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INDIVIDUAL INTERACTIONS, GROUP CONFLICTS AND THE EVOLUTION OF PREFERENCES

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Political writers have established it as a maxim, that, in contriving any system of government ... every man ought to be supposed to be a knave and to have no other end, in all his actions, than his private interest.

David Hume (1754/1898)

Lawgivers make the citizen good by inculcating habits in them, and this is the aim of every lawgiver; if he does not succeed in doing that, his legislation is a failure. It is in this that a good constitution differs from a bad one.

Aristotle (1962):1103

1. Introduction

Economists have followed Hume, and before him Hobbes, rather than Aristotle, in positing a given and self-regarding individual as the appropriate behavioral foundation for considerations of governance and policy.¹ The implicit premise that preferences are selfish and that policies and constitutions do not affect preferences has much to recommend it: the premise provides a common if minimal analytical framework applicable to a wide range of issues of public concern, it expresses a prudent antipathy towards paternalistic attempts at social engineering of the psyche, it modestly acknowledges how little we know about the effects of economic structure and policy on preferences, and it erects a barrier both to ad hoc explanation and to the utopian thinking of those who invoke the mutability of human dispositions in order to sidestep difficult questions of scarcity and social choice.

Realism, however, cannot be counted among the virtues of the exogenous preferences premise: the available evidence, while far from conclusive, suggests that economic policies and institutions affect preferences.² The primary effects appear to operate through situational construal (or framing), the effect of forms of reward on motivation, the influence of the structure of social interactions on evolution of norms, and the way institutions shape task-related learning as well as their indirect effects on the process of cultural transmission itself.

Nor does the assumption that human motivations are entirely self-regarding find

¹ To appear in Steven Durlauf and Peyton Young, *Social Dynamics*. Cambridge, MIT Press, 2000. Thanks to Katie Baird, Robert Boyd, Gerald Cohen, Marcus Feldman, Steven Frank, Astrid Hopfensitz, Charles Tilly, David Sloan Wilson, Elisabeth Wood, Peyton Young, and workshop participants at the Santa Fe Institute and the Massachusetts Institute of Technology for helpful comments, to the University of Siena for hospitality, to Bridget Longridge for research assistance, and to the MacArthur Foundation for financial support.

² See Bowles (1998) for a survey. Indeed Hume, immediately following the passage just quoted, muses that it is "strange that a maxim should be true in politics which is false in fact." While in academic settings most economists still adhere to the exogenous preferences canon and its "de gustibus non est disputandum" implication (George Stigler and Becker (1977)), many appear aware of its limitations when it comes to evaluating institutions and policies. Thus Becker (1995) refers to "the effects of a free-market system on self-reliance, initiative, and other virtues" and referring to government transfers to the poor, claims that "...the present system corrupts the values transmitted to children."

convincing empirical support: experiments by social psychologists and economists, ethnographic and historical studies of collective sacrifice towards common objectives, and simple introspection point to the importance of other-regarding preferences. Moreover preferences appear to be defined over processes as well as outcomes per se, individuals making different choices depending on how a given opportunity set was determined.³

Economists and to a lesser extent other social scientists have resisted addressing the complexity and endogeneity of human motivations, not because we think the behavioral simplicity of *homo economicus* is an adequate representation, but rather because we lack both adequate conceptual tools and empirical information on the process of preference formation. It thus may be useful to consider a formal model of the process of preference formation, one which admits the possibility that other-regarding and process-regarding preferences, as well as self-regarding and outcome-oriented motivations, might evolve.

Among the desiderata for such a model is recognition of the highly structured (rather than random) ways that humans interact both within and between groups. Just as the norms and tastes motivating individual behavior proliferate in a group when individuals copy successful neighbors, so too do distributive norms, linguistic conventions, religious faiths, and other cultural traits diffuse or disappear through the emulation of the characteristics of successful groups by members of less successful groups, often as a result of military, economic, and other forms of competition. While both individual and group interactions thus influence the updating of preferences, they have been treated quite differently by students of cultural evolution. Evolutionary game theory and the biologically inspired theory of cultural evolution have provided agent-based models of individual updating within populations. But for the most part, group-level effects have played a distinctly lesser role in formal modeling. By contrast group effects have been the primary focus of empirical studies by historians and anthropologists whose insights on such questions as the encroachment of market societies on indigenous cultures derive from a structuralist approach which eschews the reductionism of agent based modeling. Moreover many, perhaps most, formal evolutionary models abstract from two additional aspects of human social structure relevant to the process of individual updating: a tendency towards conformism in the adoption of behavioral traits and the fact that human groups are highly segregated, often deliberately so, such that individual interactions are hardly ever random with respect to preferences of the individual.

In this essay I provide a unified framework for studying the effects of economic

³ See Caporeal et al, (1989) Andreoni (1997), Fehr and Gaechter (2000), Ostrom (1998) Wilson and Sober (1998), and Bowles (2001) for surveys.

(and other) institutions on the evolution of preferences, taking account of conformist updating, social segregation, and the simultaneous operation of selection processes at the individual and group level. I begin by clarifying what I mean by preferences and explaining how evolutionary processes may be conveniently partitioned into group-level and individual selection effects. I then indicate, by way of concrete examples from the historical, anthropological, and political science literatures, the kinds of real world phenomena that an adequate model of preference evolution should be able to address. I then develop a model of individual updating incorporating the effects of both social segmentation and conformism. Next I embed this model in the process of intergroup competition. In the penultimate section I use the resulting model to discuss the effects of social institutions (and by implication economic policies) on the evolution of preferences.

2. Group and Individual Effects in Preference Evolution

Preferences are reasons for behavior, that is attributes of individuals (other than beliefs and capacities) that account for the actions they take in a given situation. To explain why a person chose a point in a budget set, for example, one might make reference to her craving for the chosen goods, or to a religious prohibition against the excluded goods. Conceived this way, preferences go considerably beyond tastes, as an adequate account of individual actions would have to include values or what Amartya Sen (1977) terms commitments and John Harsanyi (1982) calls moral preferences (as distinct from personal preferences.) Also included are the manner in which the individual construes the situation in which the choice is to be made (Lee Ross and Richard Nisbett, 1991), the way that the decision situation is framed (Amos Tversky and Daniel Kahneman (1986)), cultural beliefs (Avner Greif, 1994), compulsions, addictions, habits, and more broadly, psychological dispositions. Preferences may be strongly cognitively mediated -- my enjoying ice cream may depend critically on my belief that ice cream does not make me fat -- or they may be visceral reactions -- like disgust or fear -- evoking strong emotions but having only the most minimal cognitive aspects (R.B. Zajonc (1980), David Laibson (1996), George Loewenstein (1997), Paul Rozin and Carol Nemeroff (1990)). The term "preferences" for these heterogeneous reasons for behavior is perhaps too narrow, and runs the risk of falsely suggesting that a single model of action is sufficient; P.H. Nowell-Smith's (1954) "pro and con attitudes" or "reasons for choosing" are more descriptive, but unwieldy.⁴

⁴ In order to account for an individual's actions preferences need not coincide with the reasons given by the particular individual, of course. Nor do preferences alone generally give a sufficient account of behaviors: my consumption of aspirin is accounted for by my aversion to pain plus my belief that aspirin will relieve the pain and that this little white object is indeed an aspirin, and so on.

How might group- and individual-level processes influencing the evolution of these "pro and con attitudes" be modeled?

As has been long recognized (Price, 1970, Crow and Kimura, 1970), in populations composed of groups characterized by a markedly higher level of interaction among members than with outsiders, evolutionary processes may be decomposed into between-group and within-group selection effects. Where the degree of successful replication of a trait depends on the composition the group and where group differences in composition exist, group selection contributes to the pace and direction of evolutionary change. The classic problem of group selection arises when between group effects favor the proliferation of a group-beneficial trait such as altruism which is disfavored by individual selection within groups.

Few students of human populations doubt that institutions, nations, firms, bands, and other social aggregates may be subject to selective pressures operating at the group rather than individual level (Darwin (1873), Alchian (1950), Hayek (1990), Parsons (1964), Tilly (1990)). But at least until recently, most biologists who have modeled evolutionary processes under the joint influence of group and individual selection have concluded that the former cannot offset the effects of the latter except where special circumstances heighten and sustain differences between groups relative to within group differences⁵. Thus group selection models are widely judged to have failed in their defining task, namely to explain the evolutionary success of altruism and other individually costly forms of group-beneficial sociality. As a result, while the explanation of group beneficial behaviors has focused on inclusive, kin-based fitness mechanisms, the impressive levels of non-kin based sociality in the case of humans has remained for the most part unexplained.⁶

⁵ Williams (1966), Crow and Kimura (1970), Boorman and Levitt, (1973) Maynard Smith, (1976). The negative assessment of the likely empirical importance of group selection stems primarily from the presumed more rapid rate of selection within as opposed to between groups and the generation of differences in group means solely by drift or random assortment (Crow and Kimura point to "the much larger variance within a group than between group means, the larger numbers that minimize the "noise" from random events, and the slower effective "generation length" for inter-group selection." (1970):242.) But subsequent work suggests that impediments to group selection may be less general than the critics contend (Uyenoyama (1979), Uyenoyama and Feldman (1980), Harpending and Rogers (1987)).

⁶ These do not exhaust the explanations offered, of course. Simon (1990), Eibl-Eibesfeldt (1982) and others have proposed a mechanism whereby costly but group beneficial behaviors free ride on the individually beneficial behaviors ("docility," or "indoctrinability," for example) with which they are pleiotropically paired.

But as Boyd and Richerson (1985, 1990), Sober and Wilson (1994, 1998), Wilson and Dugatkin (1997), Boehm (1996, 1997) and others have pointed out, group selection may be of considerably greater importance among humans, given the substantial role of cultural inheritance in the replication of human traits, the advanced level of human cognitive capacities, and as a result of these, the distinctive nature of human groups. Conformist cultural transmission based on frequency dependent learning rules favoring more prevalent traits (Boyd and Richerson (1985), Cavalli Sforza and Feldman (1973)) will sustain between group variances and thus may make group selection viable when a purely payoff-based learning rule would not. Boehm notes that egalitarian social processes may also enhance the relative influence of group selection mechanisms; examples include practices such as monogamy or food sharing which reduce the phenotypic variance of traits within in a group as well as other practices like consensus decision making which additionally increase between group differences. Wilson and Dugatkin (1997), extending earlier work on assortative (non random) interactions by Hamilton (1975), Grafen (1979, 1984), and others, point out that humans are well equipped to recognize and discriminate among those with whom they interact, the resulting social segmentation sustaining high levels of between group differences in trait frequencies.⁷

Given that conformist cultural transmission, egalitarian social processes, and social segmentation may enhance the role of group selection, it would appear, first, that group beneficial but individually costly traits might be favored in human evolution, and this may help to account for the high levels of sociality of humans. Among these group beneficial traits are forms of costly punishment of those who transgress social norms, and of course altruism. A second inference is that through their influence on the group selection process, economic institutions, ingroup-outgroup relationships, social stratification, residence patterns, and other aspects of social structure may influence the evolution of norms, tastes, habits, and other fundamental bases of human behavior. (Bowles, 1998)

Consider a single trait, which may be absent or present in each individual in a large population whose members each belong to one of a large number of groups. Let $p_{ij} = 1$ indicate that individual i in group j has the trait, with $p_{ij} = 0$ otherwise. Using a discrete time non-overlapping generations framework, let p and p' represent the fraction of the population with the trait during a given period and a subsequent time

⁷ Other animals practice similar kinds of discrimination and segmentation; in some social insects an odor distinctive to a colony (acquired through food exchanges) allows individuals to distinguish colony members from unrelated outsiders, and there are other examples, including rodents and other mammals (Hamilton, 1971). However human cognitive capacities allow for discrimination on a scale unmatched by other animals.

period, respectively, and $\Delta p = p' - p$. Without specifying the nature of the trait replication and updating process, suppose in any period each individual present in the previous period is represented by some number of exact replicas (if the individual had the trait, the replicas do as well); those favored by the selection process yielding more replicas than those disfavored. Define the selection coefficient w_{ij} as the number of replicas of individual i in group j , and let w_{ij} depend (additively) on i 's own trait and the frequency of the trait in the group (p_j , $\in [0,1]$) according to :

$$(1) \quad w_{ij} = \beta_0 + p_j \beta_{wp \sim p} + p_{ij} \beta_{wp, p \sim}$$

where $\beta_{wp \sim p}$ and $\beta_{wp, p \sim}$ are the partial regression coefficients of w_{ij} on the frequency of the trait in the group and the presence of the trait in the individual, respectively and β_0 is baseline replication, a constant uncorrelated with the trait. Define $\beta_{w \sim p \sim} / \beta_{wp \sim p} + \beta_{wp, p \sim}$ as the regression of the group average number of replicas on the frequency of the trait in the group (the difference in the number of replicas between a group composed entirely of those with the trait and a group entirely without is $\beta_{w \sim p \sim}$.) Then following Price (1970) we can write

$$(2) \quad \Delta p = \text{var}(p_j) \beta_{w \sim p \sim} + E\{\text{var}(p_{ij})\} \beta_{wp, p \sim}$$

where Δp is the population average selection coefficient and the expectation operator $E\{\}$ indicates a weighted summation over groups (the weights being group size). (See also Grafen (1985), Rogers (1990) and Frank (1995).) The first term captures the group selection effect; while the second represents the effect of individual selection within groups⁸ (A simple derivation of this decomposition is in the appendix.) It follows that (abstracting from degenerate cases such as zero variances) an interior frequency of the trait will be stationary where these two terms are of opposite sign and equal magnitude (assuming that the regression coefficients and (weighted) variances making up these terms are themselves stationary.)

For concreteness, consider an altruistic behavior which costs the individual c and confers a benefit of b on a randomly paired (single) member of the group, so a member in a group composed entirely of altruists produces $b-c$ more replicas than does a member of a group with no altruists. As we assume $b-c > 0$, altruism is group beneficial. Using the definitions above, $\beta_{wp, p \sim} = -c$, $\beta_{wp \sim p} = b$ and $\beta_{w \sim p \sim} = b-c$. Then, because $\Delta p > 0$, equation (2) with a little rearranging shows that the frequency of the altruistic trait is stationary if

⁸ The covariance between group means and individual fitness will not be zero even if no group effects exist (the individual's fitness contributes to the mean); I assume groups are large enough to allow the interpretation of the regression coefficient as a group effect.

$$(3) \quad c/b = \text{var}(p_j)/[E\{\text{var}(p_{ij})\} + \text{var}(p_j)]$$

where the right-hand term, the ratio of between group to total variance of the trait, is identical to the degree of genetic relatedness in kin selection models (Crow and Kimura, 1970). It measures the difference between the probabilities that an altruist and a non-altruist, respectively, will interact with an altruist: when the variance among group means is zero, the probability that both will meet an altruist is identical, namely p . Equations (2) and (3) make it clear that the force of group selection will depend on the magnitude of the group benefit relative the individual cost (b and c in the example) and the degree to which groups differ in their mean frequency of the trait, relative to the degree of within group variance of the trait. The reason why food sharing, consensus decision making and the other within-group homogenizing practices of human societies mentioned above is important for group selection is clear: where groups are homogeneous, no individual selection can take place (The second term in (2) vanishes.) The importance of between group differentiation is equally apparent: where group means are identical group selection is precluded (The first term in (2) vanishes.)

To adapt this approach to the peculiarities of human cultural evolution I abstract from differential biological reproduction of the bearers of traits and assume that every member of the population is infinitely lived; behavioral traits, however, are differentially replicated through a process of learning from others. Reflecting the often strategic nature of human social interactions, the benefits and costs of particular behaviors and the cultural transmission process accounting for the replication of traits will depend on the distribution of traits in the population. The population is structured in two respects. First, individuals are members of groups, and interactions within groups (individual strategic interactions and learning) differ from those between groups (group "contests" and cultural assimilation). For this reason the model exhibits two distinct processes of selection. Groups (like individuals in biological models) may go extinct, and may reproduce, under conditions to be specified, yielding inexact replicas. Second, groups are segmented internally, so that while within group interactions are governed by the same rules for all members, pairings of members may be non-random with respect to type.

3. Group Selection in Human Populations: an example

Consider a concrete case: the emergence and spread of an entirely new organizational entity -- the national state -- and the norms supporting it in Europe, and their eventual diffusion throughout the world during the past half a millennium.⁹ I

⁹ Unlike its competitors -- empires, city states and urban federations -- national states in Tilly's usage "unite substantial military, extractive, administrative, and

introduce this case not to explain the rise of the national state and the diffusion of the norms associated with it (a far more complex task than can be attempted here), but to make clear what kinds of reasoning a group selection argument requires, and what kinds of facts it might explain.¹⁰ Charles Tilly (1990):4-5 poses the following problem:

The system of states that now prevails almost everywhere on earth took shape in Europe after 990 AD, then began extending its control far outside the continent five centuries later. It eventually absorbed, eclipsed, or extinguished all its rivals including the systems of states that then centered on China, India, Persia and Turkey.

Empires, city states, federations of cities, networks of landlords, churches, religious orders, leagues of pirates, warrior bands and many other forms of governance prevailed in some parts of Europe at various times over the last thousand years. Most of them qualified as states of one kind or another... But only slowly did the national state become the predominant form. Hence the double question: *What accounts for the great variation over time and space in the kinds of states that have prevailed in Europe since 990, and why did European states eventually converge on different variants of the national state?*

The success of the national state in Europe over a short historical span was dazzling:

In AD 1200 the Italian Peninsula alone boasted two or three hundred distinct city states. Around 1490...South Germany alone included 69 free cities in addition to its multiple bishoprics, duchies, and principalities...Europe's 80 million people divided into something like 500 states, would be states, statelets, and statelike organizations. By

sometimes even distributive and productive organizations in a relatively coordinated central structure." (1990):21 In addition to Tilly (1990), I draw here on Gellner (1983), Bright and Harding (1980), Tilly (1975), Mack Smith (1959), Anderson (1974), Wallerstein (1974), and Gintis and Bowles (1980).

¹⁰ Soltis, Boyd and Richerson (1995) applied a group selection model to data on group differences and extinction rates in New Guinea. Other well documented empirical cases where a group selection argument may readily be applied are the conquest and assimilation of the Dinka by the Nuer (Boyd, 1997, Kelly, 1985) and the practice of llama sharing among needy non kin in the Peruvian highlands (Flannery et al (1989) and Weinstein, et al (1983).

1990 ... depending on the rules for counting, the whole of Europe divided into a mere 25 to 28 states. Tilly (1990):43

Figures 1 and 2 provide glimpses of the situation around 1500.

Over the same period, and in part as a result of its success in Europe, replicas of the European national state flourished throughout the world, extinguishing competing forms of organization.

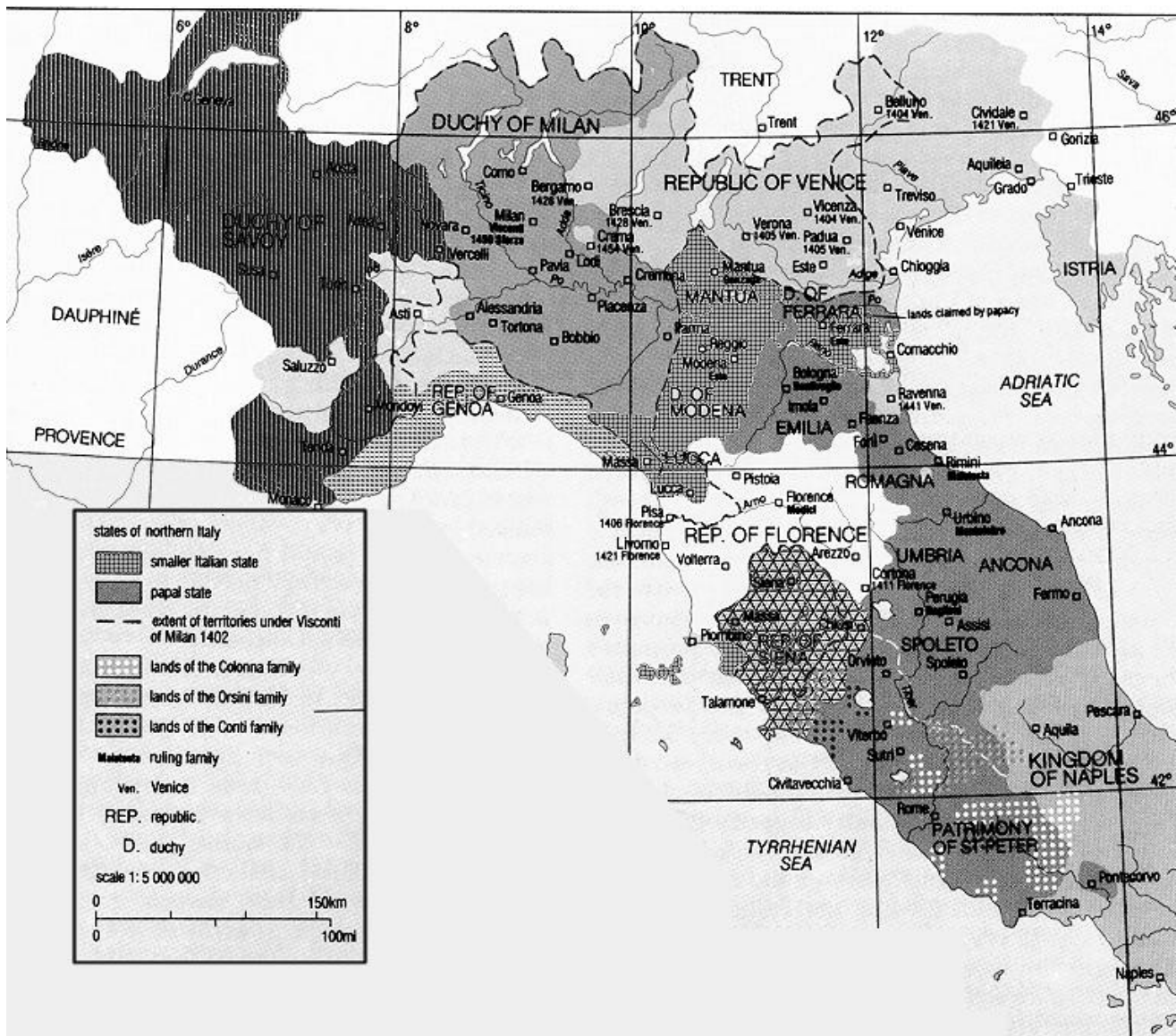


Figure 1: Political Entities in 15th Century Italy. A great many of the smaller sovereign entities (e.g. San Gimignano) are not shown; note also the many once autonomous entities (e.g. Verona, Bergamo, Padua, Vicenza, all absorbed by Venice early in the century). From Matthew (1983) p.212.

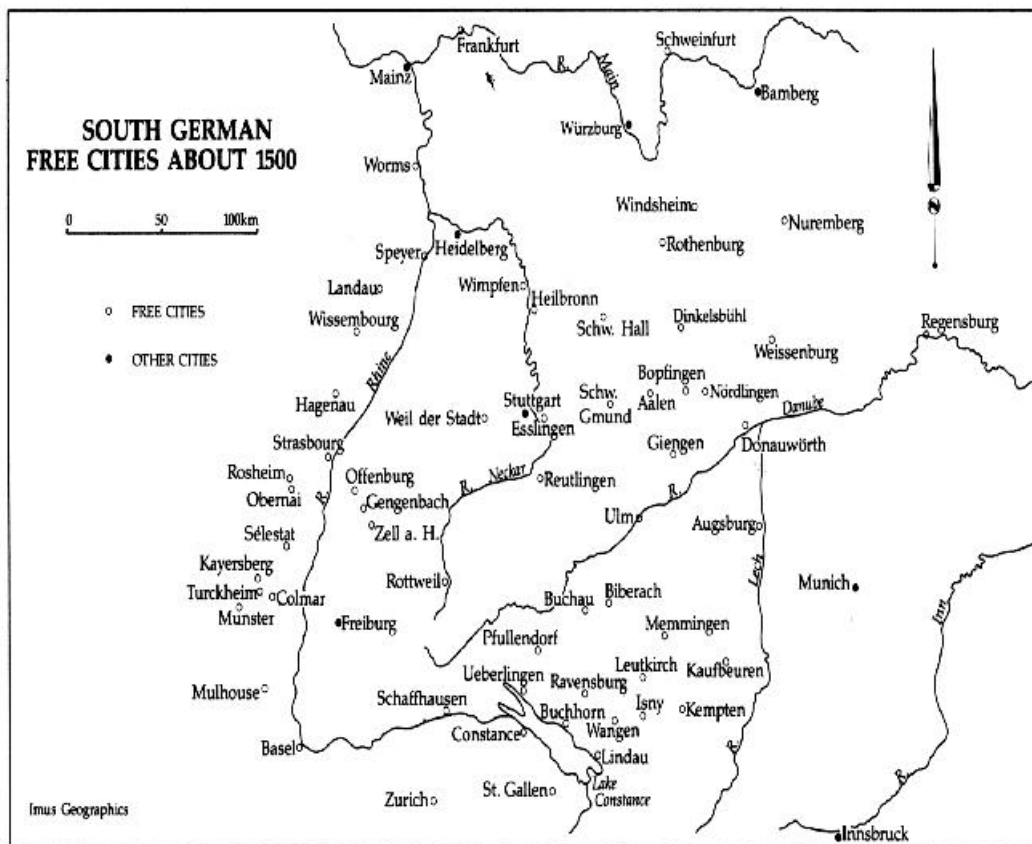


Figure 2. Autonomous South German Cities (from Brady (1985), p. xvi.)

What explains this competitive success? The simple answer is that when national states warred with other forms of governance, they tended to win.

Within limits set by the demands and rewards of other states, extraction and struggle over the means of war created the central organizational structures of states. ... Only late in the millennium did national states exercise clear superiority over city states, empires, and other common European forms of state. ...the increasing scale of war and the knitting together of the European state system through commercial, military and diplomatic interaction eventually gave the war-making advantage to those states that could field standing armies; states having access to a combination of large rural population, capitalists, and relatively commercialized economies won out. They set the terms of war, and their form of state became the predominant one in Europe. Eventually European states converged on that form: the national state. (Tilly, 1990:15)

Successfully making war required both resources and legitimacy:

No monarch could make war without securing the acquiescence of nearly all of his subject population, and the active cooperation of at least a crucial few. (Tilly, 1990:75).

Mobilizing resources to support a standing army required permanent and widespread taxation:

Before 1400 ...taxes existed in Europe's more commercialized states, but rulers everywhere acquired most of their revenues from tribute, rent, dues, and fees. Individual sovereigns borrowed money, but usually in their own names and against real collateral. (74)

...the mass of the subject population resisted direct seizure of men, food, weapons, transport and other means of war much more vigorously and effectively than they fought against paying for them. ...European states generally moved toward a system of collecting taxes in money, paying for coercive means with the money thus collected, and using some of the coercive means to further the collection of taxes. (84)

Not all states succeeded in financing war through permanent monetized taxation:

Such a system only worked well under two very demanding conditions: a relatively monetized economy and the ready availability of credit. ...The relative presence or absence of commercial cities within a state's territories therefore affected the ease of mobilization for war. (84-86)

Market environments favored state formation in a less obvious way: by inducing tax compliance:

Participants in markets already do a significant share of the requisite surveillance through the recording of prices and transfers. Properly socialized citizens, furthermore, come to attach moral value to the payment of taxes; they monitor themselves and each other, blaming tax evaders as free riders. (89)

Significantly for my interpretation of state formation as a diffusion process, European statemaking exhibited a distinct concentric spatial pattern, with large but thinly controlled states on the periphery (Muscovy and the Ottoman Empire, for example),

a grouping of city states and federations near the center (the Italian city states, the Swiss cantons), and the eventually triumphant more centralized states such as France and Brandenburg intermediate between the two. Successful national states assimilated the populations they absorbed, and over the period they promoted and eventually required a common pattern of childhood socialization through schooling.¹¹

Under the auspices of the national state European populations grew rapidly -- multiplying 15 fold in Britain in the four centuries after 1500 having grown hardly at all over the previous four centuries, and eclipsing population growth elsewhere in the world (except, perhaps, for China during the 18th century.) The diffusion of the national state globally was thus promoted not only by competitive pressures on the states of the European periphery but as well by the substantial emigration of European bearers of the cultural traits and military capacities which had favored statebuilding in Europe.

A group selection account of the diffusion of the norms associated with the national state is the following. The national state evolved because it won wars with competing organizations, and the ability to win wars depended on its peculiar ability to mobilize soldiers and other military resources. This ability depended on the extent of commerce and credit, tax compliance, and the willingness to serve rulers in war. These, in turn, were fostered by the diffusion of norms guiding individual behaviors which while not (at least initially) individually advantageous, contributed to group success in war on the above reasoning. Candidates for such norms are: voluntary tax compliance, willingness to risk danger in war for a ruler or nation, and respect for property rights. The norm of monogamy may have played a similar, if less obvious role in securing popular cooperation with the projects of the elite.¹² Each of these

¹¹ Weber (1976) describes the assimilation of distinct populations by the French national state. Gellner (1983) develops the connection between the rise of commerce, the national state, and the rise of what he terms "exo-education", that is, childhood socialization by specialists who are not members of one's family or group of close associates.

¹² Herlihy and Klapische-Zuber write: "The great social achievement of the early Middle Ages was the imposition of the same rules of sexual and domestic conduct on both rich and poor" (1985):157. See also MacDonald (1995). While reducing the advantages of the successful and powerful, the norm of monogamy may have been instrumental, as Alexander (1979) and others suggest in allowing the powerful to recruit others to their projects, including war. Referring to an earlier period, Herlihy writes:

Under conditions of acute [inter group] competition, it was necessary

norms contributes directly or indirectly to the state's warmaking capacity, but requires the bearer of the norm to forego possible gains and endure losses (including reduced reproductive success).

Of course national states eventually may have created legal and cultural environments in which those adhering to the norms which enhanced state warmaking capacities suffered little or no material loss by comparison to those rejecting these norms.¹³ But the emergence and early diffusion of the national state may have relied critically on group-advantageous but individually costly norms.

4. Cultural Learning, Segmentation and Individual Selection

An adequate model cultural group selection must evidently include a plausible account of the process by which individuals acquire and abandon norms, and how this is influenced both by the structure of groups and the nature of intergroup competition. Who is exposed to which cultural traits under what conditions (as a student, child, consumer, worshiper, neighbor, or citizen for example) and other details of the cultural learning process -- often treated as a black box -- may make a big difference in the direction and pace of evolutionary change (Cavalli Sforza and Feldman, 1973). As non-random pairing of individuals in groups and conformism in learning play important parts in the model to follow (and as both are absent in most evolutionary game theoretic treatments) I will first explain why these aspects of the social architecture of the learning process may be important, before developing the model.

In human populations individuals are non-randomly paired to meet both cultural models and others with whom they interact such that the probability of meeting a particular type is conditioned on one's own type and differs significantly from the population frequency of the traits in question. One might, for example, be disproportionately likely to interact with individuals who had had the same teacher (or the same "parent"), for example, and this would result in non-random pairing in the playing of games. Or the population might be segmented: its members living in culturally homogeneous communities and interact disproportionately frequently with their co-residents. A "community" could be a village or neighborhood but it might also be a

to maintain the moral commitment and physical energies of the citizens.
.. [A] crucial means ... was to offer all citizens access to marriage. ...
But only a system of monogamy could assure that all male citizens
would have a reasonable chance of attracting a wife.. (1991:14-5)

¹³ MacDonald stresses the socially imposed nature of monogamy, which if entirely successful would eliminate within group variance the number of sexual partners, and reduce the evolution of monogamy to a between group selection process.

class or ethnic group, or any culturally homogeneous group within which interaction is more likely than in the population at large. Segmentation might also take place in a multi-good economy through strictures governing which types of goods or services one may appropriately exchange with members of one's community as opposed to outsiders. Segmentation does not presume recognition of type, as individuals need not choose the basis on which they are paired.

I formalize the *degree of segmentation* in a way equivalent to W.D. Hamilton's (1975, 1971) degree of (genetic) relatedness (r) giving the conditional probability that the bearer of a norm (gene) is paired with the bearer of the same norm as a function of the frequency distribution of the norm in the population. Thus if p is the population frequency of x types, μ_{xy} is the probability of being paired with a y -type conditional on being an x -type (with the obvious extensions of this notation to other pairings) then:

$$(4) \quad \mu_{xx} = * + (1 - *)p; \quad \mu_{xy} = (1 - *) (1 - p); \quad \mu_{yx} = (1 - *)p; \quad \mu_{yy} = * + (1 - *) (1 - p)$$

and $*$, $[0,1)$ is the "degree of segmentation".

Concerning the process of cultural transmission per se, I model three influences: differential payoffs, conformism, and the assimilation by winners of contests of the cultures of groups of losers. Norms (like accents) may be acquired unwittingly (as part of a process of childhood socialization, for example), and once acquired they may dictate actions that do not maximize individual benefits. It is nonetheless plausible that individual benefits play an important role in the process of adopting norms. The theory (and empirical study) of cognitive dissonance provides some reasons to expect norms associated with high payoffs to be differentially adopted; one of the ways of coping with dissonance is to modify one's values to be consistent with the perceived imperatives of achieving other ends.¹⁴ Other interpretations are possible. Successful individuals may obtain positions -- as governmental leaders, media figures, and teachers for example -- in which they have privileged access to the population as cultural models and thus may be copied for reasons associated with their location in the social structure rather than success per se.

¹⁴ Adopting cultural variants which contribute to economic success in a particular game invokes but one of the standard dissonance reducing strategies. Leon Festinger, the originator of cognitive dissonance theory, describes its basic premise: "...the human organism tries to establish internal harmony, consistency or congruity among his opinions, attitudes, knowledge, and values. ...there is a drive toward consonance among cognitions." (1957) 260. Melvin Kohn (1969) found statistically robust effects of the personality demands of parents' occupational roles on parental child rearing values, parents seemingly seeking to develop in their children the values which would contribute to success in their own work situation.

While the influence of differential payoffs on the adoption of norms has direct analogies in the fitness-based natural selection of genetically transmitted traits, the second influence, conformism, does not. Following Boyd and Richerson (1985), by conformist transmission I mean that the likelihood that an individual will adopt a particular norm varies with prevalence of that norm in the population (independently of the possibly frequency-dependent nature of payoffs.) The importance of the population frequency of a norm could arise if individuals simply sought to adopt what they consider to be the most common norm. But like the influence of relative payoffs, conformism could arise because social institutions privilege the most common norm in the transmission process. This would be the case if the pool of available cultural models was disproportionately composed of those with the most common norm as occurs in most contemporary school systems.

There are five reasons for thinking that conformist learning of norms may be important. First, social pressures for uniformity are among the most convincingly documented human propensities.¹⁵ Second, there is evidence that the adoption of norms responds not only to individual circumstances (e.g. one's livelihood in farming compared to herding) of the individual, but also to group circumstances per se (e.g. the dominant form of livelihood in one's community.)¹⁶ Third, the cultural transmission processes which govern the adoption of norms and other forms of behavioral learning, have themselves evolved, presumably under the influence of natural selection, cultural group selection, and other evolutionary pressures. A plausible model must posit a transmission process which is capable of reproducing itself. Conformist learning passes this test, as there are compelling theoretical reasons to believe that under quite general conditions where learning is costly, conformist transmission of traits will be adaptive and hence might have evolved under the influence of either genetic or cultural inheritance. (Feldman et al, 1996, Boyd and Richerson (1985), Henrich and Boyd (1998).) Fourth, the ethnographically well documented long-term persistence of payoff-reducing norms in many societies (Edgerton, 1992, Durham (1991), Nisbett and

¹⁵ Boyd and Richerson (1985):223ff and Lee Ross and Richard Nisbett (1991):30ff provide surveys. See also Solomon Asch (1956) and Muzafer Sherif (1937). Newcomb and his collaborators' studies of learned political orientations suggest a powerful effect of conformism which endured decades after the originating environments. (T.M. Newcomb, et al, 1967).

¹⁶ Robert Edgerton (1971) found that herders value independence more highly than do farmers, but that farmers in predominantly herding societies value independence more than farmers in predominantly farming communities. In India fertility is strongly related to district average levels of women's education but surprisingly weakly related to individual women's educational levels. For similar evidence on contraceptive use in Bangladesh see Kaivan Munshi and Jacques Myaux (1998).

Cohen (1996)) is parsimoniously explained by conformist cultural transmission. Finally, a number of historical and anthropological studies suggest the long term stability of some norms followed by their precipitous unraveling, as well as the rapid emergence and then enduring stability of new norms: for example the thousand year long duration of foot binding in China and its virtual disappearance in a matter of decades (Mackie, 1996), the collapse of socialist values in the German Democratic Republic (Lohmann (1994)) and the long term coexistence of otherwise similar "violent" and "anti-violent" villages in Oaxaca, and the rapid transformation of one of the former (Paddock (1975 and 1990)).¹⁷ For reasons that will become apparent, these episodes are readily explained by models in which both conformist transmission of norms and important stochastic influences are important.

For these reasons both conformism in learning, and segmentation in both economic and cultural interactions will be built into the model which follows.

To capture both the payoff-based and conformist influences on the evolution of norms, consider a particular group (j) in which individuals may have one of two norms, x and y, with population frequencies p_j and $1-p_j$ with $p_j \in [0,1]$. (As we will be considering just one group in this section I will drop the group subscripts until we consider many groups in the next section.) Members of the population are paired according to the degree of segmentation \star , to interact in a single period symmetrical two person game, payoffs of which are denoted $B(0,0)$, the payoff to the strategy dictated by the norm 0 against a partner playing according to the other norm. (I will use "norm" to refer to the strategy dictated by the norm where appropriate.) For any population frequency of the x norm, the expected payoffs are thus (using (4) to take account of non-random pairing):

$$\begin{aligned}
 (5) \quad b_x(p;\star) &= \mu_{xx}B(x,x) + \mu_{xy}B(x,y) \\
 &= \{\star+(1-\star)p\}B(x,x) + (1-\star)(1-p)B(x,y) \\
 b_y(p;\star) &= \mu_{yx}B(y,x) + \mu_{yy}B(y,y) \\
 &= (1-\star)pB(y,x) + \{\star+(1-\star)(1-p)\}B(y,y)
 \end{aligned}$$

Suppose the *frequency of individual updating* is such that at the beginning of each period some fraction population, $T \in (0,1]$ may update their norm upon exposure to a cultural model (a "teacher" perhaps) drawn from the population according to the degree of segmentation \star . For example, adults may retain their norms throughout life, while children (who constitute T percent of the population in each period) condition-

¹⁷ See also Timur Kuran (1995).

ally inherit the norms of their (sole) parent, but are susceptible to social influences in retaining or replacing the norm. (Or the "parent" and the "teacher" in the above example may simply be two parents, with α then indicating the degree of assortative mating for the cultural trait under consideration.)

Suppose the updating process is as follows. If the "teacher" and the "parent" have the same norm, it is retained by the individual. But if they have different norms then the individual retains or replaces the norm inherited from the parent on the basis of a weighting of two pieces of information: the frequency of the norm in the population during the previous period (determined by costlessly sampling the population) and the payoffs enjoyed by a randomly selected bearer of each norm over the period of time since they acquired their norms (also costlessly knowable to the individual). As it will make no difference we may suppose for concreteness that the individual in this situation simply compares the benefits enjoyed by the "parent" and the "teacher".

Define the *degree of conformism*, α , $\in [0,1)$, as the importance of the conformist aspect of the learning process relative to the payoff based influences on updating, with $1-\alpha$ the relative importance of payoffs, and let k be the population frequency of the norm for which conformist learning exerts no effect (possibly one half), while for $p > k$ the prevalence of the norm in the population favors the norm in the updating process, independently of the (also frequency dependent) expected payoffs to the norms.¹⁸ We define the *replication propensity* of norm O among those updating their norms as r_O where

$$(6) \quad r_x = \frac{1}{2}[\alpha(p-k) + (1-\alpha)(b_x-b_y)]$$

$$r_y = \frac{1}{2}[\alpha(k-p) + (1-\alpha)(b_y-b_x)].$$

With probability $\$ (r_y - r_x)$ an x-type (offspring of an x parent) will change to a y-type if their teacher is a y type and $r_x < r_y$, and conversely; if $r_x \geq r_y$ the individual does not switch. The *adoption coefficient* $\$$ is a positive constant reflecting the greater effect on switching of relatively large differences in replication propensities.¹⁹ The $(1-T)$ fraction of the population not subject to this updating process do not switch.

¹⁸ The conformist effect need not be linear in p , of course, but nothing would be gained by a more general formulation.

¹⁹ Differential responsiveness to given differences in r imply different values of $\$, (0, (\frac{1}{r^{\max}})^{-1}]$, where r^{\max} is the absolute value of the maximum difference in the replication propensities (the upper bound on $\$$ restricts the probability of switching to not exceed unity.)

Thus writing $D_{y>x}$ as the probability that r_y exceeds r_x and conversely, we can write the population frequency with norm x in time $t+1$ or p' as

$$(7) \quad p' = p - Tp(1-p)(1-\alpha)D_{y>x}(r_y-r_x) + Tp(1-p)(1-\alpha)D_{x>y}(r_x-r_y)$$

This expression may be read as follows: of the base year population of x types (p), in any period a fraction $(1-T)$ are not eligible for updating and hence will not change type. The remainder T will be eligible for updating, of these $(1-p)(1-\alpha)$ will be paired with y -type teachers, and with probability $D_{y>x}(r_y-r_x)$ the information they acquire about payoffs and population frequencies will lead them to switch to becoming a y type (they make no replicas, the y -type with whom they were paired makes two). Offsetting the x 's lost in this manner, some of the offspring of y -type parents will encounter x -type teachers and by an analogous process will convert to x types. Noting that $D_{y>x} + D_{x>y} = 1$, and rearranging we can rewrite (7) as the familiar replicator dynamic with social learning based replication propensities playing the role of fitness or payoffs:

$$(8) \quad dp/dt = p'-p = Tp(1-p)(1-\alpha)(r_x-r_y) = Tp(1-\alpha)(r_x-\bar{r})$$

where \bar{r} is the group average replication propensity.²⁰ From (8) it is clear that $dp/dt = 0$ if $r_x-r_y = 0$ which requires

$$(9) \quad \alpha(p-k)/(1-\alpha) = b_y(p)-b_x(p)$$

or if p is either 0 or 1 (because when $p=1$, $r_x=\bar{r}$) or in the degenerate case that $\alpha=1$ (nobody ever meets a different type.) Equation (8) shows that segmentation dampens the response to disequilibria and implies that in a fully segmented society (one for which all pairings were with one's own type, or $\alpha=1$), all distributions of norms are stationary. When (9) is satisfied, the effects of conformist transmission (the lefthand side of (9)) offset the effects of differential payoffs (the right-hand side). Thus, in the presence of conformist transmission, and for $p \in (0,1)$ the equilibrium payoffs to the norm disfavored by conformism will always exceed the payoffs of the more prevalent norm.

For $p \in (0,1)$ dp/dt takes the sign of r_x-r_y . Given the one dimensionality of this dynamical system, an equilibrium is asymptotically stable if the derivative of (8) with respect to p is negative, requiring that:

²⁰ For $\alpha=0$, equation (8) is an exact analogy to George Price's (1970) expression for the change in gene frequency as a function of the population variance of the trait ($p(1-p)$) multiplied by the contribution of the trait to individual fitness ((r_x-r_y)).

$$(10) \quad \pi < (1-\pi)(1-\pi^*)(db_y/dp - db_x/dp)$$

or

$$(10') \quad \pi/(1-\pi)(1-\pi^*) < B(y,x)-B(y,y)-B(x,x)+B(x,y)$$

which is satisfied if the conformist advantage conferred on x by a small increase in p, namely π , is more than offset by the payoff advantage conferred on y by the same increase in p (the right-hand side of (10).) We illustrate the equilibrium frequencies of norms in figure 3, where p^* represents the solution to (9) satisfying (10) and is hence a stable equilibrium distribution of norms.

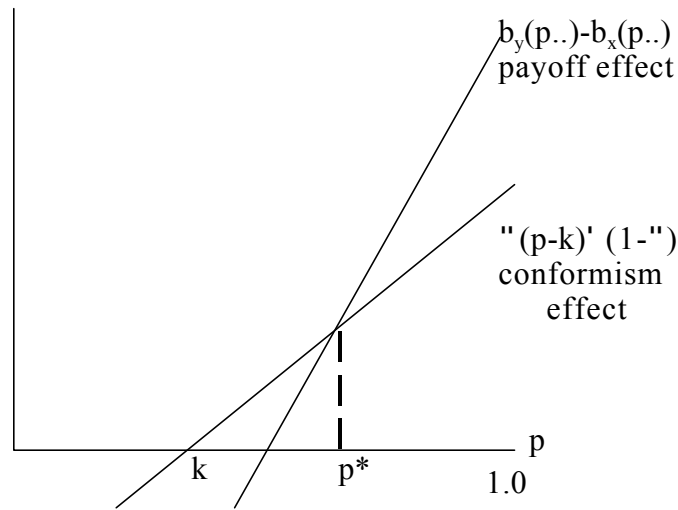


Figure 3 Cultural Equilibrium Stationarity of p requires that the conformism based advantages of the prevalent trait (x) be offset by payoff based advantages of y .

From (9) and (10) we see that conformism has two effects. First, (9) shows that strategies which yield low payoffs may persist: for example x is an evolutionarily stable strategy (ESS) as long as the expected payoffs for a small number of y -players introduced into a homogeneously x -playing population exceed the x -players payoffs by less than $\pi(1-k)/(1-\pi)$, obviously a condition less stringent than the conventional ESS. Second, sufficiently high levels of conformism will violate (10), making p^* an unstable equilibrium and thus making it the boundary between the basin of attraction of the equilibria at $p=0$ and $p=1$. In the absence of conformism and segmentation, stability requires only that the right-hand side of (10') be positive, obviously a weaker condition. Counter intuitively, conformism thus may help explain rapid cultural change, as well as the long term survival of individually costly norms, whether

collectively beneficial or not, as promised in the previous section.

5. Contests, Assimilation, and Group Selection

To integrate this process of individual selection with selection at the group level we now add subscripts identifying the updating process above as taking place in group j , with r_j , $r_{j,y}$, and \bar{r}_j the replication propensity of trait x , trait y and the group average, respectively, all in group j , and rewrite (8) as

$$(11) \quad \dot{p}_j = T(1-\alpha)p_j(1-p_j)(r_j - \bar{r}_j).$$

Equation (11) is related to the second term on the right-hand side of (2) as follows. The term $p_j(1-p_j)$ is within group variance of the trait, while $T(1-\alpha)(r_j - \bar{r}_j)$ is $\Delta_{wp,p}$ the effect of an individual's having trait on the number of replicas the individual produces, given the frequency of the trait in the group. The terms $T(1-\alpha)$ regulate the speed of within-group-out-of-equilibrium adjustment. (Nothing would be gained by letting α , T , and Δ vary among groups, so these terms do not bear subscripts.)

Turning now to the group effects represented by the first term in (2), assume that the group just modeled is one of a large number of groups in a large population, and let q_j represent the fraction of the whole population which is a member of group j . While individuals are infinitely lived in this model, groups are not, they go extinct, their members absorbed into more successful groups, and winning groups subdivide. Here is the process. Groups are randomly paired for a "contest" which may be military, cultural, economic or some other, this event happening in each period with probability β for each group. If the group is not selected for a contest nothing is affected. However if the group is engaged in a contest and wins, it absorbs the other group and assimilates its population, the new population replicating the frequency of the trait of the winning group. If the group loses, it is absorbed into the winning group.

As the winning group is now enlarged by the absorption of the losing group, we assume that following the assimilation of the new population, the winning group divides, creating two groups, which to keep things simple will be of the same size. As the bearers of the group-beneficial trait are likely to be numerically and socially dominant in the winning group, they may determine the composition of the subdivided groups so as to segregate bearers of the "other" trait insofar as recognition of traits or characteristics correlated with traits allows this (in the limiting case of no recognition and no segregation the two groups would be created by a random draw possibly of family units from the enlarged group.)

We assume that groups are always of the same size (normalized to 1) except that winning groups are momentarily (prior to subdividing) of size 2 (and losing groups are of size zero). Groups that have prevailed in a contest and absorbed another

group are by this device counted twice. Thus if group j is of size 1 this period then its expected size next period (before any subdivision) depends on the probability that a contest has taken place and the probability of victory in such a contest. Suppose the probability of prevailing in a conflict is equal to its group average payoffs scaled by $(/2$ which converts group level payoffs into a probability of victory. Then expected group size following a contest is $(B_j$ and the expected size of group j is thus 1, 2 or zero with probabilities $(1-6)$, $6B_j (/2$, and $6(1- B_j (/2)$, respectively or

$$w_j = 1-6 + 6(B_j = 1+ 6((B_j-1).$$

Thus the effect of variations in p on the number of replicas of the members of group j , namely, $\$_{w\sim p\sim}$, is just $6(B'$ where $B' / (dB_j/dp_j)$.

To summarize, the sequence of events at the group level is as follows: following all individual updating, groups are selected for contests and paired, the contest occurs, a winner is determined, losing groups are assimilated to winners, and finally the winning group divides, thereby restoring the number and size of groups. Individual updating then occurs and the process continues. The evolution of the population mean p can be represented as follows (the summation is over groups):

$$\begin{aligned} p &= E q_j p_j \\ p' &= E q_j (p_j +) p_j \\) p &= E q_j [1+6((B_j-1)-1)-1] p_j + E \{ q_j [1 +6((B_j-1))] p_j \} \\ (12) \quad) p &= E q_j (w_j-1) p_j + E q_j w_j) p_j \end{aligned}$$

The first term captures the influence of group selection. Recall that $w = 1$ and note that $E q_j (w_j-w) p = 0$ (because $E q_j w_j = w$), so the first term on the right hand side of (12) is just $\text{cov}(w_j p_j) = \text{var}(p_j) \$_{w\sim p\sim}$ where $\$_{w\sim p\sim} = (6B'$, namely the effect of variations in the frequency of the trait in the group on average payoffs and thereby (via the probability of prevailing in contests) on the number of cultural replicas made. The second term captures within group selection, namely, $) p_j$ weighted by the expected relative size the group w_j summed over all groups. Upon substitution of the previously derived expression for $) p_j$ (11), and a little rearranging, (12) becomes

$$(12') \quad) p = \text{var}(p_j) (6B' + E q_j [T(1-*) p_j (1-p_j) \$ (r_j-r_j)].$$

which can also be expressed in the more compact form:

$$(12'') \quad) p = \text{var}(p_j) \$_{w\sim p\sim} + E q_j \text{var}(p_{ij}) \$_{wp.p\sim}$$

If the second term is negative (as it will be in the case of an altruistic trait) the frequency of the trait within all surviving groups will fall over time. But this tendency will be counteracted by the continual extinction of groups with disproportionately low frequencies of the trait and their replacement by "new" groups with disproportionately high trait frequencies. The process of updating, from individual material payoffs to the population level frequency of the trait is summarized in Table 1.

Table 1.
From individual payoffs to population frequencies

<i>Variable</i>	<i>Description</i>
$B(x,y)$	payoff to playing x, against a y-player
$b_x(p, *, B())$	expected payoffs to playing x in a population p of which are x players and * is the degree of segmentation
$r_j(p, b(), ")$ $r_{-j}(p, b(), ")$	replication propensity of traits x and y (respectively) in group j, given, p, b() and degree of conformism, ".
$\Delta p_j(p_j, T, \$ (r_j - r_{-j}))$	change in the frequency of x players in group j, given p_j the updating frequency T and the adoption coefficient \$.
$\Delta p(6, (,) p_j, p_j)$	change in the population frequency of x players given the frequency of group contests 6, the effect of group mean payoffs on the outcome of contests (, and $\Delta p_j, p_j, \forall j 1 \dots n$.

Equation (12") gives us the change in p over a single period, taking the initial distribution of p_j across groups as given. The equation lacks what Lewontin (1974):7 termed "dynamic sufficiency" however, because while it provides an account of the population frequency of the trait in the next period, it does not provide the information necessary (the relevant variances) to repeat the analysis for the next-plus-one period. Providing a completely recursive version of equation (12) is a challenging task which I have not attempted. Thus the equation per se does not address a crucial question: how is between and within group variance sustained in this population?

In the case of human populations, however, it is not difficult to provide an informal answer to the question, one whose plausibility is strongly supported by simulations. Because winner groups subdivide in ways that do not produce exact copies of the winner group (in the limit by a random draw) the variance in group means may increase, decrease or remain constant over time, with increases more likely the more frequent are intergroup contests, the greater role of segmentation or other non random processes in generating group divisions, and the smaller the group

size (the latter due to the larger relative size of sampling error in the subdivision process). Taking hunter gatherer bands of 25-50 individuals as a common grouping in human history and noting that family units tend to have similar cultural traits and to remain together in group subdivision, the effective sample size could be very small (around seven using the data in Kelly (1995)) and the contribution of subdivision by random draws of families could generate substantial contributions to between group variances. Simulations of the above model (with groups averaging ten individuals and random subdivision of groups successful in contests) confirm that between group variances are sufficiently large and persistent to sustain high frequencies of a group beneficial but individually costly trait, as long as intergroup contests are sufficiently frequent (Bowles and Hopfensitz, 2000). Thus while the evolution of within and between group variances is not formally modeled here, there is no reason to believe that the between group variances would vanish, bringing the group selection process to a halt.

6. *The effects of social structure on the evolution of preferences*

We are now able to explore the effect of social structure on the multi-level selection process modeled above. It will be helpful to rearrange (12'):

$$(13) \quad \Delta p = \Delta \text{var}(p_j) (B' + T(1-\alpha) \{E_{ij}[\text{var}(p_{ij})] (r_j - r_{-j})\}.$$

which setting $\Delta p = 0$ gives the stationarity condition:

$$(14) \quad \Delta \text{var}(p_j) (B' = -T(1-\alpha) \{E_{ij}[\text{var}(p_{ij})] (r_j - r_{-j})\}$$

requiring that the between group selection effects (the left side) be equal to the within group effects. To see what (13) entails, consider the altruism example based on equations (1) and (3). Let the benefits and costs of altruism be denominated in material goods, and suppose that material goods confer advantages both in the individual trait updating process and in intergroup contests, and that the cultural transmission process does not exhibit conformism so that material payoffs alone govern individual trait replication. The effect of group beneficial altruism on differential replication at the group level is just $\Delta (b-c)$ (because $B'=b-c$). Taking account of segmentation, the effect of the individual cost of altruism on differential replication at the individual level is $T(1-\alpha)(c-b\alpha)$; from which it can be seen that if the degree of segmentation exceeds c/b , the altruism will not be selected against within the group, thereby assuring that it will proliferate in its entire population.

Consider the more challenging case when $\alpha < c/b$. Substituting these expressions into (14) the stationarity of the frequency of altruism requires:

$$(15) \quad (b-c)/(c-\alpha b) = \{E_{ij}[\text{var}(p_{ij})]/\text{var}(p_j)\} [T(1-\alpha)/\Delta] (\Delta / \Delta)$$

which says that *the ratio of group benefit to individual cost* must be equal to the product of the three terms on the righthand side of (15), each of which is the ratio of a within group to a between group process. These are:

- i) $E_{ij}[\text{var}(p_{ij})]/\text{var}(p_j)$, the relative *size of the within group relative to the between group variance* of the trait.
- ii) $[T(1-\alpha^*)/6]$, the relative *speed of the updating process* represented by the relative frequency with which individuals (compared to groups) have an updating opportunity; and
- iii) (β/γ) , the relative *effect of payoffs on success* in individual cultural replication compared to the effects of material benefits in winning group contests.

Each of these terms will be affected by the economic policies, institutions and other structures governing within and between group interactions. Consider the effects of conformism, segmentation, and egalitarianism introduced at the outset.

The following summarizes the effect of conformism on the relative within and between group variances: for groups characterized by the above payoff and transmission structures and $p_j^* \in (0,1)$, conformist cultural transmission reduces the ratio of within group to between group variances of the trait, $E_{ij}[\text{var}(p_{ij})]/\text{var}(p_j)$, and thus favors the evolution of group beneficial but individually costly traits. Indeed it is not difficult to demonstrate in this model that there exists a sufficiently high level of conformism, $\alpha^* < 1$, such that within group variance vanishes, leaving selection to operate only at the group level. The intuition behind this unsurprising result is clear from equation (10): sufficient conformism must violate the stability condition for an interior equilibrium.

The manner in which segmentation promotes the replication of an individually costly but socially beneficial trait within a group is well known and has been mentioned above. There is another effect, however, this one applying to group selection processes per se. As is obvious from equation (14) segmentation retards the within group updating process because in more segmented societies for every frequency of the trait in the population (other than 0 or 1), individuals are less likely to be paired with an individual with a different trait: as α^* approaches unity within-group updating ceases, and hence group selection is the only selection process at work ($\alpha^*=1$ is clearly degenerate, as such a population is just two internally homogeneous groups).

Egalitarianism among group members--food sharing, monogamy and progressive taxation, for example--dampens the effect of payoffs on trait replication,

effectively reducing within group differences in replication propensities and thus retarding the processes of within group selection. For example, a (costlessly administered) tax on game payoffs paid by the higher payoff individuals and distributed as a lump sum to all members of the population attenuates the individual cost to those bearing the group beneficial trait, and is thus similar to the effects of monogamy described at the outset. Because there is no analogous effect operating at the group level, egalitarianism (as defined here) enhances group selection pressures.

Rewriting (14) to take account of conformist transmission, with J the linear tax rate,

$$(14') \quad \delta \text{var}(p_i) ((b-c) = -T(1-J) \text{Eq}_i[\text{var}(p_{ij})] \left[\frac{1}{2} (p-k) + (1-J)(b^*-c) \right]).$$

it can also be seen that conformism has a dampening effect on individual level selection, similar to the effect of egalitarianism, and operating independently of its effect on the ratio of within to between group variances.

Other effects of social structure both at the population and group level can also be discerned from (14). Some insight concerning the comparative rates of updating opportunities ($T/6$) might be gained by looking at the number of wars per generation (assuming that updating takes place on a generational basis and wars are a major form of contest), for example. This interpretation may have bearing on the state formation case with which I began. In the two centuries following 1500, for example, there were major 63 wars (defined as involving over 1,000 battle deaths a year, counting only the great powers); with wars occurring so frequently that only ten years were without one. (Tilly, 1990:72). By contrast during much of the late Pleistocene period (the bulk of anatomically modern human history) intergroup contests may have been infrequent, given the very low population densities. Another example: changes in military and communications technology may alter B' , the effect of between group differences in payoffs on the outcomes of contests. Finally, the prolongation of childhood and adolescence experienced in most nations over the past four centuries may enlarge the window for individual updating of traits (T), thus accelerating individual level selection.

7. Conclusion

Two conclusions follow. First, because the structure of social interactions, both within and between groups, affects the pace and direction of cultural evolution, economic institutions and policies which influence the residential patterns, ingroup-outgroup relationships and other aspects of these structures will affect preferences, casting doubt on the economists' canonical premise that preferences are exogenous. Second, selection processes operating in human populations are likely to support group-level effects allowing the diffusion of individually costly but group-beneficial

behaviors. This is particularly the case for traits governed by cultural rather than genetic transmission. Thus, other-regarding and process-related preferences may be evolutionarily successful and the presumption in favor of an entirely selfish *Homo economicus* would appear to have little basis in evolutionary reasoning.

One wonders, then, if economists have been unwise in following Hume's advice that "every man ought to be supposed to be a knave and to have no other end, in all his actions, than his private interest." Constitutional designs and policy interventions which abstract from the endogeneity of preferences and ignore the presence-- in our variegated repertoire of motivations -- of unselfish and process-regarding preferences, may evoke preferences which exacerbate the underlying constitutional or policy problem, and may fail to draw upon or foster those motivations which might assist in a solution. The effectiveness of policies and their political viability may thus depend on the preferences they induce or evoke.

Albert Hirschman ((1985):10) points out that economists typically assume otherwise and for this reason propose

to deal with unethical or antisocial behavior by raising the cost of that behavior rather than proclaiming standards and imposing prohibitions and sanctions. The reason is probably that they think of citizens as consumers with unchanging or arbitrarily changing tastes in matters civic as well as commodity-related behavior. ... A principal purpose of publically proclaimed laws and regulations is to stigmatize antisocial behavior and thereby to influence citizens' values and behavioral codes.

A more adequate approach to the problem of preferences along the lines suggested by Hirschman (as well as Sunstein (1993)) might find broad application in policy areas such as tax compliance, criminal justice, educational policy, environmental protection, labor relations and work organization, and informal contractual enforcement. For example, there is considerable evidence that attempts to induce higher levels of work effort, compliance to norms, or environmental conservation by mobilizing self-interested motives through the use of fines and sanctions may undermine reciprocity and other motives (Fehr (2000) Bewley (1995), Gneezy and Rustichini (2000) and Cardenas (2000)). Thus, what counts as an improvement of an incentive structure in a world of exogenous selfish preferences may be counter productive where at least some preferences are other-regarding and endogenous. Similarly, ill designed policies to redistribute income to the poor may fail if they foster perceptions of the poor as undeserving or otherwise undermine generous motives for redistribution (Bowles and Gintis, 1998-1999, 2000).

Appendix

Individual and Group Selection Effects

Drawing on Price (1970, 1972), Wilson (1977), Grafen (1985), Frank (1995) and Rogers (1990), this appendix presents a derivation of the Price equation for the case of group and individual selection of a dichotomous trait. The selection coefficient (number of replicas in the next period) of individual i in group j depends on one's own trait ($p_{ij} \in \{0,1\}$) and the frequency of the trait in the group ($p_j \in [0,1]$) according to

$$(A1) \quad w_{ij} = \bar{w}_0 + p_j \bar{w}_{wp \sim p} + p_{ij} \bar{w}_{wp, p \sim}$$

Let $q_j = Q_j/Q$, where Q_j is the number of individuals in group j , and Q is the total number of individuals summed over all groups. The frequency of the trait in the population may be expressed as the summation of group averages weighted by relative group size

$$(A2) \quad p = E q_j p_j$$

and using a prime to indicate the next period

$$(A3) \quad p' = E q_j' p_j'$$

with

$$(A4) \quad q_j' = q_j (w_j / \bar{w})$$

where w_j is the average number of replicas produced by members of group j , and \bar{w} is average number of replicas over the entire population. So

$$(A5) \quad p' - p = E q_j (w_j / \bar{w}) (p_j' - p_j) - E q_j p_j \\ = E q_j [(w_j / \bar{w}) - 1] p_j + E q_j (w_j / \bar{w}) p_j$$

or

$$(A6) \quad (w_j / \bar{w}) p = E q_j (w_j - \bar{w}) p_j + E q_j w_j p_j$$

Notice that the second expression on the right-hand side is just the weighted average of $w_j p_j$, defining at the group level exactly what (A6) defines for the population as a whole. So, repeating the procedure above but at the group level we have

$$(A7) \quad (w_j / \bar{w}) p = E_j q_j (w_j - \bar{w}) p_j + E_j q_j [E_i (w_{ij} - w_j) p_{ij} + E E q_j w_{ij} p_{ij}].$$

where single summation is over groups and double summation is over groups and individuals. But $\sum_j p_{ij} = 0$ for all i and j , by the assumption that traits are replicated without error. So (A7) becomes

$$\begin{aligned}
 (A8) \quad w)p &= E q_j (w_j - w) p_j + E_j q_j [E_i (w_{ij} - w_j) p_{ij}] \\
 &= \text{cov}(w, p) + E q_j [\text{cov}(w_{ij}, p_{ij})] \\
 &= \text{var}(p) \$_{w \sim p} + E q_j [\text{var}(p_{ij}) \$_{w p, p_{ij}}]
 \end{aligned}$$

where $\$_{w \sim p}$ defined in the text is $\$_{w p \sim p} + \$_{w p, p \sim}$.

The interpretation in the text of the ratio of between to total variance of the trait as identical to Hamilton's r is motivated as follows. We know from equation (4) that \ast the degree of relatedness (or of segmentation, as defined in the text) is simply the difference in the probability of interacting with someone with the trait conditional on having or not having the trait oneself, or \ast . From Price (1970) we know that

$$w)p = \text{cov}(w, p) = \text{var}(p) \$_{wp}$$

or, using (A1)

$$w)p = \text{var}(p) [\$_{wp, p \sim} + dp_j / dp_{ij} \$_{wp \sim, p}]$$

with the stationarity condition for interior values of p thus requiring that

$$- \$_{wp, p \sim} / \$_{wp \sim, p} = dp_j / dp_{ij}$$

Recalling that p_{ij} takes the value of one for those with the trait and zero otherwise, dp_j / dp_{ij} tells us the difference in the conditional probability of meeting someone with the trait, conditional on having the trait oneself, or not. In the altruism case the stationarity condition (analogous to Hamilton's rule) is just

$$c/b = dp_j / dp_{ij}$$

which is identical to (3) in the text, the righthand side of which is now seen to be just the difference in the frequency of interactors (p_i) expected by those with the trait and those without it, namely \ast , defined in equation (4) as the degree of segmentation, or in population genetic models, the degree of relatedness.

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