Nothing else matters: evolution of preference for social prestige*†

Roman Zakharenko
NRU Higher School of Economics
September 30, 2013

Abstract

This paper seeks answers to two questions. First, if a greater social activity of an individual enhances oblique (i.e. to non-relatives) transmission of her cultural traits at the expense of vertical (i.e. to children) transmission as well as family size, which behavior is optimal from cultural evolution standpoint? I formalize a general model that characterizes evolutionarily stable behaviors. The proposed model replicates the theory of Newson et al. (2007) that fertility decline is caused by increasing role of oblique cultural transmission. Second, if social activity is a rational choice rather than a culturally inherited trait, and if cultural transmission acts on preferences rather than behaviors, which preferences survive the process of cultural evolution? I arrive at a very simple yet powerful result: under mild assumptions on model structure, only preferences which emphasize exclusively the concern for social prestige, i.e. extent to which one’s cultural trait has been picked up by others, survive.

Keywords: Cultural transmission, demographic transition, social prestige, evolutionary steady state.

JEL Codes: C73,J11,Z13.

*Previously circulated as “Children versus Ideas: an ‘Influential’ Theory of Demographic Transition.”
†Thanks to Sergei Popov and Anna Yurko for helpful discussions. The previous version has gained from discussions with Maxim Arnold, Kenneth Binmore, Sergei Lando, Ronald Lee, Lesley Newson, seminar participants at NRU Higher School of Economics, participants of the Alpine Population and of the International Economic Association conferences.
1 Introduction

Culture may flow not only from parents to children, but also between non-relatives – this phenomenon is known as *oblique transmission* (Cavalli-Sforza and Feldman, 1981). Moreover, the probability that a cultural trait of an individual is picked up by others may depend on specific characteristics of that individual, a phenomenon called *biased transmission* by theorists of cultural transmission (Boyd and Richerson, 1985). Henrich and Gil-White (2001) define a concept of *prestige* of an individual, which affects the extent to which others are willing to pick up her cultural trait. In this paper, I ask a question: if individuals are able to affect their prestige level via costly effort at the expense of family size and vertical transmission of cultural traits (i.e. transmission from parents to children), what type of behavior survives the process of cultural evolution?

In Section 2 of the paper, I specify a very general model that allows to characterize the evolutionarily stable behaviors, and analyze their dependence on model parameters. The proposed analysis is done under very loose assumptions about the model ingredients; in particular, for most of the analysis we do not require differentiability of the maximand functions, and analyze optimal behavior using derivative-free methods. The proposed model predicts that an increasing role of oblique transmission, e.g. due to exogenously lowered communication costs, causes fertility decline.

The model should be viewed as a mathematical formalization of the idea by Newson et al. (2007), that fertility decline is caused by changing patterns of social interaction. According to their theory, fertility is high when individuals are surrounded mainly by close relatives; in such environments, children primarily pick up the traits of their parents, and high fertility cultural traits dominate because low-fertility communities become physically extinct. Fertility drops as cultural traits increasingly flow between non-relatives and across communities, because in such an environment a low-fertility trait has a greater chance of survival. Newson (2009) provides cross-country empirical evidence in support of the theory; it is shown that an earlier change in cultural transmission patterns, proxied by the date of the onset of demographic transition, affects many of modern attitudes to family and to fertility behavior. Additionally, La Ferrara et al. (2012) finds that the arrival of a TV channel broadcasting “soap operas” to Brazilian communities reduces fertility, apparently by altering the flow of cultural traits such that viewers observe and absorb new, low-fertility, lifestyles.

In the field of Economics, theorization about cultural transmission usually builds on “imperfect empathy” preferences introduced by Bisin and Verdier (1998, 2001). There are several discrete cultural traits; members of each cultural trait derive utility from two ingre-
dients: traditional instantaneous utility dependent on own actions, and instantaneous utility dependent on actions of children. Instantaneous utility function differs across cultural traits; parents apply own instantaneous utility to both own actions and those of children. If children pick up the “wrong” cultural trait, they act “wrong” from the point of view of parents, which makes the latter worse off. An expectation of such outcome causes parents to undertake costly “socialization” effort to increase the chance that children pick up parents’ cultural trait.

Baudin (2010) develops a model of demographic transition that incorporates cultural transmission and imperfect empathy. There are two cultural types with ad-hoc assumptions about their fertility preferences and production mode; a productivity shock of one of types has multiple fertility effects on both types, which are analyzed in the paper.

A disadvantage of the approach to cultural transmission by Bisin and Verdier (2001) and subsequent papers is an overly restrictive domain of possible cultural types: ad hoc assumptions about the utility function are made; the set of possible cultural types is usually limited to two elements. In Section 3 of this paper, we analyze a much broader domain of possible preferences in order to characterize the “most successful” preference map, i.e. the one that is capable to emulate the most successful behaviors characterized by Section 2. We arrive at a very simple, nearly tautological, yet powerful idea: the preference map that prescribes an individual to care exclusively about the social prestige, i.e. about the extent to which others have learned from that individual, is strictly more successful than any alternative preference map, under mild regularity conditions. An individual who cares not only about social prestige but also about anything else, e.g. genetic success, private consumption, leisure, absolute wealth, relative wealth, or any combination of these, makes suboptimal decisions, her cultural trait is picked up less frequently by the next generation and vanishes over time. A preference for consumption (and other things) may survive only as long as consumption (or other things) contributes to the ultimate purpose of social prestige.

The intuition behind this result is very simple: one is more likely to pick up the cultural traits of more prestigious individuals, i.e. those whom one observes more often. But the most prestigious individuals, other things being equal, are those who have a preference for being prestigious and allocate all available resources towards this goal. Since one is more likely to pick this cultural trait than any other, the concern for social prestige should outweigh any other concern. Section 3 formalizes the intuition.

Despite the simplicity and strength of this argument, to the best of my knowledge the idea that one can derive utility from outflow of own cultural traits has not been previously
discussed in the economic literature.

Besides the above mentioned literature, there also exists a large body of theoretical work in the evolution of preferences that does not incorporate cultural transmission. Alger and Weibull (2010), for example, study the evolution of altruism with the traditional definition of fitness as physical survival. Heifetz et al. (2007) offer a game-theoretic methodology with general ad-hoc fitness functions; their key assumption is that individuals may maximize a combination of the fitness function and an “individual disposition,” with the latter being subject to evolutionary drift. The paper characterizes evolutionarily stable equilibria with non-trivial “individual dispositions.”

There also exists a large body of work on demographic transition that does not relate the phenomenon to the cultural transmission. Becker (1960); Becker and Lewis (1973); Becker et al. (1990) are classic works explaining fertility decline by increasing return to human capital (either that of self or of children) which is a substitute to family size. Caldwell (1976) explains fertility by parent’s expectation of support from children in own old age; fertility decline is explained by improvements of alternative methods to support the elderly such as social security. Kalemli-Ozcan (2003) explains fertility decline as a response to reduced child mortality by risk-averse parents.

2 Family versus social activity: evolution of behavior

In this section, individuals are viewed as dummies which inherit behaviors of the previous generation. Rational decision making is introduced in Section 3.

2.1 Setup

Consider a dynamic model of overlapping generations. There is a two-level time structure: discrete periods, with infinite horizon, each consist of a continuum of time of unitary mass. Each generation lives for two periods, such that generation $t$ lives in period $t-1$ when young and in period $t$ when old. In every generation $t$, there is a continuum of individuals of endogenous mass; the set of all generation-$t$ individuals is labeled as $G_t$. Young individuals passively absorb the cultural traits of the previous generation; old individuals divide their time between social activity $x \in [0,1]$ and family activity $1-x$.\footnote{The precise timing of social and family activity does not matter; only the division of time between the two activities.} The social activity level, also referred to as behavior, is culturally transmitted as described below.
There is a parent-child relationship in the model: each young individual has one parent from the previous generation. Young individuals pick up the social activity level from the previous generation in the following exogenous way. With probability $1 - q$ for some $q \in [0, 1]$, a young individual $i_t \in G_t$ picks up the social activity of own parent $i_{t-1} \in G_{t-1}$. With the remaining probability $q$, young individuals pick up the cultural trait of a randomly drawn old individual, as described in the next paragraph. The value of $q$ demonstrates how separated is the flow of cultural traits from the flow of genes. If $q = 0$, cultural traits are passed only to own children, and the two flows coincide. One stylized fact pursued by this paper is that the value of $q$ has increased in the last two centuries due to urbanization, higher literacy and spread of mass communication technologies: in pre-industrial societies, young individuals imitated own parents or close relatives because there was no one else to imitate, while in modern societies, the menu of potential role models has greatly expanded.

If a young individual picks up his behavior from a randomly drawn stranger, the probability measure of drawing an individual $j_{t-1} \in G_{t-1}$ is proportional to the social visibility of the latter, a function of her social activity, $f(x(j_{t-1}))$. The social visibility function satisfies the following assumptions:

(i) boundedness: $f(0) = 0$ and $f(1) < \infty$;

(ii) monotonicity: $f(x) < f(x')$, $\forall x < x'$;

(iii) upper semi-continuity: for every $\alpha \geq 0$, the set of all $x$ such that $f(x) \geq \alpha$ is closed.

When $i_t$ becomes old, he implements the social activity level $x(i_t)$ that he has picked up from the previous generation when young. The time spent not on social activity, $1 - x(i_t)$, is devoted to family, which results in the family size of $n(x(i_t)) = \frac{1 - x(i_t)}{\nu}$, where $\nu$ is the time cost of raising each child.

To analyze the dynamics of the distribution of behavioral traits, denote by $B$ the Borel $\sigma$-algebra on $[0, 1]$, by $P_t : B \rightarrow R_+$ a probability measure of the number of old individuals at the beginning of time $t$ on the set of all possible behaviors, such that $P_t([0, 1]) = 1$, and by $L_t \equiv |G_t|$ a measure of generation-$t$ population size. Then, the dynamics of $P_t(X), \forall X \in B$, is as follows:

$$L_{t+1}P_{t+1}(X) = (1 - q)L_t \int_{x \in X} n(x) dP_t(\cdot) + q \int_{x \in X} f(x) dP_t(\cdot) \frac{\bar{n}_t}{\bar{f}_t} n_{t} L_t,$$

(1)
where

\[
\bar{n}_t \equiv \int_{x \in [0,1]} n(x) dP_t(\cdot) \\
\bar{f}_t \equiv \int_{x \in [0,1]} f(x) dP_t(\cdot),
\]

are mean values of the visibility and family size in generation \(t\). The left-hand side of (1) is the measure of the future population bearing the traits from \(X\); this population is drawn from two sources. Some individuals pick up their traits from parents (first component of the right-hand side of (1)), while others pick it up from non-parents in \(G_t\) bearing traits from \(X\) (second component). Taking into account that \(L_{t+1} = \bar{n}_t L_t\), we can rewrite (1) as follows:

\[
P_{t+1}(X) = (1 - q) \frac{\int_{x \in X} n(x) dP_t(\cdot)}{\bar{n}_t} + q \frac{\int_{x \in X} f(x) dP_t(\cdot)}{\bar{f}_t}. \tag{2}
\]

It is also desirable to formulate population dynamics for every behavioral trait \(x \in [0,1]\). If \(x\) is an atom at time \(t\), i.e. \(P_t(x) > 0\), (2) can be transformed into

\[
P_{t+1}(x) = \left(1 - q \frac{n(x)}{\bar{n}_t} + q \frac{f(x)}{\bar{f}_t}\right) P_t(x). \tag{3}
\]

Otherwise, define the density function as follows:

\[
p_t(x) \equiv \lim_{\Delta \to 0} \frac{1}{\Delta} \max\{P_t([x - \Delta, x]), P_t([x, x + \Delta])\}. \tag{4}
\]

**Lemma 1** The dynamics of the density function is characterized by

\[
p_{t+1}(x) = \left(1 - q \frac{n(x)}{\bar{n}_t} + q \frac{f(x)}{\bar{f}_t}\right) p_t(x). \tag{5}
\]

**Proof.** By definition,

\[
p_{t+1}(x) = \lim_{\Delta \to 0} \frac{1}{\Delta} \max\{P_{t+1}([x - \Delta, x]), P_{t+1}([x, x + \Delta])\}, \tag{6}
\]
where
\[
\lim_{\Delta \to 0} \frac{1}{\Delta} P_{t+1}([x - \Delta, x]) = \left(1 - q \lim_{\Delta \to 0} \frac{n(x - \Delta)}{\bar{n}_t} + q \lim_{\Delta \to 0} \frac{f(x - \Delta)}{f_t}\right) \lim_{\Delta \to 0} \frac{1}{\Delta} P_t([x - \Delta, x]),
\]
and
\[
\lim_{\Delta \to 0} \frac{1}{\Delta} P_{t+1}([x, x + \Delta]) = \left(1 - q \lim_{\Delta \to 0} \frac{n(x + \Delta)}{\bar{n}_t} + q \lim_{\Delta \to 0} \frac{f(x + \Delta)}{f_t}\right) \lim_{\Delta \to 0} \frac{1}{\Delta} P_t([x, x + \Delta]).
\]

Due to continuity of \(n(\cdot)\), we have that \(n(x) = \lim_{\Delta \to 0} n(x - \Delta) = \lim_{\Delta \to 0} n(x + \Delta)\). Also note that upper semi-continuity of \(f(\cdot)\) implies \(f(x) = \lim_{\Delta \to 0} \max\{f(x - \Delta), f(x + \Delta)\}\). This implies (5).

### 2.2 Evolutionary steady state

We now define the notion of evolutionary stability of behavioral traits.

**Definition 1** A distribution of behavioral types \(P_t(\cdot)\) is said to be evolutionarily stable if

(i) it is time-invariant: \(P_{t+1}(X) = P_t(X), \forall X \in B\);

(ii) it is proof to introduction of previously non-existent behaviors: for any subset of behaviors \(X \in B\) such that \(P_t(X) = 0\), for any small enough \(\epsilon > 0\), and for any alternative probability measure \(R_t(\cdot)\) such that \(R_t(X) = \epsilon\) and \(R_t(Y) = (1 - \epsilon)P_t(Y), \forall Y : Y \cap X = \emptyset\), we have that \(R_{t+1}(X) \leq \epsilon\).

Here and thereafter, we denote the evolutionarily stable value of any time-varying function by an infinity subscript. For example, \(P_\infty(\cdot)\) denotes the evolutionarily stable distribution (ESD) of behaviors, while \(\bar{n}_\infty\) is the evolutionarily stable average family size. Also denote

\[
r_t(x) \equiv (1 - q) \frac{n(x)}{\bar{n}_t} + q \frac{f(x)}{f_t}.
\]

**Lemma 2** At every atom and at every non-atom with positive density of ESD, the function \(r_\infty(x)\) is maximized and is equal to one.

**Proof.** Equality to one can be trivially seen by comparing (3), for distribution atoms, and (5), for non-atoms with positive density, against property (i) of Definition 1. Proving maximization is equivalent to proving that \(r_\infty(x) \leq 1\) for all remaining behaviors (i.e. non-atoms with zero density), which follows directly from property (ii) of Definition 1. ■

Before continuing with the general case, we discuss the special cases with corner values of \(q\). First, observe that when \(q = 0\), we have that \(r_\infty(x) = \frac{n(x)}{\bar{n}_\infty}\), and \(x = 0\) (that maximizes...
can be shown to be the only surviving behavior. Intuitively, $q = 0$ implies that the flow of cultural traits parallels the flow of genes, and therefore the standard genetic incentive to maximize own genotype (proxied by family size) prevails.

Similarly, $q = 1$ implies $r_\infty(x) = \frac{f(x)}{\bar{n}_\infty}$, thus favoring maximal social activity $x = 1$. Note however that such social activity implies zero family size and therefore extinction of the population.

Throughout the rest of the paper, we focus on the interior values of $q$. Observe that when $q \in (0, 1)$, it must be that $\bar{n}_\infty > 0$ and $\bar{f}_\infty > 0$. Indeed, if average family size is zero, there is no one except own children to inherit one’s cultural trait, and so positive family size ($x < 1$) is favored. Likewise, if the average social visibility is zero, then anyone with positive social visibility would become infinitely popular (cf.(1)), so their behavior would outperform the zero-visibility behavior. With this result in hand, maximization of $r_\infty$ is equivalent to maximization of

$$r'(x) \equiv \frac{\bar{f}_\infty}{q} r_\infty(x) + c = f(x) - \frac{1}{q} \frac{1-q}{\bar{n}_\infty} x$$

with respect to $x$, where $c$ is some constant. Denote by $s \equiv \frac{1}{q} \frac{1-q}{\bar{n}_\infty} \geq 0$ the coefficient of the linear part of (8), and by $X(s)$ the set of all $x \in [0, 1]$ that maximize $f(x) - sx$.

**Proposition 1** The set $X(s)$ has the following properties:

(i) **existence**: $X(s)$ is non-empty for every $s$;

(ii) **boundary closedness**: $\inf(X(s)) \in X(s)$ and $\sup(X(s)) \in X(s)$;

(iii) **ordering**: for every pair $s_L$ and $s_H$ such that $s_L < s_H$, for every $x_L \in X(s_L)$, for every $x_H \in X(s_H)$, we have that $x_L \geq x_H$;

(iv) **completeness**: for every $x \in [0, 1]$, there exist $s$ such that $\inf(X(s)) \leq x \leq \sup(X(s))$.

A corollary of the ordering property is that for $s_H > s_L$, we have that $\sup(X(s_H)) \leq \inf(X(s_L))$. Also note that the completeness property does not state that every $x$ should belong to some $X(s)$. It only states that there are no “holes” between two consecutive sets, while holes within a set are possible. The proof of the proposition is in the Appendix.

As follows from Lemma 2, all surviving behaviors (i.e. distribution atoms or non-atoms with positive density) are contained in $X(s)$. This set depends on parameter $s$ which in turn itself depends on the distribution of behaviors. We now proceed to the analysis of this system.
Define by \( \bar{x}_\infty \) the mean social activity in a steady state:

\[
\bar{x}_\infty \equiv \int_{x \in [0,1]} xdP_\infty(x).
\]

The following Lemma considerably simplifies the analysis of the ESD.

**Lemma 3** The parameter \( s \) can be presented as a function of \( q \) and of mean social activity \( \bar{x}_\infty \):

\[
s = s(q, \bar{x}_\infty).
\]  \( (9) \)

**Proof.** If \( X(s) \) has only one element \( \tilde{x} \), then the entire mass of the population is concentrated at \( \tilde{x} \) and therefore (i) \( \bar{x}_\infty = \tilde{x} \) and (ii) \( s = \frac{1 - q f(\tilde{x})}{n(\tilde{x})} \equiv s(q, \tilde{x}) \), which proves the Lemma. If \( X(s) \) contains multiple types of behavior, then all of them must yield the same value of the function \( r'(x) = f(x) - sx = c, \forall x \in X(s) \) for some \( c \). Then, the function \( f \) on the set of surviving behaviors should be linear: \( f(x) = f^L(x) \equiv c + sx, \forall x \in X(s) \). The function \( f^L \) can be shown to be equal to

\[
f^L(x) \equiv f(\inf(X(s))) + \frac{f(\sup(X(s))) - f(\inf(X(s)))}{\sup(X(s)) - \inf(X(s))}(x - \inf(X(s))), \forall x \in X(s).
\]

Given linearity of \( f(x) \) on the domain of surviving behaviors, its mean value \( \bar{f}_\infty \) is equal to

\[
\bar{f}_\infty = Ef^L(x) = f^L(\bar{x}_\infty),
\]  \( (10) \)

i.e. is a function of mean social activity. The function \( n(x) \) is linear by construction on the entire domain of behaviors, therefore \( \bar{n}_\infty = n(\bar{x}_\infty) \). Thus, \( s \) is defined by (9). \( \blacksquare \)

Given that \( f(\cdot) \) is increasing in its argument while \( n(\cdot) \) is decreasing in it, it is straightforward to observe that \( s(q, x) \) is strictly increasing in \( x \), and is strictly decreasing in \( q \).

We now proceed to characterization of the evolutionarily stable average behavior, \( \bar{x}_\infty \). By boundary closedness, both infimum and supremum of \( X(s(q, \bar{x}_\infty)) \) belong to the set; the mean strategy may take any value between them. Define by \( Y(q, x) \) the set of all possible values of the mean strategy:

\[
Y(q, x) \equiv [\inf X(s(q, x)), \sup X(s(q, x))].
\]  \( (11) \)

**Proposition 2** The set-valued function \( Y(q, x) \) has the following properties:

(i) existence: \( Y(q, x) \) exists for every \( q \in (0,1) \) and \( x \in [0,1] \);
(ii) closedness: $Y(q, x)$ is closed for every $q \in (0, 1)$ and $x \in [0, 1]$;

(iii) $q$-ordering: for every $q_L, q_H \in (0, 1), x \in [0, 1]$ such that $q_L < q_H$, we have that 
$$\sup Y(q_L, x) \leq \inf Y(q_H, x);$$

(iv) $x$-ordering: for every $q \in (0, 1), x_L, x_H \in [0, 1]$ such that $x_L < x_H$, we have that 
$$\inf Y(q, x_L) \geq \sup Y(q, x_H);$$

(v) completeness: for any $y \in [0, 1]$, and for any $q \in (0, 1)$, there exist $x$ such that 
$$\inf Y(q, x) \leq y \leq \sup Y(q, x).$$

The proof of the proposition follows directly from the definition of $Y(q, x)$, Lemma 3, and the properties of $X(s)$. Note that $s(q, 1)$ is formally not defined; we assume $Y(q, 1) = \{0\}$. Intuitively, when mean social activity is unity, the mean family size is zero, so one’s cultural trait can be picked up only by own children and therefore zero social activity is best. The properties of $Y(q, x)$ entail the following

**Corollary 1** The graph of $Y(q, x)$ as a function of $x$ is closed, i.e. for any sequence $x_N$ converging to some $x \in [0, 1]$ and for any sequence $y_N$ converging to some $y$ and such that $y_N \in Y(q, x_N), \forall N$, we have that $y \in Y(q, x)$.

The proof is contained in the Appendix.

We now study the properties of the steady state mean social activity, equal to the fixed point of $Y(q, x)$ as a function of $x$, and denoted $y(q)$. Mathematically, $x$ is a fixed point of $Y(q, x)$ if it satisfies

$$x \in Y(q, x). \quad (12)$$

**Theorem 1** (i) The fixed point of $Y(q, x)$ as a function of $x$, $y(q)$, exists for any $q \in (0, 1)$;

(ii) $y(q)$ is unique for any $q \in (0, 1)$;

(iii) $y(q)$ is weakly increasing in $q$;

(iv) $y(q) \in (0, 1)$ (i.e. excludes boundaries) for any $q \in (0, 1)$.

**Proof.**

(i) Existence is established by the Kakutani fixed point theorem. The theorem requires that the set $Y(q, x)$ exists and is closed for every $q, x$, which is established by the Proposition 2, and that the graph of $Y(q, \cdot)$ is closed, which is established by the Corollary 1.
(ii) Uniqueness follows from $x$-ordering of $Y$: if there were two values $x_L < x_H$ that satisfied (12), that would directly contradict the $x$-ordering requirement that $\inf Y(q, x_L) \geq \sup Y(q, x_H)$.

(iii) Take any pair $q_L < q_H$. We have that

\[
y(q_L) \leq \sup_{y(q_L) \text{ is fixed point}} Y(q_L, y(q_L)) \leq \inf_{Y(q, y(q_L)) \text{ ordering of } Y} Y(q_H, y(q_L)) \tag{13}
\]

If both hold with equality, by uniqueness of the fixed point $y(q_H)$ we must conclude that $y(q_H) = y(q_L)$, and proof is complete. If $y(q_L) < \inf Y(q_H, y(q_L))$, we have that $y(q_L) \neq y(q_H)$. Suppose $y(q_H) < y(q_L)$. Then,

\[
\inf_{Y(q, y(q_L)) \text{ ordering of } Y} Y(q_H, y(q_L)) \geq \sup_{Y(q, y(q_L)) \text{ ordering of } Y} Y(q_H, y(q_L)) \geq \inf Y(q_H, y(q_L)) > y(q_L) > y(q_H) \tag{14}
\]

and therefore $y(q_H)$ is not a fixed point. Therefore, $y(q_H) > y(q_L)$.

(iv) Assume $y(q) = 0$. Then $s(q, y(q)) = 0$, and, by monotonicity of $f(\cdot)$, maximization of $f(x) - s(q, y(q))x$ with respect to $x$ yields $x^* = y(q) = 1$, which is a contradiction. The discussion following Proposition 2 establishes that $Y(q, 1) = 0$, hence unity cannot be a fixed point either.

Thus, mean social activity is weakly increasing (and therefore family size is weakly decreasing) with the rate of oblique transmission, i.e. rate of interaction between non-relatives $q$. This is a mathematical formalization of the idea by Newson et al. (2007) that fertility decline is caused by an exogenous increase in such interaction.

3 Evolutionarily stable preferences

If social activity is a rational choice rather than a result of imitation, and if cultural transmission acts on preferences that govern the choice of social activity, which preferences survive in the process of cultural evolution? In this section, we introduce the notion of two alternative incentives, and let individuals choose an optimal social activity by maximizing a mix of the two incentives. A cultural trait in this section is the importance of one incentive over the other; our objective is to characterize the cultural traits that survive.
3.1 The incentives

By the social prestige incentive of an individual from generation \( t \), as a function of social activity \( x \), we label the previously unnamed function \( r_t(x) \) defined in (7). By \( X_t \) we define the set of behaviors that maximize \( r_t(x) \); upper semi-continuity of the latter warrants the existence of \( X_t; \forall t \). Also note that \( X_\infty = X(s) \) by definition.

Denote by \( h(x, P_t(\cdot)) \) the alternative incentive, i.e. anything that does not include the social prestige. The alternative incentive may include all incentives traditionally assumed in Economics except the social prestige, e.g. consumption, leisure, consumption of others, or any combination of these. The alternative may depend on own choice of social activity, as well as on the distribution of social activity chosen by others. To ensure that there indeed exists a tradeoff between social prestige and the alternative, and that individuals with different preferences (defined below) indeed make different choices, we impose the following regularity conditions on the model ingredients:

(i) \( X_t \) belongs to the interior of the behavioral domain: \( X_t \subset (0, 1), \forall t \);

(ii) The function \( f(x) \) is differentiable on \( X_t, \forall t \), in addition to properties assumed in section 2.

(iii) The function \( h(x, P_t(\cdot)) \) is differentiable on \( X_t \), such that \( \frac{dh(x, P_t(\cdot))}{dx} \neq 0 \), \( \forall x \in X_t, \forall t \).

A direct corollary of (ii) is that \( \frac{dr_t(x)}{dx} \) exists on \( X_t \) and is equal to zero.

3.2 The utility

We now proceed to the definition of the individual objective function. We assume that individuals derive utility from social prestige \( r \) and from the alternative \( h \); the “importance” of each of these alternatives may vary across individuals, and is labeled by \( a \in [0, 1] \). We make the following natural assumptions about the utility function:

(i) more is better: \( \frac{\partial u(r,h,a)}{\partial r} \) and \( \frac{\partial u(r,h,a)}{\partial h} \) exist and are non-negative;

(ii) \( a \) is the comparative importance of \( r \) over \( h \): \( \frac{\partial^2 u(r,h,a)}{\partial r \partial a} \) exists and is strictly positive; \( \frac{\partial^2 u(r,h,a)}{\partial h \partial a} \) exists and is strictly negative. Moreover, \( \frac{\partial u(r,h,a)}{\partial r} = 0 \) iff \( a = 0 \), and \( \frac{\partial u(r,h,a)}{\partial h} = 0 \) iff \( a = 1 \).
An example of the utility function that satisfies the above assumptions is the constant elasticity of substitution function:

\[ u(r, h, a) = \left( ar^{\frac{\sigma - 1}{\sigma}} + (1 - a)h^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}}, \sigma > 0. \]

### 3.3 Cultural transmission

Unlike in section 2, we assume that cultural transmission acts on the preference parameter \( a \) rather than on choice of social activity \( x \). For this reason, we redefine the distribution of cultural traits. Denote by \( Q_t : B \to R_+ \) the probability measure of the distribution of \( a \) in generation \( t \), such that \( Q_t([0, 1]) = 1 \). Denote also by \( P_t : B \times [0, 1] \to R_+ \) the probability measure of the distribution of behaviors for every possible cultural trait, such that \( P_t([0, 1], a) = 1, \forall a \). Individual rationality implies that \( P_t(X, a) > 0 \) only if \( u(r_t(\cdot), h_t(\cdot), a) \) achieves its maximum at some point(s) belonging to \( X \).

With above notations, the dynamics of a given set of cultural traits \( A \subseteq [0, 1] \) is characterized by the following (cf. (2)):

\[
Q_{t+1}(A) = (1 - q) \frac{\int_{a \in A} \int_{x \in [0,1]} n(x) dP_t(\cdot, a) dQ_t(\cdot)}{\bar{n}_t} + q \frac{\int_{a \in A} \int_{x \in [0,1]} f(x) dP_t(\cdot, a) dQ_t(\cdot)}{\bar{f}_t}, \tag{15}
\]

where

\[
\bar{n}_t = \int_{a \in [0,1]} \int_{x \in [0,1]} n(x) dP_t(\cdot, a) dQ_t(\cdot),
\]

\[
\bar{f}_t = \int_{a \in [0,1]} \int_{x \in [0,1]} f(x) dP_t(\cdot, a) dQ_t(\cdot).
\]

By analogy with section 2, the dynamics of atoms in the distribution is given by (cf. (2))

\[
Q_{t+1}(a) = \left( (1 - q) \frac{\int_{x \in [0,1]} n(x) dP_t(\cdot, a)}{\bar{n}_t} + q \frac{\int_{x \in [0,1]} f(x) dP_t(\cdot, a)}{\bar{f}_t} \right) Q_t(a). \tag{16}
\]

The definition of non-atom density replicates (4):

\[
\theta_t(a) \equiv \lim_{\Delta \to 0} \frac{1}{\Delta} \max \{ Q_t(\lfloor a - \Delta, a \rfloor), Q_t(\lfloor a, a + \Delta \rfloor) \}. \tag{17}
\]
By analogy with Lemma 1, we can show that the dynamics of density is described by

$$\theta_{t+1}(a) = \left(1 - q\right)\frac{\int_{x \in [0,1]} n(x) dP_t(x, a)}{\bar{n}_t} + q\frac{\int_{x \in [0,1]} f(x) dP_t(x, a)}{f_t} \theta_t(a).$$

(18)

Define \(\rho_t(a) \equiv \left(1 - q\right)\frac{\int_{x \in [0,1]} n(x) dP_t(x, a)}{\bar{n}_t} + q\frac{\int_{x \in [0,1]} f(x) dP_t(x, a)}{f_t}\); by analogy with Lemma 2, we can show that in the evolutionarily stable distribution of preferences, \(\rho_\infty(a)\) is maximized if \(a\) is an atom or a non-atom with positive density.

We can now formulate the main result of this section.

**Theorem 2** *In the evolutionarily stable distribution, \(a = 1\) is the only surviving cultural trait, i.e. \(Q(1) = 1\) while \(Q([0, 1)) = 0\).*

In other words, only the population that cares exclusively about own social prestige survives in the process of cultural evolution.

**Proof.** First observe that any behavior chosen by any individual in the ESD should belong to \(X_\infty\), i.e. to the set of behaviors that maximize \(r_\infty(x)\). In math, \(P_\infty(x, a) > 0\) or \(p_\infty(x, a) > 0\) implies \(x \in X_\infty\), which further implies \(\frac{dr_\infty(x)}{dx} = 0\). At the same time, incentive compatibility requires that the utility is maximized at these points, too:

$$\frac{du(r_\infty(x), h_\infty(x), a)}{dx} = \frac{\partial u(r, h, a)}{\partial r} \frac{dr_\infty(x)}{dx} + \frac{\partial u(r, h, a)}{\partial h} \frac{dh_\infty(x)}{dx} = 0,$$

\(\forall x : P_\infty(x, a) > 0\) or \(p_\infty(x, a) > 0\), \(\forall a : Q(a) > 0\) or \(\theta(a) > 0\). (19)

Since \(\frac{dr_\infty(x)}{dx} = 0\), it must also be that \(\frac{\partial u(r, h, a)}{\partial h} \frac{dh_\infty(x)}{dx} = 0\). By assumption, \(\frac{dh_\infty(x)}{dx} \neq 0\), hence it must be \(\frac{\partial u(r, h, a)}{\partial h} = 0\), which further implies \(a = 1\) due to the assumptions imposed on the utility function. □

4 Conclusion

Economics traditionally makes ad-hoc assumptions about what humans are willing to achieve. Personal consumption of goods and services is the most common assumption, followed by leisure, consumption of other people, etc. Several biology-minded economists pointed out that such focus on consumption may be excessive. For example, Robson (2001) states that “consumption is only an intermediate good from a biological point of view; offspring are the final good”. The same argument is provided by Bergstrom (2007): “Evolutionary theory
predicts selection for genes that produce behavior that tends, on average, to maximize the number of their surviving descendants. This theory suggests evolution would select for individuals who act as if personal consumption is not an end in itself, but rather an instrument for reproductive success”. The main argument of the current paper is that, once cultural transmission among humans becomes possible, human preferences should evolve further from maximizing offspring to maximizing social prestige, i.e. the representation of own cultural traits in the next generation. The prestige incentive could be undistinguishable from the offspring incentive in preindustrial societies with limited communication between non-relatives, where individuals could become prestigious only among own children; but the two incentives diverge far in modern societies with low communication cost, also reducing fertility along the way.

This finding is reminiscent of the ideas put forth by the proponents of “memetics,” in particular Blackmore (2000), that humans may be “infected” by the “memes,” discrete invisible entities that may alter human behavior. Blackmore (2000) argues that, once the cost of oblique cultural transmission is low enough, the most successful meme is the one that induces its host to spread itself as much as possible.

This paper does not assume the presence of the “memes” as discrete entities, yet conveys a very similar idea. Moreover, we show that the exclusive concern for social prestige emerges with any non-zero probability of oblique cultural transmission. This result is general and applies not only to the framework proposed by Section 2 of this paper, but also to any other framework in which cultural transmission process depends on individual decisions.

The idea of this paper offers new theoretical insights about the optimal motivation schemes, specifically motivation of high-ranked employees whose efforts are potentially observable by a large number of people, e.g. those in military, political, religious, or scientific occupations. It also suggests that fertility in overpopulated countries may be reduced by increased exposure of the public to a low-fertility culture, e.g. via access to the Internet – a result that has already been proven empirically by La Ferrara et al. (2012).

Despite the simplicity of the idea, and its powerful implications for microeconomic theory, it has been surprisingly overlooked in the field of Economics. This paper is an attempt to fill the gap.

A Proofs

Proof of Proposition 1
(i) Since $f(x)$ is upper semi-continuous and is defined on closed support, so is $f(x) - sx$ with respect to $x$. A property of such function is that it has a maximum, therefore $X(s)$ is never empty.

(ii) For arbitrary $s$, consider any sequence of $x \in X(s)$ that converges to $\inf(X(s))$. Upper-semicontinuity of $f(x) - sx$ with respect to $x$ implies that $\lim_{x \to \inf(X(s))} f(x) - sx = f(\inf(X(s))) - s \inf(X(s))$. Since every $x \in X(s)$ maximizes $f(x) - sx$ by definition of $X(s)$, so does $\inf(X(s))$. Therefore, $\inf X(s) \in X(s)$. Likewise, we can prove that $\sup X(s) \in X(s)$.

(iii) Take arbitrary $s_L$ and $s_H$, $x_L \in X(s_L), x_H \in X(s_H)$. By definition of $X(\cdot)$, we have that

$$f(x_L) - s_L x_L \geq f(x) - s_L x_H,$$

$$f(x_H) - s_H x_H \geq f(x) - s_H x_L.$$

By manipulating with these expressions, we can obtain $(s_H - s_L)(x_H - x_L) \leq 0$. Therefore, if $s_H > s_L$, it must be that $x_H \leq x_L$.

(iv) Assume the contrary: there is no such $s$ that $\inf(X(s)) \leq x \leq \sup(X(s))$. Then, pick the highest possible $s_L$ such that $x \leq \inf(X(s_L))$, and lowest possible $s_H$ such that $\sup(X(s_H)) \leq x$. If $X(s_L) = X(s_H)$, we have that both contain only one element, namely $x$, and therefore $\inf(X(s_L)) = x = \sup(X(s_L))$, which contradicts the Assumption. If $X(s_L) \neq X(s_H)$, we have that $s_L \neq s_H$ and, by the ordering property, $s_L < s_H$. Take any $s \in (s_L, s_H)$; by the ordering property, $\sup(X(s_H)) \leq \inf(X(s)) \leq \sup(X(s)) \leq \inf(X(s_L))$. If $\inf(X(s)) \leq x \leq \sup(X(s))$, there is a direct violation of the Assumption. If $x < \inf(X(s)) \leq \inf(X(s_L))$, that contradicts our assumption that $s_L$ was the highest possible with $x \leq \inf(X(s_L))$. If $\sup(X(s_H)) \leq \sup(X(s)) < x$, that contradicts our assumption that $s_H$ was the lowest possible with $\sup(X(s_H)) \leq x$.

Proof of Corollary 1 Assume the opposite, i.e. that $y \not\in Y(q, x)$. Since $Y(q, x)$ is a closed set, $y$ must be either below its infimum or above its supremum. Suppose, without loss of generality, $y < \inf Y(q, x)$. By completeness and $x$-ordering of $Y$, $\exists x' > x$ such that $y \in Y(q, x')$. If $y < \sup Y(q, x')$, then every $y_N < \sup Y(q, x')$ for sufficiently large $N$, and therefore by $x$-ordering we have that $x_N \geq x' > x$ for sufficiently large $N$ which contradicts the Assumption. If $y = \sup Y(q, x')$, pick any $y'' \in (y, \inf Y(q, x'))$; $\exists x'' \in (x, x')$ such that
Then, every \( y_N < y'' \) for sufficiently large \( N \), and therefore by \( x \)-ordering we have that \( x_N \geq x'' > x \) for sufficiently large \( N \) which contradicts the Assumption.\end{itemize}

**References**


