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Evolutionary Concepts in Contemporary Economics

Richard W. England, Editor

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*This book is dedicated to the memory of
Kenneth E. Boulding, who challenged us to
imagine a peaceful, just, and sustainable
society.*



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Communication in Economic Evolution: The Case of Money

Michael Hutter

Among numismatic scholars, there is widespread agreement that the first coins were stamped in Asia Minor during the seventh century B.C., and that the use of the new money form had spread to most Ionian and Greek cities by about 580 B.C. There is also agreement that the first coins were pieces of electrum, conforming to the weight standards in force along the Ionian coast. The most primitive variety had a striated surface and a punchmark on the reverse side; a slightly earlier variety substituted a lion's head for the crude striations.

However, there is a remarkable difference with respect to dating the exact decade of emergence. There are, it seems, two schools of opinion. Both opinions are based on the evidence of a single hoard located underneath the temple of Artemis in Ephesus, which was excavated in 1908. So the issue boils down to differences in interpreting the same evidence. The dominant opinion today argues that the oldest coins could not have been in use for more than a generation, which sets their issue around 630 B.C. (Robinson 1956; Kraay 1976). A divergent opinion, based on literary sources and on an analysis of the stylistic properties of the lion-head coins of the Artemis hoard, argues that these coins were already in use around 700 B.C. (Ure 1922; Weidauer 1975).

Why does a squabble about events that happened almost three thousand years ago matter? The emergence of coin money was one of the major transformations in the history of our economy's transaction medium. Therefore, the episode contains a good part of the empirical evidence available to test competing theories. If the first coins emerged around 630 B.C., then the new "invention" of stamping molten lumps of silver, gold, or its alloy on both sides must have spread quickly among those engaged in the trade of goods, particularly the trade of those goods that were precious enough to be traded externally. Quite clearly, this interpretation supports the theory of money emergence first formulated by Menger and adhered to ever since: according to

that theory, money forms emerge as the result of unintended agreements between partners in commodity exchange. Once a new form has been found, it is observed and imitated by others. Therefore, new monetary inventions spread quickly.

If, however, the use of coins began around 700 B.C., then the new money form must have taken more than a century to really catch on. This interpretation calls either for a theory of slow continuous change, or for a theory predicting bursts of rapid change, interrupted by periods without change. In the latter view, new forms are not readily accepted, and variations of the stamps in use are a highly improbable event. In principle, evolutionary theories are able to account for such complex processes.

It is the object of this chapter to formulate an evolutionary theory of money that explains and, thus, supports the 700 B.C. interpretation. The impetus for such an effort does not stem from an interest in archaeological issues. It stems from basic logical problems in contemporary monetary theory. To put it into a nutshell: money is, in most modern models, conceived either as a rule or as a special asset. Both approaches neglect the communication property of money.

The "rule approach" has been expressed most poignantly by Hahn:

Tobin . . . has splendidly remarked that money is like language. My speaking English is useful in so far as you do also: just so, money is acceptable to me provided it is acceptable to you. One can think of this argument as a Nash equilibrium. Once there is a rule that transactions should proceed via money, it is not advantageous to deviate from this rule. (1982, 21)

It is, first, interesting to note that Hahn invokes a notion that is based on reciprocal expectations of the actors. We will return to this point later on. Even more surprising is the reference to language, and the implicit premise that such a complex arrangement of sounds comes about by adjusting to a myriad of little rules. How these rules come about is, according to Hahn and to most of the contemporary game theorists, beyond the economist's reach.

The "special asset approach" focuses on the effects of the asset that has been chosen or produced to be used as money. In general, reference is made to "search and information costs" (Brunner and Meltzer 1971) or to "reduction of uncertainty" (Niehans 1971). Information, then, is considered a key quality of the money asset. However, in a general equilibrium model, it is difficult to assign a status to information. Either it is a commodity, or it is a property of an observer. In the first case, information is indistinguishable from material features—monetary assets are just another kind of commodity. In the second case, information becomes part of unobservable subjective minds, linked to properties like trust, reputation, and confidence. There is an obvious link to

the language metaphor used by Hahn. But that "special" feature of money cannot be expressed in the categories available to the theory.

Apparently, our theoretical grasp of money depends strongly on our ability to integrate the process of communication into economic models, be they verbal or formal. In order to gain that ability, we will take advantage of the results of a number of modern research programs in other scientific fields. These results affect our way of communicating about economic action and about social evolution. To illustrate the explanatory power of that theory, I have investigated the historical pattern of events surrounding the emergence of coin signs. In conclusion, a few implications and applications of the proposed integration of communication into economic theory are discussed.

Changing the Primary Distinction: From Observer to Observation

The basic claim can be stated in a few words: communication is a process that has the same logical status as consciousness. The argument begins with us, the observers. We divide the world into conscious minds and the world outside the minds, and each observer is one of these conscious minds. This distinction seems quite natural today, but, in fact, it is one of the accomplishments of the philosophical discourse called "enlightenment." Descartes was the first to use the distinction between *res cogitans* and *res extensa*, and it took a few centuries before the difference between objective (external) and subjective (internal) truth began to appear self-evident. The method has helped to describe the world external to conscious minds in a "rational" manner, and it has been particularly successful in leading us to understand our natural environment.

The object/subject distinction has not been quite as successful in those fields that involve communication processes, i.e., the humanities and the social sciences. The reason for this difficulty is a logical implication of this primary distinction: if communication happens in the outside world, then it must have objectlike properties. In consequence, "information" is perceived as something that is, like a parcel, transmitted from one subject to the next.¹ If communication happens within the inside world, then it is part of the internal cognitive world of the mind. It is described as learning, as knowledge, or as creativity.² In both cases, communication must appear as a secondary prop-

1. Such a view is at the base of technical treatments of information in the Shannon-Weaver tradition.

2. On the borderline between subjective and objective worlds, there are interesting skirmishes for territory. Expectations were originally a subjective category. The Vienna school treated them that way, and so did Keynes, Shackle, and the post-Keynesians. A subset of expectations, however, is now assumed to be determined by rational, i.e., outside, communication. The "rational expectations" approach is based on that assumption.

erty. In the external world, the signs and symbols are “really” special objects; in the internal worlds, signs and symbols are “really” the idea, the creation of single individuals. If we are right in suspecting that communication is a process of the same logical order as consciousness, then the traditional distinction won’t do. We need a distinction that will preserve the continuity of communication, instead of splitting it into objective information and subjective creation.

The new primary distinction runs between the continuity of communication and the world outside of communication. Communication is a process observable in signs, symbols, and gestures. How do the signs turn into a process? The continuous nature of signs is only observable in *events*. The events, however, are a construction within another, observing text. The written letters of a Shakespeare sonnet, for instance, are interpreted against the background of their use in other texts, and they are open to contemporary interpretation because the verses have remained in use since then (P. Smith 1988).

The basic operation is one of *observing repetitions*—repetitions within the text, or between the text and its interpretations. The same operation takes place in observing less well-structured sequences of signs. A phenomenon—rising smoke, or resounding vocal chords, or a human motion—is interpreted as a sign by an observation registering the repetition of the sign. The observed first appearance of the sign is considered part of an event involving a preceding sign, and the observed second appearance will be followed by a succeeding sign. Such events cannot be reduced to single, individual actors, either in their operation or in their observation. Every sign needs another sign to validate its existence: only the next sign proves that the prior sign had meaning, i.e., was a sign.

One is tempted to state the point simply in one sentence: The observer picks a short sequence of events out of an infinite chain consisting of nothing but signs. However, the word *observer* is actually without meaning under the new distinction. There are only chains of signs, like texts or conversations, and something outside these chains. The self-restriction of the theory holds for the notion of the observer as well. He or she has now become a secondary distinction. If I am an *external* observer, then I register the communication nature of an event without being able or willing to participate in it. I observe that others are understanding each other, that they continue to use the same language. I have no knowledge of that understanding, but I infer that it works just the way my own messages work. This is actually the perspective chosen in the above paragraph. Or, alternatively, I am an *internal* observer. I understand what is being said to me and know how to interpret meaning. That is a purely experiential process, surrounding us since our cradle days. We always believe that “everything” is within the reach of what can be said and under-

stood, because “everything” is what can be articulated on the inside. The observer operates in the sequence of communication events around him, without access to the world outside of his communication. These two positions are so important for the theory to be formulated that their logical structure will be examined more carefully.

The basic characteristic of the internal continuity of communication events is their *self-reference*. By this, we mean that the signs emitted refer to nothing else but other signs. To sketch the process: Site *A* emits signs containing many differences; *A* observes that *B* reacts to the message by repeating some of the differences; *A* then continues the conversation by repeating some of the differences in *B*’s message. The point is: neither of the two will ever know how its counterpart has processed or “understood” the message. All it can refer to are previous and expected signs. The two sites are able to continue their dialogue under the supposition that they understand each other.³ The self-referential nature of the process implies its logical closure. Understanding appears always complete, because it contains its own foundation. Understanding operates blindly, and it has to. The sense of completeness is an eminently helpful property; without it, we would probably die of fear and insecurity. However, it is a powerful hindrance to change. In what instances, then, can we observe an opening in the closure of our own communication? Two examples are offered.

The first case is the learning of language: a baby makes noises from which parents select those sounds that they interpret as “messages”; they answer with their own noises and gestures. A year later, the baby begins to select from the surrounding noises those that he or she can use for its own messages. The baby tries out sounds and words and watches the effects of such actions. After many infantile failures, the grown-ups answer with a repetition of the sound or sign. Thus, the field of meaning of the signs becomes more and more determined, until the point is reached when the field of meaning cannot be altered at will anymore. The child has learned to use a word, or a phrase. But the word and the phrase were there before the child and before the grown-up. The two preserve the meaning of the word by reproducing it in their messages. The continuity of the already-existing communication process has been extended in time.

The second case is the acceptance of a new theory. New theories tend not to fit into the communication mold of their predecessors. But the continuity of a specific scientific tradition has to be assured. One of the ways of making new contributions understandable is to couch them in old terms. Our own science is a good example: new theoretical features, like the variability of

3. The phenomenon has already been observed by Parsons (1968, 436), who emphasizes the “double contingency” of the communication process.

property-right structures, were generated in order to correct inconsistencies in the old theory. The "Coase theorem" is a prominent example: out of a formulation that was, and still is, considered by many as an extension of the existing paradigm, new conclusions about the nature of organizations and institutions have been drawn—conclusions that are severely at odds with the premise of full information. A further example is the present text: if the basic object/subject distinction of current scientific thought creates a closed universe of discourse, then the distinction between communication and its environment is bound to introduce terms that seem familiar but are, in a rigorous logical sense, inconsistent with the old premise.

The conditions of external observation of communication events are clear by now: the external observation mirrors a communication event in another closed system of reference. The observation cannot enter the discourse.⁴ It can only assume that a process of "understanding" takes place. If the observation were able to continue a chain of communication events, it would become a *message*, a part of the process. If it is a message in a different discourse, then it regards the observed process as *information*. The observation links itself to a communication event in the (internal) form of a message, or in the (external) form of observing information.⁵ In both cases it is clear that the observation is made of the same "stuff" as the events observed.

If we, as outside observers, cannot see what we cannot see, then how can we determine that we have some closed discourse of communication before us? We can determine it because we know the logical structure of closure: in the world of signs, only signs can be used to distinguish a specific discourse from its communication environment. Such a distinction cannot be part of the discourse in question. It is the borderline of the discourse, part of it and yet not part of it: therefore, it has the logical structure of *paradox*.

The phenomenon of paradox is well known in the history of logic. From Epimenides to Russell, it has been treated as an anomaly to be avoided. Recent contributions, from Hofstadter to von Foerster, have established the fundamental importance of paradox in structuring our universe of communication. A particularly precise argument has been developed by Krippendorff (1984). He shows that the information content of paradox is infinite in statistical terms, and he draws the following conclusion:

Infinite quantities of information simply indicate a state of paralysis. In such a situation, observers are unable to process information about their world and will remain so incapacitated unless they "think twice," exam-

4. The term *discourse* describes the condition of closure quite well, even though most authors continue to connect it with traditional observers. An interesting attempt is McCloskey's application to the discourse of economists (McCloskey 1985).

5. The term *information* is now used in the sense suggested by Bateson: "Information is a difference which makes a difference in some later event" (1972, 381).

ine some of their own axioms, and resolve the descriptive problem giving rise to the paradox. . . . Unless one is able to escape a paradoxical situation, which is what Whitehead and Russell achieved with their theory of logical types, paradoxes paralyse an observer and may lead either to a collapse of the construction of his or her world, or to a growth in complexity of his or her representation of this world. It is the latter which should be characterized as morphogenesis. (51–52)

The implication of these arguments is quite straightforward: if an observation encounters *paradox*, then it is unable to articulate fully what is being communicated in that specific communication event. The communication event is distinguished by the premise of an "origin," which, to the outside, looks like paradox. This is, for example, why religions tend to look so incredible to "heathens." There is another, more general phenomenon that helps to understand the situation: when we speak of a play, we mean by that a phenomenon of communication without any serious ground. The play seems arbitrary, yet the events belonging to it are delineated clearly against other events that are not part of the play. This means: all events have something that characterizes them as parts of the play. A gesture that says openly, "This is a play," is not part of the play, whereas a gesture that says playfully, "This is not a play," is part of the play.

The kind of play to which the metaphor relates is not the kind of entertainment game that is determined by a finite set of rules, like board games. It is the kind of improvised play typical for music and theater. Here, we can experience most vividly how our own observation is drawn into worlds that have their own deeply convincing inner logic, yet it is decidedly not the logic of daily communication. Every play move, every note or every gesture, is coded for recognition by other, possible play moves. In the code of the play, there can be no observation of the play's own boundary,⁶ of the difference between the play and its environment. The play, we might say, observes its environment and possibly itself only in the terms of its own code. In understanding such plays, it is not enough to learn the rules. As Wittgenstein has observed, one can find out about understanding language plays (and *Sprachspiele* is what we are talking about) only by playing them.⁷

We will see below that the logical structure of plays can be found in discourses that seem to have little in common with children's play or operas.

6. Which is not to overlook attempts by authors like Pirandello, who have contributed to understanding the nature of the border. Just a line from "Six Persons in Search of an Author": "What do you mean, truth! I beg your pardon, here we are in the theater. Truth has its limits, too."

7. The notion of play has been in the epistemological debate at least since Kant. Huizinga (1940) gave a thorough empirical account of the importance of plays in cultural history. Bateson came to similar conclusions using his ethnological evidence (1972) and then translated his findings into more general theoretical terms.

And yet, the notion helps us to recapitulate the entire story told in this section: as we introduce the distinction between communication events and their environment, we place our observations in a world consisting of such events. The totality of these events is called "society."⁸ The boundary of understanding is marked by the condition of double contingency: it works only if someone plays that it works.

The total stream of communication called society happens in highly conditioned environments of humans and specialized machines.⁹ Within society, we can observe smaller, more elaborately coded subsystems or organizations. They all are self-referentially closed: their internal operations reproduce only other internal operations. In some of these plays, we are able to "connect"—our own signs are interpreted as messages. In other plays, we can only register the event of communication without being able to influence the internal course of the play's development. In any case, however, "we" are talking as a text among texts. The complexity of the communication play takes precedence over the complexity of the mental structures of consciousness that contribute to it. That's just the way the new distinction is played.

Economy and Money

In this section, we want to follow one basic rule: to stick to the self-imposed constraints of the theory outlined in the previous section. If we are able to do that, we gain the opportunity to perceive the economy and its environment in

8. "Society consists of communication, it consists only of communication, it consists of all communications. It reproduces communication through communication. Whatever happens as communication is thus operation and, at the same time, reproduction of society. Neither in the environment nor with the environment of society can there be communication. In consequence, the communication system society is a closed system. It is, however, only possible in an environment, thanks to psychic consciousness, thanks to organic life, thanks to physical materialization, thanks to the evolution of stars and atoms. Society registers this situation by establishing itself as an open system. It communicates about something—about topics which concern its environment or itself or the actually occurring communication. Thus, society is a closed and an open system at the same time, and communication is the form of the elementary operation which performs and reproduces this combination" (Luhmann 1984, 311; all translations are by the author).

9. Individuals do not disappear in communication systems theory, as it is often claimed. Rather, they are split into two kinds of appearances: first, they appear in social systems inasmuch as they contribute to the ongoing communication. But only the communication acts are observed. Second, they appear as separate consciousnesses, which are, in themselves, self-reproducing systems. But the reproduction of consciousness takes place outside of communication, and communication takes place outside of consciousness. The neglect of that basic distinction has led the idealist movement following Hegel into mistaking consciousness for communication. The distinction is logically necessary because systems are distinguished from their environment through the environment's higher degree of complexity. For communication events, consciousness and life forms constitute their environment, and they are inaccessibly complex. Communication can only respond to events that have been brought down to its level and form of complexity.

a way that is new and therefore revealing. The observation of the economy begins, again, with itself. The observing messages are part of the scientific discourse: they are intended as messages to be reproduced in future scientific discourse. The messages follow, though not in a rigorous way, the conventions set for the particular play of economic science. They take as their outside reference another communication play: the economy. If the economy is a communication play, it must be possible to determine its paradox, its medium of communication, and the specific form of the operations in which the play reproduces itself. All three of these issues are traditional to economic science.

The basic paradox that closes off the economic discourse is the distinction between scarcity and abundance. There is no such distinction in nature. The distinction is entirely man-made or, to be more precise, communication-made. Scarcity may be "explained" through rarity or production costs, but it is not identical with such notions.¹⁰ Scarcity is a state that is produced through the act of avoiding it. In securing the use of resources and commodities, the condition that motivated the move to secure the "good"¹¹ in the first place is created: a perfect example of self-referential closure.¹²

All the talk about scarcity in the environment of the economy is meaningless to the continuity of the play. The economy has its own medium of articulating the attribution of that self-invented property called "scarcity" to specific parts of the environment or even itself. This medium is called "money." At this point, only the basics are noted: Money is a construction that articulates the "value" of parts of the environment with respect to the notion of scarcity.¹³ The signs and symbols of that specialized language are therefore selected¹⁴ in a way that expresses or codes that property. The term *value* has, in consequence, no meaning outside of the communication play driven by the scarcity paradox. Every communication play has such an inner sense of its baseless base, and in every case the observations speak of *value*. Here, we clearly speak of economic value, and economic value is created and reproduced *exclusively* in communication events involving money (Mirowski 1990).

Describing a complex system in a linear fashion is an awkward task. Of course, the economic play consists of nothing but communication events, and

10. Note also how earlier societies looked at economic communication from the outside: they focused on abundance—the switch to scarcity is not more than two hundred years old.

11. The property of being a good emerges, self-referentially, in the same act.

12. "The taking (Zugriff) creates what it wants to remove. It wants to secure a sufficient quantity, and thus it creates the scarcity which makes it meaningful to secure a sufficient quantity" (Luhmann 1988, 179).

13. Scarcity is used as an anchor in an otherwise open world of meaning.

14. The term is to be understood in an evolutionary sense.

they haven't even been mentioned yet. But the preceding paragraphs should help in analyzing their highly specific structure. Economic communication events have already become the object of scientific investigation. The most frequently used term is *transaction*. Transaction analysis has taken two major forms: one branch is concerned with the cloud of negotiation and control communication that surrounds real, material exchange; that approach has been extended to intrafirm events where the material concreteness of exchange becomes tenuous (Williamson 1985).¹⁵ The second branch is concerned with the "uncertainty-reducing" properties of media of payment in facilitating real exchanges (Hahn 1982).

All we have to do in order to adapt these efforts to the new perspective is to combine the two branches. According to the suggested theory, transactions must be *communication events*. This implies that the central process of a transaction is the pure communication of value transfer that takes place in an act of payment. The act of giving a coin, of underwriting a credit, of changing positions in a book of accounts is entirely meaningless outside the self-referential logic of the scarcity play. We also infer that the act of payment is basically endless, that there must always be the premise of a prior and a subsequent payment. We will return to this property below, after considering the "real" side of the transaction.

If payment is central, exchange must be peripheral. Exchange is something that goes on in the environment of the continuous, closed process of payment communication. The payments use the reference to aspects of their environment, which are, in this context, regarded as goods and services. The payments comment on changes in the environment, and thus the chain of payments reproduces itself. The outside events are undoubtedly of an existential importance for the continuity of the play. If there is nothing to comment on, the play vanishes. Yet, in a strictly logical sense, the real events take place outside of the economy as it is interpreted here. We have turned around the priorities: the payment events are regarded as the central, continuous process, while the changes and exchanges in the environment are peripheral and discontinuous. It seems that the fascination of the moving stream of payments is enough to drive the process of production. To put it into one phrase: the economy is fiction driving matter.

This concludes a first rough observation of the economy based on the communication distinction. Quite expectedly, the result differs widely from the mainstream interpretation. There, the term *economic* has become synonymous with a specific kind of human action, namely, the rational choice of complex actors called individuals. It is a kind of behavior that can be applied

15. The notion of contract has interesting implications from a communication perspective. After all, the intention is to set two wills into one with respect to the content of the contract.

to all kinds of human action; commodity production and exchange just happen to be particularly convincing examples. Not surprisingly, that approach works quite well for explaining short-term choices between given alternatives. In such cases, the theory just stylizes everyday impressions. But if we want to understand long-term change, the way the choices and the actors came to be, then we cannot start our observations at a point where the constitution of self-conscious actors has already been achieved. The object/subject distinction, however, leaves no other possibility: the moving forces must be subjects, and the subjects must act according to a logic that is transparent to the observing scientist. In contrast, the new distinction adds motion to the communication events, and it transforms the universe of logic into a "multi-verse" of different logics.

We can now move on to a closer examination of money and the conditions of its emergence and development. Payment, the monetary aspect of transactions, is a communication event. Payment communication utilizes materials and symbols to code economic value in money units.¹⁶ It is quite common to call such money signs "a medium." But what, exactly, is meant by that? Here, we suggest a precise definition. Every communication act has to be shaped by combining simpler events into a complex shape that can be recognized as a message. Vocal sounds are shaped into words, letters are shaped into texts, cello sounds are shaped into a suite. Whenever we observe a rigid coupling of those basic events, we call it a *form*. Whenever we observe a loose coupling of the same events, we call it a *medium* (Luhmann 1990a, 53f.).

We can rephrase the relationship between payment and money signs in this fashion: the actual payment events are the *rigid communication forms* shaped out of the loose medium of various money signs. When this distinction was originally suggested by the psychologist Heider in 1926, it was intended for the performance of language in the natural medium of air. Now, we use it in a communication-made context. The medium does not exist naturally but rather has to be created and reproduced by society. If the quantity of the medium or its consistency are insufficient for reproducing economic value, then that should affect the immediate environment of the economy, i.e., the production processes.

Money articulates a message of scarcity and transfer under widely differing circumstances. Both of these properties must be reflected in the forms¹⁷ of money. In archaic societies, the basic quality of scarcity was articulated

16. Barter becomes observable after payment. Before, it is restricted to the territorial or social border of a community.

17. The term is used in the same sense, but in a different context: money signs are, in turn, rigid combinations of loose elements, partly taken out of religious and political imagery. There are no "final" elements in self-referential processes.

through material substances whose high production costs were known. But that is only part of the story. Invariably, the money material was associated with the communicative value of another discourse, either that of the community or that of a religion. Tool money always grew out of local religious or decorative practice, and precious metals always had magical properties. As economic discourse separated itself from the rest of a society's discussions, the coding of scarce money was taken over by organizations that were trusted to regulate an economy's money supply. But until today, it has been necessary to use a variety of symbols, like gold reserves and interest-rate declarations, in order to assure a sense of scarcity. The second quality is the indication of transfer. Scarcity has its meaning in an environment of goods and services. The taking or nontaking of the most varied components of that environment is thus given a particular meaning.

The code of money, therefore, presupposes a coding of the environment in terms of property. Payment only makes sense after the distinction between having and not having has become part of a culture.¹⁸ Once that has been established, then the acts of payment can symbolize the transfer of property rights. They do so by letting money change hands. The transfer of money must therefore be understood as part of a symbolic language rather than as an action of material consequence.

Payment communication extends into the past and into the future between a large variety of persons and between a wide variety of items. Every one of these dimensions demands its own form to ensure value reproduction. In fact, there are specific kinds of credit money for preserving value through time, there is book money to transfer value between the accounts of various persons, and there is exchange money to establish value relationships between commodities. These money forms tended to evolve separately, and the recognition of the fact that they are part of the same discourse came rather late in historical time. The claim to the earliest form probably goes to credit money, which emerged almost imperceptibly in agricultural societies. Yet, we will focus our further observations on exchange money. The reason is not, as in traditional monetary theory, the quasi-material nature of "bullion and specie." In fact, that association has contributed to the difficulties in perceiving the language property of money. The advantage of exchange money lies, however, in its visibility. Whereas many of the connotations around credit money and book money are coded into the banking institutions and are thus totally immaterial, exchange-money signs are preserved in the shapes and symbols of tools, coins, and notes. I will use these signs as evidence when I apply my theory to concrete episodes in monetary history.

18. Luhmann (1988) compares the relationship between property and money with the relationship between spoken and written language.

Conditions of Evolutionary Economic Change

Up to now, we have primarily considered static structural features of money, as they are observed when we start from the premise that an economy is a communication play. Surely, even the structural observations imply the passage of time since communication events have replaced material elements. Yet, we have not given any attention to questions of long-term, historical change. Observations of long-term change pose no particular problem in a theory of self-referential communication systems. In fact, the theory gains a major competitive advantage when it is applied to such questions. In doing so, we will draw from a field of science that has had dramatic success in explaining historical change of forms in the world of organic forms: the theory of biological evolution.

When economists speak of evolution, they have very different notions in mind. Radzicki and Sterman (in this volume), for instance, draw up a list of authors, ranging from Marx to Prigogine, that indicates their understanding of the basic characteristics of an evolutionary approach. The key conditions are irreversibility of time and change *within* a structure.¹⁹ Irreversibility of time is consistent with the event structure of self-reproducing communication plays. "Changes within" can be interpreted in various ways. Quite common is a distinction between biological structures and engineering structures. The former evolve autonomously within natural environments, whereas the latter experience change within the constraints set by a power in their environment, for instance, by the engineer. The majority of evolutionary approaches to economic change seem to favor the engineering approach: multiple equilibria, path-dependence, feedback loops, and nonlinear couplings are studied. But an engineered evolution is a contradiction in terms, and even within a self-structuring process, as it is studied in limit-cycle and chaos models, we cannot observe the emergence of new economic forms. Biological structures are a far better orientation for economic evolution.

Economists can choose to regard the economy either as a constructed entity or as a process of autonomously emerging "spontaneous order" (to borrow Hayek's term). If we choose the second alternative, then we commit ourselves to an explanation based entirely on internal change. There is no *deus ex machina* who can twist the knobs and fine-tune the parameters. The study of organic evolution has given us an immense amount of insight into such processes of internal change. Two issues stand out in contemporary biological discussion: (1) What are the advantages to an increase in internal complexity as opposed to an adaptation to external change?; and (2) What are the empirical and logical prerequisites for successful internal change?

19. For some other examples of evolutionary approaches see Witt (1991).

The dominant "neo-Darwinist" position in evolutionary biology claims that evolutionary success is determined by the degree to which a system is able to adapt to its external environment (Mayr 1982). That position coincides nicely with the optimization hypothesis in economic theory: systems compete under external constraints, and those systems that adapt most efficiently will survive. Recent authors, however, favor another interpretation: external pressure establishes a minimal standard for survival. Above that standard, a variety of evolutionary alternatives are able to survive.²⁰ The only condition of that survival is maintenance of the organism's internal self-reproduction or "autopoiesis."²¹ That result has an important implication for our observation of evolutionary processes: We do not observe forms that adapt to a given, unchangeable environment, but forms that establish an increased independence from their environment.

The argument goes as follows: Variations in reproduction lead to increases in the organism's internal complexity. That complexity increases the organism's degrees of freedom with respect to its environment. The organism detaches itself from the environment and its constraints: it is able to flee, to attack, or to migrate.²² To be sure, the "autopoietic" interpretation of evolutionary change does not replace the exclusive emphasis on the phenotype with an equally exclusive emphasis on the genotype. The entire process of "gene-organism-interaction" (Roth 1986, 166) is considered, but always with a view to the autonomy of the entire system. It should be clear that such a growth of internal complexity is a highly improbable development.

We now turn to the process of internal change. Its major components are fairly well established in evolutionary biology, although there remains a surprisingly vivid debate (Oyama 1985; Ingold 1986). For the purposes of economic theory, the task consists in identifying those aspects that are of general

20. "The scenario of Ernst Mayr and the neodarwinists is a special case of evolution. If the environment of a population changes, there are two normal cases: either none of the carriers of alternative traits survive, or several of them survive. . . . All that matters is to find a state of equilibrium with respect to the organism's autopoiesis, and these states of equilibrium can be quite different" (Roth 1986, 163).

21. The notion of "autopoiesis" is of particular relevance for the biological context. Research in the reproduction of cells has shown how simple organisms are able to produce their own elements out of structures that consist of the same elements. Autopoiesis has been introduced into the discussion of communication systems as well. Any direct analogy between organic and social processes is unwarranted and misleading. The self-reproduction of cells is a closed system, following its own laws. But the focus on molecular reproduction has brought into focus the "informational" aspects of biological change. See Varela (1979) and Roth and Schwegler (1981).

22. "Not the ability to adapt, but the ability to detach itself explains the immense stability and tenacity of life and all systems based on that principle. . . . The question is: How can a system which regulates its operations through its internal structures change these structures with the very same operations even if the system, bound by the given structures, is not able to replace them with new ones in a planned fashion" (Luhmann 1990a, 556-57).

relevance for evolutionary social processes. At this point, it is quite helpful that biological research has given such close attention to the "informational" properties of organic reproduction. We know that the reproduction of elementary units within organisms takes place through the ability of certain chemical material to exactly reproduce itself (genome) within a specific enzymatic structure (Roth 1986, 166). Such operations consist of material molecular changes, but the pattern of self-reproduction can be interpreted in logical terms: continuity is assured by a process of self-reference.

To express and articulate such continuous chains of duplication in scientific discourse, three aspects of evolutionary change are customarily distinguished: variation, selection, and stabilization. All three are hierarchically ordered: "variation" relates to differences in the reproduction of genetic material; "selection" relates to the adoption of a specific variation by a gene-organism-system; "stabilization" relates to steady states of such systems within their environments. Furthermore, events on the various hierarchical levels are brought into a circular temporal sequence: variation precedes selection, selection precedes stabilization, stabilization precedes new variation (Luhmann 1990a, 557f.). The relationship appears circular, or, more precisely, endless, because of the "strange loop" (Hofstadter 1979) that connects stabilization and variation—events on differing logical levels. This seems to be the basic reason for using the double distinction variation/selection and selection/stabilization: One is able to "model" the endlessness of biological reproduction in language. It is a notational structure enabling biological observers to communicate about the evolution of organisms.²³

It remains to be shown that the basic distinction that characterizes organic reproduction, namely the distinction between genotype and phenotype, has its correspondence in social reproduction. The task can be solved on a general level, and on the specific level of single operations. On the general level, we note that biological science has taken its terminology for processes of genetic reproduction straight from the social world: genetic "information" is said to be reproduced through a genetic "code." At first, the terms may have been intended as simple analogies. But by now, biologists have discovered that they are dealing with a process that is quite distinct from the nature of material change. Genetic information, it seems, does not inform "about" an already-existing identity; instead, it shapes the new form through its own form—through the improbability of its sharply reduced contingency.²⁴ This means that the process of genetic reproduction is observed as a process of communication reproduction. Otherwise, our observations would not be able

23. A single distinction, like between variation and selection, is not enough. Single-distinction approaches invariably use environmental change as a driving force.

24. Particularly convincing arguments are found in Polanyi (1968), Oyama (1985), and Ingold (1986).

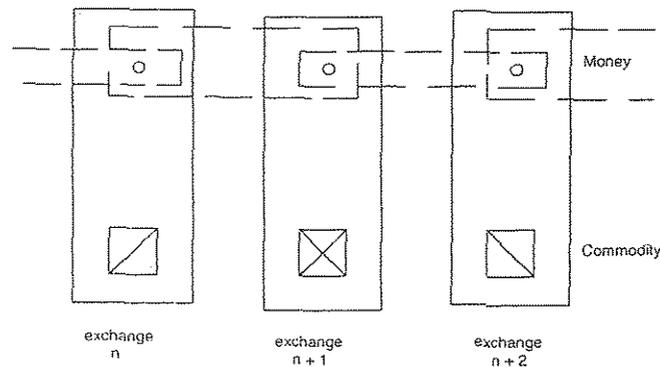


Fig. 1. The reproduction of payments

to register it. Genetic reproduction is, in logical terms, a communication process.

We will now pursue the same distinction on the level of single operations by examining the single transaction. It has already been shown that transactions consist of a continuity of payment events that relate to changes in the economy's environment. We will now take a closer look at the reproduction of payment events. Figure 1 visualizes the process: the upper row shows the sequence of payments, symbolized by a single coin. The lower row shows the goods to which the coins relate. Traditionally, that situation had been represented by economists as a sequence of exchange acts in which two kinds of matter are compared. The sequence was, as it were, divided vertically into single pieces. The division did not matter because continuity was assumed to reside in the consciousness of the actor. Now, continuity is placed into the duplication process of the upper row.

Within the sequence of payment events (dotted rectangles), every sign appears twice. A coin is accepted, and the same coin is offered in a different context: at a different time, to a different person, for a different item. The same sign, thus, appears in two different contexts: the sign has duplicated itself. This duplication has the same effect as the duplication of genetic material in organic reproduction. As in organic reproduction, the normal case is an exact duplication. In almost all instances, errors in duplication lead to a rupture in the continuity of the system. However, a few aberrations prove to be viable. They are selected, in the sense of being adopted by the system. Out of them develop new phenotypic variations and mutations that will be, in an open future, registered as new forms. The implication of the above argument for a theory of monetary change should be quite clear: money signs provide the medium for payment sequences. Payment reproduction relates to changes

in goods production and exchange in a way that corresponds logically to the relationship between gene reproduction and changes in an organism's shape and behavior.²⁵

How can something change while it continues to be the same? We are now ready to formulate two necessary conditions for evolutionary change in systems that reproduce social values, like the economic value reproduced in payments. The first condition is observed on the level of single communication events. As a sign is reproduced, it may, despite the identity, be used differently in the next event. The sign has changed meaning. Usually, the difference is noted and corrected, or it does not matter. The different usage can continue, however, if the meaning of the sign can be kept ambiguous for a sufficient period of time: two meanings are reproduced simultaneously. In that case, the traditional use of a medium runs parallel to the new, aberrant use until the new interpretation has been selected by the system.

The variation may start either as a promise or as a mistake.²⁶ In the case of promise, some address connects a present event with a future event and then tries to find others to accept its understanding. In the case of mistake, some address connects its understanding of a present message with a previous operation that never took place. In both cases, *ambiguity* bridges the gap. Thus, new variations seep into the code. The variations are reproduced many times before they are selected internally. After that, they can be noticed "consciously," i.e., outside of the economy. Only then, a new alternative of action has become observable.

The code of a communication system does not change instantly throughout a play. The starting point must be, in order to be consistent, another communication play. Such a play can be introduced as a secondary distinction. As noted above, such an internal *circle of communication* may be a group, a clan, an organization, etc.²⁷ Within the circle, the code variation

25. This implies, admittedly, a surprisingly close homology between the observations of biologists and those of economists. But the argument of the comparison rests on entirely different grounds than the metaphor of the "social organism." There, individual humans were taken to be the "elements" of the organism, thus confusing material, organic, psychic, and social reproduction. In the view suggested here, these different kinds of self-referential systems are strictly kept apart. Because of the distinction, structural and functional similarities can be observed. If the metaphor is not transferred adequately, if individuals are identified with their biological characteristics, then the result is a race-oriented theory that dresses up as social theory. The disastrous consequences of using such a theory as a basis of political action are well known. Hegelian philosophy seemed to offer a solution: the social entity continues itself through dialectical movement, one idea leads antithetically to the next one. The social continuity is transferred to a continuity of thoughts in individual minds. But the continuity is only observable in explicit messages—which brings us back to communication (Hutter 1992).

26. The German word *Versprechen* contains the ambiguity of speaking of something that is not yet (promise) and something that is not (mistake).

27. The closure of such circles has been noted by Coleman (1988).

through ambiguity finds a protected environment. It is, through repetition, brought into a standard form. From such starting plays, the change in the code spreads through imitation to other plays. Most changes never diffuse throughout the entire economy. Sophisticated coding skills need culture-rich environments, which are rare even in modern societies. There will always be a periphery where the older, less independent code variations are still current procedure.

The two conditions merge into one: ambiguity of messages in closed circles is the basic condition for evolutionary change in a communication code.²⁸ With this result, we have a theory of evolutionary monetary change. Is that theory consistent with the slow and halting change in the coin signs that were first used during the seventh century B.C.? The next step is to investigate in detail whether the course of historical events, as it can be reconstructed today, coincides with the pattern predicted by evolutionary theory.

The Evolution of Money during the Seventh Century B.C.

There is, as previously noted, general agreement that some time during the seventh century B.C., coins began to be used for transactions. Using the available numismatic and literary evidence, the change of coin forms during that period, up to the point when the form stabilized in the shape of the Athenian "owl," will be observed. The process has been divided into five steps.

Bean-shaped lumps of precious metal had been in use in various places throughout the eastern Mediterranean at least since the twelfth century B.C. The lumps, molten and flattened, conformed to the units of the weight standards of the local culture (Balmuth 1973). Such "precoins" were made of gold, silver, or electrum, which is a naturally occurring alloy of the two metals. Precoins have been found in sizes down to .13g. Even such small pieces had considerable purchasing power. Slaves, livestock, and long-term services could be bought with them (Kraay 1976). Like other forms of precious metal, the lumps were used in far trade, usually in order to equalize values in commodity exchanges (Heichelheim 1938).

This custom remained stable until about 700 B.C. At that point in time, punchmarks began to appear on the metal lumps (see coin 1 of fig. 2). However, they are documented only in electrum precoins, as they were in use in Lydia. Electrum, being an alloy, posed the problem of a fluctuation in the ratio of the two metals. By punching the metal, the content of the lump could

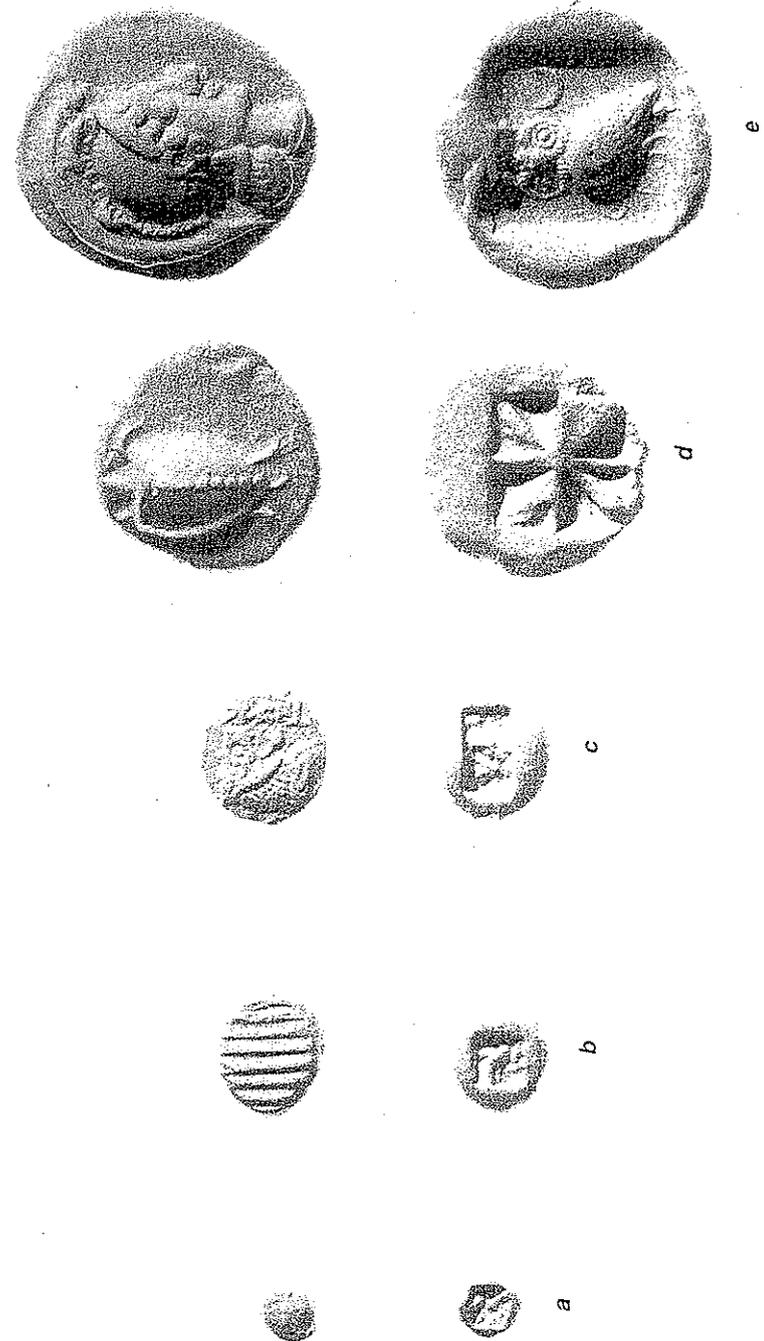


Fig. 2. The evolution of ancient coins. *a*, Coin 1: Ionia, electrum, 1/48 stater, ca. 650 B.C.; *b*, Coin 2: Ionia, electrum, 1/4 stater, ca. 650 B.C.; *c*, Coin 3: Lydia, electrum, 1/3 stater, ca. 600 B.C.; *d*, Coin 4: Aegina, silver, 2 drachmas, ca. 550 B.C.; *e*, Coin 5: Athens, silver, 4 drachmas, ca. 520 B.C. (Permission by Ashmolean Museum, Oxford.)

28. To clarify the terminology: language, observed from the outside, appears as a medium; from the inside, it appears as code.

be tested. But in addition, the person stamping had a means of *recognizing* pieces that carried its own mark:

The merchant's mark was often no more than the end of a particular broken iron nail hammered into the metal, but it could be readily identified by the man whose mark it was. This eliminated the necessity for the weighing and testing for purity of each piece of the precious metal every time it passed through the merchant's hands; he knew his mark. (Davis 1967, 21)

The point to be noted is the relevance of *recognition*. The mark communicated a quality of the material, just as we know it from the marks on livestock or other *moveable property*. The continuity of the evaluation was restricted to the absolute minimum of one dimension: the dimension of time. The place and the person remain unchanged since the act took place in the memory of the merchant. When a message is entirely new, there is no one who understands it except the person who tries it out in itself. This is the way every sign appears to begin: as a perception in memory, as a sign to oneself. The sign to oneself could be recognized by others as well. The person who had marked the pellet guaranteed its weight. Material testing was substituted by trust in the marker.

The effect of the new sign was considerable, particularly within the household or *oikos* of merchants. The archaic *oikos* was a considerable enterprise, which often included more than a hundred individuals. An important payment purpose seems to have been workers' or mercenaries' long-term services. For such purposes, coins could now circulate more rapidly in and around the *oikos* than other money forms. The stamped pieces of electrum were easy to control and could be passed back to the center of the *oikos* in order to pay for services and commodities received by workers.

Eventually, the marks lost their testing function. They only signified the marker and were applied in order to fill the space of one coin side: small pieces carry one punchmark, medium-sized pieces and large pieces two and three punchmarks, respectively. The punchmarks were hammered independently, yet in one manufacturing process.²⁹ The typeless side usually showed irregular patterns. Around 670 B.C., coins appeared whose obverse side had been arranged into regular striations (coin 2 of fig. 2). The minting of that type can be located quite clearly at Sardes, the major city in Lydia. Again, there is a plausible *material* explanation: the striations facilitated the grip of the anvil onto which the metal lump was placed in order to be marked. But there is,

29. Evidence of this is the lack of any signs that a double impact would leave on the obverse, typeless side of the coin.

again, a *communicative* aspect to it: the punchmarks fill the "upper" side,³⁰ the striations fill the lower side of the coin. The entire piece has now been shaped into a form. Thus, a double ambiguity is introduced.

In order to appreciate the improbability of the new coin form, a little historical information is necessary. Sardes was the town where the trade route from Assyria branched off to the various Ionian settlements along the coast (Heichelheim 1938). Thus, Sardes was positioned at the periphery of two vastly different cultures. Toward the east, the Mesopotamian empires had found their continuation through the Assyrian rise to power in 745 B.C. Toward the west, the Ionian migration had led to a string of coastal settlements that still operated according to the rules of their rural ancestors. In Assyria, various commodities were used as media of exchange.³¹ Gold and silver bars were also used as stores of value. The fineness of material was held constant, while weight changes were measured with sophisticated accuracy. As long as the value ratios of the exchange media remained constant, this code had the advantage of continuous measurement up to very high value accumulations. But the complicated verification procedures limited the use to a small set of public officials and traders. The system did not have one generally understood and accepted monetary medium. The basic social codes of Assyria were still religion and power.

The Ionians, like other peasant societies, used livestock and tools as media of payment and exchange. These tools must be viewed with a predominantly religious connotation. Sticks, tripods, knives, and rings invariably had been part of religious sacrifices. What worked in the "exchange" with supernatural powers was considered trustworthy in the exchange with humans (Laum 1924). Such esteem, however, was limited to the narrow boundaries of a particular community. For purposes of tribute or far trade, the tools were of little use. The code had the advantage of discreteness, since the single pieces could be added up easily without testing for material content. But the validity of the medium was restricted to small areas. For purposes of far trade, the Ionian towns also used precious metal, particularly silver, which was more easily found in the region settled by the Greeks.

The striated electrum coins of Sardes were understood as money in both of these vastly different cultures. The pieces were, simultaneously and ambiguously, perceived as Eastern signed metal (with the shine of gold) and Western metal signs (with the shine of silver). The effect was, literally, unconscious: the new form made a new medium of value communication available. Transactions that had never been possible could now be articulated. The coins were

30. On the earliest pieces, this must be considered the front side. Once the side facing the anvil begins to be filled with types, the upper side is considered the reverse side.

31. Heichelheim (1956) lists more than a dozen, from precious metals to foodstuffs, weapons, and shells.

understood in a wide area outside the merchant's internal play. The scarcity coding of the precious metals was combined with the property coding of tokens. That highly improbable change in the monetary code of archaic societies found the conditions for its selection in the transactions of early seventh-century Lydian traders.

If the impact of that particular ambiguity was as tremendous as claimed here, then there should be some trace of it in the history books. Indeed there is such a trace: the rapid circulation increased the money supply available to the merchants. As a result, the financial power of the traders who stamped money grew so great that it not only eclipsed political power, but created a new form of it—tyranny. "It was the monopoly in stamped pieces of electrum that brought the first tyrant to the king's palace and placed him on the throne" (Ure 1922, 152). Literary sources suggest that there was a considerable time period between the "tradesman king" Ardys (766–730 B.C.), who ousted the then-ruling king with the money of an "inn-keeper and waggon-builder," and Gyges (687–652 B.C.), "who completed the evolution of metal coinage by making it the prerogative of the state after he had first used it to obtain the supreme power" (Ure 1922, 143). During that period, the rather innocuous innovation of striated coins must have created an impact that changed the entire society—an effect that was far beyond the expectations of the traders involved.

The early trader-tyrants seem to have ruled under precarious circumstances. Gyges, however, was able to found a dynasty that remained in place until King Croisos was ousted by the Persians in 546 B.C. This fact, and the phenomenal wealth that has been associated with his name, seem to be connected with the third step in the development of the coin: instead of the older striations, a lion's head appeared on the side facing the anvil, while the punchmarked "back" of the coin remained unchanged (coin 3 of fig. 2).³² The lion was the sacred animal of Astarte, the supreme Lydian deity. Its image contained a powerful message: "Whoever bears the totem sign is in magic communion with the totem community, the sign is a legitimation of tribal participation" (Laum 1924, 140). In other words, a communication form that had been developed in *religious* discourse was first adapted to *political* discourse and was then used to secure *economic* value communication. Once the coin issuer had become the holder of public power, he was in a position to use public images. Thereafter, totem animal images could be used and the advantages of coinage to public finance could be exploited. In addition, the internal circulation of services and commodities could be extended to the entire circle in which the political power was accepted.

32. There are, however, other images found on coins of the same period. It seems probable that private circles continued to experiment with coin signs. But the religious-political connotation led to the selection of that particular coin form.

It was this form of the electrum coin—totem animal type on the front, ornamental punchmarks on the reverse side—that spread first to Milet, Ephesus, Samos, Phokaia, and, a little later, to Smyrna, Chios, Kyzikos, and Lampsakos (Heichelheim 1931, 42–43). The coins show, in variations, the sacred animal of the power that minted the coin. Thus, after the innovation had been monopolized in its original territory, it was now adopted by other, competing powers in the region. Again, the sources report remarkable economic growth in the Ionian towns during that time period. Far trade with standardized products, intensive regional trade, and investments in agriculture and crafts became possible (Heichelheim 1931).

At this point, we can return to the introductory question about the time span necessary for the evolution of the coin. The conventional archaeological interpretation holds that not more than thirty years passed between the use of the first striated pellets (coin 2) and the minting of animal-type coins (coin 3) throughout Ionia. The alternative interpretation allows about one hundred years for the process.³³ The traditional theory of monetary development is consistent with rapid diffusion: once the innovation had been made, it spread quickly due to individual rational choices. But slow diffusion can also be explained in the context of a consistent theory: through improbable perturbations of ambiguity, new variations seeped into the established code, without being noticed by the operations of the code. The variations changed the code or, in other terms, the "institutional" environment without any willful decision on the part of those who participated in the ongoing sequences of transactions.

The fourth step in the development of the new payment form entailed a change of only one dimension, namely the material of the coin. The Ionian electrum coins increased in silver content to almost 100 percent, but they still were considered nominally as electrum coins. The first explicit silver currency was minted on the island of Aegina, probably somewhere around 600 B.C.³⁴

33. As mentioned at the beginning of this chapter, most of our knowledge about the first coins comes from a "construction sacrifice" hoard of nineteen electrum coins, nine precoins, and several precious objects found in the base of an Artemis temple. One of the coins bears an inscription that was, for a long time, interpreted as part of the name of the Lydian king Alyattes, whose reign began in 610 B.C. Assuming, furthermore, that coins were not in use for more than a generation, the first coins were dated no later than 630 B.C. (Robinson 1956; Kraay 1976). In the light of more recent research, the attribution to Alyattes is improbable. On the contrary, the following points speak in favor of an earlier emergence: (1) there is solid evidence for a Kimmerian attack that destroyed the temple and that cannot have occurred after 626 B.C., since the Assyrian sources can be dated by the death of Assurbanipal; (2) coins were in use for a much longer period than just one human generation; and (3) there are strong stylistic similarities between coin types, particularly lion heads, and other artistic objects that were made during the first half of the seventh century (Weidauer 1975).

34. There is a literary tradition going back to Herodotus that attributes the introduction of silver currency to King Pheidon of Argos (Ure 1922). That would set the date around 650 B.C., a date that is not supported by the coins that have been found. Since the Aeginetans were an active clan of far traders, a more circle-oriented theory of emergence seems plausible. Herodotus's story

The form had not changed: sacred animal (sea turtle) on the front, ornamental "Quadratum" on the reverse side (coin 4 of fig. 2). But the material had changed to pure silver, and the denominations of the coins were extended to much smaller fractionals. This way, local trade could now be "driven" by the new monetary code. In addition, the weight system was adapted to the peculiarities of the code.³⁵ The communication quality of the new device had become more important than its material quality.

A final step brings us to the coin form that remained stable for the following centuries.³⁶ Around 520 B.C., animal heads appeared inside the incuse square of Athenian coins for the first time.³⁷ The punchmark, which had become more and more ornamental yet had remained a part of the money sign for more than a century, disappeared. Shortly thereafter, the tyrant Hippias "reformed" Athenian currency by replacing the existing coin varieties with one standard form. The reverse side now showed, still inside the incuse square, a standing owl with an olive branch. The obverse side showed the helmeted head of Athena (coin 5 of fig. 2). The sign of the owl would have been sufficient to indicate the origin of a coin. Athena's image is a reference to the gods that were common to the entire Greek culture. With respect to this image, even observers outside Athens were inside the relevant circle of communication.

The power of the religious interpretation of the image remained, but the religion had changed from an archaic local reference to the much wider reference of a unifying culture. This coin was to remain virtually unchanged until the third century B.C. It was minted in thousands of tons of silver, mainly in tetradrachms.³⁸ Some of the coins left the circuit of Athenian trade and became the dominant medium of exchange in far trade from Asia Minor to Afghanistan. The popularity of the coins was reaffirmed by numerous local adaptations and imitations.

It seems that Hippias's reform had effects far beyond the original intentions. There is reason to believe that the rise of Athens as a center of finance and commerce was partly due to the performance of the payment medium at its disposal. The complexity of public tasks grew, and the new money forms

also indicates that Pheidon called in the archaic spits that had been used as money before. Again, the willful act is probably a literary interpretation. But it is still remarkable that tool money was still in active use even among "advanced" economic powers.

35. The Aeginetan drachma was designed to "make ten silver pieces worth one gold when gold was 15 times as precious as silver" (Ure 1922, 172).

36. The account follows Kraay (1976, 55f.).

37. Athens was not the first town to have coins with images on both sides—the priority goes to Corinth.

38. In 454 B.C., Athens appropriated the treasure of the Delian League and minted it in order to pay for the building program of the Acropolis. The size of the treasure amounted to 125 tons of silver, or 7.5 million tetradrachms.

could deal with harbor fees, fines, taxes, payment for soldiers, and expenditures for public works. The sources also report that the money economy virtually exploded in Greece at the end of the sixth century. The country began to be covered with mints, and banking emerged as a separate occupation. The new medium was being produced on an industrial scale. From now on, the developing economies contained a "pure money complex" (Crump 1981), i.e., a network of institutions and organizations whose function it was to produce and process the monetary code. A new era in the evolution of the European economy was about to begin.

To summarize the historical account: the evolution of coin forms became observable whenever particular variations or "steps" were selected in a money-production system. Other variations are known from the historical evidence, but they remained without influence on the long-range development. The decisive mutation of the code occurred when the Lydian electrum coins were interpreted ambiguously as signed metal and as metal signs. After that, selection of the new form spread. But the form did not stabilize until double-image silver coins with a more sophisticated cultural interpretation became part of economic transactions. At that point, a wavelike expansion of coinage began, affecting the total social and natural environment of the payment code. Similar dramatic social changes occurred when, during the third century B.C., Rome began to mint coins and, more than a thousand years later, when the Carolingian currency reform provided the base for the reestablishment of a pure money complex, driving the emergent medieval economy. In all cases, the result was not an economy that was better adapted to a given environment, but an economy that had gained increased independence from that environment.

Final Remarks

The episode just reported was part of a concrete period in the history of money. It allows us to compare alternative explanations for changes in the value medium. The episode showed how "genetic changes" in the continuing sequence of payments succeeded only rarely but, when they did, led to dramatic changes in the "phenotype" of economic production. It is striking to observe how all changes of the form safeguarded the continuity of the "value message." The value medium changed imperceptibly around the players, in a process literally outside of rational choice, while the players continued their own self-reproduction by participating in the play.

This example was restricted to exchange money, but it could be extended to credit and book money, even to contemporary monetary processes. Modern economies are, of course, far more complex in structure and much faster in their rhythm of transaction. Trade is not limited anymore to a few staples or

luxury goods. It has expanded into a global activity, fueled by the transformation of entire landscapes. The money media available are not limited to metal coins, harvest credits, and temple treasures anymore. Today, transactions are surrounded by a host of financial institutions and markets that constantly produce and process the forms needed for value reproduction. Still, the transactions are the language in which value reproduction takes place, and the money forms are, to stay with the metaphor, the air in which that language can formulate itself.

At the very horizon of that monetary environment, we observe lenders of last resort: the central banks. They are indeed the borderline between the fictional world of economic value and all other kinds of communication. They are, however, observed as borderline only from the inside—the observing position of transactions. We are familiar with that position from our everyday experience as participants in an economy. From the observing position of scientific discourse, we have a much more detached view. Now, central banks appear to be at the center of a pure money complex of institutions, which, in turn, is at the center of the communication play we call “economy.”

There is reason to believe that the self-organization of economies through autonomous central banks or a network of central banks will eclipse political systems, just as religious systems were eclipsed by political systems a few hundred years ago.³⁹ When that will happen, or if it will happen at all, remains uncertain. It depends on the emergence of ambiguities inside the money complex that make it possible that the ongoing operations continue, while, at the same time, a new form of influencing currencies is already in operation. Thus, the process of economic evolution continues.

39. This is a final feature of a communication theory of economic evolution: Although the future remains open in principle, the theory generates projections that reach far into that future. It does so because the projections are built on observations that reach into the past in similarly large time horizons.

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