

The Historical Evolution of Polities

by

**Douglass C. North,
Washington University,
St. Louis***

In an earlier essay (North, 1981, Ch. 3) I developed a "Neo-Classical Theory of the State". This essay elaborates, extends and modifies that essay in three directions: 1. it incorporates time into the model; 2. it is explicitly concerned with the perceptions--the belief systems--that determine choices; and 3. it relates the belief systems to the external environment of the players; both the past environmental experiences that are incorporated in cultural conditioning and the present environmental experiences incorporated in "local learning".

I

The earlier essay explored the exchange relationship between a wealth maximizing ruler and constituents in terms of the gains from trade as a consequence of the economies of scale a ruler could provide in the protection and enforcement of property rights in return for revenue (taxes). The distribution of the gains from the exchange was a consequence of the opportunity costs of the players. In that essay I argued that there were two constraints on the ruler that would typically produce inefficient property rights, a transaction cost constraint and a competitive constraint.

In an important contribution my sometimes colleague Yoram Barzel (1993) has extended and modified the argument to suggest that over time both economic growth and the rule of law could emerge from such an exchange relationship. Barzel's argument can be summarized as follows: The initial condition is one of an absolute ruler who can confiscate any assets his subjects may own or any future income but, because policing and monitoring costs are positive, the ruler stands to gain by exchanging with his subjects. If he permits his subjects to own and accumulate wealth he can get more income by promising to let the constituents keep a portion of their incremental income. However the ruler continually faces a tradeoff between the higher income he can obtain by relaxing restrictions on constituents (thereby increasing their productivity and both their and his income) and the increasing threat to his security that the relaxed restrictions entail because his subjects have both more freedom of action and resources to overthrow him. Equally the constituents face the dilemma that the ruler at some point may renege on his promises and confiscate the accumulated wealth of his constituents. The solution is for the ruler to so structure the game that it is both in his and his constituents interests to abide by the rules or the ruler can guarantee his conduct by giving over some rights and coercive power to constituents or their representatives. Gradually over a long period of time both efficient property rights and the rule of law would emerge from this exchange.

Barzel makes clear the constraints that would determine the outcome. Credible commitment can only be realized over a long period of time. Time is crucial for the ruler since he/she must have a discount rate that can realize the gains from long term contracting. If the time horizon of the ruler is shortened by fiscal crises, historically a consequence of war, or by the mortality of the ruler, unleavened by the utility derived from hereditary succession, then confiscation becomes an attractive alternative. Time is crucial for the constituents since uncertainty about the ruler's behavior can only be mitigated by the ruler establishing a reputation for integrity.

II

Barzel's essay is both a simple and elegant model and an important contribution. It captures the essence of a broad pattern of political/economic development of western societies during the past half millenium and does so by incorporating time into the analysis--an essential ingredient missing in both neo-classical theory and historical analysis of polities. His model is explicitly England but it does also characterize the early development of "representative " bodies in western Europe. Moreover the essay is full of interesting insights that have charcterized the way the rule of law has evolved in particular contexts and about the learning process of the players. But Barzel's analysis raises a perplexing problem. Why doesn't it have a better fit to the specific historical evolution of particular polities? It bears only a superficial resemblance to the way England evolved,¹ and, in fact, is a much better fit to the early history of the Low Countries under Burgundian and Habsburg rule (see section V below).² It does not account for the failures in the rest of Europe--notably Spain, Portugal and France--and in the rest of the world. China, in particular, was characterized by an Emperor with many of the attributes of an absolute ruler and substantial periods of peace but never evolved the rule of law. Surely Barzel's model was the ideal strategy for imperial powers in dealing with their colonies. And why has the rule of law had such difficulty getting established in Latin America?

What is missing is an analysis of the way in which the perceptions of the players evolve over time--the perceptions that underlie the choices the players make. Ideas matter and different perceptions produce different choices and as Frank Hahn succinctly put it "there is a continuum of theories that agents can hold and act on without ever encountering events which lead them to change their theories"(Hahn, 1987, p. 324). The result is that multiple equilibria can ensue rather than a determinate equilibrium. The development of a more general theory requires that we explore the basis for the evolving different perceptions so that we can both account for and build into our models the different ideologies, dogmas, and ideas that underlie choices.

III

It is surely not controversial that individuals with different background experiences have different explanations for the world around them and in consequence will make different choices when confronted with identical problems to solve. The

substantive rationality postulate of neo-classical theory holds under the highly restrictive conditions that the problem to be solved be familiar in the sense that the most appropriate model is derivable from experiences the chooser already knows, that the chooser is motivated, and that the information feedback with which to correct incorrect models is readily available in a form that makes its relevance to the existing model transparent.³

In the world of uncertainty and ambiguity that characterizes most important political and economic choices players have different theories to explain the world around them and to serve as a basis of choice. The key to societal performance is the kind of learning that is acquired and applied to solving human problems. The learning that is acquired is the deep underlying source of both the technology and the institutions that humans apply to solve problems of scarcity. Surely learning is learning. Not so, as witness the diverse perceptions and belief systems that characterize, for example, the worlds of primitive tribes people in the Amazon basin, Communist party members of the ex Soviet Union, Shiite fundamentalists in Iran, business men and women in the United States.

Much about learning we still do not understand, but from Piaget to modern cognitive science we have made great strides.⁴ Learning consists of developing a structure by which to make sense of the varied signals received by the senses. The initial architecture of the structure is genetic but its subsequent development is a result of the experiences of the individual. The experiences can be classified into two kinds--from the socio-cultural linguistic environment and from local learning. The mind forms categories--classifications that gradually evolve from earliest childhood in order to organize our perceptions and keep track of our memory of analytic results and experiences. Building on these categories, we form mental models to explain and interpret the environment typically in ways relevant to some goal. Both the categories and mental models evolve to reflect the feedback derived from new experiences--feedback that may strengthen and confirm our initial categories and models or that may lead to modification--in short, learning.

It is at this juncture that the learning of humans diverges from other animals and certainly diverges from the computer analogy that dominated so much of the early work in artificial intelligence. The human mind appears to order and reorder the mental models in successively more abstract form so that they become available to process information outside its special purpose origins. The term used by Clark and Karmiloff-Smith (forthcoming) to describe this process is representational redescription. The capacity to generalize, to reason from the particular to the general, and to use analogy is a part of this process. Representational redescription not only is the underlying source of human creativity but also is the source of the belief systems that humans develop (and share) to explain the world around them.

Let me explore in more depth each of these aspects of learning beginning with the socio-cultural linguistic environment. Culture consists of the intergenerational

transfer of norms, values, and ideas. But the role of culture we are concerned with here is that it "is a process that permits the learning of prior generations to have more direct effect on the learning of subsequent generations." (Hutchins and Hazlehurst, p. 690). Thus H & H speculate that a population over many generations could be capable of discovering things that no individual could learn in a lifetime (p. 690). The transmission that is put in place by past generations is described by them as the artifactual structure. This artifactual structure is more than the embodied learning of past generations transmitted as culture into the belief structure of present generations. It is also embodied in the institutional structure inherited from past generations. Hayek and some other authors who have built models derived from evolutionary theory have used the term collective learning to characterize this process. While the formal rules a society puts in place will surely reflect this heritage, it is the informal constraints embodied in norms of behavior, conventions and self imposed codes of conduct that is the most important "carrier" of the artifactual structure. While the formal rules can be changed overnight (by a revolution for example) the informal constraints change much more slowly and play a critical role in the evolution of polities. "Local learning" is derived from the specific environment (both physical and intellectual) of a society and as changes occur in that environment they are gradually assimilated into the socio-cultural linguistic inheritance and embodied in the artifactual structure.

Belief systems consist of organized, integrated and more or less consistent explanations of the world around us. But such systems are more than an attempt to reason from the particular to the general (as in representational redescription); they contain a normative element. They purport not only to explain the world around us but also to explain how the world should be ordered. Religions have been throughout history the most comprehensive belief systems although they have shared the stage with less comprehensive ideologies and in the modern world they have shared the stage with secular belief systems such as communism.

How do belief systems get transferred into the institutional structure? Take the long standing view of many scholars that individualistic behavioral beliefs are congenial to economic growth. Alan Macfarlane's *The Origins of English Individualism* (1977), for example, paints a picture of a fluid individualistically oriented set of attitudes towards the family, the organization of work, and the social structure of the village community that prevailed from at least the thirteenth century in England. These attitudes were transferred into the institutional structure via a set of formal rules dealing with property inheritance and the legal status of women.

More recently Avner Greif (forthcoming) compares Genoese traders with traders who had adopted the cultural and social attitudes of Islamic society in the Mediterranean trade of the eleventh and twelfth centuries. He detects systematic differences in their organizational structure traceable to contrasting individualistic versus collectivist behavioral beliefs. The traders from the Islamic world developed in-group social communications networks to enforce collective action which, while

effective in relatively small, homogeneous ethnic groups, do not lend themselves to the impersonal exchange that arises from the growing size of markets and diverse ethnic traders. In contrast the Genoese developed bilateral enforcement mechanisms which entailed the creation of formal legal and political organizations for monitoring and enforcing agreements--an institutional/organizational path that permitted and led to more complex trade and exchange. Greif suggests the generality of these different belief structures for the Latin and Muslim worlds and then makes the connection between such belief structures in the European scene and the evolution of economic and political institutions.

It is belief systems that are the underlying determinant of path dependence, one of the most striking regularities of history.⁵ It is not simply the fact that the organizations that arise as a result of a given institutional structure have a vested interest in perpetuating that institutional structure, an argument I have advanced in the past. The argument goes deeper than that. The way the institutions evolve reflects the ongoing belief systems of the players. Path dependence, conceived this way, can account both for the pervasive influence of the past on the present and future and also for those occasions when abrupt changes in the path of a society do occur. The latter will occur when the belief system is perceived to be inconsistent with the outcomes predicted by that belief system.⁶

IV

An institutional/cognitive story of long run political/economic change can be characterized as follows: As tribes evolved in different physical environments they developed different languages and, with different experiences, different mental models to explain the world around them. To the extent that experiences were common to different tribes the mental models provided common explanations. The languages and mental models formed the informal constraints that defined the institutional framework of the tribe and were passed down intergenerationally as customs, taboos, myths that provided cultural continuity.

With growing specialization and division of labor the tribes evolved into polities and economies; the diversity of experience and learning produced increasingly different societies and civilizations with different degrees of success in solving the fundamental economic problems of scarcity. The reason is that as the complexity of the environment increased as human beings became increasingly interdependent, more complex institutional structures were necessary to capture the potential gains from trade. Such evolution requires that the society develop institutions that will permit anonymous, impersonal exchange across time and space. A polity that can provide credible commitment to the long term contracting that is an essential part of such an exchange system is a necessary condition. But to the extent that the culture and local experience had produced diverse institutions and diverse belief systems with respect to the gains from such cooperation, the likelihood of creating the necessary institutions to capture the gains from trade of more complex contracting varied.⁷ There is no

guarantee that the artifactual structure of beliefs and institutions will produce the necessary institutions. In fact most societies throughout history got "stuck" in an institutional matrix that did not evolve into the impersonal exchange essential to capturing the productivity gains that come from the specialization and division of labor that have produced the Wealth of Nations.

V

Let me use this framework to briefly outline the diverse development of three polities, the Netherlands, England, and Spain, in western Europe.⁸ Since history is about how yesterday's choices affect today's decisions, any starting point is not just arbitrary but does violence to the essential continuity of history. Accordingly both the belief structure and the institutional environment of the early middle ages require that we glance over our shoulder at their background sources.

Take the beliefs systems. If we accept that there were different beliefs systems in different societies and that they induced different forms of institutions and organizations, what produced the beliefs? The major candidate is religions since they were the dominant organized belief structures of the pre-modern world. The vast literature dealing with the effect of religious dogma on political/economic activity is, however, inconclusive since it is possible to pick out specific aspects of any religion that are antithetical to economic growth. Some of these are the Islamic opposition to insurance markets (Kuran, 1986) and the Christian opposition to interest.

The proper focus, however, should not be on specific norms but on the learning process by which a particular belief structure--in this case religion--evolves. The learning process is a function of 1) the way in which the belief structure filters the information derived from experiences and 2) the different experiences (local learning) that confront individuals in different societies at different times. Thus one can argue that the Christian religious framework of the middle ages provided an hospitable filter for learning that led to adaptations congenial to political/economic growth; or alternatively that the specific geographic/economic/institutional context of the medieval western world provided the unique experiences responsible for the resultant adaptations. In fact it was a combination of the two that produced the adaptations in the belief system that were conducive to economic growth and political/civic freedoms in the cases of the Netherlands and England (and a different external environment that produced the Spanish belief system that resulted in economic decline, stagnation and political autocracy).

The belief system embodied in Christian dogma was, despite some notorious contrary illustrations, amenable to evolving in directions that made it hospitable to economic growth and political freedoms. For example Christian beliefs gradually evolved the view that all legitimate government must be based on the consent of the governed; further the Church developed the practice of holding representative councils in making many decisions of church government, a practice that appears to have been

directly carried over to secular policies.⁹ But it was particularly the unique institutional conditions of parts of medieval/early modern Europe that served as the catalyst to precipitate such perceptions.

It was the lack of large scale political and economic order that created the essential environment hospitable to political/economic development. In that competitive, decentralized environment lots of alternatives were pursued as each society confronted its own unique external environment. Some worked, as in the cases of the Netherlands and England; some failed, as in the cases of Spain and Portugal; and some, such as France, fell in between these two extremes. But the key to the story is the variety of options pursued and the likelihood (as compared to a single unified policy) that some would turn out to produce political/economic development. Even the relative failures in Western Europe played an essential role in European development and were more successful than other parts of the world because of competitive pressures.

The last point deserves special emphasis. It was the dynamic consequences of the competition amongst fragmented political bodies that resulted in an especially creative environment. Europe was politically fragmented; but it was integrated in having both a common belief structure derived from Christendom, and information and transportation connections that resulted in scientific, technological, and artistic developments in one part spreading rapidly throughout Europe. To treat the Netherlands and England as success stories in isolation from the stimulus received from the rest of Europe (and to a lesser degree Islam and China) is to miss a vital part of the explanation. Italian city states, Portugal, and Germanic states all fell behind the Netherlands and England; but banking, artistic development, improvements in navigation, and printing were just a few of the obvious contributions that the former states made to European advancement.

The Netherlands and England pursued different paths to political/economic success but in each case the external environment was conducive to the evolution of a belief structure that induced political and economic institutions that lowered transaction costs. In contrast Spain's external environment produced just the opposite results. In each of the three polities competition among the evolving nation states was a deep underlying source of change and equally a constraint on the options available to rulers within states. It was competition that forced the crown to trade rights and privileges for revenue including most fundamentally the granting to representative bodies--variously Parliament, States General, Cortes--control over tax rates and/or certain privileges in return for revenue. But it was the evolving bargaining strength of rulers vis-a-vis constituents that was the decisive feature of their subsequent development. Three considerations were at stake: 1) the size of the potential gains the constituents could realize by the state taking over protection of property; 2) the closeness of substitutes for the existing ruler--that is the ability of rivals (both within and outside the political unit) to the existing ruler to take over and provide the same, or

more, services; 3) the structure of the economy which determined the benefits and costs to the ruler of various sources of revenue.

Let me briefly describe the background conditions of the three polities--the Netherlands, England, and Spain-- that led up to the contrasting external environments that shaped the belief systems.

To understand the success of the Netherlands one must cast a backward glance at the evolution of the prosperous towns of the Low Countries such as Bruges, Ghent, and Liege; their internal conflicts; and their relationship to Burgundian and Habsburg rule. The prosperity of the towns, whether based on the wool cloth trade or metals trade, early on made for an urban centered, market oriented area unique at a time of overwhelmingly rural societies. Their internal conflicts reflected ongoing tensions between patrician and crafts and persistent conflicts over ongoing efforts to create local monopolies which, when successful, led to a drying up of the very sources of productivity which had been the mainspring of their growth. Burgundian (and later Habsburg) rule discouraged restrictive practices such as those that developed in the cloth towns of Bruges and Ghent and encouraged the growth of new centers of industry that sprang up in response to the favorable incentives embodied in the rules and property rights. In 1463 Philip the Good created a representative body, the States General, which enacted laws and had the authority to vote taxes for the ruler. The Burgundians and Habsburgs were rewarded by a level of prosperity that generated tax revenues that made the low countries the jewel in the Habsburg Empire.

England evolved along a route different from that of continental polities. Being an island made it less vulnerable to conquest and eliminated the need for a standing army (and undoubtedly contributed to the different initial belief structure that Macfarlane describes). The Norman conquest, the exception to British invulnerability to external conquest, produced a more centralized feudal structure than on the continent. The political institutions, in consequence, differed in several important respects from those of the continent. There was a single parliament for the entire country; no regional estates as in France, Spain, and the Netherlands. There was also no divisions into towns, clergy, and nobility. But the more centralized feudal structure did not gainsay that the crown could not overstep the traditional liberties of the barons as the Magna Carta attests.

The Spanish state emerged under Ferdinand and Isabella in the late fifteenth century joining together two very different regions, Aragon and Castile. The former (comprising Valencia, Aragon, and Catalonia) had been reconquered from the Arabs in the last half of the thirteenth century and had become a major commercial center. That Cortes reflected the interests of merchants and played a significant role in public affairs. Indeed, had Aragon determined the future of Spain its history would have been different. But it was Castile with its centuries of strife against the Moors and ceaseless internal wars among feudal barons that determined the path that Spain would follow.

We can now turn to examining the evolving bargaining strength (and the three underlying determinants) of ruler versus constituent that shaped the belief structure and the path of each polity. Take the Netherlands. The productive town economies stood to gain substantially by the political order and protection of property rights provided by the Burgundians and then by Charles V. The structure of the economy built around export trades provided the means for easy-to-collect taxes on trade but not at a level to adversely affect the comparative advantage of those export trades. The liberty to come and go, buy and sell as they saw fit led to the evolution of efficient economic markets. But when Philip II altered the "contractual agreement" the Seven Provinces became convinced that they could only prosper with independence. The resistance was initiated by the States General which in 1581 issued the Act of Abjuration of allegiance to Philip II and claimed sovereignty for the Provinces themselves. The powers of the newly independent country resided with each province (which voted as a unit) and a unanimity rule meant that the States General could only act with the unanimous approval of the Seven Provinces. Cumbersome as that process was, this political structure survived. The polity not only evolved the elements of political representation and democratic decision rules but equally supported religious toleration. The belief structure that had evolved to shape the independent polity was more pragmatic than "intellectual," a consequence of the incremental evolution of the bargaining strength of constituents and rulers.

As with the Netherlands it was England's external trade that provided an increasing share of crown revenue with taxes on wine, general merchandise and wool cloth; but it was the wool export trade that was the backbone of augmented crown revenue. Eileen Power's classic story of the wool trade (1941) describes the exchange between the three groups involved in that trade: the wool growers as represented in Parliament, the merchants of the staple, and the Crown. The merchants achieved a monopoly of the export trade and a depot in Calais, Parliament received the right to set the tax, and the crown received the revenue. Stubbs (1896, 3:599) summarized the exchange as follows: "The admission of the right of parliament to legislate, to enquire into abuses, and to share in the guidance of national policy, was practically purchased by the money granted to Edward I and Edward III..."

With the Tudors the English crown was at the zenith of its power but it never achieved the unilateral control over taxing power that the crowns of France and Spain achieved. The confiscation of monastery lands and possessions by Henry VIII alienated many peers and much of the clergy and as a consequence "Henry had need of the House of Commons and he cultivated it with sedulous care" (Elton, 1953, 4). The Stuarts inherited what the Tudors had sown and the evolving controversy between the Crown and Parliament is a well known tale. Two aspects of this controversy are noteworthy for this analysis. One was the evolving perception of the common law as the supreme law of the land--a position notably championed by Sir Edward Coke--and the other was the connection made between monopoly and a denial of liberty as embodied in the Crown grants of monopoly privileges.

The Spanish political evolution was a stark contrast to the two successful cases. The Castilian Cortes, unlike its Aragon counterpart, did not represent powerful commercial interests and the towns that were represented did not pose a credible challenge to the Crown. Within Castile the chief source of revenue was the alcabala, a form of sales tax, but as the Empire grew after the ascension of Charles V to become the greatest since Rome, the major sources of revenue were external--from Aragon, Naples, Milan, but particularly the Low Countries. To these sources was joined the revenue from the treasure of the New World. The bargaining position of the crown vis-a-vis the Cortes shifted overwhelmingly in favor of the Crown with the resultant decline in the influence of the Cortes. As a result the Crown not only controlled tax policy but gradually consolidated political and economic decisions into a large and elaborate hierarchy of bureaucrats whose outpouring of royal edicts provided minute regulation over every aspect of the economy. Over 400,000 decrees had been issued concerning the governance and economy of the Indies alone by 1635. The Crown gained unilateral control not only over the polity and economy but also over Church policy and the doctrines of the Church that were enunciated. The triumph of the Crown was a triumph of medieval values, beliefs, and perceptions and perpetuated a system of medieval status. That belief system as reflected in personalized exchange, kinship ties, status systems in a completely politicized environment of centralized governmental decision making, not only never made the crucial step of creating institutions for impersonal exchange, but perpetuated that structure downstream in the polities of Latin America. After Latin American countries became independent they simply substituted centralized local bureaucratic controls in place of those from Madrid. Here is John Coatsworth's characterization of the institutional environment of nineteenth century Mexico:

The interventionist and pervasive arbitrary nature of the institutional environment forced every enterprise, urban or rural, to operate in a highly politicized manner, using kinship networks, political influence, and family prestige to gain privileged access to subsidized credit, to aid various stratagems for recruiting labor, to collect debts or enforce contracts, to evade taxes or circumvent the courts, and to defend or assert titles to land. Success or failure in the economic arena always depended on the relationship of the producer with political authorities.... (Coatsworth, 1978, p. 94)

VI

While the specific details vary the broad patterns of England successful evolution, on the one hand, and Spain's unsuccessful evolution on the other have been replicated in subsequent centuries. English settlements that were not complicated by overlying different (and conflicting) native cultures produced path dependent patterns of economic growth, political democracy, and the rule of law. As noted above

Spanish (and Portugese) settlements failed to produce such results (even in those cases such as Argentina that did not have the complications of blending different cultures).

The much more indifferent success that the English (and other colonial powers) had in inducing the development of polities and economies when imposed on an already existing culture suggests a fundamental source of institutional failure--and that is the critical role of the informal constraints in shaping the evolution of polities. Imposing a set of formal rules on an existing culture with informal constraints that are inconsistent with the new set of formal rules is a recipe for political and economic failure.¹⁰

The foregoing analysis suggests the fundamental role of path dependence in the historical evolution of polities--an argument powerfully reinforced by Robert Putnam's recent (1993) study of the contrasting historical paths of Italian regions.

Footnotes:

* I am indebted to Elisabeth Case for editing this essay.

1. The English case is only a partial fit. It was the barons who imposed the Magna Carta on King John and, after the early period of parliamentary development (which does fit his story), it was the parliament that forced the concessions from the Stuarts with both a civil war and the overthrow of Charles II which led to parliamentary supremacy. If we define the rule of law as the supremacy of parliamentary rule that rule was forced on the reluctant Stuarts.

Indeed where rulers were absolute or nearly so as in the cases of France and Spain the representative bodies did not evolve but were largely neglected or ignored. The key to the varied performance of rulers is the bargaining strength of rulers vis-a-vis constituents.

2. The Seven Provinces of the Low Countries subsequently became the Netherlands and was the first country in Europe to establish a representative polity (with a unanimity rule of the seven provinces), and the rule of law but did so all the while engaged in a century of warfare with Spain.

3. See Denzau and North (1994) for an extended discussion (and sources in the psychological and experimental economics literature) of the substantive rationality postulate.

4. The best introduction to the cognitive science literature is Induction by Holland et al (1986).

5. See essays by Arthur (1988), David (1985), and North (1990) for discussions of path dependence.

6. This is a hubristic assertion since little is really known about this crucial subject which is essential to the successful transformation of eastern Europe and third world economies.

7. Heiner, in a pathbreaking essay (1983), makes the connection between the difficulty of deciphering the environment and the rules a society will construct to restrict the flexibility of choices in such situations.
8. What follows is a very brief summary of an extended essay entitled "The Paradox of the West" in R. Davis (ed.) *The Origins of Modern Freedom* (forthcoming).
9. There is an immense literature on this subject. An excellent summary is contained in Brian Tierney "Freedom and the Medieval Church" in R. Davis (ed.) forthcoming. Weber's classic, *The Protestant Ethic and the Spirit of Capitalism* (1958) is generally consistent with this argument but downstream from the originating source and fails to make the connection between the behavior of individuals and the creation of the specific institutions and organizations that produced the polities and economies.
10. See the interesting series of working papers by Cornell and Kalt exploring the differential success of American Indian tribes in these terms. A summary is contained in their latest paper (1993).