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Advances in the Economic Theory of Cultural Transmission

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Abstract

In this article we survey recent advances in the economic theory of cultural transmission. We highlight three main themes on which the literature has made great progress in the last 10 years: the domain of traits subject to cultural transmission; the microfoundations for the technology of transmission; and feedback effects between culture, institutions, and various socioeconomic environments. We conclude by suggesting interesting areas for future research.

1. INTRODUCTION

In the last two decades, economists have intensively turned to modeling endogenous preference formation, taking inspiration from the pioneering contributions in evolutionary biology and anthropology from the 1980s. An economic theory of cultural transmission—where the adjective "economic" refers to models of the dynamics of the distribution of cultural traits with endogenous intergenerational socialization and/or endogenous identity formation—is now well developed. This has arguably brought forth a clearer understanding of (the causes and consequences of) culture's persistence over time and heterogeneity over space. Cultural transmission models in this vein have spurred a wealth of empirical studies on various themes related to the role of culture in shaping various socioeconomic and political environments of interests.[1] Furthermore, these models' theoretical arguments for cultural (and institutional) persistence have been intensely and successfully exploited as a justification in a large and lively literature, referred to as "persistence studies," causally relating historical phenomena to present-day socioeconomic and political outcomes of interest.[2]

In this survey we concentrate on the economic theory of cultural transmission, leaving an organized collection and presentation of empirical work on the topic as a future endeavor. Furthermore, we take stock of the first-generation theoretical models of cultural transmission, referring to our survey on the topic for the *Handbook of Social Economics* (Bisin & Verdier 2010). We concentrate instead on the theoretical modeling of cultural transmission—more generally, cultural dynamics—of the last 10 years or so. We organize these contributions along three main dimensions: (*a*) the domain of the traits subject to cultural transmission; (*b*) the microfoundations of the technology of transmission; and (*c*) feedback effects between culture, institutions, and various socioeconomic environments. We shall try to adopt a consistent notation and structure to better illustrate the conceptual and technical contributions of the various papers and link them to their roots in first-generation models.

2. FIRST-GENERATION ECONOMIC MODELS OF CULTURAL TRANSMISSION

Pioneered by Cavalli-Sforza & Feldman (1981) in evolutionary biology and by Boyd & Richerson (1985) in anthropology, mathematical models of cultural transmission have been introduced in economics by Bisin & Verdier (2000, 2001) after allowing for endogenous socialization choice on the part of parents. Specifically, Cavalli-Sforza & Feldman (1981) and Boyd & Richerson (1985) describe a process of intergenerational cultural transmission with a population constituted of a continuum of agents with either of two binary cultural traits, a or b. The population dynamics are highly simplified: Reproduction is a-sexual and each parent has one child. Therefore, the population is stationary and normalized to 1. Cultural transmission is the result of direct vertical socialization by parents and oblique socialization in society at large. More precisely, a parent of trait $i \in \{a, b\}$ successfully socializes their child to their own trait with probability τ^i (direct vertical socialization). With probability $1 - \tau^i$, however, the child does not adopt the trait; they are matched at random with someone from their parent's generation and acquire their trait (oblique socialization).

Denoting with q the share of a types in the population, the cultural transmission mechanism is therefore formally represented by the following system of equations for P^{ij}, the transition

[1] Readers are referred to Fernandez (2010) and Bisin & Verdier (2010) for early surveys (see also Alesina & Giuliano 2015, Nunn 2021).

[2] Readers may consult the surveys by Bisin & Moro (2021), Cantoni & Yuchtman (2011), and Voth (2011).

probability that a child from a family with trait i is socialized to trait j:

$$P^{aa} = \tau^a + (1-\tau^a)q, \quad P^{ab} = (1-\tau^a)(1-q), \tag{1.}$$

$$P^{ba} = (1-\tau^b)q, \quad P^{bb} = \tau^b + (1-\tau^b)(1-q). \tag{2.}$$

This process of cultural socialization—by the law of large numbers—results in the following cultural dynamics, describing the diffusion of trait a in the population in continuous time:

$$\dot{q} = q(1-q)(\tau^a - \tau^b). \tag{3.}$$

Equation 3 is actually a version of the replicator dynamics in evolutionary biology for a two-trait population dynamic model, where $(\tau^a - \tau^b)$ can be interpreted as the relative cultural fitness of trait a compared to trait b. When each τ^i is exogenous, the dynamics drives towards cultural homogenization, with

$$q = 1 \text{ if } \tau^a > \tau^b \text{ or } q = 0 \text{ if } \tau^a < \tau^b.$$

Frequency-dependent cultural transmission rates can be added to explain some persistence of cultural heterogeneity (Boyd & Richerson 1985, Henrich & Gil-White 2001).

The economic approach to cultural transmission introduced by Bisin & Verdier (2000, 2001) builds on the transmission represented by Equation 3, but it allows for transmission rates to vary, depending on the economic or utility payoffs obtained by specific traits and, most importantly, on costly and purposeful actions by socializing agents. Specifically, in Bisin & Verdier's (2001) model, parents can choose how intensively to socialize their children, at some cost. Parents, in turn, are motivated to socialization by paternalistic preferences over the traits that their children can acquire: Specifically, parents evaluate their children's behavior based on their own preferences. Formally, a parent with trait i gets a payoff of V^{ij} if their child acquires trait j, where $V^{ii} > V^{ij}$ whenever $i \neq j$. A parent with trait $i \in \{a, b\}$ in state q has a payoff function

$$U^i(q) = P^{ii}V^{ii} + P^{ij}V^{ij} - c(\tau^i), \ j \in \{a, b\}, \neq i, \tag{4.}$$

and they choose socialization effort τ^i at cost $c(\tau^i)$ to maximize this function with P^{ii} and P^{ij} given by Equation 1.[3] Denoting type i's cultural intolerance by $\Delta V^i = V^{ii} - V^{ij}$ for $i \neq j$, and assuming quadratic costs of socialization,[4] parental socialization choices are

$$\tau^i = (1-q^i)\Delta V^i \tag{5.}$$

and population dynamics are given by Equation 3, except that now τ^i is endogenous and given by Equation 5.

When socialization is endogenous, as posited by Bisin & Verdier (2001), a heterogeneous cultural distribution,

$$q^* = \frac{\Delta V^a}{\Delta V^a + \Delta V^b} \in (0, 1), \tag{6.}$$

emerges from almost every initial state whenever cultural intolerance is positive for each type. These dynamics are a consequence of the fact that the cultural transmission mechanism satisfies the property of cultural substitution (between vertical and oblique transmission); that is,

[3] $c(\tau)$ is supposed to be an increasing convex function with the Inada conditions $c(0) = c'(0) = 0$ and $\lim_{\tau \to 1} c(\tau) = \lim_{\tau \to 1} c'(\tau) = +\infty$.

[4] Henceforth we report results for all papers for quadratic socialization costs.

parents have fewer incentives to socialize their children the more dominant their values are in the population. Indeed, in this case, the cultural dynamics are away from the boundaries $q = 0$ and $q = 1$.[5]

The first decade of research on the economic theory of cultural transmission has contributed several applications and extensions of this basic framework. We have surveyed this literature in previous work (Bisin & Verdier 2010). Alongside this literature, a well-established tradition in evolutionary biology and anthropology considers continuous traits models of cultural transmission. These models postulate a dynamic of cultural traits that is driven by exogenous linear mixing, with no attempt at endogenous socialization (see Cavalli-Sforza & Feldman 1973, Otto et al. 1994). We introduce them here briefly.

Formally, consider a finite population of N dynasties. Each representative individual of dynasty i at time t is characterized by the intensity of a cultural trait $R_t^i \in (0, \infty)$ that they hold during their lifetime. Transmission from one generation to the next results from vertical and oblique transmission. Specifically, let $\tau^i \in (0, 1)$ represent vertical socialization by parents of type i, and let oblique transmission be represented as a weighted average of various role models in society, $O_t^i = \sum_{j=1}^{j=N} \gamma^{ij} R_t^j$, where $\Gamma = [\gamma^{ij}]_{i,j}$ is a row stochastic matrix reflecting the social connectivity of oblique influence across the different dynasties. Cultural dynamics then is postulated to follow the process

$$\dot{R}^i = (1 - \tau^i)(O^i - R^i). \qquad 7.$$

Let $R = (R^j)_{i=1,N}$ denote the population N-dimensional vector of the cultural trait, I the identity matrix of dimension N, and T a diagonal matrix of dimension N where the ith diagonal element is τ^i. The cultural dynamics can then be written in matrix form:

$$\dot{R} = (X - I) \times R, \quad X = T + (I - T)\Gamma.$$

The matrix X is a row stochastic matrix reflecting the force of the cultural inheritance–blending process resulting from the interaction between vertical and oblique transmission. When the vertical influence weights τ^i are exogenous, and the matrix X is irreducible and noncyclic, the evolutionary process induces homogeneity of the trait, leading to a melting-pot equilibrium in which the value of the cultural trait is the same across the population.[6]

3. THE DOMAIN OF CULTURAL TRAITS

A first line of research that has received increased attention in the last decade is concerned with expanding the domain of the cultural traits transmitted across generations, relaxing the binary traits assumption by Bisin & Verdier (2001). On the other hand, a recent literature has extended the economic approach to endogenous socialization developed by Bisin & Verdier (2001) for discrete traits to linear mixing models for continuous traits à la Cavalli-Sforza & Feldman (1973). These extensions naturally introduce a notion of distance between traits—independent of cultural intolerances that are implicit in agents' preferences.

[5]Formally, cultural substitution is satisfied when, for any $\Delta V^i > 0$, τ^i is a continuous, strictly decreasing function of q^i and, moreover, $\tau^i = 0$ when $q^i = 1$. Bisin & Verdier (2001) study various alternative cultural transmission processes that display cultural complementarity, where parental socialization τ^i is increasing in q^i, whose dynamics contain a force pushing toward cultural homogeneity.

[6]On the other hand, Brueckner & Smirnov (2007, 2008) show that the cyclicality of the matrix X preserves the possibility of long-term heterogeneity.

3.1. $n > 2$ Traits

The first important contribution along these lines has been the extension of the cultural transmission model by Bisin & Verdier (2001), pursued by Bisin et al. (2009) and Montgomery (2010), to a domain of $n > 2$ discrete traits.

Consider the direct extension of the dynamics in Equation 3:

$$\dot{q}^i = q^i\left[\tau^i - \sum_j q^j\tau^j\right], \text{ for all } i = 1,\dots n. \tag{8.}$$

Clearly, when the τ^is are exogenous, the dynamic converges from every interior state to a homogeneous distribution centered on trait $i \in \arg\max_i\{\tau^i\}_{i=1}^n$. Allowing for endogenous parental socialization à la Bisin & Verdier (2001), we obtain instead the following dynamics:

$$\dot{q}^i = q^i\left[\sum_j q^j\Delta V^{ij} - \sum_j\sum_k q^j q^k\Delta V^{jk}\right], \text{ for all } i = 1,\dots n. \tag{9.}$$

Equation 9 turns out to be equivalent to the replicator dynamics of an $n \times n$ random matching evolutionary game with matrix payoffs $\mathbf{\Delta V} = \left(\Delta V^{ij}\right)_{ij\in[1,n]^2}$ once ΔV^{ij} is interpreted as the payoff from playing strategy i against j. These replicator dynamics can arise from natural selection, imitation, and reinforcement learning (see Young 1998, Sandholm 2010). This formal connection between cultural transmission and other evolutionary game theory processes opens up a large body of results in evolutionary game theory to the study of cultural evolution.

Suppose, for instance, that $\Delta V^{ij} = \Delta V^i$ for all $j \neq i$ (and $\Delta V^{ii} = 0$); that is, suppose that each group's cultural intolerance does not depend on the identity of the other group. Then, the evolutionary game structure associated to the cultural transmission model is a strictly stable game. There is a unique distribution of traits, $q^i = \frac{1}{n}$, which is globally asymptotically stable, and every trajectory of the replicator dynamics in the interior of the n-dimensional simplex converges to this state. Importantly, this implies, again, persistent cultural diversity in the limit.

A recent interesting application of this general multiple-trait transmission model is by Wu & Zhang (2022), who specialize the cultural intolerance structure to study conditions for the emergence of polarization of ideologies, exploiting the implied topology of traits. Consider a 3-trait version of the model, with traits L and R representing extreme ideologies and trait C representing moderate centrist ideology. Assume a cultural intolerance matrix $\Delta V = (\Delta V^{ij})$ with the property that the extremist traits L and R and the centrist trait C are equally and symmetrically distant from each other, while the extreme traits are more distant from each other than from C:

$$\Delta V^{ii} = 0,\ i = L,R,C;\ \ \Delta V^{iC} = b > 0,\ i = L,R;\ \ \Delta V^{RL} = \beta b,\ \ \Delta V^{LR} = \alpha b,\ \alpha,\beta > 1.$$

Under this intolerance structure, a unique cultural steady state prevails in the limit. Importantly, when agents with ideology L and R have convex intolerance,

$$\Delta V^{LR} \geq 2\Delta V^{LC},\ \ \Delta V^{RL} \geq 2\Delta V^{RC},$$

then, in the limit, we have $q^C = 0$. In other words, convex intolerance is a sufficient condition for the rise of political extremism. Indeed, because intolerance is increasing and convex, agents with extreme ideology L or R have a higher incentive to maintain their ideology by exerting higher efforts than those with moderate ideology C. Consequently, the fraction q^C of moderates in the population always decreases along the evolutionary trajectory. Conversely, when agents with extreme ideologies have strictly concave intolerance, the three ideologies are in support of the stable cultural steady state, and cultural heterogeneity obtains in the limit.

3.2. Continuous Traits with Endogenous Socialization

In the spirit of the economic approach to cultural transmission by Bisin & Verdier (2001), Vaughan (2013), Buechel et al. (2014), and Panebianco (2014) allow for endogenous socialization, that is, endogenous choice of τ^i in continuous traits models. In order to ensure long-run cultural convergence, they impose additional structure on the interacting matrix $\mathbf{\Gamma}$ underlying Equation 7. In particular, when a child's trait is a weighted average of their parent's trait and the mean value of the trait in the society, cultural mixing prevents the long-run cultural heterogeneity result by Bisin & Verdier (2001). Indeed, such linear weighting models lead to a standard mean reverting linear process, which is naturally associated to cultural homogeneity in the long run.

With a proper probabilistic structure of cultural transmission, however, cultural diversity may still be obtained in the limit, once again as a consequence of cultural substitution. Indeed, this is the main result obtained by Cheung & Wu (2018) in an elegant extension of Bisin & Verdier's (2001) model along these lines. Specifically, consider a population of unit mass, where each agent in the population has a trait from set $R = [0, 1]$. The population state is a probability distribution q over R. Denote by $\Delta V^{zy} := V^{zz} - V^{zy}$ the cultural intolerance of a z-parent toward trait $y \in R$, with $\Delta V^{zy} \geq 0$ and equal to 0 only if $y = z$. A population state over R is described by its probability distribution μ. Denoting by $\tau^z(\mu)$ the socialization rate exerted by a z-parent at population state μ, the cultural evolutionary dynamic is characterized by the following differential equation for all (integrable) subset of traits $A \subseteq R$:

$$\dot{\mu}(A) = \underbrace{\int_{y\in A}\int_{z\in R\setminus A}(1-\tau^z(\mu))\mu(\mathrm{dz})\mu(\mathrm{dy})}_{\text{inflows}} - \underbrace{\int_{y\in A}\int_{z\in R\setminus A}(1-\tau^y(\mu))\mu(\mathrm{dy})\mu(\mathrm{dz})}_{\text{outflows}}. \qquad 10.$$

Intuitively, $\dot{\mu}(A)$ in the mass of agents with traits in set A is equal to the inflow of children whose parents' traits are not in set A, minus the outflow of children whose parents' traits are in set A. In this context, cultural substitutability is defined by the socialization rate $\tau^z(\mu)$ being an increasing function of the average intolerance of group z at population state μ, that is, $\Delta V^z(\mu) = \int_{y\in R}\Delta V^{zy}\mu(y)$. As in Bisin & Verdier's (2001) model, cultural substitution is satisfied by the cultural transmission process μ, and the cultural dynamics with continuous traits satisfy the following:

$$\dot{\mu}(A) = \int_{y\in A}\Delta V^y(\mu)\mu(\mathrm{dy}) - q(A)\int_{z\in R}\Delta V^z(\mu)\mu(\mathrm{dz}). \qquad 11.$$

As Montgomery (2010) does for discrete traits, Cheung & Wu (2018) note a formal connection with evolutionary game dynamics: The cultural dynamics of continuous traits in Equation 11 is equivalent to a continuous strategy–type replicator dynamics, as proposed by Oechssler & Riedel (2001). Using sophisticated measure theory tools for such dynamic systems, Cheung & Wu (2018) show that cultural substitutability is again essential for the preservation of long-run cultural heterogeneity. Furthermore, when an agent's cultural intolerance toward another agent, ΔV^{zy}, is an increasing convex function of their cultural distance $|z - y|$, Cheung & Wu show that only the most extremely polarized state distribution with mass points at the extreme traits $z = 0$ and $z = 1$ is a stable limit point of the cultural dynamics, replicating the results for discrete traits transmission found by Wu & Zhang (2022).

Michaeli & Wu (2022) exploit a simple quadratic special case of Cheung & Wu's (2018) model, adding a peer effect dimension and an identity formation mechanism on the part of children, who

in fact contribute by choice to the determination of their cultural trait.[7] In the cultural transmission process, parents have contrasting incentives regarding the cultural trait they aim at socializing their children to: On the one end, they may tend to overshoot with respect to their own trait in order to balance the possible conformist pressure through peers; on the other hand, they may undershoot to reduce the cost their children experience when deviating from peer pressure. Michaeli & Wu (2022) derive conditions such that overshooting arises, leading to increased polarization from one generation to the next, with gradual (and endless) divergence of traits across generations.

Spiro (2020) discusses a related parental overshooting effect, whereby parents are forward looking when socializing their children, naturally inducing a proper dynamic game between all generations. In equilibrium, parents behave more extremely than their own type, and the more extreme their type is, the more extreme their behavior in terms of how much they overshoot with respect to the trait they aim at socializing their children to. Still, the quadratic structure of the socialization problem implies that dynastic integration obtains in the limit, though the speed of convergence is reduced by forward-looking socialization.

4. THE MICRO-FOUNDATIONS OF THE TECHNOLOGY OF CULTURAL TRANSMISSION

In models à la Bisin & Verdier (2001) the cultural transmission process is a very stylized combination of vertical and oblique transmission. In the past 10 years several more detailed and richer versions of this process have been studied.[8]

4.1. Transmission on Networks

Panebianco & Verdier (2017) expand the analysis of cultural transmission to study its dependence on the structure of social connections between individuals, incorporating insights from the epidemiological literature on large-scale networks, as done by Pastor-Satorras & Vespignani (2003). Specifically, consider a society of agents located on a large random network, with links formed according to a standard degree-based sampling process and a degree distribution $(\xi(k))_k$ among neighboring nodes. The socialization rate of parents of type i, τ_k^i, depends on their network connectivity, that is, their degree k in the network. Let q_k denote the share of individuals of type a in the subset of agents with degree k, and let $\tilde{q}$ be the expected fraction of neighbors of cultural type a in the network: $\tilde{q} = \sum_{k=0}^{\infty} \xi(k) q_k$. In the mean-field approximation, the dynamics of q_k are the natural extension of those in Equation 3; we have

$$\dot{q}_k = \left[-q_k(1-\tau_k^a)(1-\tilde{q}) + (1-q_k)(1-\tau_k^b)\tilde{q}\right], \qquad 12.$$

where $-(1-\tau_k^a)(1-\tilde{q})q_k$ represents how many children of parents of type a with degree k become of type b; and $(1-q_k)(1-\tau_k^b)\tilde{q}$ represents how many children of parents of type b with degree k become of type a. Under quadratic degree-dependent socialization costs, $c_k(\tau_k^i) = \frac{(\tau_k^i)^2}{2c_k^i}$, the socialization rates are as in Equation 5, $\tau_k^i = c_k(1-\tilde{q}^i)\Delta V^i$, and satisfy the cultural substitution property. The dynamics therefore converge to the cultural heterogeneous steady states $\left(q_k^*\right)_k$, which are characterized by

$$q_k^* = \frac{(1-\tau_k^b)\tilde{q}^*}{(1-\tau_k^a)(1-\tilde{q}^*) + (1-\tau_k^b)\tilde{q}^*}, \text{ where } \tilde{q}^* = \sum_{k=0}^{\infty} \xi(k) \frac{(1-\tau_k^b)\tilde{q}^*}{(1-\tau_k^a)(1-\tilde{q}^*) + (1-\tau_k^b)\tilde{q}^*}.$$

[7] Identity formation is discussed in more detail in the next section.

[8] A related literature, outside the scope of the present survey, has focused on parenting styles; readers are referred to Lizzeri & Siniscalchi (2008), Doepke & Zilibotti (2017), and Seror (2022).

Two distinct forces determine the direction of cultural change and its dependence on the topology of the network. First, a network connectivity effect is due to the fact that vertical socialization rates depend on the topology of social connections and vary accordingly with the degree of nodes in the network. This effect implies that a more successfully transmitted trait across nodes tends to have a positive bias in the cultural diffusion process. The size of the bias depends on the degree distribution of nodes and on the way vertical transmission rates vary with connectivity. The second force is the usual cultural substitution effect. It turns out that the cultural substitution effect overcomes the social bias directly induced by the network structure, and cultural diversity is preserved.[9]

4.2. Identity Formation and Socialization

In Bisin & Verdier's (2001) model, children are passive with respect to their cultural identity; that is, they are the object of parental vertical socialization and societal oblique transmission factors. Several recent models of cultural dynamics, however, account for children taking conscious actions toward their own cultural identity formation, in the context of horizontal socialization—for example, peer pressure effects.[10] In these models, parents typically attempt to mitigate or control the peer pressure their children are exposed to, adding a novel mechanism contributing to the long-run dynamics of culture (see, e.g., Bisin et al. 2011 and the survey of several of these models in Bisin & Verdier 2010; see also the previous discussion of Moti & Wu 2022).

A recent contribution along these lines is by Giavazzi et al. (2019). In their paper, as in Bisin et al.'s (2011), parents choose the family socialization rates first, and then children choose their own cultural identity. Consider parents belonging to a minority cultural group (see also Lazear 1999, Konya 2005). While parents derive utility from transmitting their own cultural trait, they also care about the usefulness of that trait for the economic activity children will engage in.

Whether all dynamical paths converge to assimilation of a minority depends upon a set of parameters such as the child's expected gains from economic activity, their costs to assimilate, the degree of intolerance of parents, the technology of parental socialization, and, finally, how much parents account for their child's utility payoff—that is, their altruism. All these parameters are likely to vary across different types of cultural traits. Furthermore, Giavazzi et al. (2019) obtain results about the speed of convergence as a function of the parameters of the environment, identifying, for example, the characteristics of traits that are likely to spread quickly across generations.

Adriani et al. (2018) also provide a two-stage framework with parental socialization described as an explicit process of information transmission between informed paternalistic parents and children uninformed about the best preferences to adopt. Informed parents use their action as a strategic signal to set relevant examples to their children. This paper analyzes the implications of the signaling distortion for the long-run distribution of traits in the population. Differently from Bisin & Verdier's (2001) model, some form of heterogeneity may persist even in the absence of cultural substitution (see also Adriani & Sonderegger 2018).

4.3. Incomplete Information and Socialization

Della Lena & Panebianco (2021) extend Bisin & Verdier's (2001) model to an environment in which parents have incomplete information regarding the effects of their socialization.

[9]However, extending the network structure to homophily, as done by Currarini et al. (2009), generates an additional force that promotes long-run cultural homogeneity.

[10]Readers are referred to the interesting literature spurred by Akerlof & Kranton (2000); in particular, Darity et al. (2006) develop an exogenous replicator dynamic mechanism of identity formation.

Specifically, the incomplete information regards (*a*) the share of different cultural groups within society and (*b*) the level of efficiency of their transmission technology, in line with the notion of self-efficacy in sociopsychology (Bandura 1993). Parents, therefore, merely conjecture efficacy through self-assessments based on the available information. The analysis highlights how incomplete information can revert some of the standard results of the persistence of cultural heterogeneity in society.

Specifically, denote by I_a, I_b, respectively, the set of all agents displaying trait a and trait b. Assume that the probability d^i_ω of parent ω with trait i to transmit their own trait through vertical transmission is $d^i_\omega = \min\{1, \alpha^i_\omega \tau^i_\omega\}$; that is, it depends on the parental socialization effort τ^i_ω and an idiosyncratic technology, $\alpha^i_\omega \in \mathbb{R}_+$, capturing parental efficacy in socialization. In each generation, the parental efficacies of parents of type i are independent and identically distributed according to a stationary distribution with mean $\alpha^i = E_{\omega \in I_i}\left(\alpha^i_\omega\right)$, and their socialization probability is

$$P^i_\omega = \alpha^i_\omega \tau^i_\omega + (1 - \alpha^i_\omega \tau^i_\omega) q^i.$$

Parents have incomplete information about their own realized parental efficacy, α^i_ω, and about the population share of group i, q^i. A parent ω of type i forms some subjective expectation $\widehat{\alpha}^i_\omega$—a conjectured parental efficacy. Similarly, the parent holds a conjecture about group i's population share, $\widehat{q}^{\,i} = \widehat{q}\,(q^i)$, assumed to be a nondecreasing function of the true population share q^i. In this setup, the cultural dynamics of the population share of group a, $q^a = 1 - q^b = q$, follow the familiar replicator form,

$$\dot{q} = q(1-q)\left(d^a - d^b\right), \tag{13.}$$

where d^i now reflects an average probability of vertical socialization of all agents belonging to group i. This can be written as $d^i = (1 - \widehat{q}^{\,i})\Omega^i$, with $\Omega^i = \Delta V^i E\left(\alpha^i_\omega \widehat{\alpha}^i_\omega\right)$, capturing the fact that the probability depends on conjectures about population shares $\widehat{q}^{\,i}$ as well as on average actual and conjectured parental efficacies.[11] The long-run cultural steady states of this dynamics (Equation 13) are the homogeneous populations ($q = 0$ and $q = 1$) and interior steady states characterized by $d^a - d^b = 0$.

Differently from the benchmark result by Bisin & Verdier (2001), the homogeneous populations may now be long-run stable states, depending on the structure of perception bias from the minority and the majority groups about the actual state of the population. Consider, for instance, the steady state with $q = 0$. In the neighborhood of this point, agents of type a (the minority group) can only have nonnegative biases [as $\widehat{q} - q = \widehat{q}\,(0) \geq 0$]. Because of this, and of the embedded cultural substitution associated to Bisin & Verdier's (2001) transmission process, agents with trait a choose an average effort that is lower than the average optimal effort obtained under complete information. This reduces the probability that, in the next period, the trait of type a is transmitted, and it negatively affects the dynamics of q. Similarly, agents of type b (the majority group) cannot overestimate their population share. This, in turn, induces a higher (or equal) average effort than the objectively optimal one and, again, negatively affects the dynamics of the minority trait a. When the negative average bias of the majority group is large enough, its average socialization effort is strong enough to dominate the average socialization effort of the minority group. As a consequence, the minority trait a cannot survive for small values of q. The steady state $q = 0$ is stable, and long-run cultural homogeneity prevails. On the opposite, when at some state of the population the biases are either positive or mildly negative, stable cultural heterogeneity is observed in the long run, as under the complete information model.

[11] We refer to Della Lena & Panebianco (2021) for a complete and interesting analysis of equilibrium.

4.4. Cultural Leaders

An emerging economic literature has extended the cultural transmission process of Bisin & Verdier (2001) to allow for a cultural leader, or a cultural organization, to affect cultural trajectories in a coordinated and centralized manner.

The introduction of cultural leaders/organizations brings three new analytical features. First, leaders have their own motivations and objectives with regards to the diffusion of specific cultural traits. They can take actions that promote or discourage the transmission of those traits in society. In particular, cultural leaders might be able to manipulate directly or indirectly the paternalistic motives ΔV^i of individuals, therefore affecting the cultural dynamics inside the population. Second, because of the centralized and coordinated nature of their actions, cultural leaders have the capacity to anticipate the effects of cultural transmission on their community, internalizing the dynamic externalities associated with the diffusion of cultural attributes. Finally, cultural leaders might compete across communities, or within their own community, to acquire and maintain privileged positions.[12]

A first approach considers that leaders only care about the steady states of the cultural dynamics, disregarding the transition as a first approximation. In this context, Hauk & Mueller (2015) introduce in Bisin & Verdier's (2001) framework the possibility for leaders to manipulate the intolerances ΔV^i of parents in transmitting their trait. Cultural leaders can be either intrinsically motivated by proselytism—i.e., the desire to maximize the number of people socialized to their cultural trait—or, alternatively, they can be motivated by rents associated with the overall level of socialization effort exerted in their group. Assume, for instance, that a cultural leader is promoting cultural trait a. In this case, the steady state being given by Equation 6 as in Bisin & Verdier's (2001) model, a proselytizing leader maximizes

$$q^* = \frac{\Delta V^a}{\Delta V^a + \Delta V^b},$$

while the objective of a rent-seeking leader is instead proportional to

$$q^* \tau^a = q^*(1 - q^*)\Delta V^a = \left(\frac{\Delta V^a}{\Delta V^a + \Delta V^b}\right)^2 \Delta V^b.$$

In either case, the cultural leader has an incentive to raise the perception of cultural differences ΔV^a—i.e., the cultural intolerance—of in-group members. This can be achieved through the provision of cultural values (that is, by raising V^{aa}) or through claims of cultural superiority that make the alternative trait appear inferior (that is, by lowering V^{ab}). Furthermore, suppose the cultural leader has some influence on the intolerance of the members of the out-group toward the in-group, ΔV^b—for instance, through manipulation of V^{ba}. A proselytizing leader from group a would always want to increase V^{ba} to reduce, in turn, ΔV^b. Interestingly, a rent-seeking leader might however find it optimal to manipulate the cultural perception of the out-group toward the in-group so as to increase ΔV^b by lowering V^{ba}—i.e., going for cultural alienation, in the terminology of Hauk & Mueller (2015). This is a consequence of cultural substitution. Indeed, as ΔV^b increases, the out-group members socialize more intensively their children to keep their trait. This in turn leads the in-group members to become more minoritarian in the population, and q^* goes down. By cultural substitution, they in turn intensify their own socialization effort, τ^a. This effect on parental socialization may countervail the reduced size of the in-group, so that the rents

[12] Readers may also see Hauk & Immordino (2014) for an analysis of cultural dynamics where media industry competition plays a role in socialization.

that the leader receives, proportional to $q^*\tau^a$, may actually increase. As it turns out, cultural leaders may therefore have incentives to amplify cultural intolerances, which does not always benefit the population, not even the members of the leaders' group.

Along related lines, in a continuous-traits environment, Prummer & Siedlarek (2017) model benevolent cultural leaders who also care about the economic well-being of the members of their in-groups, not just about proselytizing or rents. Specifically, they study the case in which the beliefs and attitudes of community members whose intensity the leader has incentive to form are not necessarily well adapted to market behavior and, hence, may economically hurt the community in the steady state. The optimal intensity induced by the cultural leader is characterized, depending on the interplay between earnings and beliefs in society and in the leader's objective function.

Carvalho (2016) studies instead the emergence of organizations dealing with the free-rider and externality problems associated with cultural transmission (see also Carvalho et al. 2022). Oblique transmission in Bisin & Verdier's (2001) model is replaced by institutional transmission of a mainstream trait—for example, through the education system or mainstream media. Organizations manage cultural traits as club goods, through (*a*) rules of participation in cultural activities and (*b*) exclusion of nonmembers from social interactions. Given that participation is individually costly and that cultural socialization depends on average participation inside the organization, individuals naturally free-ride on their participation/socialization efforts. Consequently, an organization maximizing aggregate member participation imposes a minimum level of participation that is binding for all individuals joining the organization. Furthermore, the equilibrium level of strictness is shown to be increasing in the degree of intolerance associated to the promoted trait: Groups cultivating stronger oppositional cultural traits have an advantage in collective action.

Verdier & Zenou (2018) study the transitional cultural dynamics effect of forward-looking cultural leaders (see also Verdier & Zenou 2015). Specifically, consider a cultural leader of group a who provides an amount G^a of a public good specific to trait a, produced at constant marginal cost c up to capacity $\overline{G}$. The provision of G^a increases the paternalistic motive of a parent of type a to transmit their trait, such that we have $\Delta V^a = \Delta V_0^a + vG^a$ with $v > 0$. Following the same lines as in the benchmark model by Bisin & Verdier (2001), the cultural dynamics follow Equation 3 and the optimal socialization effort follows Equation 5. When the leader is never active, $G^a = 0$, the cultural dynamics converge toward the steady state $q_0 = \frac{\Delta V_0^a}{\Delta V_0^a + \Delta V^b}$; by contrast, when the leader is constantly providing the full-capacity public good $G^a = \overline{G}$, the cultural dynamics converge toward $q_{\overline{G}} = \frac{\Delta V_0^a + v\overline{G}}{\Delta V_0^a + v\overline{G} + \Delta V^b}$, which obviously is the largest possible long-run diffusion of trait a in society. The provision of G^a is, however, allowed to be time varying. Consider then the time profile $G^a(t)$ chosen by a perfectly forward-looking cultural leader along the transition path of the cultural dynamics from q_0 as the initial state. The utility for a leader of group a is given by

$$\int_0^\infty e^{-\rho t}\left(W^a q_t - cG_t^a\right) dt, \qquad 14.$$

where $W^a q$ are the leader's rent, increasing with the size q of group a, and ρ is the discount rate. The cultural leader solves then this optimal control problem, which is linear and hence has a bang-bang solution. Applying a characterization method based on a "most rapid approach path" formulation of the problem, Verdier & Zenou (2018) show that the optimal cultural trajectory has the property that it approaches as rapidly as possible some interior point q^* and stays there forever, given the constraint that q^* can be reached using the control $G^a \in [0, \overline{G}]$. The characterization of q^* [and the associated time-varying control function $G^a(t)$] clearly depends on the initial state q_0 of the population. Specifically, when q_0 is small, it might be too costly for the cultural leader to promote more socialization than what parents of the in-group already provide, and the system

stays at q_0. When q_0 is large, vertical socialization by parents might be intense enough that the leader need not spend additional resources to stimulate cultural transmission. It is only when q_0 takes some intermediate values that it might be optimal for the cultural leader to push forward cultural dynamics in the direction of a higher steady state than what would prevail without his intervention. Along the transition path of cultural evolution, a shift in a parameter has different short-run versus long-run effects in terms of the socialization activity of the group, with some overshooting or undershooting compared to the long-run effect that can be expected.

Almagro & Andrés-Cerezo (2020) explore a similar problem in the context of nation building. Using also a "most rapid approach path" approach, they study how a forward-looking leader—i.e., a central state—may promote the diffusion of a cultural trait like national identity on its territory. The key control variable in this context is the share of a fixed resource that is allocated to the provision of a public good specifically attached to the national identity trait. Differently from the model of Verdier & Zenou (2018), this model finds that the zero-sum character of the conflict over resources pushes the cultural dynamics toward homogeneous steady states and extreme levels of allocations of the public good.

Forward-looking leaders are also the focus of Carvalho & Sacks (2021), who study the conditions under which such leaders would be willing and able to radicalize a cultural group/community, transitioning it from an inclusive and liberal state to an exclusive and strict club. Two mechanisms are critical to radicalization: prestige-biased cultural transmission and niche construction.[13] Prestige bias occurs when active members of the community have greater visibility and prestige, which give them disproportionate influence over cultural transmission. Niche construction occurs when a leader can induce blanket discrimination against community members, thereby shielding the club from outside pressures. In both cases, the leader begins by forming a small but extreme club and uses it to radicalize the community over time through cultural transmission and niche construction. Competition between clubs, however, rules out these dynamic radicalization strategies.

4.5. Marriage as a Transmission Mechanism

Vertical transmission may depend on both parents' preferences. The structure of household types—i.e., the composition of cultural traits of the parents—and the marriage mechanism matter for cultural transmission and cultural dynamics in the long run.

Let $\{i,j\}$ denote a household type where the male has cultural-ethnic identity i and the female has cultural-ethnic identity j, with $i,j \in \{a,b\}$. Let H be the set of all types of households.[14] Let m^i and f^i denote the fraction of males and females with trait i in the marriage market. The marriage mechanism determines $\pi^{i,j}$—the fraction of households of type $\{i,j\}$ in the population—for each $\{i,j\}$ such that

$$\sum_j \pi^{i,j} = m^i \quad \forall i = a,b; \quad \sum_i \pi^{i,j} = f^j \quad \forall j = a,b. \tag{15.}$$

The matches produced by the marriage mechanism generally depend then on m^i and f^i as well as on the preferences of males and females for spouses, whether homophilic or heterophilic; that is, they depend on whether homogamous matches (in which the two spouses share the same

[13] Both are important in cultural evolutionary theory (Henrich & Gil-White 2001, Odling-Smee et al. 2003) but are largely ignored in economics.

[14] For simplicity we avoid environments where the marriage mechanism might produce singles. We assume each household has one male and one female child to guarantee stationarity.

cultural trait) or heterogamous matches are favored. When in the marriage market we have $m^i = f^i$ and the preferences are symmetric across gender, the mechanism is gender neutral; that is, it typically has the property that the composition of matches by cultural group is symmetric across gender, $\pi^{i,j} = \pi^{j,i}$. In this case, if the cultural transmission process is also gender neutral (i.e., male and female children are socialized equally), the only relevant interaction between marriage and cultural transmission goes through the distribution of homogamous and heterogamous matches; this is the so-called extensive margin of socialization. In this respect, a standard assumption in the literature, as in Bisin & Verdier's (2000) model, is that socialization is generally more effective within homogamous couples than within heterogamous ones.

More generally, however, socialization choices might be gender specific. In this case, the distribution of $\pi^{i,j}$ is not necessarily symmetric across gender and it depends on the distribution of m_t^i, f_t^i over traits. Letting $M_{i,j}^h$ and $F_{i,j}^h$ denote the probability that the son and daughter, respectively, of household of type $\{i,j\}$ are socialized to trait $h \in \{i,j\}$, the cultural dynamics are as follows:

$$m_{t+1}^h = \sum_{\{i,j\} \in H} \pi_t^{i,j} M_{i,j;t}^h, \quad f_{t+1}^h = \sum_{\{i,j\} \in H} \pi_t^{i,j} F_{i,j;t}^h. \qquad 16.$$

This system highlights that cultural evolution is determined by two sets of factors. The first is the prevailing matching structure $\pi^{i,j}$, which itself depends on preferences, trait distributions, and the marriage mechanism that produces the matches at equilibrium. The second is the intergenerational transmission mechanisms that characterize the transmission probabilities $M_{i,j}^h$ and $F_{i,j}^h$. Such probabilities depend on the assumptions regarding the vertical and oblique transmission processes in homogamous and heterogamous families.[15]

4.5.1. Exogenous marriage mechanisms. The interaction between the marriage mechanism and the cultural transmission process has received much attention in the literature. A first class of models considers preferences in the marriage mechanism as exogenous, that is, they are not derived as the indirect preferences over the expected outcomes—including from the socialization process—in the marriage match. Along these lines, Hiller et al. (2021), for instance, study cultural dynamics for different combinations of marriage markets and cultural transmission processes. Specifically, in their model (*a*) each individual is characterized by either homophilic or heterophilic preferences, and the marriage mechanism produces a stable match with respect to these preferences; and (*b*) vertical transmission is either perfect[16] or imperfect with cultural substitution. The marriage mechanism produces then Gale–Shapley stable matches (Gale & Shapley 1962). Consequently, these matches depend on the distribution of cultural traits and the distribution of marital preferences in both populations. Stable matching in one period determines through the cultural transmission process the joint distribution of cultural traits among populations of both men and women in the next period. Marital preferences (heterophilic versus homophilic) represent crucial determinants for the long-run evolution of culture. Indeed, under perfect vertical transmission in homogamous families, cultural diversity always prevails in the long run when the matching market is characterized by homophilic preferences. However, the presence of a small mass of heterophilic individuals is enough to break that result and to lead to cultural homogeneity in the long run.

In a related study, Wu & Zhang (2021) analyze the role of different parametrizations of matching mechanisms—i.e., their degrees of assortativeness, ranging from complete random matching

[15] Even if at $t = 0$ the marriage mechanism is gender neutral and $m_0^i = f_0^i$, the cultural dynamics are gender specific since Equation 16 implies that, generally, $m_t^i \neq f_t^i$.

[16] Under perfect cultural transmission, parents transmit their trait with probability 1.

to perfect positive assortative matching—in the process of intergenerational transmission of cultural traits (see also Wu 2021). The cultural transmission process has an exogenous gender-specific parental socialization component and an endogenous identity-formation component, and, importantly, men and women enter the marriage mechanism after they have formed their final identities. Individuals have homophilic preferences in the marriage market, independent of the degree of assortativeness of the matching technology. As a consequence, individuals whose cultural identity is not fully determined by vertical transmission choose to form their identity depending on the distribution of traits in the population, anticipating how the probability of marrying homogamously, under the specific assortativeness of the marriage mechanism, depends on the chosen identity. Together with the distribution of cost of actions, this determines for each gender the equilibrium mass of individuals, determining in turn the channel through which matching institutions affect the cultural dynamics of the populations of men and women.

The central result of Wu & Zhang (2021) is that, generically, the cultural dynamics generate multiple stable long-run steady states under random matching and a unique stable steady state under assortative matching. Intuitively, under random matching, an increase in the fraction of cultural types i in, say, the population of men, increases the likelihood of adult women forming a cultural identity i. Such action increases, indeed, their expected gains of marriage, given homophilic preferences and the higher chance of marrying a type-i man. This in turn creates, through cultural transmission, a larger fraction of male individuals with trait i in the next generation. The interaction between men and women takes therefore a form similar to a coordination game. Since men inherit partly their types from their mothers, there is an intertemporal complementarity in women's actions, and symmetrically for men's actions. Such dynamic complementarities across gender create a force for the existence of multiple stable equilibria, with either of the traits being predominant. Under pure assortative matching, there is competition between individuals with the same cultural identity in the marriage market—for example, because the probability of remaining single for a given type i is lower when there are fewer individuals with the same trait in the population of the same gender. Consequently, the interaction between men and women takes a form similar to an anti-coordination game. This intragenerational competition between individuals of the same gender tames the intergenerational complementarity through vertical transmission just discussed, and the cultural dynamics always converge to a unique equilibrium.

The cultural dynamics of Wu & Zhang (2021) crucially depend on a gender-specific (though exogenous) vertical transmission process. Along these lines, Hiller & Baudin (2016) and Baudin & Hiller (2019) consider a framework where parents may endogenously socialize their sons and daughters differently, studying the coevolution of cultural distribution within populations of males and females, respectively. They assume for simplicity that the marriage mechanism is random matching. In Hiller & Baudin's (2016) study, the joint distribution of cultural traits within both populations of men and women, by determining the proportion of homogamous couples, matters for the pattern of cultural dynamics. This is the common extensive margin of socialization. But beyond this margin, the cultural dynamics are also affected by the fact that socialization efforts depend on the utility parents expect for their child when matched with a spouse of the opposite gender. Such expected utility in turn depends on the expected distribution of preferences within the population of the opposite gender and on how the utility that the child obtains with a specific cultural trait is affected by the trait of their spouse (i.e., the nature of complementarity within the household). The combination of these different effects induces a variety of possible steady states, some of which imply a fully homogeneous cultural distributions within each population in the long run. Baudin & Hiller (2019) consider instead a simpler evolutionary model in which socialization of children does not depend on the composition of the family. They allow the intra-household

bargaining power to be endogenous and to depend on the evolving distribution of preferences (see also Bezin et al. 2022 for an example in which the composition of the family in the context of crime matters for cultural evolution).

4.5.2. Endogenous marriage mechanisms. Bisin & Verdier (2000) and Bisin et al. (2004) study the marriage mechanism as a component of cultural transmission, assuming that the preferences in marriage are endogenous and reflect the indirect preferences of the expected outcomes of the marriage match. Specifically, they assume that the only relevant characteristic of marriage matches consists in whether they are homogamous or heterogamous, in that homogamous marriages are valued because they are more effective socialization mechanism; indeed, only homogamous marriages of type i have the option to socialize their children at a rate τ^i. In this case, letting the probability of homogamous marriage of such type i be π^{ii}, the population dynamics are simply

$$\dot{q}^i = q^i(1-q^i)\left(\tau^i\pi^{ii} - \tau^j\pi^{jj}\right). \qquad 17.$$

Consider now a marriage mechanism in which each individual can affect, at a cost, the probability to be married homogamously by entering a restricted pool in which marriages, if they occur, are homogamous: Churches, clubs, and various other cultural institutions may serve this purpose. Under convexity and regularity assumptions, Bisin & Verdier (2000) show that, at equilibrium, cultural substitution applies (i.e., $\tau^i\pi^{ii}$ is decreasing in q^i), and the population dynamics (Equation 17) induce a stationary distribution that is culturally heterogeneous.

Bisin & Tura (2022) extend this class of models, in which the preferences in marriage represent the indirect preferences of the expected outcomes of the marriage match, by (*a*) allowing for the cultural transmission of heterogamous household and (*b*) allowing for fertility and divorce choices in the marriage match. The marriage mechanism produces stable matches.[17] $\pi^{i,j}$ is the solution of the following convex problem:

$$\max_{\pi^{i,j}\geq 0,\ \{i,j\}\in H} \sum_{\{i,j\}\in H} \pi^{i,j}U^{i,j} \quad \text{such that Equation 15 holds,} \qquad 18.$$

where $U^{i,j}$ represents the value of the match under transferable utility. The cultural dynamics are characterized computationally in a structurally estimated model, giving rise to long-run distributions by trait that converge to homogeneity—whereby immigrants assimilate to the trait of natives—and to interesting comparative dynamics results about the speed of assimilation.[18]

5. CULTURE, INSTITUTIONS, AND SOCIOECONOMIC ENVIRONMENTS

In general, the transmission of cultural traits in a given society interacts with various socioeconomic dimensions (production, consumption, trade, and exchange) and with collective choice and policy issues that are regulated by a given institutional context. Building on first-generation models of cultural transmission as Bisin & Verdier's (2001), a recent literature investigates the implications of these interactions for the long-run pattern of cultural evolution. Pushing forward along these lines, a few papers model the joint dynamics of culture and institutions and their interactions with various socioeconomic environments.

[17] Under appropriate distributional assumptions, the mechanism produces the optimal stable assignment (Shapley & Shubick 1971).

[18] Guirkinger et al. (2021) elaborate a model of arranged marriage of immigrants in the context of cultural assimilation.

5.1. Cultural Transmission and Socioeconomic Interactions

In an extension of Bisin & Verdier's (2001) model, and already in the original model, the institutional context enters directly into the paternalistic cultural intolerances. Typically, $\Delta V^i(p)$ is a function of a sufficient statistic p of relevant socioeconomic or policy variables. In turn, p is the result of an equilibrium outcome $p = p^*(q^i, \beta)$ that depends both on the cultural profile q^i prevailing in society and on the structure of the institutional context, denoted β.[19] The cultural dynamics then have the following form:

$$\dot{q} = q(1-q)\left[\tau^a(q, \Delta V^a(q,\beta)) - \tau^b(1-q, \Delta V^b(1-q,\beta))\right]. \quad 19.$$

Given β, general results for this class of models are derived and discussed by Bisin & Verdier (2001, 2010). In particular, it can be shown that the standard property of cultural substitution ensuring long-run cultural heterogeneity is satisfied when the social environment is characterized by the so-called property of strategic substitutability:

$$\frac{\partial}{\partial q^i}\Delta V^i(q^i,\beta) < 0. \quad 20.$$

In this case, in fact, cultural minorities face relatively larger gains from socialization, independently of the socialization mechanism. Conversely, in the opposite case of strategic complementarity, cultural minorities face smaller (possibly even negative) socialization gains. This creates a scale effect in socialization that promotes cultural homogenization in the long run. Several first-generation papers with applications of this general environment are surveyed by Bisin & Verdier (2010).[20]

Within this general framework, Della Lena & Dindo (2022) study the case in which the institutional context entering into the paternalistic cultural intolerances takes the form of general strategic interactions across agents. They show that environments with strategic complements are mostly characterized by assimilation and integration. Conversely, environments with strategic substitutes are mostly characterized by marginalization and separation, but only if the costs of direct socialization are low enough. Along those lines, Bisin & Verdier (2014) discuss the case of transmission of traits affecting consumers' preferences in the context of competitive Walrasian markets and international trade, highlighting the fact that on the demand side, the long-side of the market suffers a negative relative price effect compared to the short-side, implying strategic substitutability and the cultural persistence of the minority preference trait in the population.

More recently, Della Lena et al. (2021) study parental transmission of guilt aversion in a society where agents' interactions are centered on a trust game (with or without incomplete information); Delli Gatti et al. (2022) investigate how parental incentives to transmit patience depend positively on economic growth; Goto (2022) studies how an egalitarian culture could survive against meritocracy in a subpopulation of highly productive agents, even in an environment where high productivity is rewarded only under meritocratic institutions. Finally, some papers focus on how sharing rules in matching contexts affect long-run cultural diversity. Wu (2017) analyzes how the degree of inclusiveness of political institutions that regulate the hierarchical structure of matching interactions promotes the diffusion of traits inducing better economic outcomes. Wu (2021) highlights the impact of ex-ante binding sharing rules and ex-post bargaining rules on the

[19] Within markets, p can be related to prices, wages, and incomes. It could also reflect policy outcomes, such as taxes and transfers, resulting from the political economy or collective choice processes in society.

[20] Readers are referred to, for instance, Hauk & Saez Marti (2002), Olcina & Penarrubia (2004), Bisin & Verdier (2005), Francois & Zabojnik (2005), Olivier et al. (2008), Tabellini (2008), Maystre et al. (2014).

cultural dynamics in environments with cross-cultural matchings and interactions in production activities.[21]

5.2. Culture and Institutions

Models of the interaction between culture and institutions typically involve two building blocks: one for the cultural evolutionary process and one for the mechanism of institutional and policy change. Cultural traits evolve according to a typical (logistic) replicator dynamics, as in Equation 3, where the "relative fitness" term either follows Bisin & Verdier (2001)—i.e., it is represented by $[\tau^a(q, \Delta V^a(q, \beta)) - \tau^b(1 - q, \Delta V^b(1 - q, \beta))]$ from Equation 19)—or else it is the outcome of some related social learning process. Institutional change characterizes instead the evolution of the structural parameter β. It often involves the existence of large players in a game that determines policies and outcomes in society (see Acemoglu et al. 2006, 2021 for surveys). In a political economy perspective, β summarizes the power structure across, for example, two political groups. Institutional change may then take different forms, from incremental changes in the institutional bargaining structure to open conflicts and abrupt changes in the political system.[22] In general, though, the forces of motion of β will reflect the fact that the institutional system imperfectly and indirectly internalizes various externalities and commitment issues that plague social choice problems.

Bisin & Verdier (2017, 2021) provide a simple abstract setup that illustrates this argument. Assume that in each period t, a societal policy game is played between private agents, members of either of two political groups, and a public policy authority (the state) controlling socioeconomic policies. The political groups are aligned with cultural groups in that they have possibly distinct cultural traits (while agents in the same group are identical). Policies are the outcome of a (collective) decision problem: The public policy authority chooses p to maximize social welfare function weighting the preferences of both groups. Institutions can then be abstractly defined and represented by the distribution of political power between the two groups, that is, the (Pareto) weights β of the social welfare function. Given institutions β, a set of policies $p = p(\beta, q)$, and agents' actions $x = x(\beta, q)$, we can characterize the equilibrium of the societal policy game between individuals and the public authority, which depends on the distribution of cultural traits q prevailing in the population. Importantly, the policy game is generally characterized by several economic and political externalities that are not fully accounted for by private and public decisions. Externalities typically arise because of various frictions, from asymmetric/incomplete information to matching problems, limited rationality, market power, private opportunism, and lack of political commitment. Consequently, inefficient policies and social allocations result at equilibrium.

Institutional change can take different but related forms (see Bisin & Verdier 2021 for a unitarian framework). In Bisin & Verdier (2017), institutions change to internalize the externalities responsible for the inefficiencies at equilibrium. Institutional change takes the form of delegation of power from the current institutional structure (as reflected by the power weight β_t) to a new institutional setup (as reflected by a power weight β_{t+1}). The direction of institutional change relates to the general principle that the political group most likely to internalize the externality is the group receiving more residual decision rights along the institutional dynamics.[23] Power

[21] Ellis et al. (2020) discusses a cultural selection model with ex-post bargaining, random matching, and the existence of coordination costs for cross-cultural matches.

[22] Acemoglu & Robinson (2000, 2006) typically consider discrete phenomena like democratization, revolutions, and political coups.

[23] It is generally not the case, however, that the stationary state of such process is efficient (see, e.g., Acemoglu et al. 2010, Bisin & Verdier 2017).

weights therefore change continuously according to an endogenous dynamic law, $\dot{\beta} = \phi(\beta, q)$ (in the continuous time approximation).[24]

Bisin & Verdier (2017, 2021) apply this setup to analyze the interactions between the evolution of a bourgeois culture and the sustainability of extractive institutions, between the formation of civic capital and the empowerment of civil society, and between the dynamics of a culture of violence and the establishment of institutions guaranteeing property rights. Along the same lines, Iyigun et al. (2021) propose a model of emergence of cultural revivals in which cultural change is leveraged as an indirect source of political power by elite groups unable to directly block modes of production detrimental to their interests. A series of papers by Besley & Persson (2019a,b, 2020a,b, 2021) study various interesting applications of this setup, with applications to political economy (democratic institutions and values, state capacity and the social contract, and climate policies) and also to organizational economics.

5.2.1. Complementarities between culture and institutions. A fundamental element for the characterization of the joint dynamics between culture and institutions is whether they tend to reinforce or hinder each other—that is, whether culture and institutions are dynamic complements or substitutes (Bisin & Verdier 2017).

Several papers illustrate the role of complementarity in this context: The more a trait is dominant, the more favorable to members of this group is the institutional equilibrium, and the more favorable the equilibrium to one group, the faster the spread of this group's trait in the population (according to cultural dynamics, as in Bisin & Verdier 2001). This is, for instance, the main mechanism underlying Doepke & Zilibotti's (2008) study of bourgeois cultural values and skill accumulation in Britain's industrialization process. In Bidner & Francois (2011), on the other hand, complementarity is the feature of the relationship between norms of honesty and institutions encouraging trading. Other papers exploit complementarities between cultural values and labor market institutions (Aghion et al. 2011, Michau 2013, Alesina et al. 2015), workers' culture of autonomy and industrial take-off (Hiller 2011), risk attitudes and the process of economic development (Doepke & Zilibotti 2014, Klasing 2014, Chakraborty et al. 2016), culture of individualism and protection against the risk of expropriation (Gorodnichenko & Roland 2017), and preferences for cooperation and social capital (Salazar & Szentes 2021).

Several papers focus specifically on the relationship between culture and political institutions. Besley (2017) argues that the complementarity between aspirations and income redistribution may induce a poverty trap in which political groups are locked into a low-aspiration cultural trap. Similarly, Besley (2020) shows that a dominant civic culture allows for the expansion of fiscal capacity through a mechanism of reciprocal obligations, due to the complementarity between voluntary tax compliance and provision of public goods.[25] Besley & Persson (2021) provide another example of complementarities with their study of the dynamics of identity politics and nationalism in a context in which voters have multidimensional cleavages over redistributive policies and immigration policies.[26] In Touré's (2021) study, the dynamics of a culture of entrepreneurship in a social elite

[24] Acemoglu (2003) and Acemoglu & Robinson (2001, 2006, 2008) are the first to formally study institutional change (without culture). These dynamics also take the form of delegation of power from the elites, not to internalize externalities, though, but rather to avoid social conflict. Furthermore, in this case β is effectively discrete and hence it cannot be represented by a dynamic law. Besley & Persson (2009, 2011a,b) also study institutional change along related lines.

[25] A related form of complementarity is also investigated by Ticchi et al. (2013) and Besley & Persson (2019a) in their analyses of the coevolution between democratic values and democratic institutions. Readers are referred to Bisin (2020) for comments on this literature.

[26] Alesina et al. (2021) also propose a model of national identity formation but without explicit dynamics of cultural homogenization.

interact with the institutional setup providing public goods to increase workers' productivity, all through a general equilibrium structure of market interactions with labor and intermediate inputs as complementary factors in the production of a final good. As in Bisin & Verdier's (2017) model, institutions change to help internalize the externality due to the lack of commitment of public good policies, tilting the power structure in favor of workers. The complementarities between culture and political and economic institutions imply that only an economy with enough entrepreneurial culture, and/or enough workers' empowerment, is likely to take off and to follow a trajectory of industrialization, with further expansion of the entrepreneurial culture and workers' political representation.

Key complementarities have also been identified in the diffusion of environmental culture and its interactions with markets and political institutions. Bezin (2019) studies the interactions between environmental consumer culture, technological change, and sustainable environmental politics and shows that complementarities between culture and technology naturally lead to the existence of path dependency.[27] Relatedly, Besley & Persson (2019b, 2020b) present a political economy model with environmental cultural values evolving according to their relative role in politics, and where the political process is essentially driven by the interests of the average swing voter. These complementarities move society toward extreme cultural distributions of cultural values (the fraction of environmentalists being either 1 or 0). In Besley & Persson's (2019b) model, institutional change would tend to tilt the political power toward agents with an environmental culture. Indeed, because a majoritarian process is not able to internalize the dynamics of values induced by policy, delegating decision rights to the environmentalists would do so along the lines of the institutional change mechanism described by Bisin & Verdier (2017). Besley & Persson's (2020b) model allows for technological innovations, as does Bezin's (2019). In this context, a climate trap may arise as a result of the induced dynamic interactions, but various political elements such as the environmentalists' influence as swing voters, the engagement of environmental scientists or NGO activists, and lobbying by private firms may impact the institutional policy context and, consequently, the dynamics of environmental cultural values and the likelihood of a climate trap.

5.2.2. Cultural and institutional divergence. Dynamic complementarities between culture and institutions facilitate the emergence of different long-run social organizational forms and divergent institutional and cultural trajectories (Bisin & Verdier 2017). Some papers explicitly emphasize this dimension to model critical historical junctures in specific comparative contexts.

Greif & Tabellini (2017) compare two social organizations that sustain cooperation through different enforcement methods: the clan and the corporation. The clan, as a kin-based organization, exploits loyalty and reciprocal moral obligations within personal interactions. The corporation (e.g., a city or a guild), as a voluntary association between unrelated individuals, relies on generalized moral obligations complemented by impersonal enforcement procedures. In their model, individuals with different cultural traits (individualized or generalized morality) choose their affiliation to either their clan or the corporation. The distribution of the population by cultural trait determines the equilibrium size of these organizations, as different traits confer a comparative advantage to one or the other organization. In turn, the structure of social affiliations affects the evolution of the distribution of cultural traits through a transmission mechanism. In this context, because of dynamic complementarities, two otherwise identical societies that differ only in the initial distributions of cultural traits could evolve along divergent self-reinforcing

[27] Readers are referred to Bezin (2015) and Schumacher (2015) for models of cultural socialization into pro-environmental attitudes, in a context of externalities and capital accumulation.

trajectories of value systems, organizational forms, and enforcement institutions. This model is used to discuss the organizational dynamics over the last millennium in China and Europe.

The same logic is applied by Bisin et al. (2020) to study the role of religious legitimacy in political economy. Legitimacy helps (secular) elites to affirm their authority and to reduce the transactions costs associated with the implementation of their policy choices. However, the capacity of the religious clerics to supply legitimacy to the elites relies fundamentally on how the religious values promoted by the clerics are disseminated in society. Finally, the diffusion of religious values is in turn facilitated by institutions that entrust more political power to the clerics. Building upon the institutional change mechanism proposed by Bisin & Verdier (2017), when the legitimacy effect is sufficiently strong, institutional change pushes for a shift in the structure of power toward religious clerics, internalizing various social externalities associated to religious activity (see Benabou et al. 2015, Seror 2018 for a discussion of these externalities). Clerics then exercise this power by providing religious activities in larger quantities, in turn propagating cultural values within the population that justify the ruling and extractive capacity of the political elite. As in Greif & Tabellini's (2017) model, complementarities between culture and institutions give rise to multiple stationary states with joint diverging dynamic trajectories converging toward a religious state or, alternatively, a secular state. The model is used to illustrate the historical institutional and cultural divergent trajectories between the Christian West and the Muslim East at the end of the medieval times.

5.2.3. Substitutability between culture and institutions. While complementarity is a feature of most models analyzing the dynamics between culture and institutions, dynamic substitutability also plays a role in this literature. In an early study, Tabellini (2008) notes that legal systems based on localized external enforcement are likely to undermine the transmission of cooperative cultural values, in a transmission model à la Bisin & Verdier (2001). Similarly, Aghion et al. (2010) highlight the fact that trust and entry regulation can be substitutes, as low-trust economies demand entry regulation to prevent entrepreneurs with limited civic culture from imposing negative externalities on the market.[28] More recently, Bisin & Verdier (2021) provide an example of dynamics between civic culture, corruption, and political empowerment of the civil society that suggest that the relationship between culture and institutional structures can be one of complementarity or substitutability depending on technological fundamentals of the social environment.

In a setting of spatial transmission and diffusion of a cooperative cultural trait, Migliaccio & Verdier (2018) consider the emergence of institutions of social segregation determined by the political process at the level of local communities. Interestingly, in this case, the degree of complementarity/substitutability between culture and institutions may be time varying. Specifically, in a continuous space framework, preferences (for cooperation or not) are locally transmitted across generations through parental efforts and through some random spatial noise in socialization.[29] Social segregation is an institution allowing cooperators to limit their social interactions with noncooperators. The degree of segregation is endogenous, costly to implement, and decided collectively at the local community level. In this context, low-cost segregation institutions can emerge in new places thanks to the spatial random diffusion of cooperation. A localized cluster of cooperative preferences may then expand into the full spatial population through a traveling wave of a culture of cooperation. Institutions also evolve over time and spatially, with the equilibrium degree of segregation following a nonmonotonic path along the diffusion process in space. Places

[28] In Carlin et al.'s (2009) model, substitutability depends on the extent of social capital in society.

[29] The use of spatial diffusion on a continuum space allows for analytical results that apply mathematical techniques from partial differential reaction-diffusion equation theory.

with initially no cooperators and no local institution of segregation are, thanks to the diffusion process, the locus of emergence of an assortative matching mechanism that is first growing and then disappearing once cooperators have reached a sufficient proportion of the population locally. Culture and institutions therefore act initially as dynamic complements and then as dynamic substitutes along the diffusion process.[30]

6. FUTURE AVENUES FOR RESEARCH

As testified by the literature reviewed above, substantial advances have been made in the economic theory of cultural transmission. This has generated significant insights on how cultural diversity evolves and how it may persist. Furthermore, cultural transmission processes have been successfully embedded into models aimed at better understanding various political and economic phenomena. In this last section, we conclude by discussing three areas that, in our opinion, merit further attention in future research.

6.1. The Dynamics of Cultural Systems

The focus of most of the literature on the economic theory of cultural transmission is on the evolution of a single cultural trait, which generally takes several given different forms. Such an approach excludes cultures as systems of traits whose combinations and interactions are essential to generate new cultural meanings. This contrasts with other approaches in the social sciences that explicitly recognize this systemic nature of culture. For instance, in anthropology, there is a long tradition of viewing culture as a system of multiple traits and their relationships that changes over time (Carneiro 2003, Kuper 1999). Recently, exploiting graph theory, agent-based models have been developed to formally study such systems (Buskell et al. 2019, Jansson et al. 2021). These models can be simulated to feed into cultural transmission processes at the population level; however, they are missing an explicit modeling of the socioeconomic context. Similarly, cultural sociology acknowledges the associative properties of culture, which is viewed as a tool kit of attributes on which people draw to accomplish and legitimize particular strategies of action (Swidler 1986, Alexander 2003, DiMaggio & Markus 2010). Following this perspective, Acemoglu & Robinson (2022) have recently proposed a framework in which culture is represented by a hierarchical structure composed of a cultural set of attributes and cultural configurations reflecting specific associations of attributes within that set. Depending on the nature and connectivity properties of the attributes, the cultural system is characterized by a certain degree of fluidity—namely, the span of alternative configurations that can be generated through the system. Acemoglu & Robinson (2022) connect the components of cultural systems to specific social and political contexts, but they fall short of studying a population dynamic model of cultural transmission or diffusion, an important and challenging task.

The population dynamics of cultural systems can bring new and interesting insights on the dynamics of culture and its interactions with socioeconomic contexts. They may identify conditions for the emergence of cultural clusterings, self-organization, and path dependency. They may also illustrate how connections between traits contribute to modulating rates of cultural change, providing in turn a better understanding of slow-moving cultural change (Roland 2004) as opposed to fast-moving fads and fashions.[31]

[30] In Asano's (2022) model of competitive credit markets plagued by asymmetric information, the qualitative characteristics of the relationship between trust and legal institutions can also be time varying.

[31] In the terminology of Acemoglu & Robinson (2022), cultural sets may be expanding or contracting at low frequency, while cultural attributes may be wired and rewired at higher frequency, enriching the span of plausible responses to changes in the socioeconomic environment at different time scales.

6.2. The Economic Geography of Cultural Transmission

Cultural specificities persist and differ significantly across space (e.g., neighborhoods or cities). At the same time, cultural traits also tend to diffuse spatially, whether directly through cultural contacts of the population carrying the trait or indirectly through trade and exchange of goods embodying cultural information. Few economic models of cultural transmission focus explicitly on these spatial and geographic dimensions.

As already discussed, Migliaccio & Verdier (2018) provide an example of the application of the theory of reaction-diffusion models to the spatial transmission of a cooperative cultural trait. In this setup, though, the spatial dispersal of the trait evolves according to a simple random-walk process, leaving aside any relevant economic aspect related to mobility or location decisions. Specifically, an important insight from economic geography and urban economics has been the identification of the source of agglomeration and diffusion forces that affect the spatial distribution of socioeconomic activities and their associated amenities and opportunity costs. In economic models of cultural transmission, such elements are likely to impact cultural socialization strategies and the dynamics of the spatial distribution of cultural traits. These features have started to be illustrated in models of neighborhood formation and cultural transmission, such as those of Bezin & Moizeau (2017) and Bezin et al. (2022) in the context of education and crime, respectively.[32]

More generally, a promising area for future research might be to construct spatial models that incorporate explicitly the two dimensions of agglomeration/dispersion forces related to the location of socioeconomic activities and the transmission of cultural traits that are functional (or not) to these activities. Such an approach is expected to generate an economic geography theory of the emergence/persistence of cultural clusters and their association to specific markets and spatial infrastructures. Given the feedback effects and externalities that exist in spatial economic contexts, this can also be useful to derive interesting policy implications.

6.3. Equilibrium Models of Culture, Institutions, and Growth

As we noted in Section 5, a recent literature has successfully embedded cultural transmission and institutional change to study the dynamics of several important long-run historical phenomena. With regards to specific comparative historical contexts of differential growth, Greif & Tabellini (2017) and Bisin et al. (2020) constitute the main examples of this approach. More generally, however, after the path-breaking contributions on endogenous growth theory,[33] studies of the determinants of long-run growth and development in economics (*a*) have widened in focus to account for various relevant socioeconomic activities characterizing economic development—like the formation of democratic and autocratic institutions, public health, gender and racial equality, and ethnic fractionalization—besides economic growth; and (*b*) have searched for explanatory factors of long-run growth in persistent cultural and institutional factors.[34] In this context, theoretical models that center on institutional change and on the interaction of culture and institutions are a first step toward a novel theory of long-run growth and development. What these models are missing so far is a full integration of the dynamics of culture and institutions with the dynamics of the various relevant socioeconomic activities characterizing economic development.

[32] Rapoport et al. (2020) provides a theoretical model of migration-based cultural change that investigates how migration affects cultural proximity between home and host countries.
[33] Readers are referred to Aghion & Howitt (2008) and Acemoglu (2009) for book-length treatments of the subject.
[34] Readers are referred to North & Thomas (1973), Greif (1989, 1993), and Acemoglu et al. (2006). Acemoglu et al. (2021) and Bisin & Federico (2021) provide recent surveys and discussions of this approach.

Theoretical contributions along these lines are challenging, if only because of the dimensionality of the dynamical system to be studied. These contributions should, however, produce useful representations of qualitative dynamics to be matched with historical narratives. Most importantly, they should generate quantitative empirical implications well beyond those regarding first-order causal effects—e.g., of quality of institutions or of cultural norms—which are at the core of the "persistent studies" literature. In particular, understanding the quantitative implications regarding the mechanisms driving the total and relative effects of culture and institutions on development would be of great importance.

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