

12

Evolution of Institutions and Organizations

Thomas E. Currie, Peter Turchin, Jenna Bednar,
Peter J. Richerson, Georg Schwesinger,
Sven Steinmo, Romain Wacziarg, and John J. Wallis

Abstract

Some economists argue that institutions are the most important factor affecting variation in economic growth. There is a need, however, to better understand how and why institutions emerge and change. Informed by evolutionary theory and complexity science, this chapter develops a conceptual framework that follows models of cultural evolution in viewing institutions as part of a nongenetic system of inheritance. This framework is used to examine how broad historical factors (not just economic factors) influence present-day institutional arrangements and economic outcomes, as well as how noninstitutional aspects of culture (e.g., values, beliefs) interact with institutions to shape behavior in particular contexts. Overall, this framework emphasizes the processes by which institutions evolve, and how they can coevolve with other institutions and culture. This approach is illustrated using four examples to demonstrate how evolution theory and complexity science can be used to study institutional emergence and change. Explicit models of the processes of institutional evolution need to be developed and then tested and assessed with data. This framework holds promise to bring together and synthesize the findings and insights from a range of different disciplines.

Introduction

A consensus seems to have emerged among economists, as well as among other social scientists, that “institutions matter,” for understanding the differences in economic performances among various economies over time and space.

—Masahiko Aoki (2007:1)

Increasingly, institutions are being recognized as an important factor in explaining economic phenomena and variation in economic growth. For some economists, institutions constitute the primary factor that affects the modern wealth of nations (Acemoglu and Robinson 2012). Often, economists have

quite a specific view of what an institution is and how institutional change occurs: institutions are of a specific kind (political or economic) and, within these broad categories, there is a tendency to focus on specific types (e.g., democracy, markets, families, or courts) without ample consideration to the complex interrelations within this dense space of institutions. The economic approach to institutional emergence and change proceeds from a materialistic perspective: economic forces (income, inequality, human capital) are the prime drivers of institutional change. Perspectives from other disciplines and emerging approaches in economics (Spolaore and Wacziarg 2013; Greif 2006; Bednar and Page 2007), suggest, however, that noninstitutional aspects of culture (e.g., values, beliefs) interact with institutions to shape behavior in particular contexts. We need to better understand how broad historical factors—not just economic factors—influence present-day institutional arrangements and economic outcomes, and how institutions emerge and change. In this chapter, we develop a conceptual framework, informed by evolutionary theory and complexity science, which emphasizes the ways in which institutions change over time, evolving and coevolving with other institutions and culture.

We begin with an attempt to establish a common language to help facilitate discussion in an interdisciplinary context, providing working definitions of institutions and related concepts. Thereafter we lay the groundwork to develop a cultural evolutionary approach to the investigation of institutional change. We examine the role that culture may play in affecting how institutions actually affect behavior in societies, and the ways in which culture and institutions can co-evolve. We present four examples of how institutional evolution can be studied and conclude by reflecting on the main themes that emerged from our discussions, suggesting ways to take the study of the evolution of institutions forward.

What Is an Institution?

To debate the issues in this chapter productively, we need to establish a common language and expose some of the different conceptions that various disciplines utilize when talking about “institutions” and related terms. We conceive of institutions as human-generated regulators of social interaction and adopt a working definition of institutions as *systems of interrelated rules which prescribe particular roles and regulate social relations*. Examples of institutions would be marriage, descent and inheritance systems, codified legal systems, parliaments, and banking. A distinction is often made between formal and informal institutions. Formal institutions are equated with written rules and enforced by a disinterested third party; for example, the tax system in modern countries has detailed written rules about who is required to pay what, and adherence is backed up by institutions involved in the formal legal system. Informal institutions are often unwritten, and tend to be socially enforced, perhaps by interested parties; an example would be institutions related to kinship

(e.g., obligations to work on a relative's land), where failure to comply results in social pressure from other relatives. It is also important to distinguish broad types of institutions from particular instances of them. Accordingly, corporations are a specific kind of institution, and a particular organization would be an instance of a corporation. These organizations are "legal entities"; that is, the larger society accepts them as a recognized unit, and they are able to bear rights and responsibilities. For instance, a corporation can sue and be sued, buy and sell land, own property in its own name. Of central importance is the fact that the identity of an organization can be independent of the identity of its members (e.g., stockholders in modern corporations can all change, yet the rules and legal status of the organization remain the same).¹

As a final definitional point, it is important to distinguish what is transmitted to, or learned by, individuals from the population-level phenomenon of rules regulating behavior at the level of the social group (Smaldino 2014). Here, we distinguish social norms (i.e., what individuals learn socially or individually) from institutions that operate at the group level. This distinction is hardly necessary for very simple norms or institutions, when the whole institution is common knowledge: road right-of-way rules are an example. Virtually everyone knows and obeys such rules. For this reason, people tend to use the two terms interchangeably. This distinction becomes important when an institution takes on multiple roles. Take the example of "money": virtually everyone over a few years of age knows how to spend and save money. However, to strike coins and print bills requires highly specialized workers at mints; the institution makes it very difficult for ordinary people to mint or print money and is backed up by a specialized anticounterfeiting police force to punish deviants. Bankers know how to create money by making loans, and central bankers know how to regulate the national money supply. Currency brokers specialize in trades involving foreign currency. Yet no one individual knows enough to operate all roles. All anyone needs to know is how to operate his or her assigned role in the institution. Although built up and sustained through individual-level processes, the effectiveness of the institution is an emergent property at the population level. This effectiveness can affect the dynamics of institutional and societal evolution in important ways.

An Evolutionary Approach to Institutions and Institutional Change

In this chapter we argue that evolutionary theory is a useful framework in which to understand and investigate institutional change. Evolution is a term that has many colloquial meanings, and key conceptual differences have existed in the

¹ The performance and broader "character" of an organization may, of course change, as a result of the personal characteristics of its members and leaders.

use of this term between the social and natural sciences (Currie and Mace 2011). Here we follow the standard definition used in biology of evolution: “descent with modification,” the process of change in the frequencies of inherited traits in a population. For our purposes, the salient features of this definition are that it focuses on changes over time in a population of individuals; it is neutral as to the specifics of what the inherited traits, and their mechanisms of transmission and expression, actually are (i.e., it is not specific to genes). It is also important to distinguish between evolutionary history as the pattern of changes that have occurred over time, and the evolutionary processes by which change occurs. In a comparative framework (cross-culturally or historically), it may be useful to recognize classes of institutions based on functional equivalence (i.e., institutions with different historical backgrounds which may work in different ways, but do the same thing). For example, cross-cultural comparative anthropologists (ethnologists) code societies based on such things as their systems of marriage (e.g., polygyny, monogamy) or social organization (e.g., patrilineal, matrilineal) despite differences in the evolutionary history of the societies being examined (Murdock 1967; Murdock and White 1969).

An evolutionary approach to understanding institutional change requires that there are suitable analogies that can be drawn between the processes seen in biological systems and cultural or institutional systems. In Table 12.1, we lay out a number of important evolutionary concepts and outline how they are relevant for institutional phenomena. These analogies do not rely on the details of institutional and cultural systems being the same as those for biological systems. Notably, Darwin himself was unaware of the details of genetic inheritance and instead favored a blending model of inheritance. However, this was unimportant in successfully developing the fundamental ideas of how natural and sexual selection operate. Indeed, there now exists a substantial body of formal theories that builds upon such analogies and shows how culturally transmitted information may change over time. The field of cultural evolution tends to define culture as “information stored in individuals’ brains that is capable of affecting behavior and that got there through social learning” (Richerson and Boyd 2005:6). We should also recognize that large amounts of information can be stored externally in the form of material culture (e.g., books, tools, symbolic art) and increasingly in virtual culture (e.g., computer programs, digital files). Normally, though, such information has to be read into human brains to affect behavior. Institutions understood as a set of rules for behavior are a subset and an integral component of culture, as they are transmitted via communication processes and social learning. This view of culture allows us to examine both the processes involved in the origin, maintenance, and spread of specific cultural traits as well as the complex ways different cultural traits and individuals can interact to produce emergent properties at the population level, and then the effects of these population-level properties. Thinking about culture in this manner allows us to connect the study of institutions to a wide body of theory and formal evolutionary models that has developed over the last forty years.

Table 12.1 Evolutionary concepts that can be applied to understanding institutional change.

Concept	Meaning (for institutions)	Potential Institutional Example
Mutation (innovation)	Refers to any changes in the rules and roles of institutions. Unlike biological systems where genetic mutations are random, in human cultural systems such changes can be consciously planned or imposed by others, although even carefully planned innovations may have a large random component (Petroski 2010). Some mutations/innovations may produce beneficial outcomes, whereas other changes may be neutral or negative.	Amendment or change to a particular law. Assigning a new official role, e.g., the establishment of Konohiki land managers in ancient Hawaii (Kirch 2000).
Selection	Process by which certain institutions increase or decrease in frequency as a result of differential success. All selective processes are characterized by the requirements of variation, heritability, and competition (Lewontin 1970). In an institutional context, there would be variation in institutions across groups in a population, those institutions must be capable of being transmitted, and there must be some form of competition such that some institutions are more likely to do better and be represented at a higher frequency in the next generation. Selection of institutions can occur when (a) groups with certain institutions out-compete other groups, replacing those groups or imposing their institutions on them; (b) people vote with their feet, and leave groups with poor institutions to join those with better institutions; (c) certain institutions are transmitted from one group to another more readily.	European societies in the colonial era had many sociopolitical institutions that enabled them to outcompete other societies, setting up colonies and imposing their institutions on the existing population. Organizations competing for personnel and attempting to poach staff from their competitors. The spread of democratic forms of governance in the 20 th century.
Adaptation	Process by which such functional institutions emerge. In biological systems, natural selection drives the process of adaptation. In human systems, it is an outcome of the selective processes described above, which act on the variation generated by mutation and innovation.	The emergence of new financial instruments to cope with problems of majority voting (Wallis 2005).

Table 12.1 (continued) Evolutionary concepts that can be applied to understanding institutional change.

Concept	Meaning (for institutions)	Potential Institutional Example
Exaptation	Process by which institutions (or aspects of institutions that were initially established to solve a certain problem in the past) are repurposed to serve another function in a new situation. This may be a particularly important process in institutional evolution.	Florence (e.g., banking), cascades of new functions over the course of history, use of existing social networks in an innovative way (Padgett, this volume)
Maladaptation (mismatch)	Maladapted institutions are those which appear ill-suited to their intended function and are a source of reduced efficiency. Such institutions often emerge in a certain social, political, or environmental context, but are now in another (e.g., changing environment, or transfer to another sociocultural setting).	“European-style nation-state” political systems in ethnically heterogeneous regions in Africa (Laitin 2007) Western agricultural systems imported into Balinese rice irrigation systems functioned much worse than the traditional system, which involved religious rituals based around water temples to coordinate planting (Lansing 1991)
Vestigiality	Change in institution leading to a loss of function. May be due to a change in environmental context or because other institutions have successfully competed to perform its functions. If the institution remains, it may be in some vestigial “ceremonial” form (Note: if the ceremonial form has an important new function, then that case might be an example of exaptation.)	Ceremonial institutions such as communications protocol with royal family in constitutional monarchies (Veblen 1899/2013)

Importantly, these models demonstrate how cultural evolution may result in adaptive as well as nonadaptive change, and incorporate important differences between cultural and biological systems to show how forms of social learning can affect the transmission and evolution of cultural traits.

Drawing analogies between biological and cultural evolution is not an end in and of itself. In other words, if all this provided were a metaphorical way of thinking about institutional change, and a relabeling of existing terms with those taken from biology when describing particular instances of change, then we would not have achieved much. The real benefit of taking an evolutionary approach is that it provides a formal theoretical framework based on first principles about how inherited traits will change over time given certain conditions. In the social sciences, evolutionary explanations are often conflated exclusively with selective processes. This may be more applicable in some situations than others (below we discuss an example of change in the early U.S. state constitutions that seems to be well characterized by such processes), but as Table 12.1 demonstrates, there are a number of evolutionary concepts that can potentially be applied to cases of institutional change (see Bednar as well as Padgett, both this volume). In other words, there is not a single evolutionary hypothesis; instead evolutionary theory provides a framework for generating more specific hypotheses about the origin and spread of institutions to guide our investigations (see below). The ability of evolutionary theory to act as an overarching, synthetic framework for the social sciences (Mesoudi 2011), including economics and public policy (Wilson and Gowdy 2013), is increasingly being promoted.

Asking the Right Questions

Another theoretical contribution from evolutionary biology, Tinbergen's four questions, may provide a productive way to organize investigations into institutional change (Tinbergen 1963; Wilson and Gowdy 2013). If we wish to ask why a society has a particular institution, this needs to be addressed on a number of levels:

1. The *historical* (phylogenetic) aspects of institutions: How and when did the institution emerge? What is the history of transmission of the institution and the other cultural traits that are associated with it? Did it emerge by repurposing existing institutions?
2. The *functional* aspects of the institution: What does the institution do? What is its purpose? Why was it selected? A particularly important issue here is the issue of institutions that we build to solve collective action problems. These are often costly within groups, yet have a selective advantage between groups (Turchin et al. 2013).
3. The *mechanistic* aspects of how the institution works from day-to-day: What roles do people play, and how are the rules enforced? Such

questions directly address issues about how background culture, values, etc. or other institutions are processed to produce individual and collective behavior, as well as the psychological mechanisms that underpin this, including how culture can affect the cognition of individuals (Hutchins 1995).

4. The *developmental* aspects of institutions: how people become incorporated into institutions during their lifetime (e.g., taking up roles, learning the rules).

A benefit to laying out these issues in this way is to highlight that one explanation is not given more importance than another; indeed, these levels of explanation are logically distinct (Dunbar 1995). Although different academic disciplines may address issues related to institutional change from different perspectives (and may be more interested in one level over another), all aspects need to be addressed if we are to gain a well-rounded understanding. Just as biologists are now fruitfully exploring issues at the boundaries of these questions (e.g., how evolution interacts with developmental mechanisms), potentially important insights can be gained by examining, for example, how the historical legacy of institutions affects their current ability to adapt and change.

How Institutions and Culture Evolve and Coevolve

The rules that constitute institutions are culturally transmitted from one generation to the next. Other things that affect human behavior are also culturally transmitted (e.g., technology, symbolic culture, values, beliefs). This has potentially important consequences: (a) the manner in which institutions work (or do not work) within a society may be a result of the evolutionary history of those institutions; (b) institutions play out in populations with other institutions and other aspects of culture. This draws attention to the ways that these different culturally transmitted features may interact to shape human behavior, including the ways in which they become aligned or misaligned.

Evolutionary History and Institutions

There is an increasing appreciation that present-day economic performance may depend to some extent on the past history of the societies concerned. Several recent studies have shown positive correlations between economic performance or institutional quality in the deep past and present-day economic performance. Often these are presented as stories about long-term lock-in, or path dependence; that is, institutions and societies have undergone certain historical events that have inexorably led them to the way they are now (Morris 2013). Acemoglu and Robinson (2012) argue that virtuous and vicious circles

in institutional development are important processes in societal and economic development; that is, developing extractive institutions leads to further bad institutions as privileged elites are able to solidify their power base, whereas developing more beneficial inclusive institutions means further inclusive institutions are more likely to develop subsequently. For example, certain institutions, such as the “rule of law,” can be seen as particularly important as they curtail the more crudely exploitative aspects of elites in ways that aid the development of other inclusive institutions further down the line, thereby allowing more people to take part in political and economic activity and preventing such gains from being lost.

Evolutionary approaches to institutional change are informed by the idea that “descent with modification” is a suitable description of how such change occurs, with new forms modifying and building on previous forms. Institutional change certainly can occur through the cumulative development and repurposing of existing institutions. Later we present evidence that this has been an important process in the long-term evolution of sociopolitical organization. Padgett (this volume) also refers to many studies that demonstrate how new institutional forms can result from novel recombination of existing aspects of society, and how these can lead to feedback loops and further changes. However, human abilities for conscious decision making and future planning may mean that widespread changes in social organization could be implemented, with new institutions being set up with little or no reference to previous forms. There are many examples where societies change rapidly and take on new institutions which bear little resemblance to previous forms. For example, with the Meiji Restoration in 1868, Japan underwent a dramatic transition: many institutions from the feudal system were replaced with institutions more conducive to a “modern” industrialized political and economic system (Beasley 2000). These types of discontinuous changes might be particularly applicable to societies selectively copying institutions from other societies that are seen as successful (as in the Japanese example), ideological revolutions that result from dissatisfaction with the status quo (the French and Russian revolutions are striking examples²), or through the imposition of new institutions by a foreign ruling power (e.g., many institutions set up by European countries in their colonies).

These issues relate partly to the rate of evolution. Although evolution is often equated with gradual change, there is evidence from both biological and cultural systems that evolution may be “punctuated” by bursts of change around the time species (Pagel et al. 2006) or languages (Atkinson et al. 2008) diverge, and that change may occur unevenly in pulses at other times (Pennell

² At a mechanistic level, Kuran (1995) argues that if people realize that a desire for change (which was previously held in private) is actually shared by a large enough section of the population, then this could lead to sudden, collective behavior and result in rapid institutional change, including unanticipated revolutions.

et al. 2014). Therefore, an evolutionary approach to understanding institutions is still possible even if institutional change is primarily a rapid, discontinuous process. In reality, both processes of incremental and discontinuous change may occur, and may be more or less prevalent in different situations. Which of these two processes is most important in a given situation is an open, empirical question. We note that even in those cases where change does appear to be discontinuous, this may represent the adoption of preexisting forms from other societies and potentially their integration with existing institutions. For example, Meiji Japan modeled many of its changes on Western societies and repurposed existing institutions to fit this new model, such as the Emperor being the new head of state. Some institutional changes, however, need to bring about a swift change in behavior to a whole population (or a large part of it) to be effective; thus, the formal change of an institution can be abrupt. For example, Sweden switched driving on the left-hand side of the road to the right-hand side at 6 a.m. on September 3, 1967. However, such changes are generally based on a long period of change in elite attitudes, elite persuasion of nonelites, and some form of formal consultation.

Being able to trace the evolutionary lineage of particular institutions is an important task. This can, however, lead us to emphasize certain historical events as being of vital importance or as having had a strong, deterministic effect on what we observe in the world today. For example, Acemoglu and Robinson (2012) focus on key turning points in history such as the black death in Europe. While recognizing the importance of *evolutionary history*, and specific, contingent events, we should also recognize the possible importance of more general, recurring *evolutionary processes* that create and shape this history. Institutions may spread, for instance, if they provide solutions to collective action problems within societies, thus enabling societies to outcompete other groups which lack such institutions. Purely historical accounts may be incomplete as they do not explain why particular institutions emerged and spread at particular points in history and in particular places. Institutional theories have been placed in opposition to other theories such that institutions are argued to be more important than geographical or ecological factors (cf. Sachs and Malaney 2002; Diamond 1997). This sets up a false dichotomy. Institutions set the rules by which individuals cooperate and interact, so it is not surprising that economic behavior is going to be governed by these institutions.³ Geographical or ecological factors may ultimately explain why such institutions arose in some places but not others and affected their historical development (Currie 2013b). For example Turchin et al. (2013) developed a simulation model in which “ultrasocial” institutions that affect cohesion and cooperation within a

³ The more interesting aspect of Acemoglu and Robinson’s ideas is not that institutions are more important than other factors, but that they make specific predictions about the general characteristics of good institutions (i.e., they should be inclusive and include the talents and abilities of wide sections of societies).

society are favored in cases where warfare between societies is more intense. Under this model the costs of maintaining these ultrasocial institutions within groups are outweighed by the benefits they provide in competition between groups. Historically, they argue, warfare intensity was linked to the presence of horse-based military technologies (e.g., chariots, cavalry); war resulted from conflict between settled agriculturalists and nomadic pastoralists who inhabited the steppe regions of Eurasia (e.g., Mongols raiding Chinese cities). This conflict is ultimately linked to ecological differences between the steppe region of Eurasia (where horses and horse-based technology developed) and the regions where agriculture was productive enough to support large populations. Historical data show that large-scale societies occurred more frequently close to the borders of the steppe, thus confirming the predictions of the model.

The cultural evolutionary perspective also recognizes the ways that genes and culture interact in humans. Humans have genetically transmitted aspects to our social psychology, which may be fundamental to our ability to live in the kinds of groups we do—what Richerson and Boyd (1999) have labeled “tribal social instincts.” Many institutions can perhaps function only because most people have fairly prosocial predispositions. For example, humans tend to be much more docile and more muted in our expressions of dominance than chimpanzees. Culturally transmitted monitoring and “policing” institutions would have reduced the genetic fitness of antisocial people, resulting in the gene–culture coevolution of docility in modern humans, assuming these mechanisms evolved far enough back in the Pleistocene (Boehm 2012).

Cultural and Social Context Matters

Another key area of debate has been the extent to which institutions are influenced by other factors. For some researchers, formal institutions are by far the most important factors affecting key aspects of society, such as economic performance and political stability (e.g., Acemoglu and Robinson 2012; cf. Glaeser et al. 2004). However, noninstitutional aspects of culture (e.g., beliefs, values, technology) may affect the emergence and evolution of institutions (Nunn 2012). The rules that make up institutions—whether formal or informal, written or otherwise—have to be interpreted and then followed. The effect of any particular institution is thus dependent on the way these rules are translated into meaning and behavior (or “practice”). One source of variation is obviously individual differences in how people react to these rules, resulting from personality differences or from their socioeconomic position. Such differential responses may require adjustments to existing institutions or new institutions to address the variation. Another source of variation could stem from other institutions or other elements of culture, leading to variation at the population level. For example, the federal constitutions of the United States and Argentina contain a nearly identical clause: the federal government guarantees to its citizens that every state will have a republican form of government. In the United

States, the clause was adopted to prevent authoritarian regimes in any state, but it has virtually never been invoked.⁴ In sharp contrast, Argentina's president relies on this clause to justify frequent dismissals of democratically elected provincial legislatures, substituting a federally appointed manager as the effective ruler. Clearly, something is different between these two countries that leads to the same rule getting implemented in drastically different ways.

The process of institutional change involves rules, culture, and behavior being passed down in a dynamic relationship (Figure 12.1). From the perspective of the institution, other aspects of culture can be thought of as a kind of background which affects how institutions translate into behavior. This background is dynamic, as aspects of culture evolve themselves. Furthermore, institutions and culture may coevolve to shape how the different aspects of society change over time. Institutions can also affect one another through a kind of behavioral spillover (see Bednar, this volume). For example, if individuals are faced with a new institution, they may draw upon past behavior from another institutional context, either because that is what seems most appropriate or because they believe that others may respond in this manner.

Social dynamics may be important in sustaining particular institutions. Consider, for example, the "corporate" form. The corporation has a long history, but in the early nineteenth century in the United States (different state legislatures in the 1840s), the United Kingdom (1844), and France (1864), the formal legal rules regarding corporations were changed (North et al. 2009). These changes (e.g., the general incorporation acts in the United States), allowed any citizen to form a corporation. The adoption of this new institution was motivated for several different reasons in the different societies. In all three societies, however, the number of corporations increased dramatically. This new institution created a kind of open economic entry which changed the dynamics of markets and industries. However, it also changed the dynamics of political competition. If the government actually adhered to the rule, they had to allow entry into a wide variety of economic activities. This meant that groups could form economic organizations to compete politically. Political competition could not be sustained without economic competition. In Britain, rules about forming political parties preceded general incorporation; in the United States, the rules governing economic organizations came before changes in the rules about forming political parties. To be sustainable, both institutional changes had to occur. If the political system could close off entry to parts of the economy, then a governing political coalition could use those economic rents to affect the political interests of different groups and maintain control of the polity. If some groups in the economic system enjoyed rents from limited competition, then those groups would use those rents to affect and limit political competition. Other societies saw that this institution worked and also adopted

⁴ Measures designed to correct democratic deficits in the states, the Voting Rights Act, were upheld on different constitutional grounds.

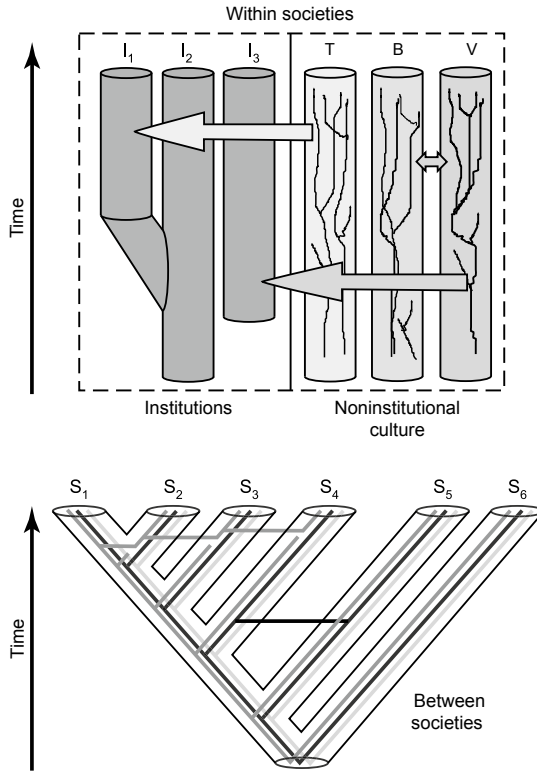


Figure 12.1 Top: Diagrammatic representation about how institutions and other aspects of culture evolve and coevolve within a society. Three institutions (I_1 , I_2 , I_3) and three aspects of culture (T: technology; B: beliefs; V: values) are shown and are subject to change over time. The figure shows how I_1 has developed from I_2 . The arrows indicate how different aspects of culture can spillover and affect other aspects of culture or institutions. The lines within the T, B, and V cylinders represent the fact that there are numerous evolutionary histories for these aspects of culture. Bottom: Potential pathways of institutional evolution between a collection of closely related societies (S) that have descended and diversified from a common ancestor. The light gray institutions (right) track these societal phylogenetic relationships. The black institutions (middle) show how institutions from different societies (S_4 and S_5) may blend together. The medium gray institution (left) shows a case where an institution from one society (S_1) has spread to others (S_2 , S_3 , S_4) replacing their version of that institution.

general incorporation acts. Unfortunately, in many of those societies, the formal institutions changed but the intended social outcomes did not materialize. For example, both France and Germany moved toward formal institutions that allowed corporations to form in the 1860s and 1870s, but in Germany political access remained limited and access to the corporate form did not open throughout German society (Brooks and Guinnane 2016). This case illustrates the way that social dynamics may lead to the coevolution of institutions in different spheres of human societies, in this case the economic and the political.

It is worth noting that there are two primary schools of thought in the study of institutions: institutions as rules and institutions as equilibria. Douglass North (North et al. 2009; North and Weingast 1989) and Elinor Ostrom (1990) are well-known figures in the rules school, while two prominent advocates of the equilibria approach are Masohiko Aoki (2001, 2007) and Avner Greif (2006; Greif and Kingston 2011). Although these two approaches agree on many things they differ as to how they conceptualize culture and institutions. The chief difference between the two schools is whether beliefs, values, and culture are considered to be a part of the institution or separable from it. The institutions-as-equilibria school views institutions as the response to the rules; that is, the pattern of behavior, and a common tendency of a population, results from how the rules are played out in practice. In the institutions-as-rules camp, beliefs, interpretations, and action are analytically separate from the institution: how somebody responds to the institution is a function of the components of the institution as well as other socially transmitted beliefs and values, previous experiences, and personality traits.

The distinction concerning how to include culture is more than semantic: it impacts the research agenda regarding institutional performance, institutional change, and the interplay between culture and institutions. In the rules-as-equilibria school, institutions must shape behavior to count as an institution. If the institution's prescription or terms of sanctions are revised with no corresponding alteration in behavior, there is no institutional change. "A mere change in statutory law is not an institutional change...unless it induces a qualitative change in their actual choices in critical mass" (Aoki 2001:233). Under the institutions-as-rules approach, these behaviorally neutral changes may pique interest and lead to an exploration of the cultural or other social factors that cause this lack of change, particularly when such a change would be beneficial or adaptive. In biology, neutral genetic changes are those that do not lead to a change in the phenotype of an organism (e.g., a genetic change that does not lead to a change in the amino acid that is transcribed), or at least does not affect the fitness of the organism (e.g., a change in an amino acid that does not affect the functioning of the subsequent protein). For institutions, it is possible that neutral changes may set the scene for later institutional changes and ultimately lead to substantial changes in behavior.

In reality, varying degrees of interconnectedness may exist between institutions and culture. At one extreme such links may form a highly integrated, functionally organized system while at the other, different aspects may interact and influence each other in a looser way, more like an ecosystem. For example, Balinese water temples help regulate a highly integrated system involving the technology of irrigation of terraced rice fields, the institutions managing those systems, and Hindu religious rituals (Lansing 1991). This interconnected nature was only exposed after colonial attempts were implemented to "rationalize" these systems by removing the religious dimension to the systems, a move that brought disastrous results. Furthermore, Steinmo (2010) describes how

political, economic, and social policy systems have coevolved to create the modern states of the United States, Sweden, and Japan, demonstrating different degrees of interconnectedness in each of these three cases. An intriguing possibility is that the strength of these linkages between different institutions and other aspects of culture may depend on the strength of selection acting on groups that have these institutions and culture.

Mismatches between Culture and Institutions

Although it is useful to consider how culture and institutions are linked, an evolutionary perspective also draws attention to the possibility of these features becoming mismatched. Both culture and institutions undergo evolutionary changes and may do so in ways that lead them to be uncoupled. Changes in ecological factors (e.g., adoption or development of new subsistence practices), the social environment (e.g., changes in population, the composition or behavior of neighboring groups), or drift-like processes leading to changing cultural values may make existing institutions less appropriate than before, eventually creating the need to realign or change the rules. For instance, changes in subsistence practices in sub-Saharan Africa (particularly the adoption of cattle) is argued to have preceded the change from matrilineal to patrilineal forms of inheritance because passing on wealth (in the form of cattle) provides an evolutionary advantage to investing in your own sons (Holden and Mace 2003). Another example can be found in attitudes toward “gay marriage”: in both the United Kingdom and United States, attitudes shifted before formal legal changes were instituted. The reverse is, of course, also possible and motivates much legislation. However, there are also cases where formal legal changes only modestly affected behavior, and thus were viewed as failures: U.S. Prohibition on alcohol use (1920–1933) or the “War on Drugs” (1971–present). Other possibilities for institutions being at odds with the background culture of a society include: (a) imposition of an institution on society from a powerful source (i.e., an elite or a colonial power), or (b) incorporation of an institution from another culture (e.g., after witnessing a seemingly successful institution in another society, attempts are made to implement that institution in their society). The first process obviously depends on the existence of elites or colonial rulers, which were probably absent for much of human history. Therefore, while mismatches between culture and institutions are possible in all societies, they may be more relevant to modern societies.

The existing cultural or institutional background of societies may have important consequences for how effectively institutions are transmitted between them. Barriers for institutional diffusion may be established by cultural distance (see case study on democracy below as well as Spolaore and Wacziarg, this volume). Adoption of institutions by a culturally distant societal unit depends on the network of institutions and culture already present in the respective social unit. Put simply, societies that are more similar to each other culturally

are likely to be more readily able to borrow institutions from one another. The greater the cultural distance, the more likely it is that such institutions would be mismatched in the receiving society. Although this barrier effect has empirical support, it could be argued that institutions of closely related societies might be too similar and there may be little added value in borrowing these institutions. More distantly related societies may have genuinely novel institutions worth trying to adopt to perform desirable functions (e.g., the adoption of Western institutions by Japan in the nineteenth century, after it emerged from international isolation). The barrier effect is likely to be most relevant to cases where a completely new and effective institution has arisen.

Studying Institutional Change

Having set out a conceptual framework, we now consider ways in which we can apply this approach to investigate institutional evolution. Human social systems and the institutions that bind them together are ridiculously complex phenomena and form large, heterogeneous, intricately and interconnected systems which make them difficult to study. To make matters worse, we have a rather limited amount of data about these systems. We have, say, a national household census that pictures humans as nodes, with some of the edges linking them to other humans and other layers, but not nearly enough to reconstruct even that human layer in anything like its full complexity. At most we have only a few centuries of data as complete as a census.⁵

The Need to Test Multiple Hypotheses

How can we make progress in understanding such intimidatingly complex systems? Faced with the similarly bewildering complexity of biological systems, evolutionary biologists and ecologists developed a strategy for investigation aimed at building the best possible model under the constraints imposed by complexity. Conventional statistical approaches rely on the idea of null hypothesis testing and tend to involve assessing whether the relationships or patterns in the data implied by a particular favored hypothesis have a significant level of support through the rejection of a nonspecific null model of no relationship (e.g., the slope of a regression line is not significantly different from zero). A more productive approach is to compare several competing hypotheses at the same time (Platt 1964). Rather than asking whether a hypothesis true (which is probably impossible to answer), this approach encourages us to think about which of the candidate hypotheses best explains what we observe.

⁵ This is not to say that having large amounts of data would be panacea: “Big Data” creates its own problems, not least the potential for data dredging to pick out correlations or associations without a good a priori theoretical motivation.

This approach of multiple hypothesis testing can be performed with standard statistical models (e.g., regression, analysis of variance), and information theoretic or Bayesian techniques allow us to assess the goodness of fit of different implementations of such models to the data. Alternative hypotheses can be ranked, and those that receive little support can be rejected. Yet even this approach involves reasoning, usually informally, from our causal models to predictions about the statistical results we expect given the model. With the statistical results in hand, we go back to evaluate the original causal models.

An alternative that is becoming increasingly feasible due to the power of modern computers is to assess the fit of models that represent how we actually think processes work, rather than conventional general-purpose statistical ones (e.g., Turchin et al. 2013; Itan et al. 2009; Kutsukake and Innan 2013). Ideally, one tries to write down all the qualitatively plausible, relatively simple models that seem like reasonable candidates to mechanistically explain the phenomena we are interested in, and to assess them with data (e.g., Gerbault et al. 2014). We can represent complexity in simulation models (Cioffi-Revilla 2013), but complex simulations are themselves very difficult to understand and require large amounts of parameter space to be explored. Therefore, if all we do is to substitute a model we don't understand with a real world we don't understand, then we haven't really got anywhere (McElreath and Boyd 2008).

The Goldilocks Principle in Model Assessment

To avoid the problems of building models that are overly complicated, we should follow Einstein's dictum: models should be as simple as possible but no simpler. Information theoretic and Bayesian statistics have criteria designed to meet this dictum in a principled way (Burnham and Anderson 2002; Raftery 1996). A too-simple model will "underfit" our data, and thus fail to extract all useful information. A too-complex model will "overfit" the data, fitting the noise in the data as well as the signal, disturbing our estimates of the parameters about which the data contain real information. In other words, we need models that are not too simple, not too complex, but "just right." To protect against overfitting, models are penalized for the number of parameters that are being fit to the data. If we try to model everything we can think of at the same time, it is usually going to fail the test for overfitting. If the data we have are quite limited, the best fitting model may be a toy model. As simple as it is, it may get the one or two most important processes right. If we are lucky, the dynamics of the local part of the complex system we are studying is dominated by one or a few processes that are well captured by one of the models we have competed against the others. In a worst case scenario, two or more models might fit equally well, and no definitive conclusion can be drawn given the present data and set of models. Even so, we will generally have learned something, even if it is only that we have no grounds for favoring one hypothesis over another, and that we need better models or better data to answer the question.

Multiple Approaches to Studying Institutional Evolution

The origin and spread of institutions and their change over time can be productively explored using the types of evolutionary and complexity theory frameworks outlined above. It is important to stress that there is no single best way to address these issues; indeed, there are multiple methodological and conceptual approaches that can and should be taken (Colander and Kupers 2014). Case studies (e.g., from ethnographies or the field of history) can provide in-depth, detailed examination of particular instances of institutional change. Another approach is that of analytical narratives, which seek to combine historical narratives with rational choice models of economics in a systematic manner (Bates 1998). Through comparing several case studies or analytical narratives, we might be able to draw generalities which could lead to the generation of hypotheses that can be further tested with data. These approaches can also be used to assess hypotheses by indicating instances where a hypothesis does not hold, or by calling into question some of its assumptions. Controlled comparisons between a limited set of closely related societies (see Kirch 2010) or through natural experiments (Diamond and Robinson 2010) can sometimes hold constant certain variables, thus helping to rule out certain hypotheses. Systematic comparative analyses involve comparing large samples of groups, cultures, societies, or nations along certain variables and using formal statistics to quantify the relationships between these variables to test the predictions made by proposed hypotheses (Ember and Ember 2009; Currie 2013a). Longitudinal or panel data can be particularly useful in assessing evolutionary hypotheses and distinguishing between causal mechanisms as they indicate the temporal sequence in which variables emerge and change. Finally, formal mathematical models or computer simulations can be used to develop theories and assess their logic, and can be tested against data. All these different approaches have strengths and weaknesses. For example, statistical approaches provide a means of objectively assessing support for competing ideas, but often sacrifice the richer, more detailed information available in narrative approaches (Leijonhufvud 1997).

Given the inherent complexity of the task facing us, it is useful to combine lines of evidence from multiple approaches. For example, we might begin with an analytical history of a certain period and phenomenon. This could be the launching point for developing a more formal model of the key processes thought to be involved. The theoretical toolkits of evolution and complexity may already have some models that parallel the causal story emerging from the narrative approach, which may have proven useful in some context or another. These models may require some adjustments, or new models may need to be built for the case at hand. These models can then be further tested against new data to assess how well supported they are in general.

Examples of Institutional Evolution

Below we present four examples to highlight the diversity of techniques available to study institutional evolution:

1. An analytical narrative of early U.S. state constitutions, derived from in-depth study of written records
2. Findings of large cross-national studies that look at the factors associated with the emergence or adoption of democracy
3. A cross-cultural comparative study that employs phylogenetic techniques from evolutionary biology to investigate how social complexity has evolved over the course of human history
4. Formal mathematical models involving nonlinear dynamics, with a focus on the long-term evolution of economic performance and its dramatic rise in the last two centuries.

In terms of Tinbergen's four questions discussed earlier, these examples focus on the ultimate explanations as they relate to the function of institutions: *why* they evolve, as well as the phylogenetic and historical issues about *where* and *when* different institutions have arisen. Some of the examples are from studies that have already been directly informed by evolutionary or complexity theory. In those cases, we highlight the added value this supplies to the study of institutional change. In the other cases, we examine how they are consistent with this approach and outline how future research can be informed and directed by a more explicitly evolutionary approach.

U.S. State Constitutions

State constitutions in the United States offer an excellent opportunity to document how institutions change over time. The states are all different, but they operate within a common national framework. Careful attention to constitutional and legal rules gives us a window into the process of institutional change at a very visible and deliberate level (Wallis 2005). As will be seen, institutions important to the economic success of the United States had their genesis in institutional innovations at the state level, which fits well with the idea of selection and persistence of different variants.

During the 1840s, twelve American states adopted new constitutions. The wave of constitutional revisions came in the wake of a severe economic crisis from 1837 to 1843, caused in part by a fiscal crisis at the state level. Eight states and the territory of Florida defaulted on interest payments on their bonds in 1841 and 1842, and five states ultimately repudiated all or part of their debts. In the 1830s, states significantly expanded investments in infrastructure, primarily canals and banks. The uniform adoption of democratic and republican institutions of government and the widespread adoption of near universal white male suffrage by the 1820s created political pressure on state governments to

promote economic growth through investments in banks and canals. Electoral pressure to provide these important government investments was counterbalanced by the difficulty of providing geographically specific projects and paying for them with geographically widespread taxation. Canals and banks benefited a minority of taxpayers, yet the potential burden of redeeming bonds would fall on all taxpayers.

In the 1820s and 1830s, states responded with several innovative institutional arrangements to finance canals and banks. This was the first round of institutional changes. “Taxless finance” schemes involved construction of canals and banks with borrowed funds, or the creation of privileges for private corporations who built the projects, so that their level of current taxes did not rise. Taxless finance often required a contingent commitment by taxpayers to service bonds in case of the project’s failure. Other schemes involved “benefit taxation,” which coordinated the tax costs of projects with the geographic benefits of canal and bank construction through the property tax. Between 1820 and 1840, states borrowed almost \$200 million to invest in canals, railroads, and banks.

When the fiscal crisis hit after 1839, states tried to determine what led them into their fiscal difficulties. In large part, they concluded that taxless finance schemes were the problem. The promise of providing valuable infrastructure investments without raising taxes was literally too good to be true. After the worst of the crises had passed, states responded by changing their constitutions to eliminate the possibility of taxless financing in the future. The new economic institutions put in place were the second round of institutional change. Eleven of the twelve states adopted new procedures for issuing government debt and for chartering corporations through general incorporation acts. These institutional innovations were American inventions. Today, hard budget constraints and transparent corporate forms with secure stockholder rights are important institutional determinants of successful economies, but they are not institutions that are closely associated with one another by default. Wallis (2005) investigated how and why these two important institutional reforms occurred at precisely the same time. The institutional inventions were not independent, but part of an institutional solution that forced legislatures and taxpayers to raise taxes deliberately when infrastructure investments were made. Government borrowing, however, was only one way for states to finance infrastructure. Closing off the possibility that legislatures would create privileged economic corporations to induce private groups to provide public services was an integral part of eliminating taxless financing. In more general terms, Americans consciously decided to limit their legislature’s discretion to manipulate the economy (for a detailed history of these institutional changes in America, see Wallis 2005, 2006).

This example illustrates how changes in one institution (here a shift to democratic governance in the 1820s) can lead to a reaction in another institution (the tax system in the 1830s). The first changes had unintended consequences,

which then led to a second round of institutional changes (debt provisions and general incorporation in the 1840s). These institutions were not invented independently in each state. Different states faced similar problems. By viewing the positive economic effects of new institutions in other states, political leaders were able to adopt them, leading to their rapid spread (Lamoreaux and Wallis 2015, unpublished).

Examining the historical record in this way highlights the fact that many institutional innovations have not persisted to the present day. Out of the steady stream of institutions that change, only some get selected and spread and ultimately persist. Thus, if we solely examine the present-day institutions, we may miss important processes of institutional change. Here, taxless financing was one innovation available to states. Its initial attractiveness allowed it initially to spread and become a dominant mode of taxation to finance infrastructure investments, even though it was ultimately problematic. It was an institutional change that did not persist.

If we want to understand the process by which new institutions are generated and then selected, we should try to make as much use of historical sources as possible. In evolutionary biology, researchers are increasingly integrating data from the fossil record with comparative data from contemporary species to understand macroevolutionary processes (Slater and Harmon 2013). The historical record arguably contains more information than the fossil record, and there is real opportunity to test hypotheses about the evolution of institutions using the kind of systematic approach demonstrated here (see also Turchin et al. 2015).

The Rise of Democratic Modes of Governance

An important example of institutional emergence and consolidation is the transition experienced by many countries over the last two hundred years toward democratic modes of governance. Here we define democracy as the broader participation of a country's population in the political process, as well as constraints on the delegated exercise of executive power. A vast literature in political science and economics has examined this emergence quantitatively, with the goal of identifying salient empirical regularities concerning the democratic transition, and testing hypotheses concerning the rise of democracy. It is helpful to divide accounts of the democratic transition into internal (within-society) forces and external forces. The former help characterize the socioeconomic preconditions for the emergence of democracy, whereas the latter help identify the precise timing and geographic diffusion of democracy.

Internal Forces. The modernization hypothesis is particularly salient (Lipset 1959) and states that increases in income per capita and human capital (what is termed as "economic modernization") is conducive to democracy. This hypothesis has received considerable empirical support. Initial tests were based

on cross-sectional variation, using categorical indices of democracy. In a sample of 100 countries, Barro (1999) found that the level of per capita income and primary education were statistically significant determinants of democracy in a dynamic specification where current democracy was related to lagged democracy and a series of putative determinants of the steady-state (target) level of democracy. More recent literature has employed within-country variation to control for omitted third factors which could simultaneously affect both democracy and income levels. Using a long time series that extends back to 1870, Murtin and Wacziarg (2014) show that both primary education and per capita income are significant determinants of the democratic transition. The time pattern of the evolution of these variables suggests that the direction of causality is mostly from economic variables to democracy. These contributions, and many others, constitute quantitative evidence in favor of the modernization hypothesis.

The exact mechanisms that link democracy and economic modernity have not, however, been completely elucidated, and a firm theoretical foundation is lacking. Complements to the modernization hypothesis have stressed that characteristics of the income distribution, not only income levels, are important components of democratic emergence. In particular, a sizeable middle class has been identified empirically as an important determinant of democracy; a critical mass of citizens demanding broad political rights is a precondition for their sustained emergence. Moreover, the manner in which the income is produced seems relevant. For instance, resource-rich countries seem to have experienced difficulties in consolidating democracy, although this is controversial. It should also be noted that some argue (e.g., Acemoglu et al. 2008) that the causality runs from democracy to income levels, not the other way around. Perhaps a fair reading of the overall literature might suggest that causality runs in both directions. Furthermore, other internal forces (e.g., the cultural features of a society) have been less researched and constitute a promising avenue for future investigations into the determinants of democracy. Notable exceptions exist to these relationships between democracy and economic development: China is still highly autocratic despite its recently elevated level of income, and India has remained tolerably democratic despite low degrees of economic and social development for extended periods of time. Relationships between these variables may vary over time as well. Acemoglu and Robinson (2012) use the example of the U.S.S.R. to argue that nondemocratic societies (or at least societies lacking inclusive institutions) may experience very high levels of growth early on, especially as they transition from agrarian to industrial modes of production, but may be unable to sustain this over time when people are disenfranchised from political and economic activities. These counterexamples suggest that purely economic forces are insufficient to provide a convincing account of democratization, yet research into the cultural factors that shape the emergence or lack of emergence of democracy, particularly quantitative research, is uncommon.

External Forces. External forces can also affect whether societies develop democracy, but have largely been under-researched. A characteristic of democratic transitions is that changes tend to occur close together in time and space. Certain regions seem to experience concurrent democratizations, suggesting contagion between countries, Huntington (1993) identified three waves of democratization: (a) a European wave in the nineteenth century, (b) a short-lived wave after World War II, and (c) a third wave that began with the 1974 democratization of Portugal.

This suggests that cross-border factors are important and that the process of institutional diffusion is necessary to understand the timing and geography of democratizations. The spread of democracy during the third wave seems to correspond to how far a country was from the institutional innovators in terms of culture and geography. Deep historical factors may determine how likely a society is to adopt the democratic institutions of its neighbors. Briefly, cultural divergence between countries creates a barrier that hampers the spatial diffusion of democratic modes of governance across culturally distant populations (for further discussion, see Spolaore and Wacziarg, this volume).

Evolutionary Approaches to Studying the Relationship between Democracy and Economic Performance. The studies outlined above between democracy and economic performance demonstrate the value of large sample, cross-national comparative analyses in establishing broadscale patterns and empirical regularities between institutions and economic outcomes. There is considerable scope for furthering these investigations with an evolutionary approach. Given the observations on within-society factors, it would be desirable to develop more explicitly the mechanism linking democracy and economic performance within the framework of cultural evolutionary theory. Such models would not presume that there is anything inevitable about democratic modes of governance but instead examine the necessary conditions and processes by which it can emerge. For example, a cultural evolutionary model might examine how different levels of economic development could affect populations in ways that affect the probability or rate of innovation of ideas that underpin democracies, and their probability of spreading through a population. These factors could be further affected by other cultural traits that also alter the probability of adopting more democratic forms of governance. In terms of external factors, evolutionary forces may play a role in shaping cultural divergence between societies, and therefore the propensity to adopt modern modes of political governance. A significant component of the cultural distance between groups may relate back to the long-term history of population expansion during the Holocene, fueled by the adoption of agricultural and other important innovations (Diamond 1997; Bellwood 2005). This process is thought to underpin the kind of hierarchical, tree-like, phylogenetic relationships that are noticeable between aspects of culture such as language (Currie 2013a). Linguistic distance, computed from such language family trees, is often an

important predictor of the barrier effects described by Spolaore and Wacziarg (this volume).

Long-Term Evolution of Sociopolitical Complexity

One of the most visible features of human history has been the emergence of increasingly complex forms of human sociopolitical organization. Until the end of the last ice age, humans lived as hunter-gatherers in small groups, bound together predominantly through face-to-face interactions. Since the development of agriculture, human groups became larger, underpinned by various forms of social organization such as the emergence of social classes, formal offices of leadership, and bureaucracies. Anthropologists, archaeologists, and other social scientists have long debated how and why these increases in social complexity came about, and whether there are regularities in the way societies change over time.

As mentioned above, the utility of evolutionary approaches to institutional and social change rests on the idea that “descent with modification” can suitably describe how such change occurs, with new forms modifying and building on previous forms. In terms of the evolution of large-scale, complex societies, the argument goes that for groups to get larger, societies must develop institutions that bind smaller subunits together in a coordinated manner. For example, it is argued that having official positions of leadership (e.g., “chiefs”) enabled more efficient decision making, an innovation that consolidated previously autonomous villages into larger political units (“chiefdoms”) (Carneiro 1981; Spencer 1990; Johnson and Earle 2000).⁶ Only once institutions emerge to make these larger groupings stable is it possible for even larger groups to form (e.g., the idea that chiefdoms only cohere into larger, stable “states” once institutions such as bureaucracy develop) (Spencer 2010; Wright 1977). If institutional change of this kind is characterized by incremental changes, we should be able to see evidence of changes in hierarchical complexity having occurred in a stepwise fashion. If, on the other hand, conscious decision making or other mechanisms mean that human social evolution is relatively unconstrained, then we might expect to see evidence that large jumps in organizational complexity have occurred.

Currie and colleagues examined these ideas by undertaking a cross-cultural comparative analysis of the diversity of forms of hierarchical organization in the Austronesian-speaking societies of islands in Southeast Asia and the

⁶ It should be noted that increasing hierarchical complexity is not the only way for societies to cooperate on a large scale, as exemplified by the Turkana (Mathew and Boyd 2011), Comanche (Hämäläinen 2009), and Aboriginal California (Bettinger 2015). Horizontal complexity, or *heterarchy*, may also be a route to join groups together. The historical, archaeological, and ethnographic records suggest, however, that the more common, or successful, route involves a large degree of hierarchical organization.

Pacific (Currie et al. 2010; Currie and Mace 2011). They employed phylogenetic comparative techniques, which form a major way of testing evolutionary hypotheses in biology. Ethnographic data on the number of decision-making levels within a society were mapped onto evolutionary trees which showed how those societies were related to each other. The combination of synchronic data with an evolutionary tree, or phylogeny, allows historical inferences to be made from purely contemporary data. Based on debates in the literature, six simple evolutionary models were derived to describe how changes in hierarchical complexity occurred throughout Austronesian history. In three models, changes in the direction of increasing complexity were stepwise. These sequential models differ as to how decreases in complexity occur: in one model, no decreases can occur; in another, decreases are sequential; in the last, decreases reflect the possibility of widespread societal collapse, or perhaps the breaking away of small groups of much lower complexity. The nonsequential models of evolution, on the other hand, allow for larger increases in complexity to occur (indeed, in one model, any change is possible). Each model was tested against the data and assessed using the goodness-of-fit measures described above. The results were extremely clear: The two best-fitting models allowed only sequential increases in complexity. Both allowed decreases in complexity but differed as to the allowed changes in the direction of decreasing complexity (both performed about equally well statistically). There was a strong signal in the data indicating that the rate at which larger increases in complexity occurred was zero, which means effectively that there is no evidence that such jumps occurred (Figure 12.2).

This type of phylogenetic comparative approach offers a powerful toolkit for systematically studying the evolution of institutions. In a further study, Currie and Mace (2011) tested the idea that an increased number of decision-making levels within a society tends to emerge in conjunction with broader distinctions of social classes; that is, inherited differences between “elite” and

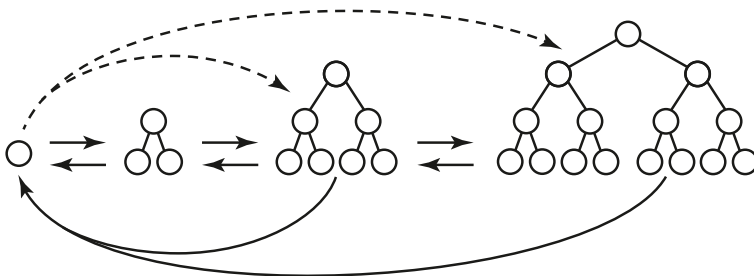


Figure 12.2 Evolution of increasing hierarchical complexity proceeds through a series of incremental steps. Circles represent human groups that are either independent (far left), or joined in hierarchical decision-making relationships with other groups. Solid lines relate to evolutionary changes that the analyses in Currie et al. (2010) showed were possible, while dashed lines indicate those transitions that did not occur.

“commoner” sections of the population. In this case, an evolutionary model in which class stratification co-occurs with political organization extending beyond the level of the village outperformed a model in which those two traits evolved independently. This further illustrates how institutions can affect each other and coevolve. Currie and Mace (2014) have also used these kinds of analyses to show that a range of institutions or aspects of social organization change at similar rates in two different regions of the world: Austronesian-speaking areas of Southeast Asia and the Pacific, as well as Bantu-speaking sub-Saharan Africa. These analyses support the idea that there are general processes involved in the way culture and institutions change, and point to mechanisms that constrain the diversity of cultural traits.

A Nonlinear Model of the Long-Term Evolution of Economic Performance

There is a broad agreement among economic historians that the long-term pattern of economic and population growth resembles a “hockey stick” (Figure 12.3). Prior to 1800, for many millennia, population growth was very small and the income per capita was basically flat; despite fairly minor fluctuations, there was no discernible upward trend. During this time, increases in productivity were generally translated into increased population numbers such that productivity per person remained essentially the same. In the eighteenth century, in countries in northwestern Europe (i.e., Britain, the Netherlands, Belgium, northern France), the Industrial Revolution caused productivity to increase at a rate that was not matched by population growth. Broadly speaking, despite brief periods of economic growth in certain parts of the world (Scheidel et al. 2007; Lindert 1985), the two centuries post-1800 represent the first time in human history that income per capita exhibited sustained growth.

While this pattern is not in dispute, the causes underlying this regime change have been the subject of considerable debate. There is a voluminous literature that proposes various hypotheses. The most common way to approach an explanation is to look for the specific technological or institutional innovations that propelled societies in this direction. For example, North and Weingast (1989; see also North et al. 2009) focus on one particular event in English history: the Glorious Revolution of 1688, which in their view was a key institutional innovation that radically altered the English political and economic system (for a critique, see Murrell 2009). Others have moved the “trigger” that eventually brought about the Industrial Revolution back in time, by identifying other key institutional or technological innovations, such as the commercial revolution involving innovations in banking and textile industries in northern Italy during the Renaissance, which in turn had its roots in medieval northern France (see Padgett, this volume). Another important precursor of the Industrial Revolution was the increased productivity of agriculture, which released labor from the land (and fed new industrial workers) (Allen 2000). Technological innovations that underwrote increased agricultural productivity

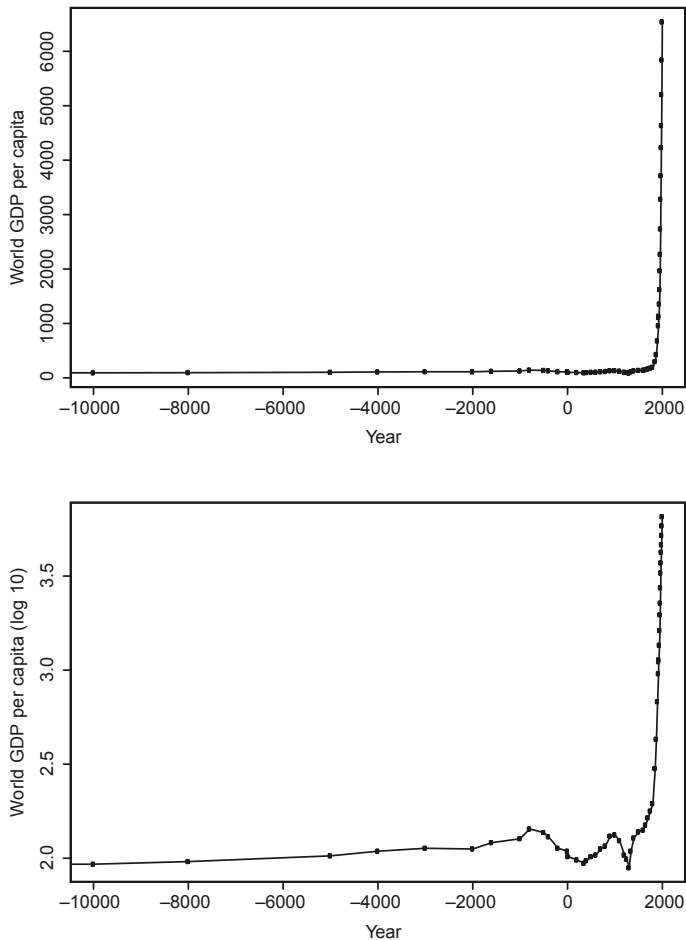


Figure 12.3 Long-term historical pattern of global economic performance, showing the recent and dramatic uptick in economic productivity. Data are based on De Long's "preferred" time series of estimated values for GDP per capita (De Long 1998). With GDP shown on a log-scale (right), the earlier periods can be seen to exhibit generally very slow growth, with occasional rises and falls. It is only in the last few hundred years that economic growth has been large and sustained.

first appeared in the Netherlands in the fifteenth century, diffusing to England in the seventeenth century. Between 1600 and 1800, the yields of wheat (in bushels per acre) in England tripled, resulting in a corresponding increase in the population-carrying capacity. This enormous increase in agricultural productivity was potentially one of the key enabling mechanisms for the English industrial takeoff.

Nonetheless, some believe that there was nothing special about England in the eighteenth century or northern Italy in the fifteenth century. For example,

the jump in agricultural productivity that took place in early modern north-western Europe was not unprecedented. During the Northern Song Dynasty (960–1127 CE), agricultural productivity leaped forward as a result of the introduction of new high-yielding varieties of rice. As a result, the carrying capacity of China doubled: from 50–60 million people between the Han and Tang periods (220 BC–907 CE) to roughly 120 million (Modelski and Thompson 1996). Rather than simply being the result of a particular institutional innovation, or the serendipitous historical confluence of certain enabling features, the Industrial Revolution might be explained as resulting from a slow accumulation of the stock of knowledge (most importantly, productive technologies and social technologies, or institutions) over the millennia before 1800.

This alternative view appears at first to be at odds with the seemingly discontinuous pattern of stagnation until 1800 and the sudden transition to the regime of rapid growth; it suggests to most scholars that there had to be some discontinuity in human history. However, theoretically, it is entirely possible to have no discontinuity in the mechanism of change, no exogenous intervention (e.g., a specific novel institutional form), and still see an abrupt change in the outcome. This can occur if the interactions generating change are non-linear enough. We can illustrate this simple, yet powerful idea with a simple model, based on the work of Kremer (1993), Komlos and Nefedov (2002), and Korotayev and Khaltourina (2006). The model has two state variables: N , the total population of the World, and T , the accumulated stock of *useful* knowledge, including productive technologies and social technologies (norms and institutions). We begin building the model by using the standard and very simple model for the dynamics of population numbers, the logistic model:

$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K} \right). \quad (12.1)$$

The model has two parameters: r is the intrinsic rate of increase or the per capita rate of growth obtaining when population numbers are low (well below the carrying capacity); K is the carrying capacity, or the maximum population size sustainable given the current level of technology. Again, technology here is understood in a generalized sense to include technologies as well as institutions. K is a function of the accumulated stock of knowledge. Again, we use the simplest possible assumption to relate the two: $K = aT$. Next, we need the dynamical law for the evolution of T :

$$\frac{dT}{dt} = cTN. \quad (12.2)$$

This equation assumes that the production of new technologies is an autocatalytic process involving people and the accumulated stock of technology. The idea is that the larger the total population, the more potential inventors and

innovators there are. Having a stock of technologies and institutions, however, also affects the production of new technologies since many new technologies arise as older ones are combined. The more technologies we have, the greater is our ability to produce novelty.

Without loss of generality we can scale T in such a way that $K = T$ (thus, getting rid of the parameter a). The full model then becomes:

$$\begin{aligned}\frac{dN}{dt} &= rN \left(1 - \frac{N}{T}\right) \\ \frac{dT}{dt} &= cTN.\end{aligned}\tag{12.3}$$

This is a very simple system of equations. In fact, we can also scale out parameters r and c , which means that the model generates the same type of generic dynamics, no matter what the parameter values are. However, by not scaling out the other two parameters, we can attempt to match this model to the observed historical pattern by adjusting the units of time and population numbers.

The generic behavior of the model is illustrated in Figure 12.4. We start human population 10,000 years ago (in the real world this was at the dawn of the agricultural revolution). Population numbers are initially well below the carrying capacity; however, it does not take much time for population growth to bring the population near carrying capacity. At this point, the Malthusian regime reigns. Technology grows very slowly, partly because there are few people (and thus few inventors), but more importantly because the existing stock of technologies is so meager that there is little scope to generate new ones through recombination. Technology (and carrying capacity) grow so slowly that population growth always ensures that N is essentially at T . Any gains from improved technologies and institutions are immediately eaten up by population growth. However, even though the initial growth of T is glacially slow, it gradually accelerates as a result of larger accumulated stock of technologies and, correspondingly, more people. Eventually, although it takes thousands of years, the growth rate of T accelerates to the point where population growth cannot match it (remember, that maximum population growth is r). At this point, the two curves (T and N) diverge. A simple measure of per capita consumption is T/N . In the Malthusian regime, per capita consumption is 1 (the subsistence level). If N goes over T , consumption level falls below 1, birth rates fall and death rates rise, and population returns to T . When the Malthusian regime is over, however, T grows much faster than N , and T/N begins to increase. This is the characteristic of modern economic growth: per capita consumption exhibits a sustained increase.

This is a very simplistic model and is in no way designed to capture all of the important process, or to necessarily capture how we think this process actually occurred. It does illustrate how relatively simple mechanisms involving

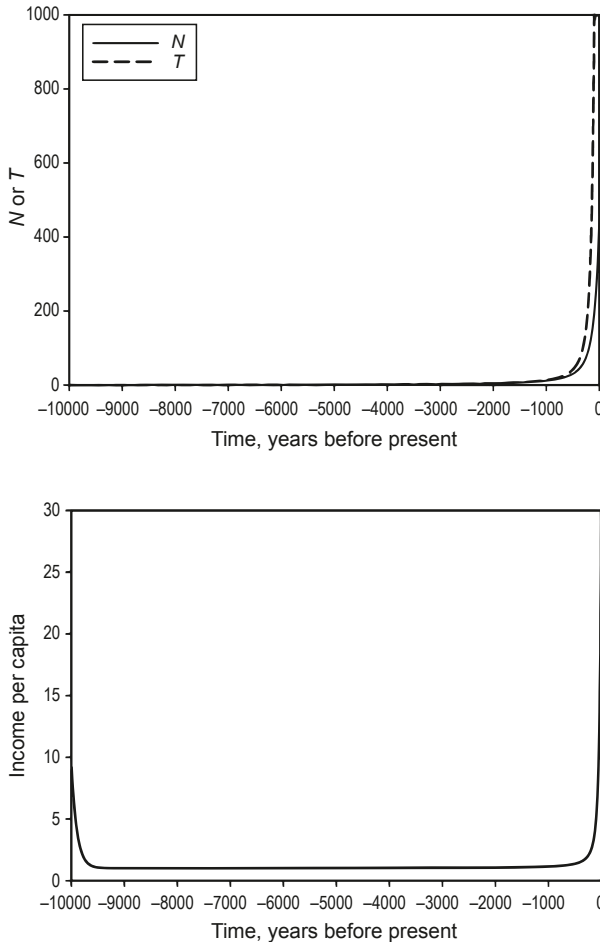


Figure 12.4 Top: Model dynamics of population size (N) and accumulated stock of technologies (T), from 10,000 years ago to today. Bottom: Model dynamics of per capita consumption levels (T/N) from 10,000 years ago to today.

feedback loops and nonlinear dynamics can produce quite complex outcomes. This example serves to highlight the difficulty of identifying the “key” tipping points in history. Informally, a tipping point arises when a small event leads to a large change (the proverbial straw that breaks the camel’s back). This intuition can produce incorrect inferences about when a tipping point occurs. The tipping point need not imply an immediate large change, but instead a change in what will occur. To capture this, Lamberson and Page (2012) define a tipping point as a large change in the probability distribution over the future: after a tipping point occurs, the distribution over futures undergoes a large change. Metaphorically, imagine a ball on the top of a hill. The tip occurs when the

ball begins to roll in one direction. The actual movement of the ball is small, but the future position of the ball (at the bottom of the hill) represents a large change relative to the starting point. For a tipping point to occur, the system must be in a state in which a small change can produce such an effect (i.e., the context in which a tip can occur and the action that produces the tip). One can then distinguish between a change in the context (e.g., change in a parameter in a physical model, or a change in the social structure or economic system) in which tips are possible. Thus, there is a contextual tipping point (a change in social structure or the environment in which a tip might occur) and an active tipping point (the actual action that causes the tip). Historical accounts often attempt to identify active tipping points. However, this may miss an important part of the process in that for those events to occur or lead to changes, the context must be ripe, and any variety of events may contribute to this.

Studying the Evolution of Institutions: Developing Theories, Methods, and Data

These four examples show a number of ways in which the evolution of institutions and their economic and political consequences can be studied in a productive manner. The example of early U.S. constitutional changes in tax systems highlights insights that can be gained from an in-depth study. Here, attention is on the broader social and cultural context in which institutional change occurs; this can reveal more about the microscale processes involved which sometimes get overlooked in broader-scale studies. The study of the spread of democracy and the evolution of sociopolitical complexity both outline the benefits of broadscale comparative studies and the explicit incorporation of information about the evolutionary history of the groups being studied. Such studies allow us to draw out the general evolutionary patterns and processes involved in shaping the diversity of societal and economic outcomes witnessed in the world today. The final example highlights how the building of explicit mathematical models can construct and assess theories. Mathematical models treat institutions more abstractly but they are particularly useful in highlighting how processes (e.g., feedback loops) can generate outcomes that are not obvious with more linear modes of thinking.

Each type of study makes certain trade-offs between the detailed, specific levels of information available to a focused case study or analytical narrative, and the more general, abstract insights that can be gained from comparative or modeling approaches. These studies have shown how historically informed data and analyses can answer historical or phylogenetic questions about where and when institutions have arisen, and how they have spread or been inherited over time. They also address the functional level explanation by examining why certain institutions or societies outcompete others and spread, while others are selected out. In the future, these types of methodological approaches

could be used to examine the more proximate issues relating to psychological mechanisms and processes involved in developing and maintaining institutions, or how these develop within the lifetime of individuals. A more complete understanding of institutional change will come from making use of all these different approaches and, as such, they should be seen as complementary. The mechanistic and developmental aspects of institutions may be particularly important in understanding how and why certain institutions are successfully introduced into some societies but not in others. Indeed, there is scope here to develop approaches at the boundaries of these questions to examine how the evolution of institutions is shaped by developmental processes, similar to approaches in evolutionary developmental biology. Given our earlier discussion of the coevolution of institutions and culture, this is an area of particular interest. We argue that the conceptual framework outlined here is well-suited to this task as it provides a means for integrating the approaches used in economics, political science, and cultural evolution.

To advance understanding of the roles played by institutions in economic and political development, we need better theories and models, better data, and better integration between theoretical and empirical approaches. The coevolution of institutions and other types of culture (e.g., values and beliefs) constitutes a particularly fruitful area for future theoretical development (see also Bowles and Gintis 2011). To develop a full model of coevolution between rules and values, we would need to be much more specific about concepts (e.g., the “efficiency” of different institutions) and make clear the relationship between the cultural traits of societies or organizations and their “fitness.” An explicitly mathematical approach may help address these issues due to the nonlinear feedbacks between institutions and values. While economists are well versed in building mathematical representations of economic processes, our approach is more flexible and is not as constrained by particular assumptions about human behavior and the study of economies at equilibrium. Indeed, from experience in many applications in complexity theory, it is quite clear that once dynamic, nonlinear feedbacks enter the fray, mere verbal reasoning becomes woefully inadequate for yielding insights and testable, quantitative predictions (Efferson and Richerson 2007). This should not be taken as a call on our part to build a hugely complex model that includes all processes. Rather, what we have described is a theoretical framework, within which multiple models can be designed, each addressing a different “slice” of the overall problem.⁷ One

⁷ This follows a general approach in science of reductionism, where complex phenomena are broken down to make the problems more tractable (Dunbar 1995). In economics, a similar approach forms the basis of so-called partial equilibrium models, which attempt to model parts of the economy rather than the whole economic system (the latter is the focus of general equilibrium models) (Mandal 2007). Both approaches have limitations, and their usefulness should be judged on how well they advance understanding rather than rejecting either out of hand. In science, reductionism is not the end goal. The need to integrate different models and see how they join up should always be kept in mind.

approach is to reduce the degree of theoretical abstraction by focusing on specific institutions, such as those involved in democratic governance. Focused models will result in specific predictions which can be tested with data, and may be particularly important for generating insights that may have direct policy implications (Lawson et al. 2015; Waring 2010). More abstract models are also extremely important, as they can provide insights into more general processes that are common to different institutions (e.g., they may say something about the design features of “good” institutions; Wilson et al. 2013) and can be tested with appropriate data.

Assumptions, hypotheses, and models about the evolution of institutions need to have their predictions assessed empirically. To test the kinds of co-evolutionary hypotheses outlined above requires data on specific institutions and information about other pertinent cultural elements (e.g., beliefs, values). Longitudinal data that describe how culture changes over the long run would be of particular use. Currently a global-scale historical database of cultural evolution—Seshat: Global History Databank—is being developed to include variables for use in testing the kinds of models outlined above (Currie et al. 2015; Turchin et al. 2015). Conceptualizing and measuring cultural variables that characterized historical societies, in which we cannot run sociological polls, is a very difficult task. Yet it must be faced if we aim to test empirically evolutionary theories of institutional change. Case studies on democracy and sociopolitical organization also demonstrate how evolutionary inferences can be drawn from synchronic comparative data, when such data are paired with information about the historical relationships between groups. Phylogenetic comparative methods have well-established techniques for assessing the co-evolution of traits (Currie 2013a; Currie and Mace 2011, 2014), and could be particularly useful in assessing the kinds of hypotheses outlined above. Data sets, as used in the case study on U.S. constitutions, are a fascinating resource for studying variation in institutional arrangements. They provide a detailed time series with which to track changes through time, thus allowing researchers to understand more about the specifics of institutional change and the context in which it occurs.

Conclusion

Our discussion was motivated by two central questions: How can we explain variation in the form and effectiveness of institutions around the world? How and why do institutions change over time? Theoretical frameworks from complexity science and cultural evolution can help us understand the general processes involved in shaping institutional change and creating the diversity of institutions and societies we see in the world today. Three main themes emerge from the preceding discussions that appear most pertinent for understanding the evolution of institutions and their role in economic performance:

1. “Descent with modification” is a major feature of institutional change.
2. Beliefs, values, and other aspects of culture affect how institutional rules play out.
3. Institutions are embedded in complex networks with other institutions and aspects of culture in ways that affect their evolution and can even lead to unforeseen consequences.

There are a number of processes by which institutional change can occur. Societies can deliberately replace their current institutions with new versions. Under this view, change can be rapid, showing little continuity with what has gone before. We might view this as institutional and societal history bouncing from one equilibrium to another; however, this appears to be an insufficient theory of change. In contrast, many institutions may have been built piecemeal, layered with inconsistencies and vestigial characteristics that are no longer functional, or which required several rounds of experimentation before successful strategies were achieved. Horizontal transfer of institutions represents another route to innovation, either through imitation or imposition. While such institutions may be new for the recipient society or organization, they obviously have their own history. Such institutions may also be changed or adapted to better suit the new “host.” Institutional innovations can also be borrowed from very different institutions within the same society. The study of early U.S. constitutions illustrates many of these points and shows how the U.S. tax system initially imported policies from Europe only to develop new policies when these failed. The idea that institutional change is a process of “descent with modification” is a useful way to think about how institutional diversity is created, and how institutional innovations emerge and spread.

We have worked with the idea that institutions are systems of rules that shape human behavior. However, a direct line cannot be drawn from institutions to behavior (or “practice”); a number of factors affect how the “rules of the game” are played. People’s behavior is partly due to the information that is available to them about the likely actions of others. These *beliefs* are formed by observing the behavior of others as well as by learning from parents, teachers, and peers. For example, in societies suffering from “amoral familism” (Banfield 1958), children are taught by their parents that no one outside of the immediate family can be trusted. Thus, beliefs about actions of others are cultural traits (by virtue of being socially transmitted, whether by observation or teaching). Other elements affecting behavior are the motivations of people, their needs, wants, and values. These, too, can be culturally transmitted. The great majority of game-theoretic models, with which economists and political scientists investigate social dynamics, tend to base their assumptions on *Homo economicus*, responding in a purely self-regarding manner to materialistic rewards and punishment. Similarly, the theoretical literature on autocracy (see Kokkonen and Sundell 2014) typically assumes that the autocrats are motivated entirely by a desire to stay in power and to maximize their rents. Yet historical

autocrats exhibit a much more complex set of motivations. After all, autocrats are human, and although some of them may closely fit the Machiavellian idea of a pure power seeker, others depart from it in very significant ways. Some hold “sacred values” (Atran and Ginges 2012) that cannot be trumped by mere materialistic considerations. Others may be “fused” (Swann et al. 2012) with the nation they lead. Therefore, the beliefs and values of a population or those in positions of power can affect what institutions are developed or adopted as well as how the rules given by institutions actually unfold. Identical rules of the game (institutions) may produce wildly different patterns of behaviors in societies with different cultures. An oversimplified *H. economicus* vision of humans as *individualistic* utility maximizers, purely constrained and incentivized by different institutional rules and structures, is inadequate for explaining the obvious variations found across time and place.

Institutions are at the foundations of significant historical transitions, although this may not necessarily be obvious at any particular moment in time. Institutions are embedded in other institutions and must be understood in the context of complex systems of networks. These networks are also embedded in a broader ecology of relationships (with other institutions and culture), which extend back into the past, any aspect of which could change. Often these changes do not always have predictable results: a certain change might lead to nothing or, under different circumstances, might cascade to any number of changes; seemingly small changes can have large effects. In some sense, humans construct their own institutions, but they do not always get their desired outcomes. Values and beliefs alter the effectiveness of institutions, and institutions also affect how values and beliefs change, though this can take an indirect, evolutionary route. If certain types of political institutions favor particular types of behaviors and beliefs, institutional differences may have greater long-run evolutionary consequences than political strategies chosen in one context over another (Sardemov 2007). More specifically, it is possible that a Madisonian system of check and balances (which is premised on and *encourages* self-interested individuals and behaviors by explicitly pitting interest against interest) encourages a culture of self-interested egoists.⁸ This has important implications for trying to affect changes in institutions to bring about positive effects in societies, as it draws attention to the idea that simply trying to import existing institutions from one society to another may not always result in the desired outcome.

⁸ Similarly, genetic studies suggest that growing up in a violent household encourages low monoamine oxidase A individuals to become more violent (Alford and Hibbing 2004). Just as violence-prone individuals may become more violent if they grow up in a violent environment, more self-centered or rationalist individuals may be more self-centered if they come from an environment that rewards self-centered behavior. Alford and Hibbing (2004:717) suggest that “acting alone, monoamine oxidase A deficiencies or violent childhood have little predictive power, but the *interaction of genetic and environmental* forces is disconcertingly powerful.”

In our discussions of the evolution of institutions and their role in economic and political development, dialogue with researchers from a variety of academic backgrounds has underscored the need to understand how different disciplines view institutions. As noted by Marwell and Ames (1981), people who study neoclassical economics appear most likely to behave according to its precepts; thus they might not be able to challenge existing economic frameworks. If understanding is to be advanced, we argue that an interdisciplinary approach is necessary. We have attempted to move the debate forward by creating a common language and conceptual framework in which issues can be discussed.

Different disciplines and individual researchers will have different interests and motivations. This plurality should be embraced, and our attempt to create a conceptual framework should be seen as enabling the insights and understanding of different disciplines to be shared and synthesized more easily. We have no desire to create a monolithic “theory of institutions.” Instead, we see complex systems theory and evolutionary theory as providing a framework to develop a range of hypotheses and models that can be used to explain the evolution of institutions. The ultimate utility of these models or hypotheses will be in how well any particular model is able to explain the observed data in comparison to alternatives.

Acknowledgment

T. E. Currie and P. Turchin are supported by research grants from the Tricoastal Foundation, and the John Templeton Foundation. J. Bednar, P. Turchin, and P. J. Richerson would like to thank the NSF funded National Institute for Mathematical and Biological Synthesis at the University of Tennessee for their support of our Working Group on the Evolution of Institutions. Sven Steinmo acknowledges the funding he has received from the European Research Council under the European Union’s Seventh Framework Programme, ERC Grant agreement no. 295675.