle Ages) ... this discipline being political economy. But how much qualitative change does this transformation in socio-economic interaction entail? Has the *process* of social interaction significantly changed? Or is this simply a *structural* novelty?

¹⁶¹ See Harvey (1989).

Building the Conceptual Hierarchy

Now that the process of mental conception and perception *per se* has been addressed, this next section can explore the relation between the two more fully by explicitly introducing the dimensions of space and time (i.e., the spatio-temporal). One might say that one's concepts come into greater focus, which manifests as a more effective operational understanding, when the spatio-temporal dimensions of perception are matched with the system's qualitative and interactive process. Similar to a distorted visual perception, a distorted concept will still fail to achieve its goal: to effectively translate and represent experience. Although the set of effective operational concepts was limited in the past as a result of the physiological constraints of perception, this has been overcome, to some degree, through the use of observational instruments.

The initial assumption is that a specific focal system can be characterized by a particular set of structural qualities and their homeorhetic rate. By fixing the dimensions of perception, a decomposition of the observational experience occurs which creates explicit spatial appearance and temporal relatedness. Additional observation sets can be created of otherwise unobservable phenomena through the use of instruments which allow one to take "pictures" at both faster/slower and smaller/larger perceptual dimensions. For example, one can compile data on population size, sales volume, pollution readings, temperature, chemical densities, and electro-magnetic radiation. Such observation sets will have a temporal dimension (e.g., every quarter for GDP or every ten years for

Census Data) and will frequently extrapolate a representative sample of spatial qualities and their covariations (e.g., consumer spending, average age, or income) to determine the general pattern of the focal system. The main point is that *every* observation set carries with it a spatio-temporal dimension.¹⁶²

Homeorhetic Difference and Apparent Quality of Being

One can speak of the time period necessary for a focal system to realize stable internal relations, e.g., after perturbation, as its *homeorhetic rate*. Two points: (1) Homeorthesis is a term coined by embryologist C.H. Waddington to represent the quality of stability within a trajectory or time extended course of change. Homeorhetic is used instead of *homeostasis* in order to avoid some of the equilibrium bias of the latter term: the former is a stabilized flux and the latter a stabilized state. (2) A representative homeorhetic rate involves stabilizing relations set by the structural elements of the system and its atmospheric parameters (e.g., thermometer reading = temperature). The rate at which this process achieves stability will depend on the *rate* at which it closes the gap between the actual state of the system (e.g., temperature) and the goal (e.g., thermometer

¹⁶² It is interesting to reflect on the fact that the categories of time and space emerge within the process of self-consciousness. There is no reason to assume that such qualities exist outside of this systemic process. One might speculate that the dimensions of time and space are endogenous to the process of observation due to distinctions drawn by a discriminating awareness. While the complex logical paradoxes created through the use of a space-time framework when reflecting on the nature of self-consciousness shall not be discussed here, the quality of self-consciousness as manifested within individuals is explicitly included as an active element of the socio-economic process. This conceptual dimension, however, will evade observation in the traditional sense except perhaps through the trace of an individual's speech and actions.

setting, 70° F). If *rate* is constant, it can be shown that 95% of this gap will be closed in a time period of approximately $3/\text{rate}$ (Goodman 1974). Whether the remaining gap represents a significant deviation from stability is a question of perspective and meaning.

Phenomena which remain *spatially local*, but stabilize at a homeorhetic rate significantly *faster* than the temporal dimension of observation, are not perceived as manifesting interactive change, but as a *quality of thingness* (e.g., hardness or flexibility in atomic/molecular interaction). For example, the temporal dimension of the process of human visual perception results in a blinking light being perceived as either a blinking or continuous light *depending on the rate of blinking relative to the alpha rhythms of the visual cortex* (Varela et. al. 1991:73-75). On a more pedestrian note, the propeller of an airplane will appear as a *fuzzy surface* and a sparkler twirled through the air appears as a *line of light*, even though we know that these perceptions are not true. The temporal dimension of the system relative to that of the process of perception determines the system's appearance.

Is it possible to claim which perceptions are an illusory representation of the 'true' system? On what basis do we determine what is and is not an illusion? While it is a difficult task to speak of truth in a universal sense, one can contend that false representations will yield ineffective concepts. For example, an illusory lion (e.g., a holographic image) does not have the whole set of qualities which make a 'real' lion. This holographic lion depends on a particular machine to create this image, its appearance requires human intervention, and it consists of only the visual quality of a lion, but would lack substantiality with respect to touch and smell. This will translate

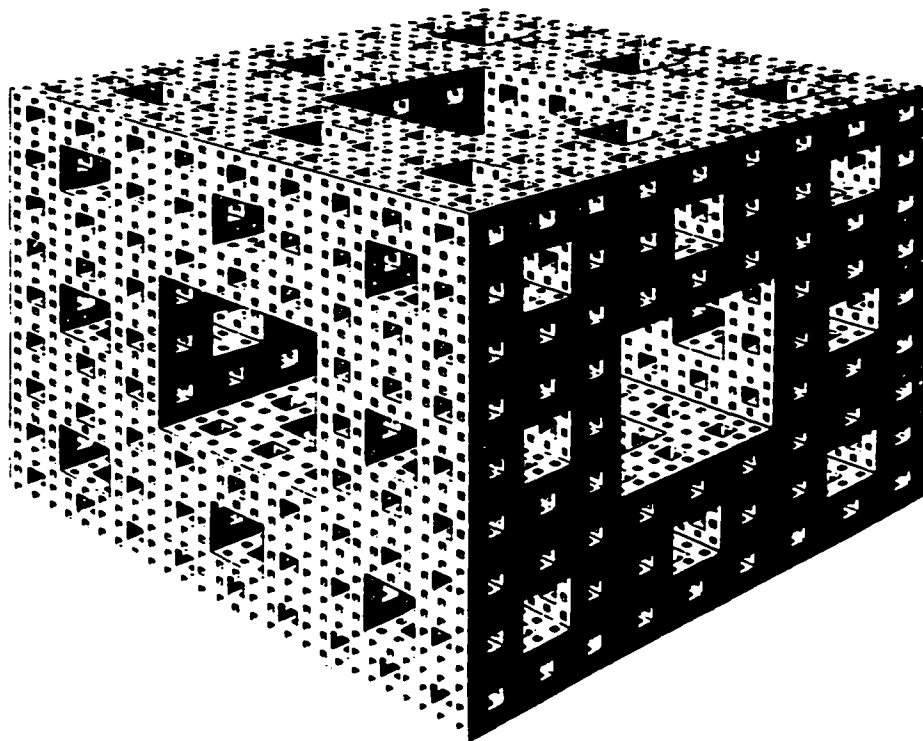
into different responses. While the illusory lion is nothing to be afraid of, a real lion is. The belief that the illusory lion is a threat, and the resulting chaos this could cause among an audience (e.g., group panic or individual coronary problems), is unnecessary. In a similar way, one would not want to touch the illusory surface of an airplane propeller. The determination of the illusory-ness of our perceptions is influenced by our ability to alter the spatio-temporal conditions of the system (e.g., an airplane engine or holographic plate) and thereby create or destroy the perception. When we no longer volitionally support these conditions, the appearance fades and we are left with more accurate perceptions. The absence of our influence on the phenomenal process under observation is assumed to allow the phenomenon to appear in its 'natural' form. This lack of distortion on the part of the observer is of critical importance when considering the conceptual dimension of socio-economic phenomena. What would such a freedom from distortion entail?

Returning to sparklers and propellers, the fact that increasing the speed of a point/line can create the perception of a line/surface leads to the possibility that the relation between a system's homeorhetic rate and the temporal structure of perception may change the spatial appearance of a phenomenon. Since touch is a sensory perception, this may even translate into physically tangible differences. For example, the atoms which compose the table I am writing on move at a much faster speed than I can perceive. In fact, the desk is more space than matter, but I perceive and experience it through sight and touch as a solid due to relative spatio-temporal differences. Unlike the airplane's propeller, I cannot influence the temporal dimension of this process.

Therefore, I assume the 'natural' autonomy of this system, and my perception of its inherent insubstantiality must be inductively gathered through instrumentally augmented observations or deductively through analogy.¹⁶³

The phenomenon of shifting dimensional appearance can even be explored from a mathematical perspective. For example, it is possible to construct a sponge (formally named a Menger sponge, see Figure 43, reproduced from Schroeder 1991:180) which has zero volume but infinite surface area: this is done by iteratively removing the central twenty-sevenths from a cube and from all its subsequent subcubes. These ideas can also be applied to lines and surfaces (e.g., see Rosser 1991).

Figure 43: Illustration of a Menger Sponge



¹⁶³ A physicist might refer to this as the inability to collapse probability functions, these probability functions being an aggregative representation of the higher speed dynamics of lower level processes.

Therefore, something can *appear* to exist within three dimensional space (i.e., possessing volume) yet lack such existence from a mathematical perspective. Such findings provide support for the possibility that the apparent dimensions of a process (i.e., its structural qualities) are by no means self-evident or given to perception.

How does one deal with such insubstantial perceptual dimensions? Rather than sticking to the belief that things possess only integer dimensionality, one could expand the concept of dimension to allow for *fractal* dimensions. In this case the Menger sponge would have an effective dimension of 2.73 (Schroeder 1991:180). Yet even these notions of fractal dimensions are not immune to perceptual variations caused by a changing resolution. For example, Mandelbrot (1977) notes that changes in the spatial appearance of an object will occur as the spatial resolution of perception is allowed to vary. As this resolution is increased, the size of the phenomenon relative to one's field of view will increase, the deeper structural substructure will manifest to perception and the initial structure is lost:

... a ball of 10 cm diameter made of a thick thread of 1 mm diameter possesses (in latent fashion) several distinct dimensions. To an observer placed far away, the ball appears as a zero-dimensional figure: a point. ... As seen from a distance of 10 cm resolution, the ball of thread is a three-dimensional figure [solid]. At 10 mm, it is a mess of one-dimensional threads [lines]. At 0.1 mm, each thread becomes a column and the whole becomes three-dimensional again. At 0.01 mm, each column dissolves into fibers, and the ball again becomes one-dimensional, and so on, with the dimensions crossing over repeatedly from one value to another. (Mandelbrot 1977:17)

The structural detail within the observation set is determined by the degree of resolution within perception. What is most interesting is that the judgement of 'good' versus 'bad' resolution would imply a knowledge of the process being observed. To conclude that *a*

cell which is observed through a microscope is out of focus, one must know what *in focus* is. If no-thing exists, then resolution is not an issue.

Differing perceptual perspectives also have implications for the viability of controlled experimentation. Since the observer has definitive spatio-temporal existence, she will actually be part of some process' spatial environment and hence be able to influence its context (e.g., atomic, molecular, and cellular interactions). This manipulative ability will not only involve spatial extent (e.g., human beings are larger than cells), but also temporal extent (e.g., humans live longer than cells). Therefore, the observer can, e.g., alter the chemical composition, temperature, and lighting which forms the context of cellular respiration. And since these systems have synthetic lifetimes significantly shorter than the observer's, there is the possibility for multiple observations within this controlled environment.

In contrast, systems which appear at a higher structural level relative to the observer will not allow for controlled experimentation and easily repeatable observations. What becomes critical when attempting to conceive of these latter systems is the length of the observation set and the types of measurements taken.¹⁶⁴ One example would be theories of ecosystem succession which explore the changing structural and relational composition within a developing ecosystem (e.g., the growth of forests). An observation set which is only one year long will not provide an adequate foundation. In addition, observations of cultural change must be composed and confirmed through

¹⁶⁴ This is a current problem in the analysis of global warming since data have only been collected for a few decades. The expeditions into the arctic regions to take ice core samples, yielding measurements of past CO₂ levels, is one attempt to circumvent this problem.

intergenerational observations and offer no opportunity for conditional experimentation. Furthermore, if one is to rely on the historical record to inform representative concepts of higher level structures, then this observation set must correspond to the relevant elements of the system. The absence of relevant elements has the potential to skew the concept and lead to ill informed action (e.g., see Repetto (1992) concerning the flaws of the national product accounts).

Since the perception of structure within an interactive process results from relative differences in homeorhetic rates, systems with slower homeorhetic rates present the observer with an additional problem.¹⁶⁵ Not only does the use of instruments create multiple perspectives which decompose lower level phenomena at different spatio-temporal dimensions, but being able to manipulate the environment of lesser wholes allows one to perform controlled experiments. Therefore, one is able to investigate these interactive processes through both a perception of simultaneous spatio-temporal decompositions and a controlled analysis of the systemic significance of individual elements.¹⁶⁶ In other words, the synthetic quality of the whole *as a part* of the higher

¹⁶⁵ It is interesting to note that the direct perception of a higher level whole by an expanded consciousness which is cultivated through the active refinement of one's existing consciousness (i.e., one which perceives with less distinction) would not be considered scientific, but rather a mystical experience. Such conclusions, however, would be incorrect. It is more appropriate to state that the process of refinement necessary to permit such perceptions requires the development of a host of qualities (e.g., giving, morality, patience, vigor, mediation, and wisdom, see Sangharakshita 1957). The laboratory for experimentation is the individual, and even though this is the only arena to test such theories, few people are willing to make the necessary efforts. Since this refinement is within the inherent process of perception, the experiences themselves cannot be shared but only described. Therefore, the higher evolution of consciousness is denied much as the average person 200 years ago would have vehemently denied the vacuous nature of reality within a world of apparently pervasive solid form.

¹⁶⁶ For example, unaided visual perception can observe an infection of a cut as redness. A microscope can then be used to augment this observation set using various degrees of refined spatial sensitivity. Such refinements can also occur from a temporal perspective as instruments are used which are more sensitive to finer temporal distinctions. All in all, this creates a set of nested simultaneous observations which

process can be used to discern the significant elements which compose its pattern (e.g., the removal of the human appendix). Whereas the elements which compose lower level systems may actually appear and disappear as the spatio-temporal dimensions of perception are varied, the structural elements which compose higher level synthetic qualities must appear within our conceptual re-organization of the existing observation set. A lower level observer who perceives a higher level process is not able to alter its environmental conditions as readily and will not have the privilege of using a synthetic quality to experiment with the relevancy of its constituent parts. Instead, the whole must be inferred from atmospheric variations which modify the interaction of its parts by filtering the environmental conditions. Allen and Hoekstra (1987:71-72) offer an example from ecology:

Consider diurnal temperature fluctuations and a forest. Outside the forest, temperature fluctuations are quite large. Inside, the biomass of the trees moderates these fluctuations. Forest trees experience cooler temperatures during the day and warmer temperatures at night than a single tree standing alone in a field. The forest tree experiences only the modified influence, and it is beside the point that the night temperature outside the forest is low. Thus it is by drawing an inference from the observation of the temperature inside and outside the forest that it can be stated that the environmental influence is modified by the forest.

Such environmental modifications lead to the discovery of synthetic qualities and the conceptual unification of higher level synthetic qualities. For example, the phenomenon of culture is perceived through an atmospheric quality: a civilized society presents an individual with a distinctly different atmosphere from one which is barbaric.

"naturally" decompose the focal system into its lower level constituents.

Generally speaking, since a human observer perceives from a fixed position in reality, she will make observations as either *a part of the greater system* or *the context of a lesser system*. This distinction significantly alters the means by which one can identify synthetic qualities and presents unique difficulties for socio-economic theory since there are very few systems to observe, these systems are not accessible to controlled experiments, and historical events will probably never repeat the contextual conditions necessary to confirm or falsify a socio-economic model. As a result, diverse proliferation of socio-economic models can co-exist without empirical feedback: these concepts evolve faster than their empirical counterparts. To overcome this potential problem, materialistic selection criteria for the structural elements of socio-economic theories have been adhered to. These 'objective' elements are then aggregated into the larger macro and global economy without much concern for the determination of higher level systemic properties. By restricting oneself to quantifiable elements, the concepts become empirically explicit and hence accessible to formal modelling. This allows other individuals attempting to understand the same focal system to learn from, critique, or attempt to refute a given concept of social existence more readily. One could say that the size of the experimental vacuum declines as a wider diversity of human experience and perspective is homogenized through this technique and brought to bear on the problem.

The problem is that quantification and mathematization begin to define the appropriate elements of a given system. As with theoretical science, mathematics is a "shorthand language, rather than an engine of inquiry" which should be illustrated by real

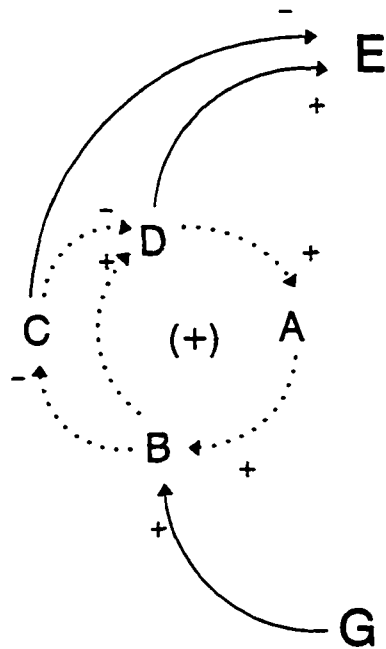
life examples (Marshall as cited in Whitaker 1975). It is a conceptual *tool* which clarifies thought and highlights our understandings of phenomena, not a *criterion* used to identify the relevant variables in our theory. Qualities such as values, morals, and ethics are outside the jurisdiction of mathematics, and hence frequently taken to be outside the scope of socio-economic theory. In fact, these variables embody the essence of Georgescu-Roegen's notion of 3rd order rationality: socio-economic theory composes its own observation set of variables. Yet, if variables excluded from the scope of discussion are circularly linked to the system *per se*, the conceptual model of the system will fail to effectively describe its behavior.

A good example of these difficulties is the economic theory of the firm, which recognizes the interdependence of component parts which are engaged in a process of production (e.g., labor, capital, raw materials). The firm is observed, and therefore conceived, as parts whose complementary interaction creates an *atmosphere* distinctly different from the surrounding environment. Due to this perception, these material observations are compiled as the significant characteristics of a parametric black box concept of what a firm is. The implicit acceptance of a parts/whole synthetic quality is witnessed in the division of profits. The fact that one portion of a firm's profits is theoretically *defined as variable* (i.e., owner's profits) allows the proceeds of the complementary whole to be divided between its constituent parts: the division of a non-summativ e whole through the inclusion of a variable component. This variable component also serves to absorb the fluctuating role of the individual firm within the competitive and complementary regional economic process. Although the competitive

relations of these external changes are highlighted and emphasized in our theory without regard for the complementary relations, firms frequently recognize the complementary aspects of regional development and attempt to appropriate these greater economies through political concessions (e.g., tax breaks).

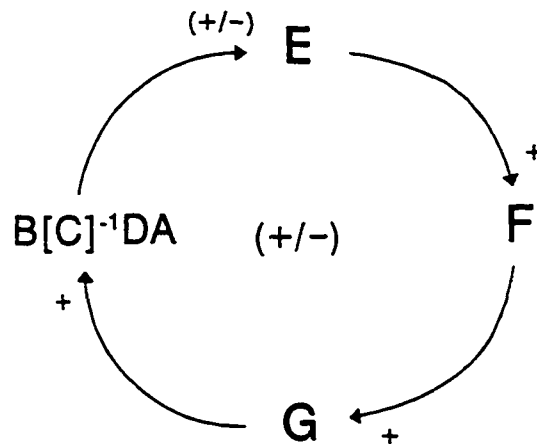
Causal Diagramming and the Structure of Perception. Causal loop diagramming can provide a more concrete image of this spatio-temporal structuring of the observation set. Suppose one is observing the dynamic relationship between a group of variables which interact with one another at two different homeorhetic rates. The first group of variables (dashed links; homeorhetic rate= T_{sys1} ; dimensioned in, e.g., seconds) display interactive behavior that proceeds at a rate significantly faster than the second group of variables (solid links; homeorhetic rate, T_{sys2} , where $T_{sys2} \gg T_{sys1}$). The perceived form of this process will depend on the spatio-temporal dimension of the observation set used in analysis. If the process is observed at a temporal dimension which is fast enough to detect the interaction of the high speed dynamics (i.e., $T_{obs} \approx T_{sys1}$, meaning T_{obs} results in a structural decomposition which can be used to effectively represent these faster relations) then the interactive dynamic process of A, B, C, and D will be perceived, and the C→E and D→E link will appear as matter/energy or information flows, and the G→B link will appear as an input. The structural elements E and G may appear as simply environmental parameters from this perspective (see Figure 44).

Figure 44: An Observation Set with 'Faster' Temporal Dimension ($T_{obs} \approx T_{sys1} \ll T_{sys2}$)



However, if a slower temporal dimension is used (e.g., $T_{sys1} \ll T_{obs} \approx T_{sys2}$) then our perception of this process can change. The variables A, B, C, and D may appear as an entity (e.g., a Stock, Fund, or Systemic Element) and their internal process of structural interaction will appear to have a *semi-autonomous* quality. Although this interactive subset will not necessarily possess a synthetic quality, it will appear as a single entity from this perspective (e.g., a table, hurricane, or cell). Using $[C]^{-1}$ to denote the divergence of C from A, B, and D, the expanded system can be diagrammed as follows.

Figure 45: An Observation Set with 'Slower' Temporal Dimension ($T_{sys1} \ll T_{obs} \approx T_{sys2}$)



This higher level decomposition will be nested within a still larger context. Whether this context is important enough to warrant investigation depends on the questions being asked, but one must always remember that the focal process co-evolves with this context and is never independent of it.

'Significant' Spatio-Temporal Differences. What exactly are 'significantly faster' and 'significantly slower' homeorhetic rates? This seems to be an empirical rather than philosophical question. However, Herbert Simon (1953, 1969) and others (e.g., Simon and Iwasaki 1988) have suggested that the distinction between levels may be bound up in the relative strength of attractive and repulsive forces between elements. In other words, stronger forces will act at a higher speed than weaker forces. The ability to abstract from lower and higher levels is then related to the distinctiveness of the temporal separations. He states,

we can build a theory of the system at the level of dynamics that is observable, in ignorance of the detailed structure or dynamics at the next level down, and ignore the very slow interactions at the next level up. The goodness of our approximation will depend only on the sharpness of the high frequencies from

the middle-range frequencies, and of the middle-range frequencies from the low frequencies. (Simon 1953:11)

Therefore, the sharper the temporal distinction between levels, the more distant will stable patterns be from one another, and the more easily will one be able to identify these distinctions.

The preservation of this temporal leveling is of critical importance in mathematical equations which attempt to embody causal relations. Frequently, individual elements are carelessly aggregated into a whole and different temporally dimensioned elements are hastily added and subtracted to yield some mathematical insight. However, temporal differences can create counter-intuitive solutions. For example,

Suppose that a young man has a choice between two jobs. Each offers a starting salary of \$1800 per year, but the first one would lead to an annual raise of \$200 whereas the second would lead to a semiannual raise of \$50. Which job is preferable? (Kline 1959:2-3)

While one may think that the answer is obvious, the use of both annual and semiannual rates introduces a counter-intuitive solution. In order to see this, one can work out the semiannual salary expected from the two options. A semi-annual increase of \$50 means that the semiannual salary will begin at \$900 and then increase by \$50 in each subsequent period: i.e., \$900, \$950, \$1000, \$1050, \$1100, \$1150, etc. An annual raise of \$200 will result in an annual salary of \$1800 the first year, \$2000 the second year, and \$2200 in the third, which translates into a semiannual salary of: \$900, \$900, \$1000, \$1000, \$1100, \$1100, etc. Since the salary increases start after the first six months with a semiannual raise, it will pay more during the latter six months of each year and is therefore preferable. Although this problem concerns simple dimensional complexities

which can be overcome through clear thinking, it demonstrates the subtle difficulties of working with different temporal dimensions.

One implication of these findings suggested by Simon (1953) is that an element dimensioned in months cannot be freely intermingled with elements dimensioned in quarters without destroying the causal ordering contained in the equations. In other words, if a concept of nested systems has any value, this value will definitely be lost within mathematical manipulations which allow the unrestrained intermingling of differently dimensioned temporal variables. This is more than a mere plea to keep the dimensions of one's variables in order since it implies that the temporal continuum (e.g., 360 seconds = 60 minutes = 1 hour) is not necessarily amenable to aggregation and reduction. In other words, the addition of an inappropriately dimensioned "one" to both sides of an equation may destroy the causal ordering embedded in the equations if the appropriate dimensional distinctions are not preserved.

The Co-Evolution of the Economy and the Environment

Connecting these ideas to real world examples, one immediately thinks of the economy-environment interaction and the concept of sustainable development (e.g., Costanza 1991; Norgaard 1984, 1985, 1987). First, there is a high probability that the homeorhetic rates of these two processes are different from that inherent to human perception. This will limit one's access to multiple observation sets and hinder the ability to utilize the methodology of controlled experimentation. Furthermore, both of

these processes contribute an atmospheric quality (i.e., material affluence and biological sustenance) within which social existence has evolved, and hence become structurally dependent. The problem is that the complementary facet of the nesting of these two systems is not widely appreciated. Instead, the competitive interaction between niggardly nature and the socio-economic system is emphasized. As a result, both the expansive and degenerative co-evolutionary potential is missed.

Since both the economy and the environment are higher level phenomena relative to human observation, the higher level synthetic qualities which inform an effective concept of each process will be inferred by composition rather than being decomposed through varying perceptual dimensions (e.g., the political boundaries of economic processes or the emphasis on material possessions). The effectiveness of such concepts of higher level interactions must accord with one's perception, but the possibility exists that significant spatial qualities are not collected and hence our concept will be biased and out of focus. In addition, the significant qualities which dominate the higher level interaction may change as the process itself evolves (e.g., Boyer's (1988) models of growth regimes in economics).

Perhaps the simplest concept of this economy-environment interaction conceives of the economy as experiencing a progressive spiral (i.e., self-reinforcing process) of ever greater material growth. The earth is frequently included as an infinite stock variable: a horn of plenty with respect to resources and a bottomless sink with respect to waste. More recently, the environment has begun to be modelled as a systemic element, which could easily become a fund variable without precautions. However, such

concepts *invert* the relationship between these two systems: the environment is seen to be a structural part of the economy. The slower and larger ecological process in which the economy is nested begins to be viewed as an element which can be manipulated, such as laws and technology, and this anthropocentric delusion becomes implicit within our actions. The ramifications of such beliefs are not immediately available to perception since the dynamic loops of the larger system proceed at a significantly slower temporal rate (e.g., soil erosion with intensive agriculture techniques, climate change, and species extinction).

Even as scientists begin to analyze the gross effects of increased urbanization, industrialization, resource depletion, and population growth, the more subtle interaction of human civilization with the earth's ecology has yet to be explored (e.g., the prolific use of antibiotics and the evolving immunity of bacteria). One reason for this exclusion is undoubtedly the fact that subtle ecological changes resulting from our actions have not been dramatic enough to create an impression upon our senses. In fact, Western civilization lacks a fully developed notion of ecological interaction, let alone an effective concept of economy-environment interaction, and therefore is only now developing a conceptual foundation from which to inform such perceptions. These concepts thereby lack the accumulated historical record required for calibration and testing. We must optimistically hope that this spiral of conceptual advance converges on an effective description.

However, we remain unable to fully anticipate the unfolding of the ecological pattern we participate in. The implications of higher level structural variations on lower

level patterns are phenomena of the 2nd order and remain unknown (e.g., the microbiotic organisms which provide the substratum for human existence). When the ecological system is stable (e.g., temperature, precipitation, and variabilities thereof), more complex lower level patterns can evolve (recall Simon's watchmaker). While the discussion of synthetic qualities has been implicitly assumed to flow up from the pattern of individual parts, one must not forget that context may be a critical parameter of this pattern. For example, the transition of water from solid to liquid or liquid to gas is a result of contextual change. Plants are known to survive in some climates and die in others. The extinction of an individual, culture, species, or biosphere may be precariously balanced on environmental parameters with this dependency being impossible to perceive until after it occurs: 2nd order rationality.

Emergent Qualities and Scientific Knowledge

This section uses the previous discussion as a framework within which to investigate the overall structure of scientific knowledge. The working hypothesis I wish to put forward is that the major fields of scientific knowledge represent the predominant qualitative components of reality as human experience: matter, life, mind, and self.¹⁶⁷ A significant characteristic of this list is that each quality emerges out of its predecessor

¹⁶⁷ This idea is taken from the Buddhist concept of the five *niyamas*, or five levels of conditioned existence: (1) the physical order; (2) the biological order; (3) the mental order; (4) the karmic or volitional order; (5) the transcendental (see Sangharakshita 1967:69). This formulation was offered as a response to the erroneous belief that *everything* is the result of karmic conditionality and seems just as applicable to notions of material dominance.

in this list such that each subsequent quality appears to be *nested within* the previous one. Life is a quality of specific patterns of matter, mind is a quality of specific patterns of life, and self-consciousness is a quality of specific patterns of mind.¹⁶⁸ Furthermore, each of these synthetic qualities also present a process novelty. As a result, the context of higher level systems will frequently include the synthetic qualities of lower level systems. This hierarchical order is implicitly supported through the separation of different fields within the natural sciences and their relationships to one another (i.e., physics, chemistry, and biology).¹⁶⁹ The social sciences (e.g., psychology, sociology, anthropology, political science, and economics) do not continue this neat trend since no clean dialectic distinction between mind and self-consciousness has been accepted by Western science. However, it is these self-conscious individuals whose interaction with one another forms the object of social science investigation. None of the individual social sciences investigates this social whole. Rather, each explores different facets of this composition. In addition, this social whole does not represent a novel process, as with the natural sciences, but merely a synthetic quality.

Due to psychology's emphasis on the internal life of the individual human being, it could concern itself with the spectrum of qualitative transition from mind to self, but will obviously fail as a purely theoretical extrapolation when attempting to bridge this

¹⁶⁸ Theories of mind and consciousness which are built from philosophical speculations similar to those contained in this essay are available (e.g., Buddhist thought in general, Bateson 1972, 1988; Macy 1991; Maturana and Varela 1980; Varela et.al. 1991).

¹⁶⁹ Newer fields, such as biochemistry and biophysics, may represent an investigation of the interaction of the emergent biological process (and structures thereof) within the broader context of chemical and physical processes.

qualitative gap. In fact, it is commonly assumed that mind, and frequently self-consciousness, is just an aggregative biological phenomenon ... which it is, and isn't. Regardless, this aggregative tendency based on materialist criteria is retained from the natural sciences, by assuming that social science explores a novel process rather than simply synthetic qualities within the institutional structures built from human beings and the diversity of lower level synthetic qualities. Even then, these investigations are frequently devoid of the distinguishing quality of human existence, self-consciousness. From the perspective of the hierarchical decomposition outlined above, the next field of science would be one which explicitly investigates the quality of being self-conscious and the evolutionary process of a self-transcendence. Social institutions would then help to provide the context in which this evolution occurs. They would be seen as means to an end, rather than the frequent belief that they are ends in themselves. Although Buddhism offers just such an analysis, these ideas will not be explored here even though the author considers these insights to be empirical support for the aforementioned hierarchical propositions.¹⁷⁰

It is worth remembering that this is not an ontological assertion concerning the existence of such a hierarchy within some ultimate reality. It is *our conceptions and perceptions* which are discrete (or penumbral in Georgescu-Roegen's system of terms), hierarchical, and spatio-temporally nested. The purpose of exploring this conceptual hierarchy is threefold: First, to hypothesize the relative validity of different scientific

¹⁷⁰ The interested reader is directed to Sangharakshita (1969) and Cooper (1995) for an *evolutionary* formulation of Buddhist ideas. In addition, those which an inbred aversion to the use of a hierarchy concept are referred to Saramati (1995).

theories to the particular existential decompositions they seek to describe. As Polanyi (1975) has stated, even if Laplace's Demon *does* know the exact past, current, and future positions of all atoms in the universe, this information would provide *no* insight into a field of daisies (i.e., the phenomena of life). Second, to posit that the fixed nature of human observation has divided our theoretical models into the natural and social sciences around the qualitative thresholds of the mental and self-conscious order of things. And third, to propose that the different fields of the established social sciences are merely different levels of synthetic quality within the novel process of self-consciousness.

Exploring this hierarchy of synthetic qualities and process novelties more deeply, a synthetic quality continues to be subject to the lower level interactive processes, but opens up a window of novel opportunities within this interactive *status quo*. This conceptual hierarchy of scientific fields starts with matter and physics: electrons, neutrons, and protons interact to form atoms which interact to form molecules.¹⁷¹ Let us assume that the next emergent layer of order is life. Two significant characteristics of this conceptual shift from matter to life require our attention. First, life presents novel interactive opportunities which are not present for matter. It represents a system in entropic disequilibrium which actively perpetuates and replicates itself (see Maturana and Varela 1980). Of interest is the fact that the endogenous interactive dynamic which provides the motor for life consists of a positive causal loop between lower level elements that are contained within its systemic boundary (e.g., the photosynthetic and

¹⁷¹ Although it is easy to admit chemistry as another field within this nesting, that would stretch the limits of my understanding. This essay hopes to explicitly acknowledge the presence and investigate the implications of such a hierarchical layering within scientific knowledge rather than to establish a definitive number of layers.

Krebs cycles).¹⁷² Second, this vertical transition from matter to life appears to be associated with increases in the minimum spatio-temporal dimensions of the system relative to human experience (i.e., self-consciousness). Simplistically, matter is observed to exist at a faster temporal and smaller spatial perspective than the smallest and quickest systems which would qualify as living. While this fact is not significant within the hierarchy of qualities *per se*, since it arises from the perspective of active observation, it becomes important when it is extrapolated into social systems.

The emergence of mind arises out of life just as life emerged out of matter. By mind, I am referring to non-volitional systemic behavior (e.g., a Pavlovian stimulus-response model), perhaps qualifying as instinctual behavior. Once again, mind seems to have arisen through a positive causal relation within life (see Cooper 1995). With respect to its minimum spatio-temporal dimension, the prediction that systems possessing the quality of mind would be observed to occur at a slower temporal and larger spatial perspective is not as obvious. However, the character of this shift needs to be more carefully thought through. For example, the spatial extension that occurs in the transition from biological to psychological systems involves the system's *spatial influence* or *effective spatial range*. In other words, rather than the system expanding, the system's context of interaction expands. In this way, purely biological and psychological systems present an ever increasing *freedom of interactive opportunity*, of expanding context, while concurrently operating within *narrower windows of permissible environmental parameters*. For example, an amoeba has more interactive freedom than a carbon

¹⁷² Such a conceptual approach has been proposed within the field of biology (e.g., see Reidl 1977).

molecule, but the former requires stricter environmental conditions for existence than the latter, as diagrammed in Figure 46.

Figure 46: The Hierarchical Nesting of Interactive Processes

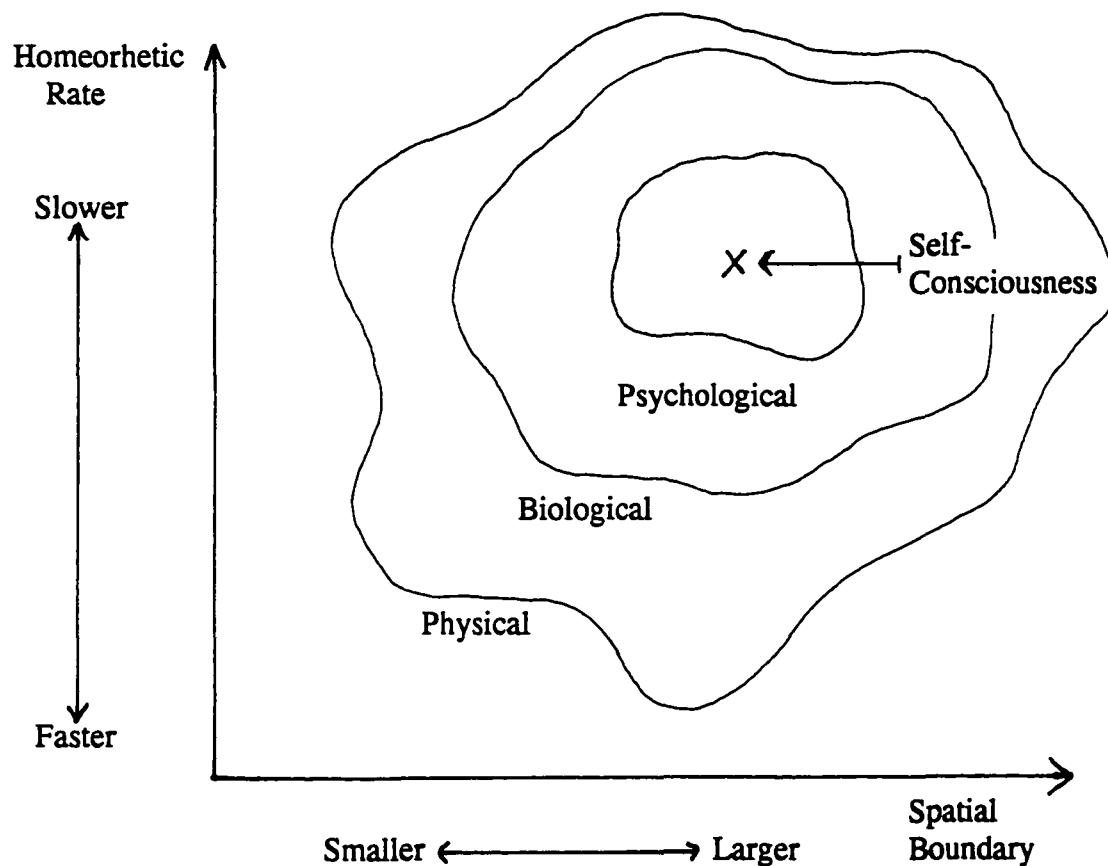
		Subject to the Interactive Limitations and Possibilities of:		
		Physical Existence	Biological Existence	Psychological Existence
Systemic Process	Physical	Yes	No	No
	Biological	Yes	Yes	No
	Psychological	Yes	Yes	Yes

This diagram conveys the idea that purely physical systems are subject to neither the limitations nor the possibilities of higher level processes. Likewise, biological systems operate within the limitations and possibilities of physical existence in addition to their own, but are not subject to psychological limitations nor open to the latter's inherent possibilities. While this representation may appear tautological, in that physical systems are subject to physical laws, this tautology merely reflects the fact that structures are defined by their relations just as relations have meaning through the structures they interrelate. One can escape this apparent horizontal tautology by acknowledging that there exists a *dynamic progression of evolving individual systems*, from inanimate matter to complex sentient life forms, which are moving through our static representation of this structure/process hierarchy. The introduction of *time* makes the horizontal circle a vertical *spiral* of growth and evolution, which breaks the horizontal tautology. It is this

continuous dynamic which I believe led Marshall to proclaim that "Nature makes no leaps."

This spatio-temporal progression of these emergent systems can also be plotted out on a graph as in Figure 47. Obviously, since higher qualitative levels are embedded within their lower level predecessors, their spatio-temporal dimensions, based on a system's homeorhetic rate and spatial boundaries, will be included in the latter's range.

Figure 47: Spatio-Temporal Variations within the Structure-Process Hierarchy



Of particular note is the fact that the *discussion itself* is made from the perspective of a self-conscious observer. Therefore, there will obviously be a convergence of these spatio-temporal discriminators as one moves up this conceptual hierarchy. The empirical

ramifications of this fact influence the manner in which observations of self-consciousness can be collected: one can only experiment and observe one's own self-consciousness. In addition, the process of exploring self-consciousness requires the cultivation of awareness and therefore implies the presence of self-consciousness itself. Furthermore, the process of self-consciousness can never be demonstrated to another, but only inferred by dwelling in the situational context of another and considering their actions. This notion of "indwelling" is a fruitful idea introduced by Polanyi (1975) and subsequently used by him to explore art, poetry, literature, and religion. This line of reasoning is fascinating, however, it leads me away from my main points.

While the dimensions of time and space seem to share a high level of correlation within perception (e.g., slow phenomenal processes are usually large and fast ones usually small), synthetic qualities will not necessarily emerge within increasingly slower/larger phenomenal processes. For example, the emergence of organic life is not strictly related to the size of the molecular aggregation nor consciousness to the size of the organism. However, an extrapolative error of this type is present in the social sciences when socio-economic/political interaction is seen to represent a new *field* of study; it is considered an *emergent process* rather than merely the *emergence of varied structures within a given interactive theme*. Social science is the study of emergent social structures which result from the interaction of individuals. Although it is the evolution of an individual's consciousness which represents an emergent process, such themes can be highly controversial.

Within this hierarchy of qualitative change, do the social sciences represent a novel emergent process? There are four different possibilities: (1) There may be a complete lack of emergence in social systems such that social phenomena can be represented by logical aggregations of lower level structural elements (e.g., a mere stimulus-response system of psychological, biological and physical interactions). This seems to go against empirical fact since human beings have the potential to demonstrate more than simple stimulus-response behaviors. (2) Accepting the quality of sentience, social phenomena *per se* (e.g., culture and institutions) may represent structural novelties, but these novel elements may continue to act within a given interactive framework of lower level possibilities and limitations (e.g., similar to the introduction of a new species into an ecosystem). In this option, human beings embody the pinnacle of interactive qualitative potential. This seems a bit presumptuous as a base hypothesis, although some people do hold this position. (3) One can, however, suppose that higher level interactive possibilities exist. Therefore, *building onto the last possibility* of structural novelty, these novel elements may begin to engage in novel interactions (e.g., the emergence of life within matter or mind within life). The question then becomes one of determining whether (a) it is the synthetic qualities of social institutions *per se* which engender process novelty, or (b) since social phenomena are composed of individuals, and since mind and self-consciousness are qualities of the individual organism, the next significant layer of novel process may be within self-consciousness and hence within the individual. From this last perspective, social phenomena help form the conditional parameters of the context which supports the evolution of the individual. Which of these possibilities we

embrace is a difficult question that rests on one's honest experiences and philosophical belief, within the illuminating context of awareness. What are the roots of qualitative social progress? This dissertation adheres to the belief that they emerge within *individual action*, and hence accepts 3(b) as the working hypothesis.

This choice of perspective does have practical implications. For example, some of the literature concerning environmental degradation due to economic expansion seems to imply that one can correct the problem by constructing the appropriate legal, cultural and economic social infrastructure. This overemphasis on institutions is epitomized by the attempts to establish Communist and Socialist regimes through political and institutional manipulations. While the ideals which fueled these initiatives were based on a vision of human relations, their arena of application and, hence, of communication were both wrong. What is important here is that we don't have the tail wagging the dog, but recognize the hierarchical order of causal relatedness.

If it is within the individual that the next level of process novelty emerges (i.e., the evolution of consciousness), then an isolated change in the institutional conditions may not alleviate the problem: individuals may continue to evade the behavior towards which the institutions are attempting to steer them. For example, if the destruction of the environment is due to a human quality (e.g., the pursuit of wealth or power which is blind to the interdependence between people and the environment), then to the extent that institutional change merely alters the structural conditions under which these individuals act, rather than attempting to change individual attitudes and beliefs, the problems will continue. It is for this reason that a growing environmental *awareness* within the

individual, as opposed to merely particular environmental regulations, is so critical.¹⁷³ It is important to remember that since institutions are the result of individual behavior, the evolution of individuals' self-consciousness will entail the emergence of new institutions. But this must not distract us from the realization that the process novelty, the truly new and creative way of interacting with the world, emerges from within the individual.¹⁷⁴ In other words, we should be looking at our *way of living* and our individual attitudes towards the meaning and purpose of human existence.

It is also possible to discuss the fragmentation of the social sciences from the vantage point of our conceptual hierarchy. Physics, biology, and psychology are all subdivided into narrower fields which represent the different subsystems and logical aggregations thereof. The social sciences, as a whole, are not markedly different from this. The subdivisions within the analysis of human interaction are made on the basis of the individual human beings, aggregates thereof. Sometimes these aggregates are represented as synthetic structural qualities (e.g., the firm in economics or culture in sociology) and sometimes as logical aggregates (e.g., perfectly competitive market structure in economics). Dividing the social sciences on the basis of what they study is interesting. Psychology is the study of the individual, which can rather ambiguously

¹⁷³ This is, of course, not a call for ideological re-education. But rather for the cultivation of conscious awareness of the interdependence of things.

¹⁷⁴ In making these assertions concerning the individual as the context within which the next level of process novelty arises, I am acutely aware of the possibility that some people may label my ideas individualistic. In this manner, they can easily place my ideas within a particular box on the shelves of their mind, a box which will undoubtedly contain a host of automatic associations. Rather than venture into this hornet's nest at this time, I would like to direct the interested reader to Hayek (1946, 1967b) and Sangharakshita (1969). Hayek's papers attempt to sort out the meaning of individualism with respect to social theory, while Sangharakshita discusses what *true individuality* consists of within the evolution of self-consciousness.

includes the whole qualitative spectrum from simple mind (e.g., Skinner) to more complex models of the self (e.g., Freud and Jung). Sociology is the study of a group of individuals from within the group, while anthropology seems to embody a sociological perspective from one group on another (both current and historically). Political science involves either larger aggregates of individual human beings (e.g., nations) or broader spatial categories (e.g., class distinctions) than sociology. Economics is a distinct aberration within this pattern since it takes as its subject the *material, and hence more easily quantifiable, dimensions* of social existence.¹⁷⁵

As the only social science eligible for a Nobel prize, economists *purposefully* restrict themselves to structural elements and interactions thereof that are quantifiable and thereby, hopefully, empirically testable. By concentrating on the material and hence quantifiable dimensions of human interaction, economics has been able to form a concept of the economic process which is independent of the structural qualities of self-consciousness and even simple group psychology. The economic concept of the individual has remained, as Veblen (1898) put it almost a century ago,

that of a lightning calculator of pleasures and pains, who oscillates like a homogeneous globule of desire for happiness under the impulse of stimuli that shift him about the area, but leave him intact. He has neither antecedent nor consequent. He is an isolated, definite datum, in stable equilibrium except for the buffets of the impinging forces that displace him in one direction or another.

¹⁷⁵ It is important to note that historically, it was political economy that emerged in the 18th century from Adam Smith's (1937[1776]) writing and was continued, for example, by Ricardo and Mill. Marshall's definition of economics as "a study of mankind in the ordinary business of life; examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of wellbeing" in his *Principles* (1990[1920]:1) signals a split between political theory and economics which occurs around the beginning of the 20th century. A further split that occurs after the Increasing Returns Debates of the 1920's is marked by Lionel Robbins' (1937:16) definition of economics as "the science which studies human behavior as a relationship between [unlimited?] ends and scarce means which have alternative uses."

Self-imposed in elemental space, he spins symmetrically about his own spiritual axis until the parallelogram of forces bears down upon him, whereupon he follows the line of the resultant. When the force of the impact is spent, he comes to rest, a self-contained globule of desire as before. Spiritually, the hedonistic man is not a prime mover. He is not the seat of a process of living, except in the sense that he is subject to a series of permutations enforced upon him by circumstances external and alien to him.

Human beings become no more than Funds of Labor Services which allow the economic model to achieve an equilibrium between conflicting and competing wants by facilitating the transformation of matter and energy.

The drawback of such a self-imposed myopia is that many psychological and sociological insights investigate the conceptual, and hence self-conscious, dimension of human existence.¹⁷⁶ There is no doubt that this facet of human interaction will continue to evade simple quantification. However, the difficulty of quantifying such elements suggests nothing with respect to the significance of their inclusion within a theoretical representation of socio-economic interaction. With respect to models of long-run socio-economic development, adding an explicit social dimension to economic theory would have a significant and immediate impact on economics. For example, there would be a greater recognition that economic activity involves conscious choice and thereby a more wholehearted attempt to honestly and openly investigate the consumer side of the economy. The distinction between consumers' needs and wants, which were previously taken to be exogenous to the socio-economic system, have been recently explored by a few theorists (e.g., Bowles and Gintis 1993). Facets of the socio-economic system may be found to be co-dependent with individual and social expectations (e.g., Brewer and

¹⁷⁶ Note, however, the recent publication and relative success of an intermediate microeconomic text (Frank 1991) which includes chapters on psychological and cognitive dimensions.

Porter 1993; Douglas and Isherwood 1979; Frank et. al. 1993; Lavin 1995). While the endogenous technological change literature has already started to delve into heterogeneous technology as a driving force of economic development between regions, an investigation of *heterogeneous social concepts* may prove fruitful (e.g., Hacket and Lutzenhiser 1991). The next section presents a contemporary concept of socio-economic change which models it as a synthetic quality in such a way that it highlights the institutional context's role in shaping individual behavior as well as the individual's construction of the institutional context itself.

The Institutional Context of Individual Action

The theory of institutional change, which emerged from the works of Thorstein Veblen, John R. Commons, John Dewey, and Clarence E. Ayres, provides a framework from which to analyze the conceptual dimension of the socio-economic process. Through an explicit separation between the *ceremonial* and *instrumental* facets of institutions, this theory serves as a more detailed exposition of the complementary/divergent circular relationship which Myrdal theorized to exist between the conceptual and material dimensions of development. This framework has also been used to inform contemporary case studies which support these ideas. The following presentation relies heavily on Bush's (1983, 1987) exposition and is meant to give an outline rather than serve as a substitute for reading the original works first hand.¹⁷⁷ It should be noted that I have made minor additions to this theory.

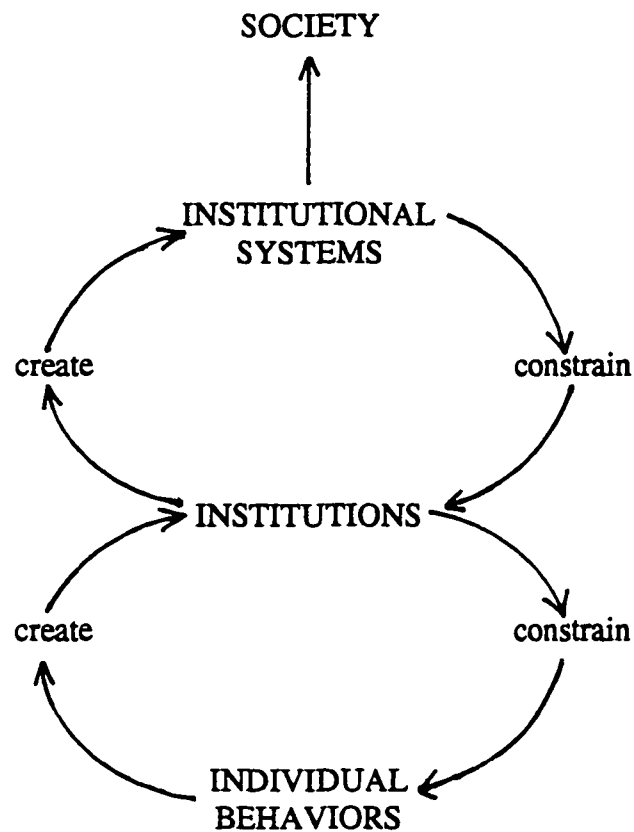
Values and Patterns of Behaviors

To begin this discussion, what is an *institution*? Bush answers this question by saying that society is a set of institutional systems, an institutional system being a set of

¹⁷⁷ Bush's research provides an excellent source from which to explore the theory of institutional change for two reasons: (1) It is clear, concise, and well formulated, although expressed in its own particular language. (2) It includes J. Fagg Foster's refinement of the Veblen institution-technology dichotomy into a ceremonial-instrumental dichotomy which significantly clarifies and refines the theory (Waller 1982).

institutions, and an institution being a set of *socially prescribed patterns of correlated individual behavior*. Therefore, society is a web of interrelated institutional systems which consists of patterns of patterns of patterns of individual behaviors. Figure 48 represents this arrangement in a hierarchical diagram.

Figure 48: Patterns of Patterns of Patterns of Individual Behaviors



This is a compositional hierarchical arrangement in which higher layers of the institutional structure are composed of lower level elements. Although all these elements may help to shape an individual's life, society as a whole is most easily influenced by institutional systems, less so by institutions, and even less so by individuals. In other

words, on average, few individuals will have a significant impact on society as an individual. However, as one moves down this institutional hierarchy, the amount of influence that individuals have increases. A quote from Veblen (1975[1899]:190, emphasis added) helps to make this more apparent by defining what an institution is:

... institutions are, in substance, prevalent habits of thought with respect to particular relations and particular functions of the individual and of the community; and the scheme of life, which is made up of the aggregate of institutions in force at a given time or at a given point in the development of any society, may, on the psychological side, be broadly characterized as a prevalent *spiritual attitude* or a prevalent *theory of life*.

For example, the predominant spiritual attitude of American society could be called *consumerism*.¹⁷⁸ There will be a host of institutional systems which maintain this general atmosphere: advertising, strip-mall and home cable television shopping, credit cards, mass entertainment, and a "work to consume" attitude. The institutions which lie underneath these institutional systems represent the collections of individuals whose behaviors actually create socio-economic existence; the host of institutions and institutional systems define the context within which individuals focus their creative energies. It is this duality between contextual constraint and compositional expansion which begs to be explored.

Building up this socio-political dimension (i.e., the spiritual attitude or theory of life in Veblen's terms) will involve three notable characteristics of the individual. First, individual behavior that is not random, but rather purposeful and hence volitional. Second, the correlation of this behavior through an individual's underlying values.

¹⁷⁸ Jung's (1954) exploration of *science* as a religion is also applicable here.

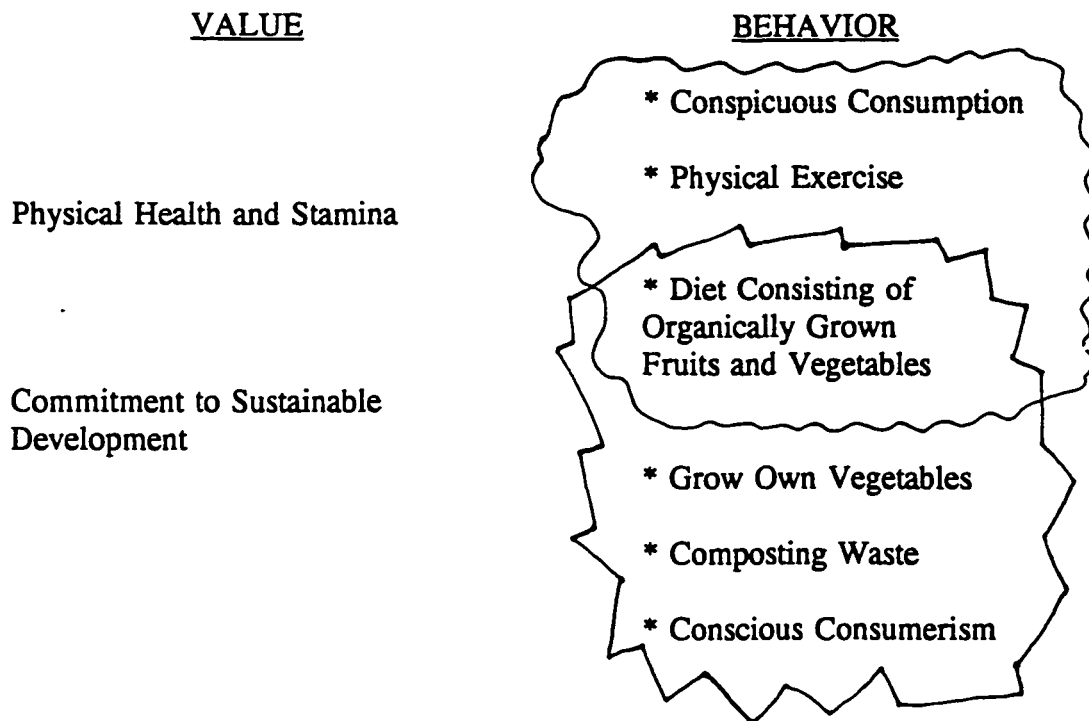
Third, a general level of awareness which attempts to validate this value to behavior translation. While Bush does not explicitly include this last facet in his discussion, it forms a critical link in my analysis. Exploring these three facets more fully, each individual unifies the host of behaviors that they call their life through their system of values. Within this interdependent pattern, two different behaviors may be correlated with one another through a common value or a single behavior may be motivated by two different values. The function of awareness is to make the link between values and behavior a conscious one which can be reflected on; and a lack of awareness will cause this translation to remain unedited. There is an insidious tension within this relationship since individuals may not be aware of their lack of awareness and hence they will assume that their value-behavior translation is appropriate. This factor will be very important later in the discussion.

Individuals with similar behavioral patterns can form institutions which unify individuals on the basis of their common behavior.¹⁷⁹ For example, assume that someone values his physical appearance and health. This might lead him to eat organically grown fruits and vegetables in order to avoid chemical preservatives and pesticides. In addition, he might adhere to a strict regiment of daily physical exercise and spend a large percentage of his income on status goods such as fancy clothing and cars. A different person might value the earth's ecology such that they refuse to willingly and knowledgeably do things which degrade it. As a result, they might buy organic foods, grow their own vegetables, compost waste, and be conscious of their

¹⁷⁹ Note that 'common behaviors' is not an analytic concept, but a dialectical one (Georgescu-Roegen 1971).

consumption patterns. From Figure 49, one can see that these individual's behaviors will partially overlap.

Figure 49: Value-Behavior Correlation



It is on the basis of this common behavior that individuals become grouped together to form an institution (e.g., a natural foods cooperative founded by someone who values worker-owned businesses). Hence, contradictions among the group's members are to be expected. Although it is the common behaviors shared by a diverse set of individuals which forms the sufficient condition for the emergence of an institution, it is the correlation of underlying values which establish the integrity of such institutions through time. In fact, although individuals with different behavior patterns can experience a significant bond through shared values, institutions based on predominantly common behaviors motivated by diverse values will depend more heavily for support on the

greater institutional system (e.g., fashion trends) unless the underlying values converge to some degree. In a similar way, a factory represents an institution in which the people who work there may be motivated by many different values (e.g., to make a living, learn a skill, or be with one's friends). Worker alienation, or conversely active worker participation, involves the underlying values motivating individual action. One is creative when one's energies are integrated and engaged, and a firm is successful in the long run when its workers are creative.

This host of institutions come together to form the socio-economic process. Within each layer of this institutional context, there is an active dynamic process which attempts to fit together the different institutional pieces which are in conflict or harmony with one another: people become friends, businesses and special interest groups are formed, environmentalists clash with industrialists, labor battles management, and pro-life proponents kill pro-choice advocates. In the end, however, there remains nothing but individual values and behavior.

The Ceremonial/Instrumental Dichotomy

One can demarcate the values which underlie institutions into two categories: ceremonial and instrumental. The basis on which this distinction rests is the logic and validation process employed in the justification and rationale of individual behavior. Ceremonial values motivate and correlate behaviors through criteria based on invidious distinctions which "prescribe status, differential privileges, and master-servant

relationships" and thereby "warrant the exercise of power by one class over another" (Bush 1987:1079). There is an obvious element of such values involved in questions of intergenerational equity (e.g., see Norgaard and Howath 1991) and economy-environment interaction (e.g., see O'Connor 1989). This formative logic of distinguishing self from other is paired with a validation process in which someone justifies her or his behavior through *sufficient reason*, i.e., the values motivating behavior are "accepted on authority and regarded as absolute" (Bush 1987:1079). They are ends in themselves. All that is required under sufficient reason is a *plausible* argument. Bush comments,

The boundaries of the logic are as limitless as the human imagination. A particular pattern of behavior may be required 'because the memory of man does not run to the contrary,' or because 'it is the will of God,' or because 'blacks are inherently inferior to whites,' or because 'it is consistent with the requirements of national security'. (Bush 1987:1083)

This is the distinguishing feature of the ceremonial translation of value to behavior.

Ceremonial values are immune to critical scrutiny. They appeal to tradition and ideology for support and therefore represent an end to the process of inquiry in which the question "Why?" is asked. Using the terminology of equilibrium economics, one could say that the marginal effort required to be aware of and reflect on the value to behavior translation with respect to one's interpersonal relations is higher than the marginal gain *expected* from any refinement of one's value-behavior matrix that this may allow. In this way, ceremonial values represent a level of complacency with respect to the current explanation for why things are the way they are. However, since this complacency is based on a lack of reflexive awareness, its foundations are mere pillars of smoke. Once again, the characteristic quality of the ceremonial dimension of

institutions resides in the fact that their acceptance is not a *contingent* hypothesis which is tested in one's life, but rather a wholesale acceptance which serves to define one's life. The key is that one's life experiences are not used to temper ceremonial values: there is no co-dependence, no circularity, but only a linear relationship of dictated ends. To simplify the language of this discussion, the validation process for this type of value-behavior translation is called *ceremonial adequacy* and the patterns of behavior bound in this way *ceremonially warranted*.

In dramatic contrast to this, instrumental values motivate and correlate behaviors on the basis of their continued efficacy in the problem-solving process; they are, and remain, means to an end. The question of "Why?" and "How?" never cease to be asked. What is the problem-solving process? It can be thought of as the human endeavor to cope with, understand, and possibly transcend the current state of existence.¹⁸⁰ Therefore, the nexus of this problem-solving process is not merely the skills involved in manipulating physical tools or financial resources, but includes the *whole fund of knowledge*, both the arts and sciences, available to the individual for addressing this essential problem. Technological innovations can therefore be broadly defined as any "creative endeavor" which improves our understanding, and the process of socio-economic advance involves the efforts of the "entire community, not just some academic or scientific elite" (Bush 1987:1088). The logic of this justification process is one of *instrumental efficiency* in which the values are effectively translated through one's

¹⁸⁰ Marshall's (1990[1920]:1) definition of economics as *the study of individual and social action directed towards the attainment and use of the material requisites of well being* is a neat subset of this broader definition.

behaviors. Values and behaviors which conflict with the continued success of the problem-solving process are discarded and replaced.¹⁸¹ It is this ongoing process of problem-solving which provides a never-ending tempering and self-correcting quality to society's *instrumentally warranted* patterns of behavior. This means that such patterns of behavior may be quite stable through time, but their acceptance will always be contingent on their efficacy in achieving the stated goals and this efficacy is subject to a continual reflexive awareness.

Unlike values, behaviors and institutions can have both ceremonial and instrumental motivations simultaneously. For example, Ayres' (1971:241, as cited in Bush 1987) discussion of the "cult of the tub" provides an instance in which the ceremonial cleanliness of the upper classes is coupled with the instrumental value of personal and public hygiene.¹⁸² Whether a behavior ultimately takes on ceremonial, instrumental, or hybrid significance is determined by the intention of the individual and the social context in which that behavior occurs. Although ceremonial values can combine purely instrumental behaviors with ceremonial or dialectically mixed behaviors, instrumental values can *never* rationalize purely ceremonial behavior due to the tempering quality of the problem-solving experience.

re particular values which then possess the ability to be translated into behaviors. For example, one may believe in an 'equality of individual rights' which is expressed through tolerance and forbearance towards certain behaviors (e.g., religious choice and speech) and a lack of tolerance with respect to others (e.g., physical violence).

¹⁸² Huxley's (1943) discussion of the relationship between Christian ascetic morality and bathing practices in the late sixteenth and early seventeenth centuries present us with a historical perspective on the varied dynamic balance which can exist between the ceremonial and instrumental values which motivate behavior.

The extent of this endogenous process of self-correction within instrumental behaviors will depend on an individual's "conscious awareness" of their warranted patterns of behavioral and the degree to which instrumental efficiency is left open to the "surveillance of the community" (Bush 1987:1080). The practical manifestation of this individual transparency with respect to values is an openness to challenge and dialogue, honest communication, and explicit objectives, all of which are noticeably absent under the standards of ceremonial adequacy. However, since this whole process of tempering the instrumentally warranted dimension of institutions is dependent on a conscious awareness, a lack of awareness would signal an *unconscious shift* in the employment of the instrumental efficiency criteria towards one of ceremonial adequacy, as behaviors become ends in themselves rather than conscious means.

This leads to the possibility that behaviors which were once innovative and creative may become mechanical and habitual, as society becomes locked-in to a method as an end in itself. Although this will not necessarily lead to instrumental inefficiency, it does lend itself to the reification of social relations and a possible inertia to future change. Individuals will believe that their behaviors are "the source of instrumental efficiency" even though they are not (Bush 1987:1085). An individual will rarely, if ever, perceive ceremonial behavior as *purely* ceremonially warranted, but will always impute unto it an instrumental dimension. For example, parents may continue treating their grown children as children in the spirit of "knowing what is best" for them. Or, racists who believe that one race is superior to another will act on the basis of this bubble of self-created 'truth.' This caveat also creates the possibility that *whole groups of people*

possess erroneous concepts of what is and is not instrumental behavior without being consciously aware of this possibility. This is perhaps one of the reasons why tolerance is such an important facet of social progress.

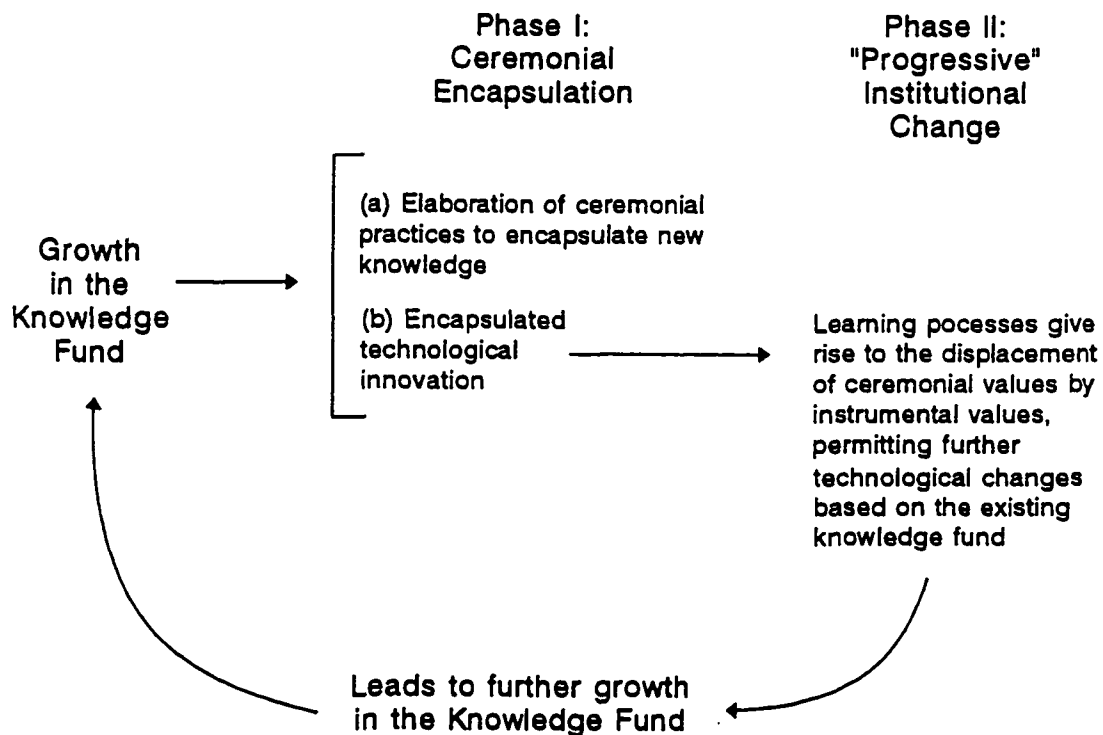
Ceremonial Encapsulation and Social Progress

This categorization of institutions by way of the ceremonial and instrumental motivations which underlie them permits one to speak more clearly of the general phenomena of social inertia. Cultures can get locked-in to a certain way of viewing themselves in relation to the rest of the world, fields of science can become locked-in to particular methodologies, individuals become addicted to certain ways of living, and spirituality becomes defined rather than discovered. The ceremonial dimension of society is non-dynamic, habit-oriented, attempts to preserve and extend the existing invidious distinctions, and will resist both social and material innovations which lead to a lessening of such distinctions. In this respect, the ceremonial dimension represents a stabilizing relation within society; tradition serves as both the rudder which steers the course and the brake which controls the speed of socio-economic evolution.

As a result of this ever present ceremonial dominance, all innovative instrumental behavior is required to pass the test of ceremonial adequacy in order to be explicitly sanctioned by the community. As Bush (1987:1093) remarks, "technological innovations will be permitted only if it is anticipated that they will not disrupt the existing value structure of the community." Taken by itself, the idea of ceremonial dominance leads

to a rather dismal state of affairs. However, this base of knowledge which is sanctioned by the community under the auspices of ceremonial adequacy (i.e., an instrumental-ceremonial hybrid) is *used to the fullest*. The use of this knowledge within the problem-solving process changes behavior and thereby creates new problems for the community. An expansive potential, which is endogenous to the problem-solving process as a result of the instrumental behaviors which have been warranted, accumulates into a potentially eruptive influence within the sanctioned boundaries of permissible behaviors and knowledge. This may be strong enough to break down restrictive ceremonial values, and thereby give way to instrumental values which permit an even greater degree of technological innovation to be absorbed into the social structure. Truly progressive institutional change consists of this lessening of the degree of ceremonial dominance. Bush (1987:1104) diagrammed this relationship in the following way:

Figure 50: The Process of Institutional Change



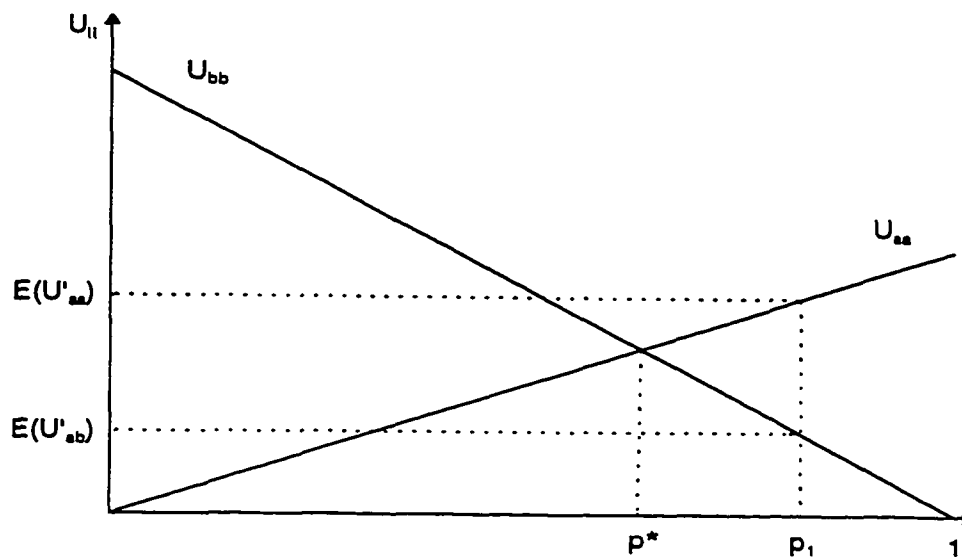
Boyer and Orlean (1992) used the tools of noncooperative games to formalize the difficulties inherent to social transitions in general. In their analysis, a *convention* is defined as a set of behaviors (e.g., A versus B) whose payoff is determined by whether one is interacting with *other like minded individuals* (i.e., U_{aa}) or *those who act and think differently* (i.e., U_{ab}). The expected utility received for adhering to a particular convention (i.e., U_{ai} , where i is the other convention) is defined as the proportion of individuals adopting convention A (defined as p) times the payoff U_{aa} plus the proportion of individuals adopting convention B times the payoff U_{ab} (i.e., $E(U_{ai}) = p * U_{aa} + (1 - p) * U_{ab}$). It is assumed that the utility received by an individual adhering to one convention when interacting with an individual adhering to the opposing convention is zero (i.e., $U_{ab} = 0$ and $U_{ba} = 0$), although this assumption can be relaxed without doing injury to the essential insights of the models. It is also assumed that individuals expect to encounter all other individuals within the community with equal probability.¹⁸³

Their analysis of this behavior coordination problem identifies two evolutionary stable strategies: the adherence of the entire population to one of the two conventions. Between these two stable institutional relations there exists a threshold proportion of the population (p^*), determined by the ratio of the utility from one convention (U_{bb}) to the sum of the utilities for both conventions ($U_{aa} + U_{bb}$), above which one convention dominates (A) and below which the other comes to dominate (B). This can be represented graphically as follows with the expected payoffs to adhering to a particular

¹⁸³ This assumption is partially relaxed by Boyer and Orleans later in their paper, but the essential insights of the model remain the same. One would assume that relaxing this assumption would lead to partial segregation on the basis of beliefs.

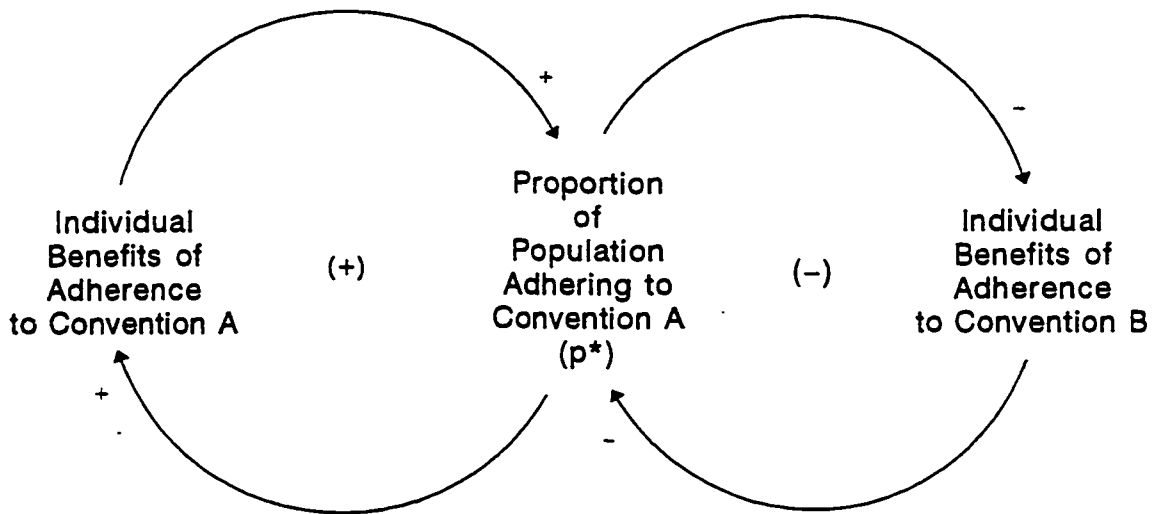
convention being determined by the proportion of the population adhering to the same convention (Boyer and Orleans 1992:169). For example, with p_1 of the population adhering to A, it is in an individual's best interest to adopt convention A (i.e., $E(U'_{aa}) > E(U'_{ab})$).

Figure 51: The Threshold of Institutional Change



One can imagine that this represents the existing ceremonially and instrumentally warranted conventions (i.e., A and B respectively). Even when the existing social relations provide a lower level of mutual benefit, the dynamic pressure of conformity will cause each individual to continue acting in accordance with these existing mores. This divergent co-dependence can be represented in a causal diagram as follows.

Figure 52: Causal Diagram of Institutional Change



The potential for progressive institutional change involves pushing society past this threshold proportion. Boyer and Orleans identify four different ways that this could happen: (1) A collapse in the payoff that a certain convention gives (e.g., $U_{aa} \rightarrow 0$ such that the value p^* increases). (2) The invasion of a new group of players which changes the composition of the population through their open espousal of convention B, such that p^* increases. This possibility seems to violate the assumption of spatial ambiguity between individuals and thereby recognizes the fact that people and conventions possess a definite spatio-temporal existence. (3) The presence of a transitional compatibility whereby the utility of one convention is not zero when played against its opponent (e.g., $U_{ba} > 0$). For example, this would result in an increasing p^* as the hybrid utility U_{ba} approaches U_{aa} (e.g., the collapse of the usury laws which prohibited the lending of money at interest in Europe based on moral considerations). (4) A collective action by

the population as a whole which recognizes the advantages of U_{bb} over U_{aa} and sanctions the transition (e.g., political solutions to common resource problems).

As knowledge advances, there will always be an initial attempt to *encapsulate* the innovative instrumental behaviors within the existing ceremonial patterns of the social group. New technologies will not be intentionally sanctioned if they disrupt the existing value structure of the community, and therefore changes in instrumentally warranted conventions *which cannot be denied* are accompanied by offsetting ceremonially warranted conventions such that the underlying ceremonial relations are not significantly disturbed. The encapsulation of a *limited* application of an innovative technology may preserve the existing ceremonial relations, while concurrently serving as a potential transitional opportunity (i.e., a hybrid behavior) between different socio-economic systems. Within this model, ceremonial dominance could be indexed by p^* , with a low percentage being associated with heavy social inertia and lack of instrumental flexibility.

Bush noted three different types of ceremonial encapsulation: past-binding, future-binding, and the "Lysenko" type. Figure 53 (reproduced from Bush 1987:1092) illustrates where these three types are found within the possible juxtapositioning of feasible and nonfeasible, ceremonial and instrumental behaviors.

Figure 53: A Partitioning of Institutional Space

	Instrumentally Feasible	Instrumentally Nonfeasible
Ceremonially Feasible	Sector of Ceremonial Encapsulation (Past/Future-Binding)	Sector of Lysenko Effects
Ceremonially Nonfeasible	Sector of Lost Instrumental Efficiency	Empty Set

The upper left corner contains the first two forms of ceremonial encapsulation. Past-binding ceremonial encapsulation is when the existing traditions of the community actively *suppress or hinder* the absorption and diffusion of technological innovations (e.g., $U_{ba} < 0$). For example, the preindustrial mores which inhibited quick rates of technological infusion, the delay in the legislation of workmen's compensation and child labor laws following the industrial revolution, and the current hesitation to adopt ecologically sound consumption habits. Past-binding encapsulation frequently occurs when social innovations are in direct conflict with the existing institutional structure. This allows for few opportunities for transitional behaviors and frequently creates a tangible tension which results in either revolutionary change or forceful suppression (see Kuran 1989).

The class of future-binding ceremonial encapsulation involves the proactive development of technological innovations which strengthen and expand the existing control of the vested interests.

In this case, the introduction of technological innovations into the life process of the community is carefully coordinated with the formulation of an appropriate mythology and related ceremonial practices that rationalize and enforce the legitimacy of the control over the technology by the vested interests that have captured it. (Bush 1987:1095)

Many examples of this type of encapsulation have been researched: (1) The ability of the large chemical, farm machinery, and agribusiness industries to encapsulate technology at the expense of maintaining a healthy food chain and ecology (Hayden 1984). (2) The encapsulation of knowledge concerning diet and health by the "American food power system" (Junker 1982). (3) The study of "corporate hegemony" in which the corporation becomes the dominant institution within American society (Duggger 1984). (4) Munkirs' (1985) postulate that the growth of the American economy is determined through *centralized private sector planning* which involves the giant financial and industrial corporations. This later study did not attribute ceremonial dominance to particular institutions, but rather to a *capitalist ideology* (e.g., the values of self-interest, profit seeking, and laissez-faire) which is posited to be so deeply ingrained in American living that its existence is not consciously perceived. As a result, society's ability to institute instrumentally warranted social policies is hampered (e.g., national healthcare and minimum efficiency standards for automobiles).

The third type of ceremonial encapsulation involves an attempt to claim instrumental efficiency for infeasible techniques on the basis of their ceremonial adequacy. This type is named the "Lysenko" effect in honor of the Russian scientist who believed that genetic change could be achieved through environmental conditioning within the lifetime of a given biological organism. This view was also shared by the famous

taxonomist Linnaeus. However, the difference between the two is that while Linnaeus' ideas fell prey to contradictory empirical observations, those of Lysenko were embraced by Stalin as being *the biological theory consistent with Marxist-Stalinist ideology*. Lysenko's ideas thereby became the official dogma in agronomy and the affiliated biological sciences in the Soviet Union for several decades. Anyone familiar with this period of Soviet history will need no reminder of the social horrors and the technological retrogression this type of ceremonial dominance can produce. Such a shift actively moves society away from instrumental efficiency.

In contrast to ceremonial encapsulation which attempts to retain the current ceremonial relations, the *embodiment* of technological innovations implies that new instrumental behaviors and values are actually merged into society and its institutions. As a result, the ceremonial dominance within society becomes diluted as instrumentally warranted behaviors increase in proportion to their ceremonial counterparts. It is this idea which forms the basis for Bush's distinction between regressive and progressive institutional change; for a *given fund of knowledge*, the displacement of instrumentally warranted behaviors by ceremonially warranted ones is regressive while the displacement of ceremonially by instrumentally warranted behaviors represents progressive institutional change. An evolutionary flavor can be added to his discussion by recognizing that the criteria of ceremonial adequacy will continually attempt to grow over the instrumentally warranted behaviors that arise: innovations inevitably become tradition in time. Our heuristic use of Boyer and Orlean's graph breaks down at this point since this dynamic will cause a continual drift of payoffs from instrumental to ceremonial conventions. In

order to avoid this continual onslaught of ceremonial inertia and social ossification, knowledge must be 'eternally rediscovered' through individual experience to remain fresh. Note that this shifting between progressive and regressive institutional change is *not* dependent on the level of knowledge, but on the basis by which actions are motivated and justified. In fact, a technologically primitive culture could be more progressive by this measurement than an advanced one.

What would a completely instrumental society be like? Let's reconstruct the argument: (1) Instrumental values and behaviors are based on their continued efficacy in the problem-solving process. (2) The problem-solving process involves an *individual's* endeavor to cope with and understand the state of human existence. (3) The instrumental dimension of *institutions* and *institutional systems* is that which contributes to the effective continuation and extension of the problem solving process. (4) A purely instrumental society is therefore one which encourages and supports an individual's attempts to understand her own existence. Therefore, an instrumental society supports the individual just as the atmosphere provides the chemical context within which life flourishes. Although there has been a tendency on the part of social scientists to view society and institutions as the critical determinants of social utopia, our argument points to the conclusion that society can only encourage *individuals* to discover and build this utopia for themselves.

CONCLUSION

Where do all these ideas lead? When pulled together, what is one left with? This dissertation began by introducing the use of circular causal diagramming as a heuristic tool with which to explore the evolutionary dimension of economic theory. These tools were then used to highlight the distinctly evolutionary relations implicit within the history of economic thought and to identify the *meaning* of the evolutionary concept as emphasized by the different theorists explored herein. Adam Smith's use of a complementary circular relation between the division-of-labor and extent-of-the-market serves to unambiguously establish the fundamental role of these ideas within economic theory. However, it was found that the division-of-labor involves facets of both differentiation and integration: the former being a movement towards greater individuality, and the latter towards greater dependence on others.

But how are we to theoretically embody this insight into the evolutionary process? Marshall's implicit answer was to introduce different layers of interactive process within his economic theory (e.g., the individual, firm, and industry). For example, he recognized that people and raw materials could be brought together under the guise of a firm which would serve to focus the diverse talents of those involved into a single purpose: a collection of individuals who were effectively engaged in meeting their material needs as a group. Cooperation between individuals occurs within the context of competition between firms. However, this method caused a tangible tension within

Marshall's economic theory since he was unable to synthesize the different layers of economic cooperation and those of competitive struggle into a unified whole.

This tension came to a head within the economics profession during the 1920's in what has been coined the Increasing Returns debates. An isolated emphasis on the complementary facets of the firm led to the question of what prevents a single firm from dominating its entire market? However, instead of pursuing Marshall's implicit excursion into a nested hierarchy of socio-economic relations, the profession was engaged in a theoretical elaboration around equilibrium themes. Such a logical extrapolation was made possible when the apparent gap between the firm and the industry was conceptually bridged through the creation of an equilibrium firm, even though the empirical connection remained unsubstantiated as a general rule. However, this tactic was bolstered through the adoption of a philosophical stance in which the realism of the assumptions was not as important as the predictive ability of the final theory, and the profession quickly flowed into these mathematical paths of least resistance. A casualty of this outcome was the evolutionary paradigm. Rather than attempt to synthesize the evolutionary and equilibrium perspectives, these two quite distinct positions were posited as mutually exclusive theoretical stances: in this way, the Increasing Returns debates represent a bifurcation point within economic theory. It was hoped that an extrapolation of a logically consistent axiomatic foundation for economic theory could provide a description of the entire structure of economic interaction. This strategy would have worked if there had been no synthetic qualities within the aggregation, but it was these very qualities which Marshall had identified when he implicitly layered his economic

theory. Although the profession was attempting to unify economic theory on the basis of such axiomatic foundations, Allyn Young resisted these tendencies as he analyzed the macroeconomy by expanding the division-of-labor concept originally proposed by Smith. Not only was he openly critical of the methodological restrictions that were being levied against what he perceived to be facets of the socio-economic process in general, but in shifting his theoretical emphasis from the firm to the macroeconomy, he was able to effectively develop the evolutionary paradigm by extending the possible layers of synthetic qualities to include the macroeconomy as a whole. This exploration of the greater socio-economic process was continued by Gunnar Myrdal and Nicholas Kaldor, both of whom openly criticized the methodological bias towards equilibrium formulations within contemporary economic theory.

As a result, the criticism of equilibrium methodology has been well established and the intellectual and emotional task at hand, which a number of people appear to have whole heartedly embraced, is to develop a novel theory of socio-economic interaction which makes an honest attempt to insert cooperative relations back into economic theory. However, these investigations into complementary circular relations have produced some amazing insights. We have discovered that complementary circular relations can display multiple equilibria, path dependency, and the potential to lock-in to certain patterns of development. As a result, the assumption that efficiency is a natural quality of a smooth functioning economy has come under scrutiny: inefficiency is a natural process also. But even more radical, these ideas can be tied to Myrdal's exploration of values and ideals in general. And this introduces the theoretical possibility that our concepts of socio-

economic interaction may actually prevent us from achieving our fullest potential. We may be limiting ourselves through our static notions of what culture is and the way the world is.

These ideas can be found within the theory of institutional change. By distinguishing between the ceremonial and instrumental dimensions of society, this theory establishes the natural potential of society and institutions to become stagnant. From a materialistic perspective, this might manifest in particular ways of doing things which cease to be questioned. Such methods will have become ends in themselves rather than means to an end. In other words, life becomes defined by certain *ways of being* and *ways of living* which are habitual, mechanical, and lacking in critical reflection. In those moments when awareness is present, the process changes; the efficacy of the translation of values into behavior comes under scrutiny and ways of being and living which are perceived to be in conflict with one's values are changed. As long as awareness is applied to one's actions and experience, one's method of living becomes more fully self-conscious and truly spontaneous. The difficulty is that one is frequently unaware of one's unawareness.

By exploring the evolutionary perspective in greater philosophical detail, the hierarchical nesting of concepts becomes more pronounced. Its roots can be traced to our process of perception and the way in which we think. In fact, mental conception is a synthetic quality of sensory perception: a synthetic quality which creates a process novelty (i.e., self-consciousness). In line with these facts, these limitations manifest themselves within the organization of human knowledge as a whole. If one looks at the

hierarchy of nested qualities, higher level systems have emerged out of lower level novelty: life has emerged from matter, mind from life, and self-consciousness from mind. The nesting of qualitative change has spiraled into the individual and my intuition leads me to believe that the next level of change will emerge within the individual, yet it will simultaneously transcend the individual. From this perspective, society becomes the lower level structural context for this higher level process which arises through the application of awareness.

While it is impossible for us to honestly contend that the world is unambiguously the way we perceive it and conceive of it, we do know that our perceptions are frequently wrong and that our attempts to conceptually penetrate into the intestinal substructure of our experience has yet to create a panacea for society's ills. Over the past two hundred years, the dominance of western society seems to have simply managed to move things around the world without addressing the fundamental problems of human existence or contributing anything meaningful to human history. Yet, we have created the potential for material opulence, a context within which an honest exploration of the potentials of human experience can occur. And hopefully, this dissertation has helped to elucidate some foundations from which a truly evolutionary theory of socio-economic change can emerge. One which doesn't explicitly deny humanity of its distinctive qualities, but attempts to incorporate them into the very fabric of our thoughts concerning what we are.

APPENDIX A

GLOSSARY

Concept: an abstract representation of experience synthesized from the five senses which attempts to understand the spatial behavior of a focal system through time. Has two complementary facets: (1) a structural dimension which identifies the qualitative elements, and (2) a process dimension which describes the interaction between these different structural classes.

Conceptual Hierarchy: a nesting of conceptually discrete theoretical relationships which manifest to perception simultaneously. Although this simultaneity is not directly observable, it emerges as the spatio-temporal dimension of perception is varied, thus creating a nesting of experiential decompositions; a layering of synthetic qualities and novel processes which are not amenable to logical aggregation. Ultimately due to the subject-object duality of analytic knowledge rather than any ontological rational.

Emergent Quality: see *synthetic quality*.

Entity: a thing that has real and individual existence relative to a given perspective, in reality or in the mind. (16th century)

Epistemology: a branch of philosophy concerned with the study of the nature, source, limitations, and validity of knowledge. Questions are directed towards 'how' and 'what' a knower knows. (19th century)

Form: the particular pattern of qualities that gives something its unique nature or character; combination of qualities making something what it is.

Homeorhetic Rate: time period necessary for a system to return to a characteristic quality of being after a perturbation (e.g., due to environmental fluctuation). This rate will be influenced by a system's structural composition and internal process of interaction, along with its interaction with other systems and its context.

Homeostatis: the tendency to maintain, or the maintenance of, normal internal stability in an organism by coordinated responses of the organ systems that automatically compensate for environmental changes; any analogous maintenance of stability or equilibrium, as within a social group.

Level: used to acknowledge the perception of synthetic qualities and novel processes which are not effectively embodied within logical aggregation of a system's structural elements. The necessity of theoretical levels is due to the process of perception and mental conception rather than being a quality of reality *per se*.

Observer: a generic term for a perceiving self; when used to denote a human being, the dimensions of perception are six: taste, touch, smell, sight, and hearing. In addition, mental conception can be thought of as a form of perception. See *subject*.

Ontology: a branch of metaphysics which studies the nature of being or existence. The question of 'what is.' (18th century)

Path Dependency: when a system's particular history plays a significant role in the determination of its current existence.

Pattern: the quantitative disposition of qualitative parts or elements.

Perception: the sensory awareness of difference or lack thereof (e.g., sight, sound, taste, touch, and smell for human beings).

Positivism: the belief that knowledge is strictly limited to observable facts and their interrelations and hence, that the sciences provide the only reliable knowledge.

Problem-Solving Process: the human endeavor to cope with, understand, and possibly transcend one's current state of existence.

Process: the dynamic facet of mental conception which represents the interaction of structural qualities.

Quality: that which makes something what it is.

Quantity: the exact amount of a particular thing.

Scientific Inquiry: an investigation of experience which seeks to compose a representative concept which can be used to effectively navigate one's environment. Such concepts should be communicable to others and empirically testable against one's experience.

Social Science: the field of theoretical science concerned with human interaction. This would include the fields of sociology, political science, economics, psychology, history, literature, and the arts.

Spatial Dimension of Perception: the structural decomposition of experience into dialectically distinct qualities.

Spatio-Temporal: the dimensions of space and time taken as interrelated characteristics of sensory experience.

Stable Process: an interactive process which retains its qualitative characteristics in spite of perturbations in external or internal variables; basically the consistency of structural quality, but is frequently extended to different orders of quantitative consistency. A stable process can be conceptualized through the use of stabilizing circularities.

Structure: the qualitative elements of a particular decomposition of experience.

Subject: originally denoted one who is under the dominion of a sovereign (14th century), but did not take on the meaning of a thinking agent until the 18th century (during the Enlightenment era). This etymology demonstrates the implicit semantic primacy of object over subject.

Synthetic Quality: a quality or meaning which a pattern displays in and of itself (i.e., beyond the qualities of its individual elements). The use of this term, in coordination with a language of *emergent qualities*, serves to explicitly recognize that qualities are not inherent, but relative characteristics.

System: a group of parts so combined as to operate in unison and appear as a group; the structural facets and interactive relations being used in build a mental concept of a particular decomposition of experience.

Systemic Bias: an inclination, partiality, or prejudice which results from the interaction of the structural elements of the process under discussion and is therefore a 'natural' characteristic of the process. Opposed to a non-systemic bias where the inclination, partiality, or prejudice is more appropriately affiliated with elements external to the process under discussion.

Taxonomic Science: a categorical method of scientific inquiry in which *things* are grouped together by virtue of qualitative similarity. However, the leap to categorization on the basis of generalized process is not made.

Temporal Dimension of Perception: the unit of time between cross-sectional observations of reality. It is the relations between this dimension of the process of perception and a system's *homeorhetic rate* which decomposes experience into structural elements and interactive process.

Theoretical Science: a method of scientific investigation in which general interactive relationships are established from within the categorical structure of taxonomic science. Uses the rules of logic to aggregate stable qualities and thereby derive predictions about their interactive behavior.

Thing: that which is conceived, spoken of, or referred to as existing as an individual; a distinguishable entity (see *entity*).

Transitive Chaos: chaos characterizes the quantitative dynamic behavior of a system in which small deviations in some parameters lead to large discrepancies in the quantitative evolution of the system. Transitive chaos is when a process displays periods of chaotic behavior intermittently.

Whole: a system which displays a synthetic quality.

NOTE: Some of these definitions have emerged within the context of this essay, but most have been taken from Webster's (1979) and Honer, Hunt, and Okholm (1992).

APPENDIX B

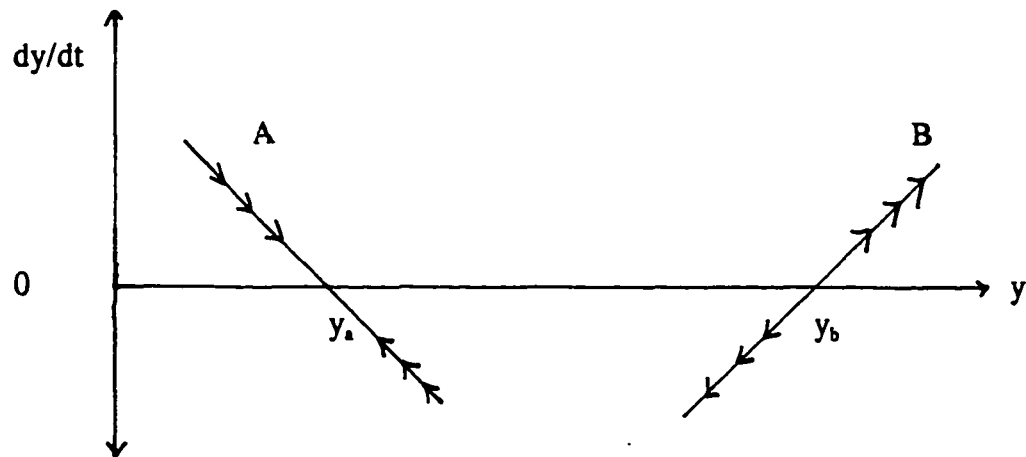
QUANTITATIVE VERSUS QUALITATIVE ANALYSIS

The presentation of dynamic relationships within this dissertation is done qualitatively through the use of causal diagramming techniques. The advantage of this approach is that the cumbersome mathematical formalities of quantitative solutions are avoided while still providing some degree of insight into the stability of the system under investigation. For example, the following linear differential equation can be analyzed both qualitatively and quantitatively:

$$\frac{dy}{dt} = -ay + b$$

The phase diagram corresponding to this equation, Figure B1, will depend on the value of a . If $a > 0$, then phase line A applies. If $a < 0$, then phase line B applies (b will determine the placement of the phase line along the horizontal axis and is freely manipulated in this discussion).

Figure B1: Phase Diagram of Dynamic Stability and Instability

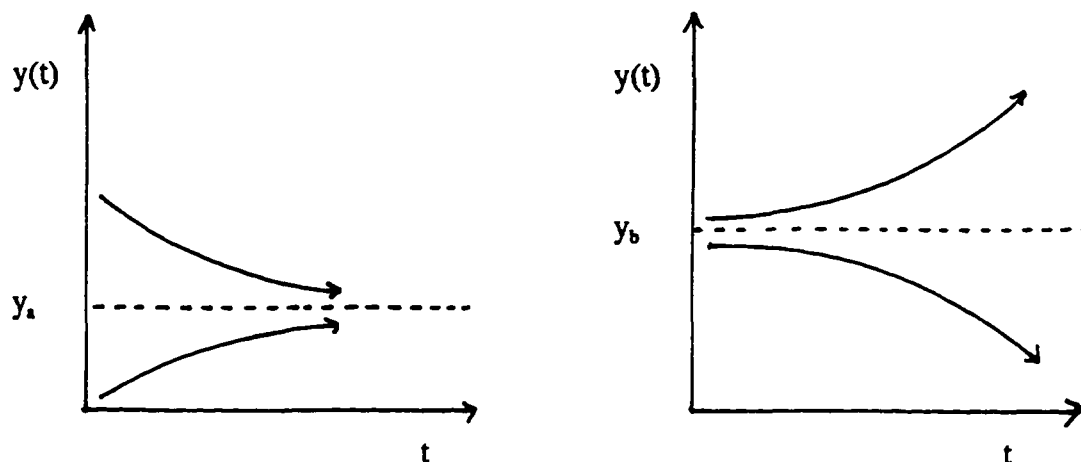


In reading this diagram, any point above the horizontal axis ($dy/dt=0$) is associated with an increasing y ($dy/dt > 0$) while any point below the horizontal axis is associated with a decreasing y ($dy/dt < 0$). These tendencies are represented by the arrowheads along the phase lines. If an equilibrium level of y exists, it will occur at a point where $dy/dt=0$, and therefore corresponds to the intersection of the phase line with the horizontal axis. In the above diagram, points y_a and y_b represent equilibrium levels of y . However, while y_a is a stable equilibrium in the sense that any deviation from y_a introduces dynamic forces which pull the system back to y_a , any deviation from y_b will engender dynamic forces which push the system away from y_b . Point y_b is called an unstable equilibrium. From this analysis the following conclusions are possible regarding the dynamic behavior of this equation:

- 1) If $a > 0$, $y(t)$ converges to equilibrium.
- 2) If $a < 0$, $y(t)$ diverges from equilibrium.

These conclusions can also be diagrammed as in Figure B2.

Figure B2: Time Path of Dynamic Stability and Instability



These qualitative conclusions as to the system's dynamic behavior have not required a detailed quantitative solution. Yet these conclusions *coincide perfectly* with those gleaned from the quantitative solution of this equation presented below, while concurrently utilizing a much more manageable presentation (see Chiang 1984:494-496).

$$y(t) = \left[y(0) - \frac{b}{a} \right] e^{-at} + \frac{b}{a}$$

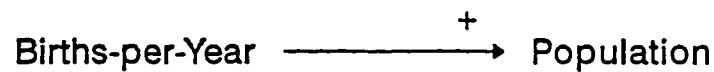
Since this essay is interested in the interrelations between multiple variables, this phase diagramming technique would need to be extended to include more than one variable. However, while it is possible to represent the dynamic interdependence between two variables with such means, it is not possible to represent more than two variables without getting into a three-dimensional representation. As an alternative, one can utilize causal loop diagramming to determine the contribution which certain causal sequences make to the dynamic behavior of a multivariate system. This method of

determining a system's dynamic behavior through a diagrammatic representation of the causal relations between the individual elements of the system is explored in the body of this dissertation. However, since this technique only utilizes a positive or negative sign to designate the quality of the causal relation between two variables, only general categories of dynamic behavior (e.g., convergence or divergence) can be identified. If more detailed information is required, a knowledge of the relative parameter values of the coefficients of interrelation between different variables is required in order to discern the relative strengths of the composite causal linkages. This points to the fact that causal diagramming is only the initial step in successfully modeling a system.

In addition, there are a few caveats that one should be aware of when working with causal diagrams. These difficulties center around the definitions frequently used to draw conclusions from causal loop diagrams. A positive loop (i.e., one with either zero or an even number of negative causal links) is usually defined as one in which an initial change in any variable ripples through the loop to induce further self-change in the same direction. In contrast, a negative loop (i.e., one with an odd number of negative causal links) is defined as one in which any initial change in a variable tends to be counteracted by self-change in the opposite direction, thereby tending to stabilize the system around some equilibrium value. When using these definitions, one must be careful to clearly distinguish between *rate-to-level* causal links versus *information* or *proportional* ones (Richardson 1981). A rate-to-level relation is a causal link between a variable and its rate of change, while a proportional connection occurs between two different variables. In other words, a rate-to-level relationship involves an accumulation of a conserved flow.

An example of this type of causal connection is that between births-per-year and population, as illustrated in Figure B3.

Figure B3: Rate-to-Level Causal Link

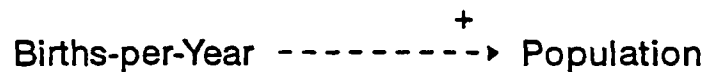


One might be tempted to qualify this causal relation with a positive sign, thus implying that an increase in births-per-year will increase the population. However, this would also imply that a decrease in births-per-year will decrease the population. This latter statement can only be true if we allow births-per-year to be a net value which could then fall below zero (i.e., births-per-year minus deaths-per-year). Even then, the fact remains that a decrease in births-per-year does not necessarily mean that the population will decline. The problem is that births-per-year is a flow which accumulates as the population.

The dilemma that such rate-to-level connections pose for causal loop diagramming is that the individual links of the causal loop can no longer be simply "summed-up" in order to categorize the dynamic behavior of the loop as self-reinforcing or stabilizing. As a result, causal loop diagrams which do not distinguish between rate-to-level links and proportional ones may lead to inaccurate predictions of a system's dynamic behaviors. In order to overcome this possible ambiguity, Richardson (1981) has suggested that a dashed line be used for proportionate causal links while solid lines be used for rate-to-

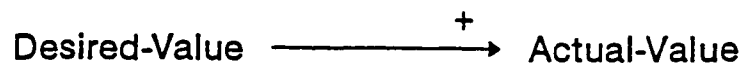
level ones.¹⁸⁴ However, since it is rate-to-level links which are of particular interest, I have chosen to reverse this recommendation and signify rate-to-level links with a dashed line. Figure B4 illustrates the births-per-year and population causal links using this convention.

Figure B4: Dashed Line Signifies Rate-to-Level Causal Link



In addition to this last caveat, one must be wary of hidden stabilizing circularities within causal diagrams. For example, this problem will arise when the adjustment mechanism which equilibrate two variables (e.g., a desired-value and actual-value) is erroneously replaced by a single linear connection such as in Figure B5.

Figure B5: Hidden Stabilizing Circularities



What one is attempting to communicate here is the idea that the desired-value and actual-value of the variable will be equivalent, but that the mechanism by which the system achieves this equivalence has been abstracted away from: An increase (decrease) in the

¹⁸⁴ It is interesting to note that Richardson (1984:108) does not take heed of his own advice.

desired-value leads to an increase (decrease) in the actual-value. However, whether or not a particular change in the desired-value will cause the actual-value to increase, decrease, or remain constant will depend on whether the current desired-value is greater than, less than, or equal to the actual-value. Although such hidden loops will cause the particular dynamic behavior (e.g., the presence or absence of oscillations) to be undeterminable through the investigation of the causal diagram, their presence will not alter the overall convergent or explosive nature of the causal relations.

Taking these two caveats into consideration, causal diagramming can still serve as a useful tool for presenting the dynamic relations between variables and predicting their behavior. Since the purpose of the present dissertation is to emphasize the evolutionary dimension of economic thought through history, this can be done effectively through casual diagrams by highlighting the positive causal circularities within the system. Although the analysis is fated to remain conceptual and therefore a bit abstract, I believe that it will serve as a fruitful heuristic tool. Since the equilibrium dimension of the economy is a well accepted fact, the reader is reminded that when the equilibrium and evolutionary facets of the system are brought into an interactive whole, the resulting system will be *nonlinear*.¹⁸⁵

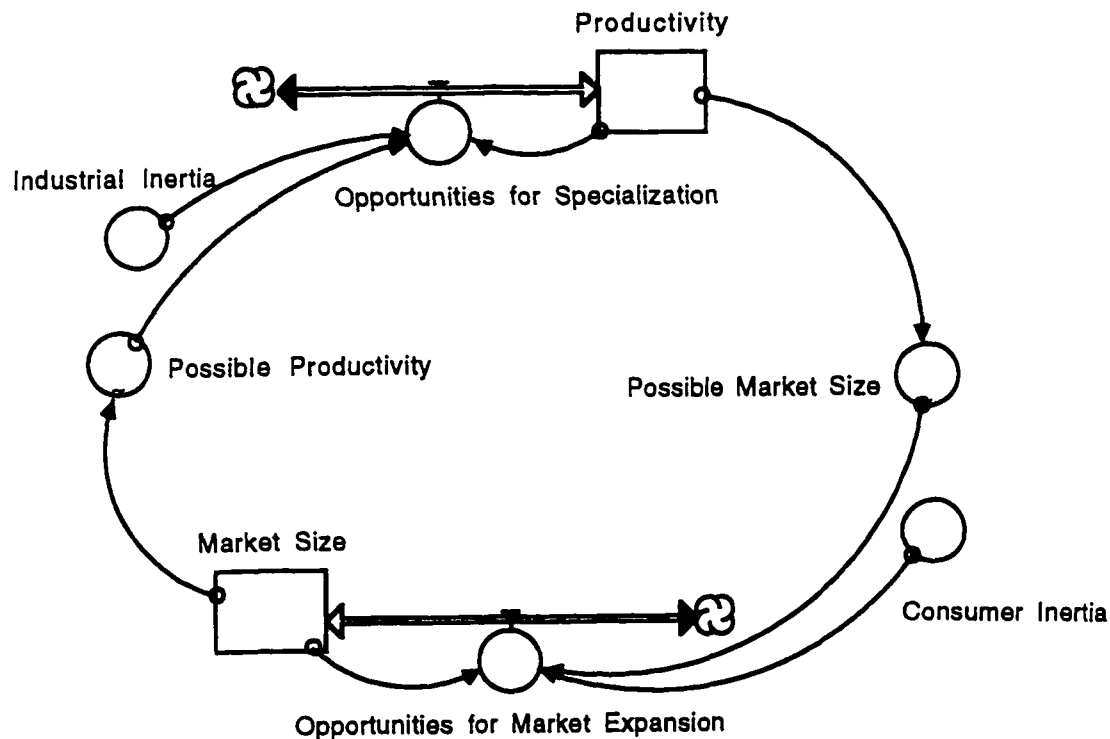
¹⁸⁵ A concise introduction to the neatly wrapped equilibrium framework of Neoclassical economic theory can be found in Wolff and Resnick (1987:Chapter 2).

APPENDIX C

A COMPUTER SIMULATION OF THE DIVISION-OF-LABOR AND EXTENT-OF-THE-MARKET RELATIONSHIP

It is possible to formulate a simple model, composed of two linear causal links, between productivity and market size that reflects Adam Smith's division-of-labor and extent-of-the-market circularity. Figure C1 is a diagrammatic representation of the STELLA model used in this simulation.¹⁸⁶

Figure C1: STELLA Model of Divison-of-Labor and Extent-of-the-Market Circularity



¹⁸⁶ Although one could use many different computer simulation programs, the STELLA modeling platform was chosen for this exercise. The advantage of this choice is that this platform is well developed and simple to use. Therefore, people can easily reproduce this model and build their own without a large investment of time in learning a programming language. A significant disadvantage of the STELLA platform is that the causal relations within the model are not easily arrayed into a heterogeneous web of structurally similar systems.

Although the particular dynamic behavior of the model will be dependent on the relative quantitative relationships between the variables, such a simple system demonstrates the possibility for quite complex and varied behavior (e.g., exponential growth, limit cycles and single point equilibriums). This model also provides some insight into the impact of social inertia (e.g., within productive and consumer relations) on the dynamic adjustment mechanism between the division-of-labor and extent-of-the-market.

In this model, capital and labor accumulation is held constant and all productivity advance is assumed to occur through *organizational* changes. One could imagine an economy in which everyone produces all of their needs themselves and has already accumulated all of the capital necessary for this production. However, as individuals begin to specialize and therefore purchase some of their needs from others, the general degree of specialization deepens, the agglomeration of capital utilized within market production increases, and the market economy expands (i.e., amount of goods traded between individuals rather than produced by one's self).

The model involves two causal relationships. First of all, a given MARKET SIZE (i.e., extent-of-the-market) is used to determine the level of POSSIBLE PRODUCTIVITY (i.e., division-of-labor) attainable.¹⁸⁷ The rate of change of PRODUCTIVITY is determined by the difference between the *possible* and the *actual* productivity. This gap is closed at a particular rate, i.e., INDUSTRIAL INERTIA, which is determined by the responsiveness of the community as a whole to productivity

¹⁸⁷ Words in all capital letters represent variables within the simulation model. MARKET SIZE is set between 0 and 2000, while PRODUCTIVITY ranges between 0 and 20. These values themselves are not significant.

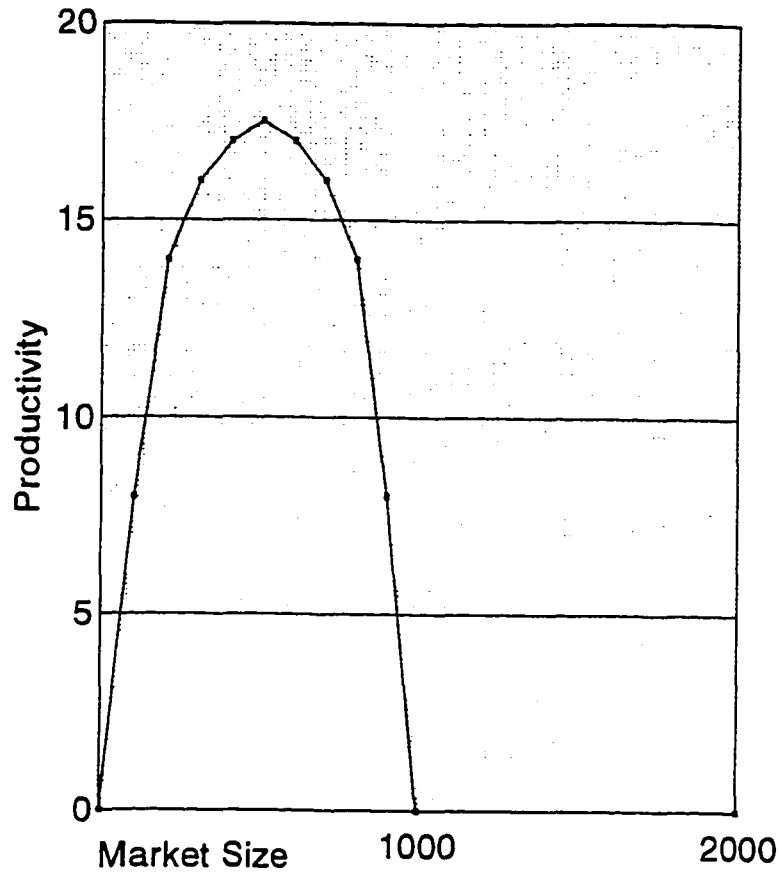
opportunities. For example, if capital and labor specialization occurs instantaneously (INDUSTRIAL INERTIA equal to one), then the economy will always fully expand to its optimum productive capacity given the size of the market. The inclusion of an inertial variable reflects Smith's interest in the social relations surrounding production.¹⁸⁸

In the current simulation model, the POSSIBLE PRODUCTIVITY variable is represented graphically rather than algebraically.¹⁸⁹ However, the model could easily be converted to an algebraically defined relationship if so desired. Figure C2 is a reproduction of the assumed POSSIBLE PRODUCTIVITY relationship, as determined by the actual MARKET SIZE, which is used as one initial parameter in the model.

¹⁸⁸ Such a notion was also addressed by the other theorists discussed in this dissertation. For example, Kaldor referred to the dynamic character of the people in control of production and Marshall spoke of this factor with respect to the management of firms.

¹⁸⁹ STELLA allows for graphical relationships to be "drawn on the screen" and hence one can easily and quickly alter the relationship to explore the dynamic implications of different structural assumptions.

Figure C2: POSSIBLE PRODUCTIVITY Graph



The parabolic form of this relationship reflects the standard assumption of initial increasing returns, followed by decreasing returns in production. As in conventional economic theory, this relationship thereby provides a constraint on the growth of the economy. A pure increasing returns relationship would result in exponential growth which would continue until constrained by the consumer side of the economy.

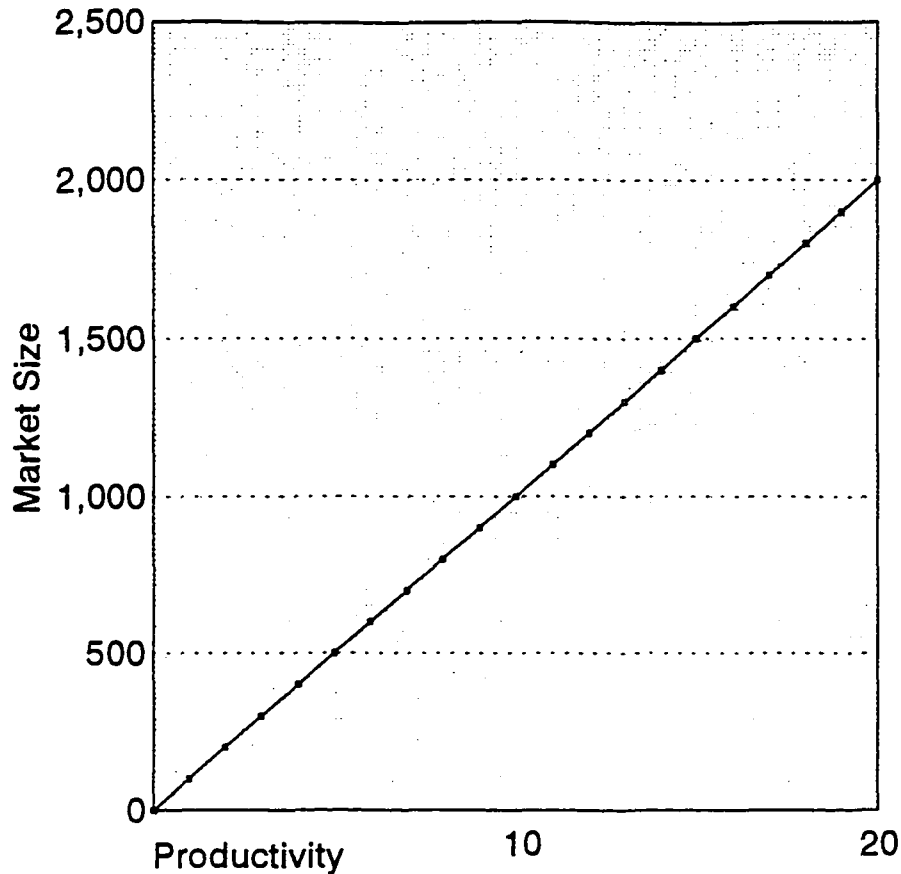
The second relationship at the core of this model involves the idea that a given level of PRODUCTIVITY will determine the POSSIBLE MARKET SIZE. One can think of this in two ways: (1) As productivity increases, costs fall and possibly prices. If prices do fall, this will subsequently influence the size of a product's market relative

to other products. (2) In addition, this relationship also represents the creation of income whereby the means by which to purchase the given goods within the economy is acquired. An increasing income (i.e., increasing market production) allows for more market trading regardless of relative prices. Although these details are not explicitly included in this model, this latter idea provides a promising inroad to *income distribution* considerations: income changes for different groups within the economy will create different effects since their consumption decisions will differ. As a result, these two facets of the POSSIBLE MARKET SIZE relationship should not be collapsed into a single explanation (e.g., declining real prices).

While the level of PRODUCTIVITY will determine the POSSIBLE MARKET SIZE, the rate at which the economy closes the gap between the *possible* and *actual* MARKET SIZE will be determined by the degree of CONSUMER INERTIA.¹⁹⁰ One can think of this as the rate at which consumers expand their trading behavior in response to higher levels of income (i.e., productivity increases). This relationship is included in the simulation as a graphical function under the assumption that the POSSIBLE MARKET SIZE expands at a uniform rate relative to the PRODUCTIVITY variable. Figure C3 illustrates this relationship.

¹⁹⁰ The actual simulation model has a y-intercept of five rather than zero within the POSSIBLE MARKET SIZE graph. Since (0,0) is an unstable equilibrium (see Figure C4), the simulation will not depart from this point if the initial values for MARKET SIZE and PRODUCTIVITY are zero. Therefore, this assumption allows the simulation model to display change without the need for an exogenous shock or non-zero initial values. In Smith's conception of the economy, the initial impetus for economic change comes from changes which were occurring in the social relations, which would represent an extension of the causal relations within this model.

Figure C3: POSSIBLE MARKET SIZE Graph



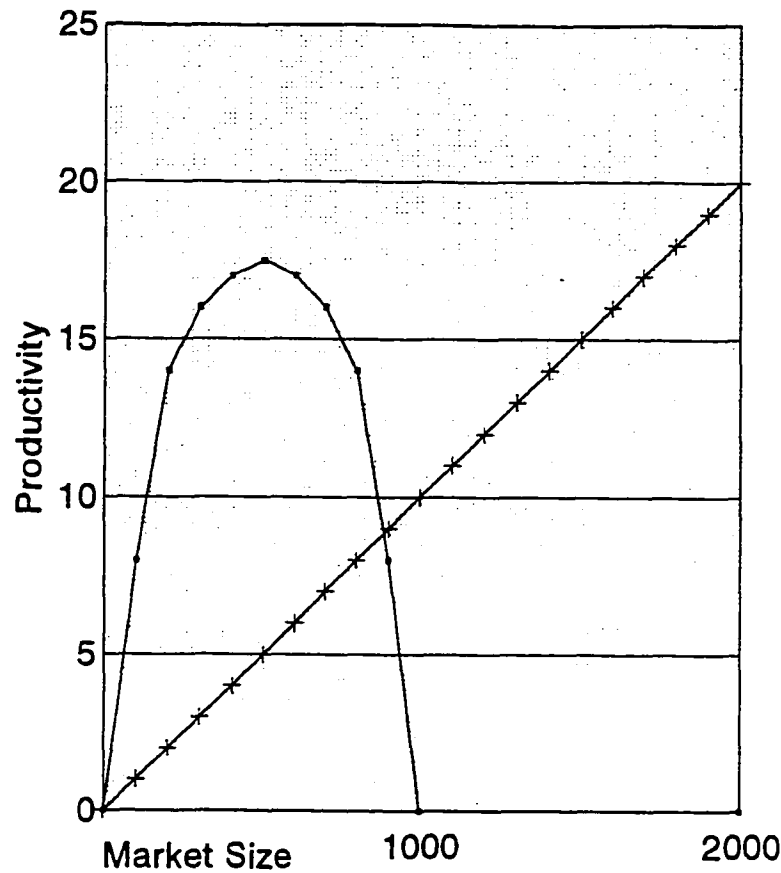
The assumption that declining prices and rising incomes will always elicit an increase in consumer desires for the product (e.g., similar to a constant marginal propensity to consume) may not be true for individual products, but it may hold greater validity as a macroeconomic phenomenon. This linear relationship is chosen for simplicity of presentation.¹⁹¹

These two core relationships can be placed in a single graph as shown in Figure C4. This graphical juxtapositioning was originally done by Boyer and Petit (1991), but

¹⁹¹ A more complex consumption relationship (e.g., a nonlinear function such as that used for PRODUCTIVITY) would have entailed a more detailed analysis without making a meaningful contribution to the conclusions.

is extended here into a computer simulation model which explores the system's behavior under variable parametric relationships.

Figure C4: Relationship between PRODUCTIVITY and MARKET SIZE

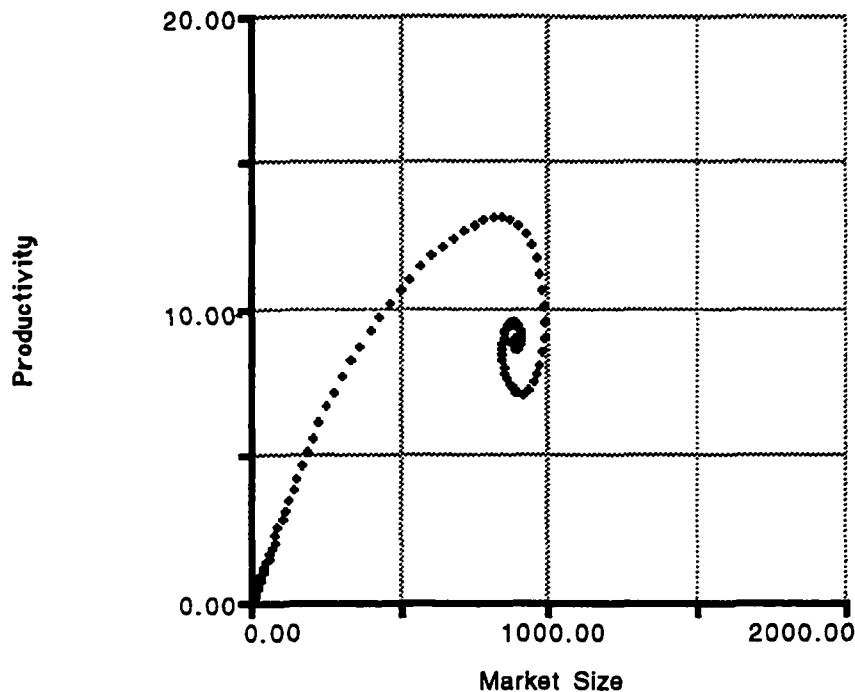


If the inertial variables are set at unity, the dynamic path of the system can be easily traced out within this graph through an iterative process. However, as the inertial variables decline in value, these graphic relationships represent the variable component within the determination of a variable's velocity of change.

For the sake of presentation, both the INDUSTRIAL INERTIA and the CONSUMER INERTIA rates are initially set equal to one, reflecting an instantaneous

adjustment process within the economy.¹⁹² Using the graphical relationships given above, the phase diagram in Figure C5 shows the dynamic evolution of the MARKET SIZE and PRODUCTIVITY variables.

Figure C5: Phase Diagram with Initialized Parameters



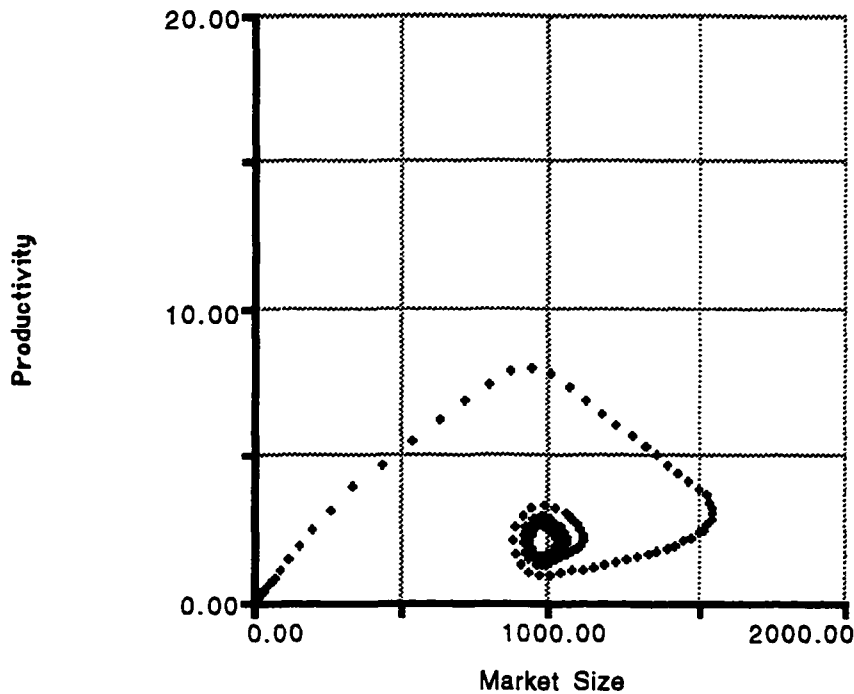
After experiencing an increasing MARKET SIZE and PRODUCTIVITY, the system demonstrates a short period of oscillatory behavior but quickly settles into a stable equilibrium position.

Leaving the POSSIBLE PRODUCTIVITY graph unchanged, but allowing the slope of the POSSIBLE MARKET SIZE graph to vary, this simulation model will manifest different dynamic behavior. Figures C6 represents an increasing slope for the

¹⁹² The time step of the simulation, using Euler's iteration method, is set at 0.0625 in order to get the most finely detailed dynamic behavior possible.

POSSIBLE MARKET SIZE graphical relationship. This means that market demand is more responsive (i.e., experiences a larger increase) to some given change in productivity. As a result of these changes, the system goes from settling into a simple equilibrium state to cyclical behavior.

Figure C6: More responsive MARKET SIZE

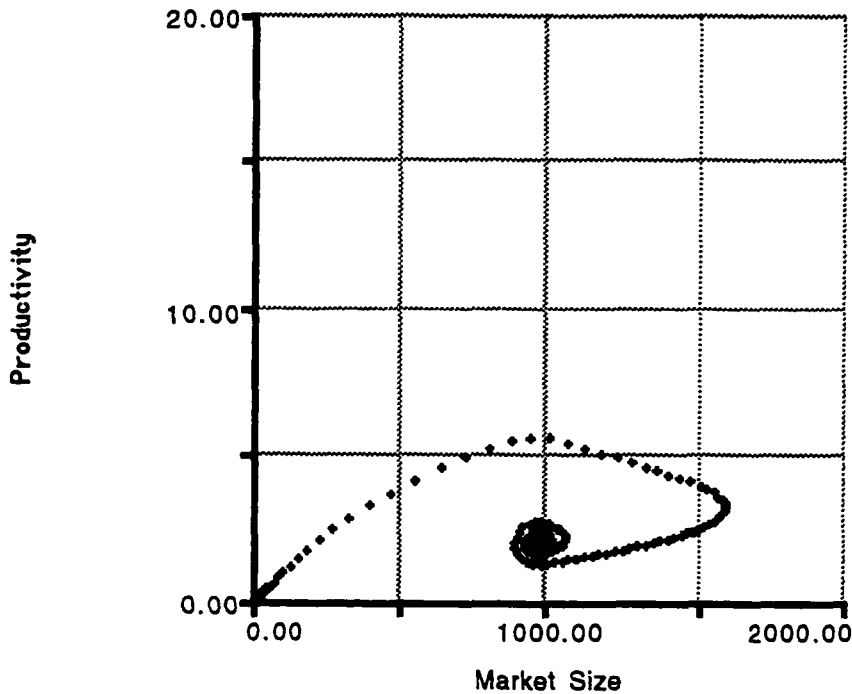


Figures C5 and C6 represent two generic dynamic behaviors into which the system can fall. One could also include exponential growth (e.g., if PRODUCTIVITY experiences continual increasing returns and individuals continually desire increased consumption), however this possibility has not been included here.

The implication of parametric shifts in the inertial variables of this system are to decrease the rate at which the system adjusts itself to new possibilities. For example,

a decreased INDUSTRIAL INERTIA variable (e.g., 0.5) will dampen any oscillations in the system by decreasing the rate at which the gap between the possible and actual PRODUCTIVITY variable is closed. For example, Figure C7 uses the same graphical relations as Figure C6, but alters the INDUSTRIAL INERTIA variable (set equal to 0.5).

Figure C7: Decrease in INDUSTRIAL INERTIA



Note that MARKET SIZE reaches a higher peak value than it did in Figure C6, but that PRODUCTIVITY peaks at a lower value. This is due to the restriction of the change in the PRODUCTIVITY variable relative to the MARKET SIZE variable. When the CONSUMER INERTIA variable decreases, the peak in PRODUCTIVITY will increase while that for MARKET SIZE decreases.

The purpose of this exercise is to demonstrate the use of simulation techniques in modeling the systems discussed in the body of this dissertation. A simple simulation model such as this can provide a basis by which to build a more detailed analysis of economic change which incorporates sectoral division and income distribution considerations. However, such a task would require a programming language which could more easily accommodate an array of structurally similar but historically different systems (e.g., see Costanza and Maxwell 1991).

APPENDIX D

A HYPOTHESIS CONCERNING THE EVOLUTION OF SELF-CONSCIOUSNESS

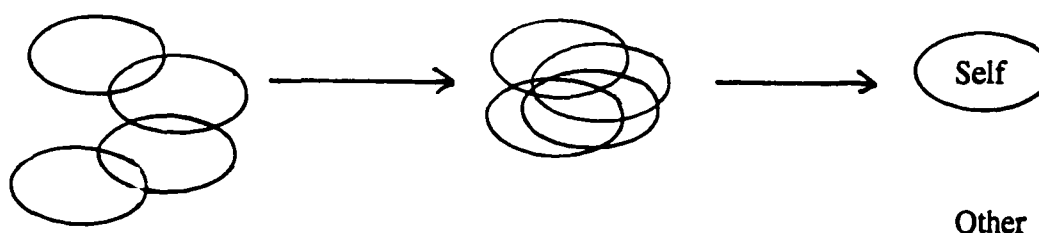
In Bartley (1987), the contention appears that the sensory perception of animals may not be coordinated into a unified whole. He cites cognitive research on a frog's visual perceptions which identifies five generic visual perceptions (i.e., windows) which elicit different responses from the frog. For example, the frog is responsive to small dark objects which pass within its field of vision (e.g., flying insects) and also to sudden drops in lighting intensity (e.g., the approach of a predator). Bartley believes that these findings suggest that a connection between the different sensory "windows" is not drawn, and that the animal acts as if these windows are from mutually exclusive sources. It is as if one were to look out from the different windows of a house *without the idea* that all these views are of a unified whole (i.e., an external world). These distinct sensory windows and their correlated behavioral responses take on an instinctual flavor involving a response to environmental gradients. For example, a plant grows towards light and its roots toward water without necessarily having the concepts of light, root, and water.

However, as one moves up the evolutionary ladder, these windows of perception might entail more complex activities.

A primitive animal might have a hunger space that it uses when hungry, a separate thirst space, a separate escape space for escape from each predator, a mate-finding space, and so on for each important activity. (Bartley 1987:38)

As one moves to "higher" animals, not only may the activities become more complex, but the hypothesis emerges that these perceptual spaces begin to overlap (ibid., 38). *To the extent that these previously isolated windows into the world become united, the world begins to be seen as an external whole, and the knower becomes a 'self.'* This progression can be illustrated with Venn diagrams as follows:

Figure D1: The Condensation of Self-Awareness



This complementary unification of perceptual spaces may signal the beginning of self-consciousness (i.e., the perception of a unified self in contrast to an external environment). A synthetic quality emerges from the pattern of sensual perceptions. Once the windows of perception are unified, the self is established through its continuity of existence and its *absence* within the unified perception of the external environment. After this initial declaration of "I" as an independent and continuous entity has arisen, this duality of self and other is projected within the realm of the external world: other phenomena which display a continuity through time are assumed to have *self*-existence also. Georgescu-Roegen ties distinct concepts to the sense of self:

Every arithmomorphic [discretely distinct] concept stands by itself in the same specific manner in which every Ego stands by itself perfectly conscious of its absolute differentiation from all other Egos. This is, no doubt, the reason why our

minds crave arithmomorphic concepts, which are as translucent as the feelings of one's own existence. (Georgescu-Roegen 1971:45)

Descartes' declaration is hereby inverted, "*I am, therefore I think.*" Furthermore, once the concept of an *animated self* has emerged, it makes sense that objects would be imbued with the same internal sense of independence that the observer feels, hence an inbred tendency for the emergence of an animistic conception of the world. Although these ideas are relatively new to the Western mind, they were explicitly embodied in the doctrines of the Yogacara school of Mahayana Buddhism (see Suzuki 1930, 1931; Sangharakshita 1957).

One should not forget that the emergent quality of self-consciousness arises from biological foundations and distinct windows of perception. Therefore, there would still be a tendency to react mechanically or behaviorally to particular situations since the evolution of a unified self has emerged from a pattern of previously exclusive perception-behavior correlations. This is witnessed by the fact that human beings are frequently *situational animals* with strong habitual tendencies. In other words, are your behaviors context dependent in a generic way? Are you a "different person" around your family or at work than when out with friends? This idea of a fragmented self is a pervasive theme within Buddhist thought (e.g., see Sangharakshita 1967, 1986) which has also been explored by the Russian philosopher P.D. Ouspensky (1974, 1981).

APPENDIX E

THE STRUCTURE-PROCESS INTERPLAY WITHIN ECONOMICS

Georgescu-Roegen's (1971: 211-275) discussion of *parallel* and *serial* production methods is an exemplary example of static increasing returns. He defines a parallel technique as one which has a continuity of incomplete goods flowing through the production process with partially completed products existing at every stage of production. In other words, every piece of the productive infrastructure is continually in use. For example, (1) the three machines and three laborers needed to cut the wood necessary to build 1000 birdhouses/day, (2) the five laborers with five hammers and a stock of nails necessary to assemble 1000 birdhouses/day, and (3) the ten laborers with ten brushes and a stock of paint necessary to paint 1000 birdhouses/day are "matched" in such a way that the flow of incomplete birdhouses is roughly equivalent through each segment of this production process. In this way, the amount of idle time experienced by the productive infrastructure is reduced (e.g., both capital and labor). In contrast, a series technique puts a host of inputs sequentially through each step of the transformative process as a group. For example, imagine a single laborer who owns a saw, hammer, brush, nails, paint, and wood; a serial technique would involve multiple boards being cut, then assembled, and lastly painted *as a group*. From such a perspective, the movement towards a more parallel technique is one of degree and the serial dimension

to production is continually lessened rather than absolutely removed since all production processes appeal to the natural environment and human beings in the final analysis.

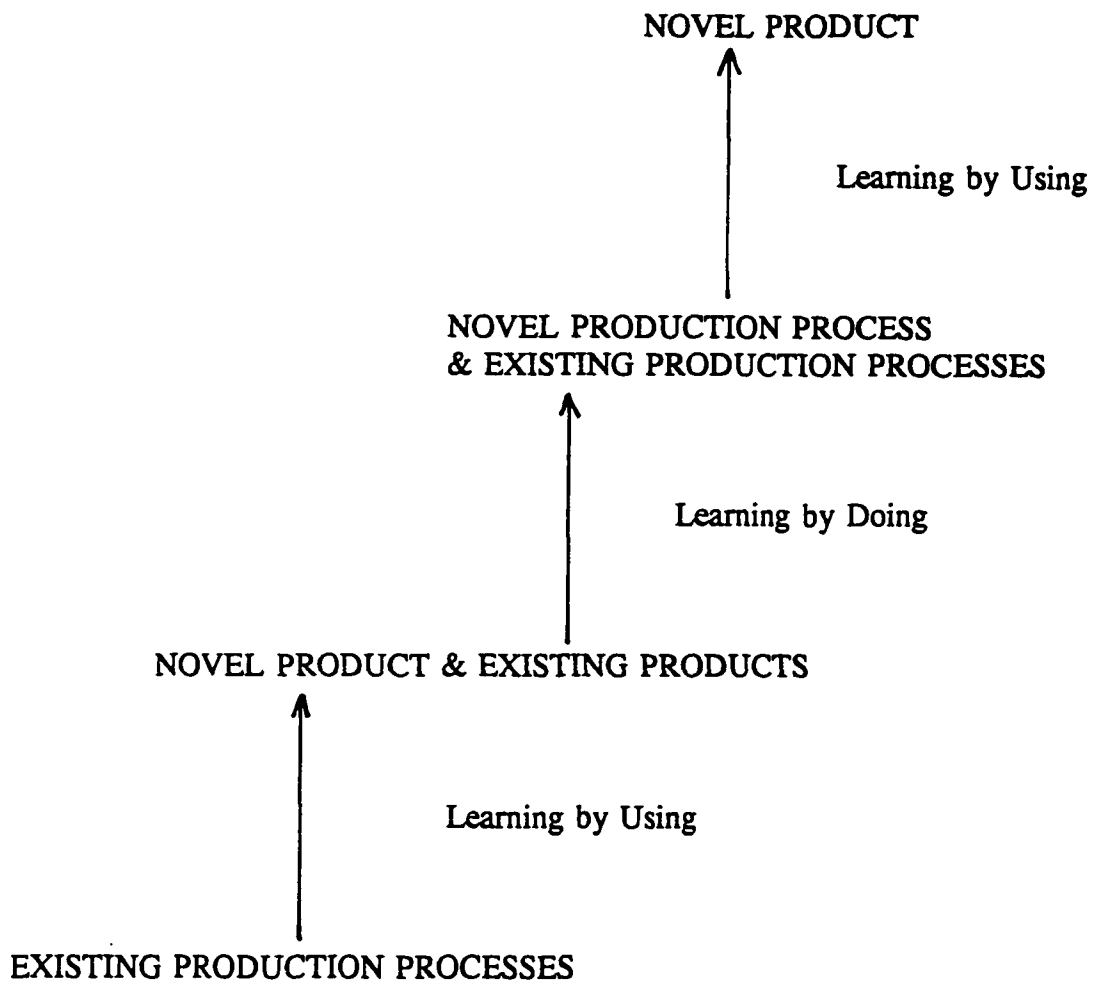
There will always be limits to the feasibility of parallel techniques in production. For example, our dependence on sunlight and the photosynthetic growth process of plants limits our ability to utilize a parallel techniques in agriculture. In contrast, manufacturing allows for a greater degree of parallel processing and therefore a reduction of idle funds. In a climate of growing environmental awareness, the process of creating raw materials and disposing of consumer or industrial waste is coming under closer scrutiny and may begin to impose limits on industrial expansion. These examples draw our attention to the fact that one can think of these production processes as involving the services of other *processes* rather than merely transforming *things*. For example, agriculture is ultimately dependent on relatively short ecological cycles of birth and death (e.g., photosynthetic process) while manufacturing depends on longer cycles (e.g., geological and forest growth). And both rely on the integrity of workers. This fact gives insight into the process of static returns: they are limited by the dynamic process of their compositional elements.

The concepts of *learning by doing* (Arrow 1962) and *learning by using* (Rosenberg 1982) embody a explicitly dynamic sense of IR relations. The former involves advances in producing a given good via new ways of using a given group of tools (i.e., whole as parts), garnered through experience and frequently proxied by cumulative output or investment. Whereas the latter involves the innovative productive uses for a given product (i.e., part as whole). Both learning by doing and learning by using involve the

necessity of time.¹⁹³ In other words, by using a given variety of tools in different ways, learning by using is the process by which one arrives at novel products. To the extent that these innovative products are used as tools in production (e.g., computers), learning by using creates the context in which learning by doing can unfold. An evolving circular relation exists between these two facets of learning, as illustrated in the following diagram.

¹⁹³ Although Arrow did comment that "the very activity of production" gives rise to new problems to which "favorable responses are selected over time," his ideas concern fixed raw material→final product translations which form the arena for learning. But, he stops short of explicitly saying that experience provides the context from which novel products evolve.

Figure E1: The Progressive Concatenation of Learning by Doing and Using



Learning by doing accounts for improvements in the production process of a given product while learning by using accounts for novel applications of a given product in production: the first is structural, the second interactive.

Recall Kondratieff's (1925) distinction between static and dynamic concepts in which the former seek an understanding of the interaction of unchanging elements while the latter consider the interaction of changing elements. In Georgescu-Roegen's parallel

versus series distinction it was the relative quantity of productive inputs rather than the inputs themselves that change. However, with the static-dynamic interplay between Arrow and Rosenberg's concepts of learning, it is the functional relationships between inputs and the quality of the outputs that changes. It seems to be the case that the distinction between static and dynamic facets is merely one of spatio-temporal perspective: dynamic returns endogenous to the firm are the static returns of the industry, and the dynamic returns of an industry are the static returns of the national or regional economy as a whole. Kondratieff's comment that ultimately everything is dynamic seems to hold.

Although the leveling of static IR concepts can be found within Marshall's Principles, the hierarchical relations between static and dynamic IR concepts was clearly outside the mainstream boundaries of economic inquiry after the IR debates of the 1920's. The use of dynamic IR concepts within economic theory was curtailed although static notions were still provisionally allowed, presumably since they dealt with quantifiable and stable elements. As a result, research tended to focus on the different structural levels of the economy (i.e., international, regional, institutional, industry, and firm) and thereby tended to identify increasing returns as inherent structural qualities of economic institutions. Dynamic IR foundations have been implicitly explored through research on static IR concepts (e.g., economic development), and have resulted in explicit criticisms of equilibrium methodologies. Since the appropriate mathematical tools did not exist for formally modelling these dynamic IR concepts, their exploration

tended to be highly literary and expositions were frequently narrative with a smattering of historical statistics used to capture broad historical trends.

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