

Not for publication appendix to the paper:
The Persistence of Inferior Cultural-Institutional Conventions

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A. Why Intergenerational Transmission of Cultural Traits is Insufficient to Explain Cultural Persistence

Intergenerational transmission of cultural traits cannot explain the historical evidence for long term persistence of cultures (surveyed in Spolaore and Wacziarg 2013) for two reasons: (A.1) the empirically measured degree of transmission for most traits is quite modest; (A.2) even where transmission is substantial, cultural differences are dissipated over just a few generations if there are no other mechanisms favoring persistence.

A.1. Vertical transmission from parents, either genetic or cultural, appears to be substantial for some traits (those relating to political values and religion in particular), but measures of parent offspring similarity for most traits relevant to the study of culture seem to be quite limited. The surprising weakness of vertical transmission from parents may, of course, reflect the difficulty in measuring preferences or other cultural traits rather than the absence of underlying effects; but the available data does not support the inference of strong transmission.

A meta-study of parent-child transmission of the so-called Big Five personality traits yields a mean correlation of 0.13 (Loehlin 2005). Even for cognitive traits in which genetic transmission plays a major role, the parent offspring correlations are quite modest (for example 0.38 for IQ (Black, *et al.* 2009)). Feldman, *et al.* (1982) found parent offspring correlations of 0.69 for religion and 0.48 for a measure of political values, with average correlations including these and other cultural traits (concerning beliefs, tastes in entertainment, etc.) of 0.35. Nowak's sample from Poland in the early 1970s (Nowak 1981) found no significant correlation between the values of parents and those of their (grown) children excepting religion. Kohn (1983: 3) concludes “that the relationships between parents and children's values are probably only

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modest in magnitude.” Surveying a number of studies, he writes “studies of values have consistently found rather modest levels of agreement – correlations of roughly 0.15 to 0.25 – between parents and children.” Feldman, Cavalli-Sforza, Dornbusch, *et al.* (1982) find, in a Taiwanese sample, strong vertical transmission (parental) for religion and political beliefs but not for other traits (preferences for films, recreation). Rozin (1991) likewise finds evidence of the direct transmission of values (about homosexuality, abortion, religiosity, and other values): mid-parent offspring correlations averaged 0.54.

Food tastes differ considerably between cultural groups, a major predictor of food likes and dislikes being one's nation or ethnic group of origin; yet parental tastes are poor predictors of the tastes of offspring, even when parental tastes are themselves congruent. The mean correlation for mid-parent-child tastes for particular foods (black coffee, lima beans, hot sauce, and so on) in the study by Rozin (1991) is 0.17. He calls this the “family paradox” concerning “the sources of variance in preferences. Genetic factors and family influence account for a very small part” (Rozin 1991: 101). Because cultural differences in tastes are maintained over long periods of time, it seems clear that a significant part of the transmission process is taking place at the societal level, with important roles played by either horizontal transmission (from age peers) or oblique transmission (from non parents in the previous generation).

A.2. Consider two populations. In each it is widely thought that some animal is sacred; but the cultures differ in which the sacred animal is: in one society it is forbidden to eat rabbits, in the other eating deer is taboo. Parents pass on their ideas about sacredness of animals to their offspring, but the process is imperfect, so that with probability r the child will adopt the norm of their parents, while with probability $1-r$ the other norm is adopted. For plausible values of the transmission coefficient, r , the cultures of these two populations will become indistinguishable in just a few centuries, or less.

Suppose the cultural aversion to eating rabbits or deer is very strongly transmitted directly from parents to offspring and that, initially, virtually all of the members of the two societies have adopted their respective norms; to bias the example to favor persistence suppose further that marital assortment is complete, so that parents always share the same trait. Let p_t^k be the fraction of each population ($k = 1,2$) sharing the respective norm (either rabbit taboo or deer taboo) at time t . This fraction in the next generation, $t+1$, becomes $p_{t+1}^k = rp_t^k + (1-r)(1-p_t^k)$.

Assume that at time $t=0$ in each of the two populations $p_0^k = 0.9$ and $1 - p_0^k = 0.1$. Then transmission coefficients $r=0.7$ and $r=0.85$ generate a parent-offspring correlation of about a quarter and a half, respectively (see, e.g., Cavalli-Sforza and Feldman 1981). Figure A1 illustrates that the two populations would be barely distinguishable after respectively 10 generations and 5 generations.

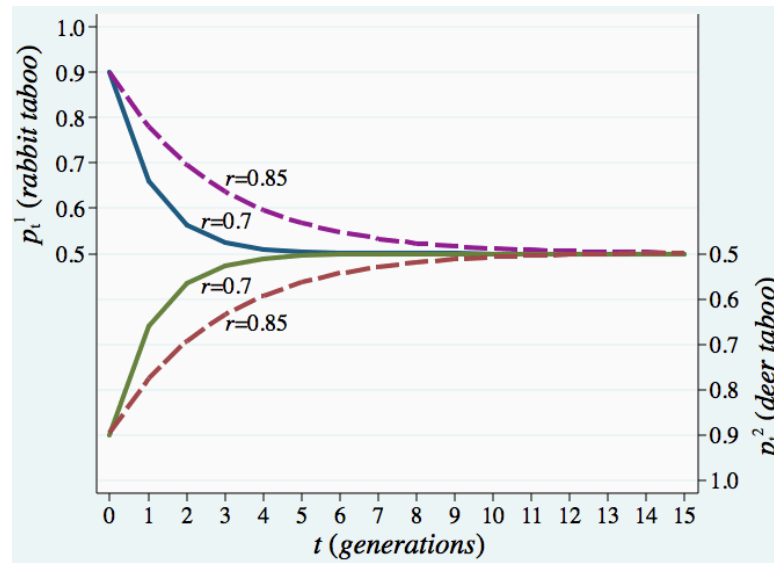


FIGURE A1: CULTURAL CONVERGENCE WITH EMPIRICALLY PLAUSIBLE LEVELS OF INTERGENERATIONAL TRANSMISSION

A.3. References

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B. Mathematical Appendix

B.1. First result: For sufficiently rational agents (large β), the expected waiting time for a transition ($E[W]$) is decreasing in the superiority of the Pareto-dominant convention (Δ_1^i).

Using equation (2) in the text, we have (with $i=A,B$):

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(\Delta_1^{i'}, \beta)}{P_i(\Delta_1^i, \beta)} = \frac{z! / [(z\phi_i^{*'})!(z - z\phi_i^{*'})!]}{z! / [(z\phi_i^*)!(z - z\phi_i^*)!]} \times \lim_{\beta \rightarrow \infty} \frac{[\sigma_i(\beta)]^{z\phi_i^{*'}} [1 - \sigma_i(\beta)]^{z - z\phi_i^{*'}}}{[\sigma_i(\beta)]^{z\phi_i^*} [1 - \sigma_i(\beta)]^{z - z\phi_i^*}}$$

where $\phi_i^* = \Delta_0^i / (\Delta_0^i + \Delta_1^i) > \phi_i^{*' } = \Delta_0^i / (\Delta_0^i + \Delta_1^{i'})$ with $\Delta_1^{i'} > \Delta_1^i$, $\sigma_i(\beta) = 1 / (1 + e^{\beta\Delta_0^i})$, and we have used the fact that $\binom{z}{z\phi_i^*} = z! / [(z\phi_i^*)!(z - z\phi_i^*)!]$. Omitting the constant term and using (1) in the text, it follows:

$$\lim_{\beta \rightarrow \infty} \frac{[1 / (1 + e^{\beta\Delta_0^i})]^{z\phi_i^{*'}} [1 - 1 / (1 + e^{\beta\Delta_0^i})]^{z - z\phi_i^{*'}}}{[1 / (1 + e^{\beta\Delta_0^i})]^{z\phi_i^*} [1 - 1 / (1 + e^{\beta\Delta_0^i})]^{z - z\phi_i^*}} = \lim_{\beta \rightarrow \infty} \frac{(1 + e^{\beta\Delta_0^i})^{z\phi_i^*}}{(1 + e^{\beta\Delta_0^i})^{z\phi_i^{*' }}}$$

where we have used the fact that $\lim_{\beta \rightarrow \infty} [1 - 1 / (1 + e^{\beta\Delta_0^i})] = 1$. After defining $y \equiv e^{\beta\Delta_0^i}$ and for finite z , we obtain

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(\Delta_1^{i'}, \beta)}{P_i(\Delta_1^i, \beta)} = \lim_{y \rightarrow \infty} \left[\frac{y^{\phi_i^*}}{y^{\phi_i^{*' }}} \right]^z = \infty.$$

Hence, there exists $\bar{\beta}$ such that for $\beta > \bar{\beta}$ it must be that $P_i'(\Delta_1^{i'}, \beta) > P_i(\Delta_1^i, \beta)$ with $\Delta_1^{i'} > \Delta_1^i$

and $i=A,B$. From equation (3) in the text it thus follows that $E[W'] = (P_A' + P_B' - P_A' \times P_B')^{-1} < E[W] = (P_A + P_B - P_A \times P_B)^{-1}$.

B.2. Second result: *The expected waiting time for a transition ($E[W]$) is increasing in the degree of individual rationality (β).*

Using equations (1) and (2) in the text, we obtain (with $i=A,B$):

$$\begin{aligned} \frac{dP_i[\sigma_i(\beta)]}{d\beta} &= \frac{dP_i[\sigma_i(\beta)]}{d\sigma_i(\beta)} \times \frac{d\sigma_i(\beta)}{d\beta} = \\ &= \frac{z!}{(z\phi_i^*)!(z - z\phi_i^*)!} \sigma_i^{z\phi_i^*} (1 - \sigma_i)^{z - z\phi_i^*} [z\phi_i^* \sigma_i^{-1} - (z - z\phi_i^*)(1 - \sigma_i)^{-1}] \times [-\Delta_0^i e^{\beta\Delta_0^i} / (1 + e^{\beta\Delta_0^i})^2], \end{aligned}$$

which is negative if and only if $\phi_i^* - \sigma_i > 0$, which is always the case for sufficiently large β .

Hence from (3) in the text it follows that $E[W] = (P_A + P_B - P_A \times P_B)^{-1}$ is increasing in β .

B.3. Third result: *For sufficiently rational agents, the expected waiting time for a transition ($E[W]$) is increasing in the cost of deviation from the inferior convention (Δ_0^i).*

Using equation (2) in the text, we have (with $i=A,B$)

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(\Delta_0^i, \beta)}{P_i(\Delta_0^i, \beta)} = \frac{z! / [(z\phi_i^*)!(z - z\phi_i^*)!]}{z! / [(z\phi_i^*)!(z - z\phi_i^*)!]} \times \lim_{\beta \rightarrow \infty} \frac{[\sigma_i'(\beta)]^{z\phi_i^*} [1 - \sigma_i'(\beta)]^{z - z\phi_i^*}}{[\sigma_i(\beta)]^{z\phi_i^*} [1 - \sigma_i(\beta)]^{z - z\phi_i^*}},$$

where $\phi_i^{*'} = \Delta_0^i / (\Delta_0^i + \Delta_1^i) > \phi_i^* = \Delta_0^i / (\Delta_0^i + \Delta_1^i)$ and $\sigma_i(\beta) = 1 / (1 + e^{\beta\Delta_0^i}) > \sigma_i'(\beta) = 1 / (1 + e^{\beta\Delta_0^{i'}})$

with $\Delta_0^{i'} > \Delta_0^i$. Omitting the constant term, we can write:

$$\lim_{\beta \rightarrow \infty} \frac{[1 / (1 + e^{\beta\Delta_0^{i'}})]^{z\phi_i^{*'}} [1 - 1 / (1 + e^{\beta\Delta_0^{i'}})]^{z - z\phi_i^{*'}}}{[1 / (1 + e^{\beta\Delta_0^i})]^{z\phi_i^*} [1 - 1 / (1 + e^{\beta\Delta_0^i})]^{z - z\phi_i^*}} = \lim_{\beta \rightarrow \infty} \frac{(1 + e^{\beta\Delta_0^i})^{z\phi_i^*}}{(1 + e^{\beta\Delta_0^{i'}})^{z\phi_i^{*'}}}.$$

After defining $y \equiv e^\beta$ and for finite z , we obtain

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(\Delta_0^i, \beta)}{P_i(\Delta_0^i, \beta)} = \lim_{y \rightarrow \infty} \left[\frac{y^{\Delta_0^i \phi_i^*}}{y^{\Delta_0^{i'} \phi_i^{*'}}} \right]^z = 0$$

because $\Delta_0^i \phi_i^* < \Delta_0^{i'} \phi_i^{*'}$. Hence, there exists $\bar{\beta}$ such that for $\beta > \bar{\beta}$ it must be that

$P_i'(\Delta_0^i, \beta) < P_i(\Delta_0^i, \beta)$ with $\Delta_0^i > \Delta_0^i$ and $i=A,B$. From equation (3) in the text it follows that $E[W'] = (P_A' + P_B' - P_A' \times P_B')^{-1} > E[W] = (P_A + P_B - P_A \times P_B)^{-1}$.

B.4. Fourth result: For sufficiently rational agents, the expected waiting time for a transition ($E[W]$) is increasing in the group size (z).

Using equation (2) in the text, we have (with $i=A,B$):

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(z', \beta)}{P_i(z, \beta)} = \frac{z'! / [(z' \phi_i^*)! (z' - z' \phi_i^*)!]}{z! / [(z \phi_i^*)! (z - z \phi_i^*)!]} \times \lim_{\beta \rightarrow \infty} \frac{[\sigma_i(\beta)]^{z' \phi_i^*} [1 - \sigma_i(\beta)]^{z' - z' \phi_i^*}}{[\sigma_i(\beta)]^{z \phi_i^*} [1 - \sigma_i(\beta)]^{z - z \phi_i^*}}$$

with $z' > z$. Omitting the constant term and using equation (1) in the text, we can write:

$$\lim_{\beta \rightarrow \infty} \frac{[1 / (1 + e^{\beta \Delta_0^i})]^{z' \phi_i^*} [1 - 1 / (1 + e^{\beta \Delta_0^i})]^{z' - z' \phi_i^*}}{[1 / (1 + e^{\beta \Delta_0^i})]^{z \phi_i^*} [1 - 1 / (1 + e^{\beta \Delta_0^i})]^{z - z \phi_i^*}} = \lim_{\beta \rightarrow \infty} \frac{(1 + e^{\beta \Delta_0^i})^{z \phi_i^*}}{(1 + e^{\beta \Delta_0^i})^{z' \phi_i^*}}.$$

After defining $y = e^{\beta \Delta_0^i \phi_i^*}$, we obtain

$$\lim_{\beta \rightarrow \infty} \frac{P_i'(z', \beta)}{P_i(z, \beta)} = \lim_{y \rightarrow \infty} \frac{y^z}{y^{z'}} = 0.$$

Hence, there exists $\bar{\beta}$ such that for $\beta > \bar{\beta}$, it must be that $P_i'(z', \beta) < P_i(z, \beta)$ with $z' > z$ and $i=A,B$. From equation (3) in the text it then follows that $E[W'] = (P_A' + P_B' - P_A' \times P_B')^{-1} > E[W] = (P_A + P_B - P_A \times P_B)^{-1}$.

C. Additional Sources

Our representation of the joint dynamics of cultures and institutions has borrowed from the working group on the Co-evolution of Behaviors and Institutions at the Santa Fe Institute and on the literature on cultural evolution initiated by:

Boyd, Robert, and Peter J. Richerson. 1985. *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

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