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An evolutionary approach to global political economy

What would an evolutionary approach to the global political economy (GPE) look like? The usual approaches to GPE all have some elements of an evolutionary approach, but none assembles them into a coherent theoretical argument. In this chapter, I will advance both concept and something resembling proof of concept, albeit very briefly given the small space provided. The first section lays out the essentials for an evolutionary model in general to show why existing approaches are not evolutionary in the full sense. The second section presents the concept; namely, an evolutionary model for the GPE based on the preceding section. This model is analogous, but not identical, to natural evolution because humans occupy an unstable intermediate position with respect to their ability to orchestrate co-operative behaviour as compared to most species. What I will label ‘social exhaustion’ of relatively abundant resources for growth thus matters as much as exhaustion of material resources. The third and fourth sections present proof of concept by way of stylized pictures of two different periods of the GPE. These sections highlight transformation through material and social exhaustion. The fifth section concludes by arguing for the utility of an evolutionary approach in contrast to the usual paradigms.

Evolutionary models

Ian Lustick (2011) argues that much social science writing uses ‘evolution’ in an unsystematic way, typically as a synonym for any process of gradual change. This broad brush picture misses several more coherent efforts. On the one hand, George Modelski (1996) made an early attempt to organize an evolutionarily oriented research agenda around the development of the world economy. On the other hand, Geoffrey Hodgson (1993) has systematically tried to apply evolutionary thinking to understand economics and particularly institutional economics. Hodgson suggests that a coherent evolutionary model necessarily has four parts which collectively add up to a mechanism for explaining both gradual and abrupt change in the constitutive parts of a given system. These are principles of variation and divergence for units, a process of natural selection among those units, and a phylogenetic rather than ontogenetic outlook on any given ecological/biological system and its units. Put in natural language, an evolutionary theory must answer the questions of why and how individual organisms are

different; and what determines how those differences affect the probability that a given unit will survive long enough to reproduce; and, finally, accept that equilibria are unstable and that evolution has no final stopping point.

So first, evolution assumes a population of dissimilar units – both individuals and species – occupying the same environment. Mutation creates variation and this variation is what allows natural selection to occur. If all members of a species were identical and could faithfully transmit their genetic make-up to successor generations, then selection processes would not operate on individuals inside that species.¹ Selection might operate across species though. Second, the characteristics that define units must be heritable. Selection is rarely an ‘all or nothing’ phenomenon, in which all units with similar characteristics are wiped out in one go.² Instead, selection operates over time by reducing the probability that an unfit individual will survive long enough to reproduce. Characteristics that are not heritable will not affect the probability that successor generations survive long enough to reproduce. Third, obviously, a process of natural selection must operate such that better adapted, fitter organisms have a higher probability of having offspring and thus proportionately more offspring than worse adapted individuals. Over time, these offspring crowd out those from worse adapted individuals, producing either extinction of competing species or of deviant individual organisms within a species.³ Together, all three factors imply common descent. All known life forms on earth use deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) to reproduce themselves; all known life is thus descended from the operation of selection on variations in the organisms produced by these first self-replicating proteins.

Hodgson (1993: 94) also argues that variation, heritability and selection imply a phylogenetic rather than an ontogenetic outlook on a given system and its units. An ontogenetic outlook assumes that species (and thus their individual units) have unchanging features or qualities. Tuna are Tuna, can be identified as such through a list of qualities, and remain Tuna regardless of genetic drift or changes in the environment. By contrast, a phylogenetic outlook assumes that – despite common descent from the original self-replicating proteins we know now as RNA, DNA and prions – units carrying those proteins are constantly changing. Darwin’s tree of life implied a phylogenetic approach in which sexual recombination, genetic mutation and environmental disturbances continuously created variety within and across species. Organisms constantly changed as selection worked its inexorable magic on them. This change means that a permanent and stable equilibrium is impossible. In this view, a ‘species’ is simply a shorthand expression for a group of organisms that vary from individual to individual but cluster around a node of shared characteristics; the modal point for that node can and does change over time. Species are not permanent. The process of selection for individuals that best fit the environment thus never optimizes in the strict sense of the word. Evolution does not work without variation among individuals. Instead, the average set of characteristics defining a species shifts towards those that define the fitter individuals. Selection produces differentiation, not uniformity, and species can exhibit considerable internal differentiation. Evolution is thus completely agnostic about the issue of ‘progress’ or ‘decline’. Adaptation is everything, and the struggle to acquire resources needed to reproduce both explains and produces adaptation.

At the most basic level, this struggle for resources can be understood as a struggle for energy to drive self-replication. All life requires energy inputs, and all energy transformation involves a loss of some energy. Life is thus the uphill, temporary creation of order in the form of organized structures (viruses, bacteria, cells, organs, individual animals or plants) at the expense of greater entropy (disorder) in the surrounding environment. Forms of life that can directly

transform solar energy into biological energy can partially avoid the issue of entropy because they have direct access to what is in essence an unlimited supply of energy. Everything else, however, is parasitic on those primary transformers of solar energy. Evolution is the process by which individual organisms, and the species those organisms constitute, compete to capture energy from the environment in order to raise the probability that their DNA will be able to reproduce itself. A relatively greater ability to capture energy, as compared to other individuals inside the species and across species, defines ‘fitness’ with the environment. This ability increases the probability that a unit will reproduce, passing its DNA on to successor generations. The demiurge in this drama, to the extent that there is any, is DNA. Evolution through adaptation is not necessarily driven by conscious behaviours.

Do mainstream understandings of the GPE have a fully evolutionary outlook? The closest thing to an evolutionary argument in international relations (IR) in general is that found in Waltz’s (1979) rather thin neo-realist model for the guns side of the usual guns and butter divide in IR. This model is taken almost directly from a neoclassical model of pure economic competition, which explains its strong evolutionary elements. The core of the neoclassical model is competition among firms for consumers’ dollars (the resource in the system) in order to assure a given firm’s survival into the next round of competition. Waltz replaces the profit motive with security seeking (more properly, death avoidance). The neo-realist version of GPE takes this security-seeking motive over into its analyses through the concept of relative gain (Grieco 1988b). While this subordinates economic logics to the security dilemma, it provides a clear principle for selection. What neo-realist analyses lack, however, are any principles of variety and differentiation, and any argument about heritability. Like neoclassical economics, neo-realist political economy assumes that the GPE comes to an equilibrium state through the balance of power. Unlike the constant differentiation that a phylogenetic approach predicts, individual states converge on the same strategies. Units may come and go, but their basic strategy remains the same. Neo-realist approaches thus either posit invariant units or display an unwillingness to observe and explain variation among units. Neo-realist political economy thus does not have all the elements needed for a coherent evolutionary theory. A realist world settles into an equilibrium defined by the balance of power rather than by phylogenetic change.

What about neo-liberal approaches? Like neo-realist approaches, neo-liberal approaches stress equilibrium; but unlike neo-realist approaches, they see co-operation rather than conflict as the source of that equilibrium. While the original neo-liberal approaches saw bureaucracies and firms as the basic units in the GPE, neo-liberal approaches after Keohane’s *After Hegemony* (1984) looked to states as the basic unit for the GPE. They also took up the neo-realist assumption about invariant human nature, even though they posited a search for absolute gain rather than relative gains. Unlike neo-realist approaches, neo-liberal approaches imply that the pool of resources in the environment can be increased by conscious human action. The GPE is not zero-sum. The ability to increase the pool of exploitable resources through co-operation is an important insight we will pick up later in the discussion of social power. But neo-liberal approaches assume away competition among units. Relatively high transaction costs explain the failure to co-operate, not a competition over differential rates of reproduction.

Finally, constructivists are mute on almost all the elements needed for an evolutionary approach. While most constructivists would agree that there are some irreducibly material elements to the GPE, constructivist approaches basically reverse the causality implicit in neo-realist and neo-liberal approaches. The primary unit of analysis is not individual states or indeed discrete individuals, but rather social units that constitute their interests through shared

understandings of their roles and identities. Different identities imply different abilities to resolve the security and co-operation dilemmas that the two neo-schools posit. Because identities are constituted through interaction among individual units and are not a property of individual units (whether those are states or individuals), constructivists are basically operating with species as their core unit. The constructivist emphasis on emergent social properties comports well with the flavours of evolutionary theory that emphasize complex bases for selection, rather than reductionist views focusing only on individual selection (Morris 2001: 92–7; Gould and Lewontin 1979). This is hardly surprising, as reductionist evolutionary arguments have much in common with the methodologically individualist rational choice thinking that constructivism criticizes. But the idea that selection also operates on species (rather than just among individuals within species) is highly contested inside evolutionary theory (Morris 2001: 107–11). Finally, constructivists also lack a theory of change. Despite the absence of evolutionary elements in constructivist approaches, the emphasis on identity as the constituent force for interests will be important for us when we talk about social exhaustion below.

An evolutionary model for GPE

Can we model the GPE using variation, differentiation, heritability and selection? Two issues immediately seem to leap out. First, the GPE is a complex social order. Second, because the GPE is a complex social order, social exhaustion matters as much if not more than material exhaustion. Can evolution make sense of the emergence of these more complex social orders in addition to change and differentiation among the individual components of the biological order that evolution tries to model? Arguments that complex ‘social’ order promotes reproduction of DNA are consistent with evolutionary theory. For Darwin, a complex social order can arise as the unintended consequence of the interactions among conflicting self-interested individual units. But the plans or intentions of individuals make no difference at all to whether they survive, as it is the environment that exerts selection pressure.⁴ Organisms can use complex forms of organization to transform the environment. Think of E. O. Wilson’s (1990) ants. But most of these examples of complex social order are drawn from organisms whose behaviour seems strongly instinctual and pre-cognitive (Hölldobler and Wilson 2011). By contrast, complex human social orders superficially appear to be consciously constructed and managed, fluid, and capable of rapid adaptation to changes in the environment.⁵

A focus on social order helps explain variation and differentiation among units in the GPE, because the imperfect reproduction of social order is at the heart of common descent among human organizations. Without common descent, differentiation among human social orders could be, as constructivists seem to argue, purely a matter of chance without heritability. This would invalidate an analogy to evolution. What is the source of common descent in the GPE? Humans, like other organisms, harvest energy from their environment to assure reproduction. What makes humans different from most other organisms is the variety of ways in which humans harvest energy. Most of these are novel social forms of organization that mobilize human labour more effectively, rather than novel biological structures. Consequently, variation in human social forms does not create new physical species. Inuit, Patagonians and everyone in between can all reliably interbreed – the true test of speciation.

By contrast, different forms of social organization can hybridize in their search for more ways efficiently to utilize human energy in pursuit of organizational goals, including, most importantly, organizational reproduction. The GPE is a collection of social strategies for harvesting more energy, understood as directed human activity. We call these strategies firms, clusters of firms, and states. These three obviously exhibit variety, differentiation over time and selection, both among and within themselves. What unites all three, their common descent, is that they are constellations of social power, what Lewis Mumford (1966: 188–202) called ‘megamachines’, and what Michael Mann (1984) disaggregates in *Sources of Social Power*. Almost all forms of organized, non-individual power in the GPE are descended from, and in general are refinements of, the original megamachines Mumford identifies in the neolithic revolution.

These megamachines are the basis for what we call civilization, because they enable some humans to enforce specialization and co-ordination of production on other humans. By co-ordinating production across time and space, megamachines can generate enormous increases in output from both more extensive production and more intensive production as compared with tribal or nomadic societies. Intensive production is particularly important after the agricultural and industrial revolutions, which is to say, after the emergence of capitalist forms of social organization. Mumford’s humans and Mann’s do not naturally build pyramids, irrigation systems and central granaries. Instead, elites harness human bodies to these tasks through various forms of social organization, like religion, civil and military bureaucracy or sale of wage labour in a market. Megamachines are the organism or unit in an evolutionary understanding of the GPE.

This coercion-centred view is contrary to that in Ridley (2010), where voluntary exchange, not coercion, is the source of greater energy capture through specialization and comparative advantage. Plausibly both views are correct, although temporally it appears that states emerged just as much to control long-distance trade as they did literally to harvest a local surplus from agriculture. So the relevant organism in the GPE is not individual humans, but rather different kinds and forms of social organization that cage humans inside routinized behaviours that benefit elites. As Mann (1984) argues, this caging works better when it takes the form of self-motivated behaviours by individuals reacting rationally to a structure of power rather than openly coerced behaviours. This is the essence of his distinction between infrastructural and despotic power.

The overlap between routinization of exploitation and elite interests creates heritability, albeit imperfectly, in human social organization.⁶ Heritability occurs through what Dawkins (1976) labelled ‘memes’ and what the rest of us call standard operating procedures or logics of appropriateness (March and Olsen 1989). Organizations tend to select and promote individuals whose identity and behaviour match those of the organization; and organizations exist to capture energy in the form of human labour and creativity, prestige, money and material resources. The more carefully these megamachines assure compliance with organizational norms, the more likely it is that they will continue to mobilize energy and labour, as well as pass those norms along to future versions of the organization.

What creates variation among megamachines? Two phenomena drive variation. First, the reproduction of memes is imperfect. Unlike ants, whose behaviour is reliably coded in their DNA, humans maintain social organizations by transmitting cultural information (i.e. memes) from generation to generation inside organizations as much as they do inside family lines. One of E. O. Wilson’s books (Hölldobler and Wilson 2011) is subtitled *Civilization by Instinct*. While Thorstein Veblen (1914) makes much of the *Instinct of Worksmanship*, this is a far cry from

what Hölldobler and Wilson describe for ants. Instead, as Berger and Luckmann (1966) describe, contestation occurs over the meaning and operationalization of memes, because actors understand that memes are carriers of social relations and creators of social power, and also because subsequent generations lose important contextual knowledge about standard operating procedures. This tends to make standard procedures inflexible and unresponsive to changes in the environment.⁷ Second, variation and differentiation emerge from both conflict and co-operation. By observing other organizations, and how organizations interact and try to make their routines mesh, these organizations learn new techniques to mobilize labour. This institutional isomorphism does not always promote efficiency.

Finally, selection operates because megamachines compete with each other for control over human bodies. This competition eliminates organisms with relatively inefficient or ineffective routines. As realist IR and GPE both emphasize, strong selection pressures like war force societies and organizations to develop and replicate memes for organizing human production and violence more efficiently than those with whom they compete. All other things being equal, societies whose elites can extract more resources and mobilize more labour will tend to prevail in conflicts with other societies, whether that conflict is cultural, economic or military. So organizations face strong pressure to replicate their operating systems in ways that expand their control over resources. Elites at the top of religious organizations want more adherents; states want more citizens and territory; firms want more market share. Conflict among megamachines selects for those megamachines that are better able to mobilize the kinds of human labour and material resources that the environment provides, or to innovate new social technologies that make new or more efficient sources of human labour and material available.

But diversity does not emerge solely from conflict. Diversity also creates and reinforces diversity, as Ridley (2010) argues. Interaction with other units creates pressure to specialize based on societies' differential abilities to tap into resources in the global economy. Just as an expanding Darwinian tree of life creates more ecological niches for organisms and species, an expanding division of labour can create new economic niches in which different kinds of firms and societies can thrive. The *Varieties of Capitalism* (Hall and Soskice 2001) literature provides one way to understand this differentiation at the level of firms, though Spruyt (1994) provides an analysis of competition producing homogenization among state forms in late mediaeval Europe. Greater complexity produces instability and disruption that in turn exert selective pressure on units in the GPE, as when an economic crisis drives firms into bankruptcy or triggers social revolutions.

The second big issue emerges from the first issue of social complexity. In nature, only material exhaustion matters for individual and species survival. Wolves that are too efficient at catching sheep may cause a collapse in the population of sheep that in turn drives down the wolf population. Wolves cannot negotiate a lower rate of consumption among themselves. But in the GPE, we have a complex interplay between material and social exhaustion. Material exhaustion is easy to understand; imagine the exhaustion of (cheap) oil production in the face of rising demand for liquid fuels. But what is social exhaustion? Social exhaustion occurs when relatively docile and thus low-cost human bodies suddenly become less compliant with the megamachine trying to mobilize their labour. Low cost means lower levels of supervisory labour input to get a given level of work output. Low cost implies bodies which are self-propelled, require little supervision, accept their social role, and, most importantly, adapt that role to changes in the environment in ways that comport with a continuation or expansion of the relevant megamachine.

Understanding social exhaustion requires some elaboration. Assume that the global environment at time one is characterized by two abundant resources. One is material – cheap oil; the other is social – a pool of semi-skilled male labour made exceptionally docile by mass conscription and the experience of global war. We also have a set of countries that differ in their institutional capacity to use those available cheap and abundant resources. Some economies may already be organized around mass production and have a spatially extensive economy. Some may already have mass production, but spatially concentrated economies. Others may already be organized around small and medium enterprises that are also spatially concentrated. Given cheap oil and docile semi-skilled labour, the first economy will prosper, which in evolutionary terms means that it will expand its share of the GPE faster than the other economies. The market selects for firms able to turn docile labour and cheap oil into goods.

Because units in the GPE are capable of social adaptation, the other two societies in this example will tend to shift their production systems towards readily available resources. Moreover, social pressures to adopt ‘best practices’ will reinforce this tendency. Better adapted, and thus better performing, economies will be lauded as the model for all other economies. This institutional isomorphism (Dimaggio and Powell 1983; but Lustick 2011: 16 argues against conscious mimesis) shifts deviant economies towards a greater use of the cheap and abundant resource. So both social and market pressure pushes countries and firms to emulate the successful models at time one.

But the fallacy of composition matters here for material resources, and perhaps social resources as well. If all economies try to use the cheap resource, it stops being relatively cheap. (Gazelles might be the best food for predators, but if all predators hunt gazelles, zebra live quiet lives and the total number of lions, hyenas, wolves, etc. falls.) If all economies shift towards an oil-based and spatially expansive economy, then demand for oil will rise as production processes consume more oil and distances travelled increase. As oil prices rise, firms and countries characterized by lower consumption of oil will be favoured by the new environment.

By the same token, imperfect transmission of social or cultural information behind standard operating procedures or logics of appropriateness also leads to social exhaustion in this example (Berger and Luckmann 1966: 66–70). An expansion of assembly-line production beyond the existing supply of semi-skilled labour made docile through war might bring in workers less inured to assembly-line routines. New, younger workers who never experienced the disciplining effects of wartime military routines might similarly revolt against the rigours of assembly-line discipline. This exhaustion of the social basis for compliance with routines directing human labour makes assembly-line production relatively less successful as a production strategy, causing firms or economies based on this strategy to lose market share relative to firms relying less on docile semi-skilled labour. (We will return to this example in the proofs of concept below.) So time two is characterized by material and social exhaustion that shifts selection pressures to favour economies characterized by smaller enterprises and spatial concentration.⁸ This resource exhaustion in turn undermines the material and social basis for what had been a model previously favoured by the environment.

Proof of concept No. 1: evolution and exhaustion in the nineteenth century GPE

Can we make sense of the nineteenth-century GPE using the evolutionary model briefly sketched above? The nineteenth century saw a dual evolution of absolutist states into modern nation states, and very small family-owned firms into larger firms based on wage labour. Within agriculture, a parallel transformation from peasant production to capitalist (family) farming occurred. In other words, forms of social organization (organisms) that were unable to master the new nation-state or new production formats largely disappeared. While family-based production expanded on the back of the expansion of commercial agricultural production, family-based production units relatively lost ground to more formal organizations. These organizations ultimately had absentee ownership. At the level of the GPE, a very interventionist British state, sometimes aided by other European states, developed a highly articulated global economy moving unprecedented volumes of manufactures out of northwestern Europe in return for equally massive return flows of raw materials. Huge flows of people and capital accompanied these flows of goods.

Easily available resources material and social resources drove this transformation. In the material world, a whole range of easily exploitable common pool goods like cod, timber and minerals could be transformed into capital. Similarly, land previously occupied (but not ‘owned’) by nomadic or lightly settled populations in the temperate peripheries was easily engrossed and, via mortgage markets, transformed into capital (Belich 2009; Crosby 1986; Denoon 1983; Weaver 2003). For example, world wheat acreage expanded by 78 per cent between 1885 and 1929 (Friedmann 1978: 546). Newly emerging nation states played a critical role in the strip-mining of these resources by removing indigenous peoples, establishing title for those lucky enough to be the first to stumble on those goods or land, and providing enough public infrastructure physically to abet strip-mining. Strip-mining plus public infrastructure simultaneously injected generous and parallel volumes of supply and demand into the GPE. On the one hand, strip-mined raw materials could be sold; on the other hand, the corporations doing that strip-mining and the owners of newly stolen land could raise and then spend capital based on the expectation of future income flows. Acquisition of these common pool goods provided an essential supplement to capital accumulation, because their sale allowed the social transformation of inert resources into real and fictitious capital (Luxemburg and Bukharin 1972; Schwartz 2012).

The most important social resource was what seemed like an essentially unlimited supply of labour. As cheaply acquired land outside Europe and on Asia’s frontiers began producing ever-cheaper food, urban populations started booming and uncompetitive peasants began moving off the land. This started a great and largely voluntary migration of Europeans to new temperate-zone production sites and an equally great and largely involuntary migration of Asian indentured labour to tropical-zone production sites. Including ‘internal’ migrants heading to frontier zones in places like Manchuria, Siberia, Borneo, or Cochin China, perhaps 150 million people shifted location in the nineteenth century.

Relatively ineffective states, societies and firms vanished or shrank in the face of competitive pressure from more effective organizations. Although many states tried to emulate the European military model, few did so quickly and correctly enough to ward off predation by European empire builders (Ralston 1990). European handwork production also largely evaporated in the face of machine-powered production. Nonetheless, continued growth required continuous inputs of the initially abundant material and social resources. Both were exhausted by the end of the nineteenth century. The closing of the US frontier was soon followed by the closing of the Argentine, Australian and Canadian frontiers; North American forests near

navigable waterways were already timbered out. Socially, as Hatton and Williamson (1998) have shown, wages in the north Atlantic area had steadily converged with those of western Europe by 1913, by which time the gap was less than 2:1. The convergence of north Atlantic wages and the ever-growing scale of factory production slowed emigration and led to a growing labour movement in western Europe. An ecology characterized by extensive production and depletion of almost all common pool resources started to give way to one based on intensive production.

Proof of concept No. 2: evolution and exhaustion in the twentieth century GPE

Expansion of the GPE after the Second World War also rested on new organizational forms and the availability of cheap material and social resources. We have already hinted at the most important of these – oil and docile semi-skilled labour – in the previous section. A second socially important resource was acceptance of state management of economies that had come to be characterized by assembly-line-based mass production (van der Pijl 1984). The emergence – often state-enforced – of large firms using continuous flow production required macro-economic stability and labour quiescence. Continuous flow production systems were highly productive and thus potentially highly profitable, but they could reap the benefits of that increased productivity only by running at high levels of capacity utilization (Piore and Sabel, 1986). Maintaining social stability and balancing supply and demand in this situation required the state to enforce – both in the sense of ‘force on’ and the sense of ‘guarantee’ – a class compromise over wages. Though this compromise naturally varied from country to country, in all countries, a generation of conscripted men was available for factory work, and willing to accept factory discipline in exchange for stable employment, steadily rising wages and a social safety net. States that could stabilize wages and keep wages rising in tandem with productivity not only maintained these class compromises, but also maintained steady economic growth (Shonfield 1965).

Yet by the late 1960s and early 1970s, each of these resources was exhausted. Materially, cheap oil at stable prices gave way to expensive and volatile oil. Socially, the new generation of factory workers revolted against the older generation of union leaders, producing a wave of unauthorized strikes. And states came under increasing pressure from financial elites to deregulate the economy. As noted in the previous section, economies characterized by spatial concentration (e.g. Japan) or small and medium-sized firms using skilled labour (e.g. Germany) had relative advantages in this new environment. As in the nineteenth century, the very success of a set of organisms – institutions – in expanding their population based on a set of cheap resources led to resources exhaustion and a ‘die back’ of those units. Instead, firms with smaller factories flourished, and many firms began outsourcing to reduce their footprint. States shifted from direct management of investment towards pure monetary stimulus (though this was disguised as a retreat from Keynesianism rather than a retreat into Keynesianism).

Conclusion

An evolutionary approach to the GPE yields some insights that are not available from other paradigms. If we view states and firms as megamachines with varying capacity to mobilize and co-ordinate human activity – to exert social power – then we can explain their relative survival

rates. We can also explain the continuity in both organizations and in species like the state, or militarized resource-extraction firms, that have changed over the past five centuries, but still bear a marked resemblance to their earlier forms. Both states and firms try to reproduce themselves, or even better, expand their ‘market share’ over the long run. This expansion rests on access to low-cost resources, which function as literal or figurative energy for these megamachines. Success reinforces success only up to the point where expansion and emulation of success leads to resource exhaustion. In turn, resource exhaustion leads to the extinction or transformation of different kinds of organizational formats.

An evolutionary approach thus emphasizes power and the limits to power in ways that the other approaches obscure or oversimplify. Neo-realists correctly focus on power, but have a static, ontogenetic approach. Neo-liberals emphasize the gains from mutualism, or symbiosis, but obscure conflict and competition. Constructivists correctly focus on the importance of socially constituted identities – what we have called standard operating procedure or logics of appropriateness – but without any systematic explanation of how these change and what that change means for the GPE. An evolutionary approach encompasses both competition and cooperation, long-term change and the crucial importance of low-cost resources for the development of specific megamachines.

Notes

Author’s note: the author would like to thank Bent Sofus Tranøy for very useful discussions, and more importantly, some prodding to develop and write down the arguments below. All errors remain mine.

- 1 This model ignores epigenetics – modification to the expression of genes that occurs as a result of contact with the environment. Darwin’s model lacked genetics, let alone epigenetics, so this is in the nature of a simplifying assumption. A more complex model could incorporate epigenetic effects with no violence to the original model, as epigenetic expression creates variation across individuals constituting a particular species. It is unclear at this point in time whether epigenetic effects are heritable. If they were, it would shift the debate about evolution away from a strict focus on individual reproduction towards species and clusters of species.
- 2 However, this is what appears to have happened in the great Permian extinction and the apparent extinction of those dinosaurs that did not turn into birds.
- 3 “I think it inevitably follows, that as new species in the course of time are formed through natural selection, others will become rarer and rarer, and finally extinct. The forms which stand in closest competition with those undergoing modification and improvement will naturally suffer most.” Charles Darwin, *The Origin of Species*, (1870: 103).
- 4 Darwin’s (1870) outlook here is similar to and perhaps influenced Max Weber’s (1978, 38-40) core concept of ‘action behind the backs of actors’, or *auslese*, which literally means ‘selection’.
- 5 Rapid is, of course, a relative concept. Fruit flies can mutate into new species over a period of years. But given that there are only about 55 centuries of complex societies (starting with the Sumerians in 3,500 BC), and that many species are stable over

geological time measured in hundreds of thousands of years, human innovation of socially organized adaptation to environmental changes is fairly rapid.

- 6 Social reproduction combined with social adaptation could imply either a Lamarckian view of social evolution, in which new behaviours that emerge from interactions with the environment become heritable in future iterations with the environment, or an epigenetic view, in which it is standard operating procedures that are modified.
- 7 This can be seen in 1970s Germany, where the Social Democratic Party (SPD) set up a new technology ministry to generate research in biotechnology, electronics and atomic energy. Only the latter was strongly successful, because the normal policy routines favoured the wrong kinds of firm (Jasanoff 1985; Giesecke 1999).
- 8 Alert readers will realize that I have just reproduced the argument in Piore and Sabel (1986) as a parable.