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ADVANCES IN THE ECONOMIC THEORY OF CULTURAL TRANSMISSION

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Advances in the Economic Theory of Cultural Transmission
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ABSTRACT

In this paper 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 ten years: the domain of traits subject to cultural transmission, the micro-foundations for the technology of transmission, and feedback effects between culture, institutions, and various socio-economic environments. We conclude suggesting interesting areas for future research.

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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 80's. An *economic theory of cultural transmission* - where the adjective *economic* refers to models of the dynamics of the distribution of cultural traits with endogenous inter-generational socialization and/or endogenous identity formation - is now well-developed. It has arguably brought 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 socio-economic 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 socio-economic 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 2010 survey on the topic for the *Handbook of Social Economics*. We concentrate instead on the theoretical modeling of cultural transmission - more generally, cultural dynamics - of the last ten years or so. We organize these contributions along three main dimensions: i) the domain of the traits subject to cultural transmission; ii) the micro-foundations of the technology of transmission; iii) feedback effects between culture, institutions, and various socio-economic environments. We shall try to adopt a consistent notation and structure, to better illustrate the conceptual and technical contributions of the various paper and link them to their roots in "first generation" models.

2 First generation economic models of cultural transmission

Pioneered by Cavalli-Sforza and Feldman (1981) in evolutionary biology and by Boyd and Richerson (1985) in anthropology, mathematical models of cultural transmission have been introduced in economics by Bisin and Verdier (2000, 2001), allowing for endogenous socialization choice on the part of parents. Specifically, Cavalli-Sforza and Feldman (1981) and Boyd and Richerson (1985) describe a process of intergenerational cultural transmission with a population constituted of a continuum of agents with either of a binary cultural trait, a or b. The population dynamics are highly simplified: reproduction is a-sexual and that each parent has one child. So the pop-

[1] See Fernandez (2010) and Bisin and Verdier (2010) for early surveys; and Nunn (2021).

[2] See Bisin and Moro (2021), Cantoni and Yuchtman (2011) and Voth (2011) for surveys

ulation is stationary and normalized to 1. Cultural transmission is the result of *direct vertical* (parental) socialization and *oblique socialization* in society at large. More precisely, each parent (asexually) produces one child, socializes them and then dies. With probability τ^i, a parent with trait $i \in \{a, b\}$ successfully passes on her trait to her child. With probability $1 - \tau^i$ however the child remains "unsocialized". He then becomes subject to a second stage of socialization by the social environment of his parent (ie; oblique transmission). Specifically he is matched at random with someone from her parent's generation (ie; oblique transmission).and acquires their trait.

More precisely, letting q equal the share of a types in the population, the cultural transmission mechanism is represented by the following system of equations for P^{ij}, the transition probability that a child from a family with trait i is socialized to trait j:

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

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

Take for instance trait a. The probability P^{aa} for a child of a family of type a to be socialized to that trait includes two terms: the direct vertical socialization probability τ^a plus the indirect oblique socialization probability $(1-\tau^a)q$ reflecting the fact when he is not successfully socialized by the family in the first stage (with probability $1 - \tau^a$), he is socialized by a similar type a from the population at large with probability q. Conversely, the probability P^{ab} for a child to acquire the other trait b reflects the fact that the child was not successfully socialized by his parent (with probability $1 - \tau^a$) and was exposed to an oblique role model of type b from society at large (with probability $1 - q$). Finally, using the Law of Large Numbers and continuous time, this process of cultural socialization results in the following cultural dynamic, describing the diffusion of trait a in the population:

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

Equation (3) is actually a simple version of the replicator dynamics in evolutionary biology for a two-trait population dynamic model, where $\left(\tau^a - \tau^b\right)$ 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 $q = 1$ *if* $\tau^a > \tau^b$ *or* $q = 0$ *if* $\tau^a < \tau^b$*)*.

Boyd and Richerson (1985) work with the same transmission process leading to Equation 3; but they introduce the possibility of frequency-dependent cultural transmission rates to explain some persistence of cultural heterogeneity.[3] The nature of frequency dependent bias is assumed to be fixed in the short run, and to be subject to genetic evolution in the long run. Typically, the bias specifies whether individuals are predisposed to adopt more than proportionally the behavior of a larger (conformist bias) or a *smaller* group (anti-conformist bias).

The economic approach to cultural transmission introduced by Bisin and Verdier (2000, 2001) also builds on the same transmission process; but it allows for transmission rates to vary, depend-

[3]See also Henrich and Gil-White (2001).

ing on the economic or utility payoffs obtained by specific traits and, most importantly, depending on costly and purposeful actions by socializing agents. Specifically, in Bisin and Verdier (2001), 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 her 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 she chooses socialization effort τ^i at cost $c(\tau^i)$ to maximize this function with P^{ii} and P^{ij} given by(1).[4] Denoting type i's *cultural intolerance* by $\Delta V^i = V^{ii} - V^{ij}$ for $i \neq j$, and assuming quadratic costs of socialization,[5] parental socialization choices are

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

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

Bisin and Verdier (2001) show that an *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. They also show that these dynamics are a consequence of the fact that the cultural transmission mechanism described in (1) satisfies the property of *cultural substitution,* (between vertical and oblique/horizontal transmission); that is, parents have less incentives to socialize their children the more widely dominant are their values in the population. Indeed, in this case, the cultural dynamics are away from the boundaries $q = 0$ and $q = 1$.[6]

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 Bisin and Verdier (2011). In the last decade, research on the economics of cultural transmission has tackled new and interesting theoretical dimensions. We proceed to survey them here.

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

[5] We report results for all papers in this survey for quadratic socialization costs, without anymore mentioning it.

[6] 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 and Verdier (2001) study various alternative cultural transmission processes which display *cultural complementarity*, where parental socialization τ^i is increasing in q^i, whose dynamics contain a force pushing towards cultural homogeneity.

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, allowing for multiple (more than 2) discrete traits and for a continuum of traits. This extension is very important because it naturally introduces a topology over cultural traits - a notion of distance between traits - independently of *cultural intolerances*, implicit in agents' preferences.

3.1 Multiple (discrete) traits

The first important contribution along these lines has been the extension of the cultural transmission model in Bisin and Verdier (2001) (from now on BV), 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 to n cultural traits:

$$\dot{q}^i = q^i \left[\tau^i - \sum_j q^j \tau^j \right], \text{ for all } i = 1, \dots n. \tag{7}$$

Clearly, when the τ^i's 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 BV, we obtain instead the following dynamics:

$$\dot{q}^i = q^i \left[\sum_j q^j \Delta V^{ij} - \sum_j \sum_k q^j q^k \Delta V^{jk} \right], \text{ for all } i = 1, \dots n. \tag{8}$$

Equation (8) represents the replicator dynamics of a $n \times n$ 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).

There is therefore a formal connection between cultural transmission and other evolutionary game theory processes. This allows us to exploit a large body of results about the replicator dynamics to study cultural evolution. Specifically, 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 in Wu and 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 $\Delta V = \left(\Delta V^{ij}\right)$ 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:

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

Under this intolerance structure, Wu and Zhang (2022) show, 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, $q^C = 0$. 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 the support of the stable cultural steady state, and cultural heterogeneity obtains in the limit.

3.2 Continuous traits

A well established tradition in evolutionary biology and anthropology considers continuous traits models of cultural transmission. These models postulate a dynamic of cultural traits which is driven by exogenous linear mixing; see Cavalli-Sforza (1973), Otto et al (1994).

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 he/she holds during his/her 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 $\Gamma = \left[\gamma^{ij}\right]_{i,j}$ 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

$$\dot{R}^i = (1 - \tau^i)(O^i - R^i). \tag{9}$$

Let $R = \left(R^j\right)_{i=1,N}$, 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 i^{th} diagonal element is τ^i. The cultural dynamics can then be written in matrix form:

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

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 induce homogeneity of the trait, leading to a "melting-pot" equilibrium, in which the value of the cultural trait is the same across the population.[7]

In the spirit of BV, Vaughan (2010), Büchel et al (2014), and Panebianco (2014) allow for endogenous socialization, that is, endogenous choice of τ^i. In order to ensure long run cultural convergence, they impose additional structure on the interacting matrix $\mathbf{\Gamma}$. In particular, when a child's trait is a weighted average of his parent's trait and the mean value of the trait in the society, cultural mixing prevents the long run cultural heterogeneity result in BV. Indeed, such linear weighting models lead to a standard mean reverting linear process, 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 and Wu (2018), in an elegant extension of BV 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 towards trait $y \in R$, with $\Delta V^{zy} \geq 0$, $= 0$ 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 $A \subseteq R$:

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

Intuitively, $\dot{q}(A)$ 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, $\Delta V^z(q) = \int_{y\in R}\Delta V^{zy}q(dy)$. As in Bisin and Verdier (2001) *cultural substitution* is satisfied by this cultural transmission process $\mu$and the cultural dynamics with continuous traits satisfy the following:

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

As Montgomery (2010) for discrete traits, Cheung and Wu (2018) note a formal connection with evolutionary game dynamics: the cultural dynamics of continuous traits in Equation (11) is

[7] On the other hand, Brueckner and Smirnov (2007, 2008) show that cyclicity of the matrix X preserves the possibility of long term heterogeneity.

equivalent to a continuous strategy type replicator dynamics, as in Oechssler and Riedel (2001). Using sophisticated measure theory tools for such dynamic systems, they therefore show that cultural substitutability is again essential for the preservation of long run cultural heterogeneity. Furthermore, when an agent's cultural intolerance towards another agent ΔV^{zy} is an increasing convex function of their cultural distance $|z-y|$, Cheung and Wu (2018) 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 in Wu and Zhang (2022).

Moti and Wu (2022) produce an interesting application of continuum trait models of cultural transmission - in fact, exploiting a simple quadratic special case of Cheng and Wu (2018), but 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.[8] In the cultural transmission process, parents may try to "overshoot" the cultural trait they aim at socializing their children to, in order to balance the possible conformist pressure through peers. On the other hand, if parents sufficiently internalize the cost their children experience when deviating from peer pressure, they may also try to reduce such cost by "undershooting." Moti and Wu (2022) show that when parents have strong intolerances and do not internalize sufficiently the social cost embodied in the peer pressure, they indeed overshoot in socialization, leading to increased polarization from one generation to the next, with gradual (and endless) divergence of traits across generations. Conversely, when the peer pressure effect is sufficiently internalized, parents undershoot and the dynamics converge towards cultural homogeneity.

A related parental overshooting effect occurs in models where parents are forward looking when socializing their children, taking into account how children themselves will raise grandchildren, naturally inducing a proper dynamic game between all generations. Spiro (2020) presents a simple linear-quadratic version of this class of models. In equilibrium, parents behave more extremely than their own type, and the more extreme their type is the more extreme they go for. Still, the linear quadratic structure of the socialization problem implies that dynastic integration obtains in the limit. Intuitively, forward looking parents anticipate this process. To fight against it, they overshoot, like in Moti and Wu (2022), the trait they aim at socializing their children to. Still, this is not enough to prevent convergence, and the best they can do is to reduce the speed of convergence.[9]

[8] See the next section for a detailed study of identity formation.

[9] In the case where the child's type of a given group is influenced both by her own parent's and by the parents in the other group, in the linear Markov Perfect equilibrium, both groups overshoot and overshooting is stronger when the other group is more influential. Nevertheless, the two groups converge over time, as overshooting by both groups tends to cancel out.

4 The micro-foundations of the technology of cultural transmission

In models a' la BV the cultural transmission process is a very stylized combination of vertical and oblique transmission. In the past ten years several more detailed and richer versions of this process have been studied, producing important insights in addition to those obtained in the original model, used as the benchmark.[10]

4.1 Transmission on networks

Panebianco and Verdier (2018) expand the analysis of cultural transmission to study its dependence on the structure of social connections between individuals. They consider the case of complex random social networks, merging insights from the epidemiological literature on large scale networks (Pastor-Satorras and Vespignani, 2003) and the cultural transmission literature. 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, i.e., 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 (3):

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

where $-(1-\tau_k^a)(1-\tilde{q})q_k$ represents how many children of a parents with degree k become of type b; and $(1-q_k)(1-\tau_k^b)\tilde{q}$ represents how many children of b parents 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 (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 $(q_k^*)_k$, which are characterized by

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

Intuitively, two distinct forces determine the direction of cultural change and its dependence on the topology of the network. First, there is a "*network connectivity effect*" due to the fact that vertical socialization rates depend on the topology of social connections and vary accordingly with the degree of nodes on the network. Because of this, the trait that across neighbors is relatively

[10] A related literature, outside the scope of the present survey, has focused on parenting styles; see Lizzeri and Siniscalchi (2008), Doepke and Zilibotti (2011,2014) Seror (2022).

more successfully transmitted tends to have a positive bias in the cultural diffusion process along the network structure. This network connectivity effect depends on the degree distribution of neighbors and the way vertical transmission rates vary with connectivity. The second force is the usual "cultural substitution" effect. Cultural substitution effect overcomes the social bias directly induced by the network structure, and cultural diversity is preserved.[11]

4.2 Identity formation and socialization

In BV, 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 account however for children taking conscious actions towards their own cultural *identity formation*.[12] In these models, the technology of cultural transmission is predicated on the interactions between parental socialization processes and horizontal socialization, e.g., peer pressure effects. In this respect, parents typically attempt in various ways to mitigate or control the peer pressure their children are exposed to, e.g., prevent interactions with other kids, provide counter-balancing values, or be more closely engaged with their children. Such parental internalization of peer pressure effects contributes to the long run dynamics of culture.[13]

We discussed several of these models in Bisin and Verdier (2011). In particular, we discuss there in some detail the contribution by Bisin et al. (2011), where after being socialized by the family to a particular trait (directly or indirectly), an individual chooses the intensity with which he identifies to that trait. Choosing high intensity is conceptualized as a form of *cultural distinction* process. Parents decide how much to invest in socializing their children to their own ethnic trait anticipating the identity formation process on the part of their children. The paper shows that both cultural substitution and cultural distinction induce resilience and persistence of minoritarian traits.

A recent contribution along these lines is Giavazzi et al (2019). In this paper, as in Bisin et al. (2011), parents first choose the family socialization rates and then children choose their own cultural identity.[14] Specifically, consider a child whose parents belong to a minority cultural group, say a. This child meets randomly with another individual in the population. The value of this match depends on whether the two individuals share or not the same cultural trait. Prior to the meeting, the child forms his/her identity trading off the gains of switching cultural identity with the costs, where the latter is partly affected by parental socialization effort. A child switches identity (which may be interpreted as assimilating) if the expected gain is higher than the

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

[12] See the interesting literature spurred by Akerlof and Kranton (2000); in particular, Darity et al (2006) develop an exogenous replicator dynamics mechanism of identity formation.

[13] See also the previous discussion of Moti and Wu (2022).

[14] See also Lazear (1999) and Konya (2005).

expected gain from keeping the parental identity. While parents derive utility from transmitting their own cultural trait, they also care about the usefulness of that trait for their children when the latter meet in society. Parents therefore choose their optimal level of socialization taking into account the child's own optimal choice problem. Two types of equilibria can then emerge: one where all dynamical paths converge to assimilation of that minority, and another where the minority group does not assimilate. The occurrence of complete assimilation depends upon a set of parameters such as the child's transaction gains and switching costs from assimilating, the degree of intolerance of parents, the technology of parental socialization, and finally on 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, and very importantly, Giavazzi et al (2019) obtain results about the speed of convergence as a function of the parameters of the environment, e.g., identifying the characteristics of traits which are likely to spread quickly across generations.

Adriani et al. (2017) consider parental socialization as an explicit process of information transmission. Specifically, they consider a two stage binary action global game where parents adopt a cultural trait in the first stage and children choose what trait to adopt - that is, which identity to form - in the second. Parents and children are heterogeneous in their tastes and can choose between two alternative actions. Children do not have full information on their preferences; they observe the action taken by a role model (parent or society), form beliefs about the desirability of that action and decide their own optimal action. Adults have better information about the value of each action trait and have a paternalistic attitude toward their children. The key feature is the fact that the adults' behavior conveys information to children, thus generating an information externality. Moreover, as informed parents are aware that their own behavior sets relevant "examples" to their children, they may use this signal strategically, and exert for instance self-restraint to avoid setting a negative example to the next generation. Embedding this information mechanism into a dynamic model of cultural transmission, one may investigate the implications of the signaling distortion for the long run distribution of traits in the population. Interestingly and differently from BV, some form of heterogeneity may persist even in the absence of *cultural substitution*. For instance, take the case of an "undesirable" trait (such as a preference for smoking). When the trait becomes rare, the signaling value for someone who holds that trait to express self-restraint is reduced. Such type of adults then use less their action as a strategic signal to affect the youngster's behavior. This in turn increases the chance that the trait will be adopted by the next generation, creating therefore a channel to maintain some degree of cultural heterogeneity in the population independently from otherwise cultural substitution or complementarity forces.[15]

[15] Adriani and Sonderegger (2018) consider an extension of the framework to analyze how the desire to conform to peer pressure or to a social norm interacts with parents' signaling distortion, and affects cultural transmission.

4.3 Incomplete information and socialization

Della Lena and Panebianco (2021) extend BV to an environment where parents have incomplete information regarding the effects of their socialization practices, via their interactions with children and with society. Specifically, in their environment, the incomplete information regards i) the share of different cultural groups within society and ii) the level of efficiency of their transmission technology, in line with the notion of self-efficacy in socio-psychology (Bandura, 1993). Parents therefore merely conjecture this efficacy through self-assessments based on their available information. The analysis highlights how incomplete information in the technology of transmission affects both parental socialization efforts and long-run population dynamics. In particular, it shows that it can revert some of the standard results of the persistence of cultural heterogeneity in the society.

Specifically, denote I_a, I_b, respectively, the set of all agents displaying trait a and b. Assume that the probability d^i_ω of parent ω with trait i to transmit their own trait through vertical transmission is $d^i_\omega = \min\left\{1, \alpha^i_\omega \tau^i_\omega\right\}$, that is, it depends on the parental socialization effort τ^i_ω and an idiosyncratic technology, $\alpha^i_\omega \in \mathbb{R}_+$, capturing the parental efficacy with which parents transmit their own trait. In each generation, the parental efficacies of parents of type i are i.i.d. distributed according to 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, he holds a conjecture about group i's population share $\widehat{q}^i = \widehat{q}(q^i)$ assumed to be a non-decreasing function of the true population share q^i. In this set-up, 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. It can be shown that it writes 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 it depends on conjectures about population shares $\widehat{q}^i$, as well as on average actual and conjectured parental efficacies.[16] The long run cultural steady states of this dynamics (13) are the homogenous populations ($q = 0$ and $q = 1$) and interior steady states characterized by $d^a - d^b = 0$.

Interestingly, and different from the benchmark result in BV, the homogenous populations may now be long run stable states. The reason relates directly to the structure of perceptions bias from the minority and the majority groups about the actual state of the population, and how they

[16] We refer to Della Lena and Panebianco (2021) for the complete and interesting analysis of equilibrium.

react to this. 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 non-negative biases (as $\widehat{q} - q = \widehat{q}(0) \geq 0$). Because of this, and the embedded *cultural substitution* associated to the BV 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. This 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.

4.4 Cultural leaders

An emerging economic literature has extended the cultural transmission process in BV to allow for a cultural leader, or a cultural organization, to affect cultural trajectories in a coordinated and centralized manner.[17]

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 might e.g., be concerned with economic and cultural rents that crucially depend on the population size of individuals endowed with the traits they promote. As a consequence, 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, affecting therefore the cultural dynamics inside the population. Second, because of the centralized and coordinated nature of their actions, cultural leaders have the capacity to internalize group-related effects of cultural transmission for their community. In particular, they may incentivize and coordinate collective action by followers, changing again endogenously the payoffs of acquiring or maintaining the traits they promote in the population. In particular, they may take a forward-looking perspective on cultural evolution, thereby 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 their privileged positions. From a conceptual point of view, the process of cultural transmission is therefore not only determined by decentralized parental and oblique transmission motives (the

[17] See Verdier and Zenou (2015, 2018), Hauk and Mueller (2015), Prummer and Siedlarek (2017), Carvalho (2016), Carvalho and Sacks (2021), Carvalho et al (2022).

"demand side" of cultural transmission) but also by the competitive context in which cultural leaders and organizations "offer" incentives and motivations for cultural diffusion (the market structure of the "supply side" of cultural transmission).[18]

A common simplification assumption when studying the role of cultural leaders in cultural transmission is that leaders only care about the steady states of the cultural dynamics, disregarding the transition as a first approximation. In this context, a first paper investigating the impact of cultural leaders' motivations in cultural transmission is Hauk and Mueller (2015), who introduce in the BV framework, the possibility for leaders to manipulate the intolerances ΔV^i of parents to transmit their trait. Cultural leaders can be either intrinsically motivated by proselytism, i.e., to maximize the number of people socialized to their cultural trait, or alternatively they can be motivated by rents associated to 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 (6) as in BV, a proselytizing leader 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, the *cultural intolerance*, of in-group members. This can be achieved through the provision of cultural values, that is, raising V^{aa}; or through claims of "cultural superiority" making the alternative trait appear inferior, that is, lowering V^{ab}. Furthermore, suppose the cultural leader has some influence on the intolerance of the members of the out-group towards the in-group, ΔV^b, for instance through manipulation of V^{ba}. In this environment, a proselytizing leader from group a, would have an incentive to increase V^{ba}, to reduce in turn ΔV^b. Interestingly, this is not necessarily the case for a rent-seeking leader, who might find it optimal to manipulate the cultural perception of the out-group towards the in-group so as to increase ΔV^b by lowering V^{ba} - going for *cultural alienation,* in the terminology of Hauk and 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 population of in-group 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 that the leader receives, proportional to $q^*\tau^a$, may actually increase. In such a case, the cultural leader prefers to have a small in-group

[18] See also Hauk and Immordino (2013) for a supply side analysis of cultural dynamics, where the media industry plays a role in socialization and provides coverage to cultural traits.

of members who are intensively active in the socialization of their children, the source of his/her rents. In other words, cultural leaders may have incentives to amplify cultural intolerances, which does not always benefit the population, nor even the members of their group.

Along related lines, in a continuous traits environment, Prummer and 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 their 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 organization dealing with the *free rider* and *externality* problems associated with cultural transmission. His analysis concerns, more precisely, how cultural clubs regulate the process of cultural transmission. Oblique transmission in the BV is replaced by institutional transmission of a "mainstream trait," e.g., through the education system or mainstream media.[19] In this set-up, organizations cultivate cultural traits through (i) rules of participation in cultural activities and (ii) exclusion of non-members from social interactions; making cultural traits into a *club goods*. Indeed, consider one such organization wishing to maximize aggregate participation of its members. 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. The organization therefore imposes a minimum level of participation that binds for all individuals joining the organization. Furthermore, the equilibrium level of strictness is shown to be strictly increasing in the degree of intolerance associated to the promoted trait; that is, groups cultivating stronger oppositional cultural traits have an advantage in collective action.

Two papers study the transitional cultural dynamics effect of forward looking cultural leaders. In both these studies leaders provide community public goods that affect positively the paternalistic motive of their members to transmit their trait to their children. Verdier and Zenou (2018), in particular, consider a cultural leader for 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 his trait, such that $\Delta V^a = \Delta V_0^a + vG^a$ with $v > 0$. Following the same lines as in the benchmark BV model , the cultural dynamics follow (3) and the optimal socialization effort follows (5). When the leader is never active, $G^a = 0$, the cultural dynamic converges towards the steady state $q_0 = \frac{\Delta V_0^a}{\Delta V_0^a + \Delta V^b}$;

[19] See also Carvalho et al (2022) for a model of education choices when the education system transmits a mainstream cultural trait, and the minority group may culturally react at the individual level or as a coordinated group.

while when the leader is constantly providing the full capacity public good $G^a = \overline{G}$, the cultural dynamic converge towards $q_{\overline{G}} = \frac{\Delta V_0^a + v\overline{G}}{\Delta V_0^a + v\overline{G} + \Delta V^b}$, 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 perfect-forward looking cultural leader, along the transition path of the cultural dynamics from q_0 as the initial state. The utility of a leader for group a is given by

$$\int_0^\infty e^{-\rho t} \left(W^a q_t - c G_t^a\right) dt; \tag{14}$$

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 and 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 $G^a \in \left[0, \overline{G}\right]$. 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 do 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. Interestingly, the comparative dynamics along the transition path of cultural evolution indicate that a shift in a parameter has different short run versus long run effects in terms of the socialization activity of the group. There will always be some over-shooting or under-shooting compared to the long run effect that can be expected. These transitory dynamics have important policy implications in terms of the reaction of minority cultural community associations to changes in their environment.[20]

Almagro and Andrés-Cerezo (2020) explore a similar problem in the context of nation-building. Using also a "Most Rapid Approach Path" approach, it studies 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 Verdier and Zenou (2018), the zero-sum character of the conflict over resources pushes the cultural dynamic toward homogeneous steady states and extreme levels of allocations of the public good.

Forward looking leaders are also the focus of Carvalho and Sacks (2021), who study the condi-

[20]The analysis can be extended to the case of competition between two perfectly forward looking cultural leaders with respective ingroups a and b, where leaders may differ in terms of their discount factor ρ.

tions under which such a leader 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*. Both are important in cultural evolutionary theory (Henrich and Gil-White 2001, Odling-Smee et al. 2003), but otherwise largely ignored in economics. Prestige bias occurs when active members of the community have greater visibility and prestige, giving 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, using 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 depends on both parents' preferences. The structure of household types - 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 j with $i,j \in \{a,b\}$. Let H be the set of all types of households.[21] 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, f^i as well as on the preferences of males and females for spouses, e.g., whether homophilic or heterophilic; that is, whether homogamous matches (in which the two spouses share the same cultural trait) or heterogamous matches are favored. When in the marriage market $m^i = f^i$ 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 (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 a so-called *extensive margin of socialization*. In this respect, a standard assumption in the literature (see Bisin and Verdier, 2000) is that socialization is generally more effective within homogamous couples than within heterogamous ones.

[21] 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.

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:

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

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, as well as the marriage mechanism which produces the matches at equilibrium.The second is the inter-generational transmission mechanisms which 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 and the vertical transmission process in homogamy and heterogamy families.[22]

The interaction between the marriage mechanism and the cultural transmission process has received much attention in the literature. In the first class of models preferences in the marriage mechanism are 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 combination of marriage markets and cultural transmission processes. Specifically, i) each individual is characterized by either homophilic or heterophilic preferences and the marriage mechanism produces a stable match with respect to these preferences; ii) vertical transmission is either perfect[23] or imperfect with cultural substitution. The marriage mechanism produces then Gale and Shapley stable matches (Gale and Shapley, 1962). Consequently it depends on the distribution of cultural traits and the distribution of marital preferences in both populations. Stable matching in one period determine 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 and Zhang (2021),[24] analyze the role of different parametrization of matching mechanisms - its degree of assortativeness, ranging from complete random matching to perfect positive assortative matching - in the process of inter-generational transmission of cul-

[22] 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 (16) implies that, generally, $m_t^i \neq f_t^i$.

[23] Under perfect cultural transmission, parents transmit their trait with probability one.

[24] See also Wu (2021).

tural traits. Another distinctive aspect of this paper, however, is that the cultural transmission process has an exogenous parental socialization component and an endogenous identity formation component. Specifically, vertical parental socialization goes along gender lines: a son has a probability τ_m of inheriting his father's type and a probability $1-\tau_m$ of inheriting his mother's type. Similarly, a daughter has a probability τ_f of inheriting her father's type and a probability $1-\tau_f$ of inheriting her mother's type. Importantly, men and women enter the marriage mechanism *after* having 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 one 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. Jointly with the distribution of cost of actions, this determines for each gender, the equilibrium mass of individuals; in turn determining the channel through which matching institutions affect the cultural dynamics of men and women populations.

The central result of Wu and Zhang (2021) is to show 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 type 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 inter-temporal 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 trait being predominant. Under pure assortative matching, there is competition between individuals with the same cultural identity in the marriage market; e.g., because the probability of remaining single for a given type i is lower when there are fewer individuals with 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; the intra-generational competition between individuals of the same gender trades-off with the inter-generational complementarity through vertical transmission just discussed. As it turns out, in the set up investigated by Wu and Zhang (2021), the intra-generational competition effect is strong enough to tame the inter-generational complementarity effect, so that the cultural dynamics always converge to a unique equilibrium.

The cultural dynamics of Wu and Zhang (2021) crucially depend on a gender-specific (though exogenous) vertical transmission process. Along these lines, Hiller and Baudin (2016) and Baudin and Hiller (2019) consider a framework where parents may endogenously socialize their sons and

daughters differently, studying the co-evolution of cultural distribution within populations of males and females respectively. On the other hand they assume for simplicity that the marriage mechanism is random matching. Specifically, in Hiller and Baudin (2016), the joint distribution of cultural traits within both populations of male and females, 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, in this context, 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 how the utility that the child obtains with a specific cultural trait is affected by the trait of her/his spouse, (i.e., the *nature of complementarity within the household*). The combination of these different effects induce a variety of possible steady states, some with fully homogeneous cultural distributions within each population in the long run. Baudin and Hiller (2019) instead consider a simpler evolutionary model in which socialization of children does not depend on the composition of the family. On the other hand, it allows the intra-household bargaining power to be endogenous and depending on the evolving distribution of preferences. Stable equilibria in which males and females exhibit different preferences may co-exist with other stable equilibria in which there are no gender differences in preferences.[25]

4.5.1 Endogenous marriage mechanisms

Bisin and Verdier (2000) and Bisin et al (2004) study the marriage mechanism as a component of cultural transmission, where 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 consist 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

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

Consider now a marriage mechanism where 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

[25] Bezin et al (2021) provide another example in which the composition of the family, affected by a particular economic context, matters for cultural evolution. Specifically they consider an environment where socialization to certain relevant traits, e.g., honesty/refusal of partaking in criminal activities, depends on whether the father is or is not at home: children from broken families are more susceptible to oblique transmission and peer effects encouraging criminal participation.

homogamous.[26] Under convexity and regularity assumptions, Bisin and Verdier (2000) show the existence of a unique symmetric Nash equilibrium of this marriage game, where all individuals of type i choose the same marital segregation effort. At equilibrium, cultural substitution applies (ie., $\tau^i \pi^{ii}$ is decreasing in q^i), and the population dynamics (17) induce a stationary distribution which is culturally heterogeneous.

Bisin and Tura (2022) extend this class of models, where the preferences in marriage represent the indirect preferences of the expected outcomes of the marriage match, by i) allowing for the cultural transmission of heterogamous household; and by ii) allowing for fertility and divorce choices in the marriage match. The marriage mechanism produces stable matches.[27] The cultural dynamics are characterized computationally in a structurally estimated model, giving rise to long run distributions by trait which converge to homogeneity - whereby immigrants assimilate to the trait of natives - and interesting comparative dynamics results about the speed of assimilation.[28]

5 Culture, institutions, and socio-economic environments

In general, the transmission of cultural traits in a given society interacts with various socio-economic 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 BV, a recent literature which we survey in the next section, investigates the implications of these interactions for the long run pattern of cultural evolution. In Section 5.2 we survey instead models of the joint dynamics of culture and institutions, and their interactions with various socio-economic environments .

5.1 Cultural transmission and socio-economic interactions

In an extension of the BV model, already in Bisin and Verdier (2001), 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 socio-economic 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

[26] Churches, ethnic clubs, and various other cultural institutions may serve this purpose.

[27] Under appropriate distributional assumptions, the optimal stable assignment (Shapley and Shubick, 1971), $\pi^{i,j}$, is the solution of the following convex problem,

$$\max_{\pi^{i,j} \geq 0,\ \{i,j\} \in H} \quad \sum_{\{i,j\} \in H} \pi^{i,j} U^{i,j} \quad s.t.\ (15) \tag{18}$$

where $U^{i,j}$ represents the value of the match under Transferable Utility.

[28] See also Guirkinger et al. (2021) for a model of arranged marriage of immigrants in the context of cultural assimilation.

society, and on the structure of the institutional context, denoted β.[29] The cultural dynamics then have the following form:

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

Given β, general results for this class of models are derived and discussed in Bisin and 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 a so called property of *strategic substituability*:

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

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 (even possibly negative) socialization gains. This creates a scale effect in socialization that promotes cultural homogenization in the long run. Within this general framework, Della Lena and 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.

Several first generation papers with applications of this general environment are discussed in Bisin and Verdier (2010).[30] More recently, along these lines, 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) study how parental incentives to transmitting patience depend positively on economic growth; and Goto (2022) study how an egalitarian culture could survive against meritocracy in a sub-population of highly productive agents, even in an environment where high productivity is rewarded only under meritocratic institutions. Finally, Wu (2017, 2021), to this point, focuses on how sharing rules in matching interactions affect long run cultural diversity.

In Wu (2017) political institutions regulate the hierarchical structure of matching interactions inside a society composed of two cultural groups: a majority group and an alternative group. A set of rules determines how political representatives from these groups can bargain over the allocation of high positions which provide by status a larger share of the economic outcome than

[29] When individuals interact on markets, p can be related to market prices, wages and income levels. It could also reflect policy outcomes such as taxes and transfers, themselves the result of political economy or collective choice processes in society.

[30] See for instance, Hauk and Saez Marti (2002), Olcina and Penarrubia (2004), Francois and Zabojnik (2005), Bisin and Verdier (2005), Tabellini (2008), Olivier et al.(2008), Maystre et al. (2014).

low positions. Political institutions are parametrized by their degree of "inclusiveness", reflecting how equally representatives from the two groups interact when they determine the allocation of positions. Following such allocation, a random matching process associates each high position holder to a low position holder to engage in pairwise economic activities. The traits of the two groups belong to a continuous space set, and their evolution is determined by relative fitness based on economic payoffs. The paper characterizes which kind of political institutions tend to favor the spreading of traits inducing better economic outcomes. Under "exclusive" political institutions, it can be shown that any trait can be prevalent. In contrast, "inclusive" political institutions select only traits that result in the largest comparative advantage in terms of holding a high position.[31] Indeed, cultural evolution has stronger selective power under more inclusive political institutions: for such institutions the advantage of the bargaining power of the majority becomes less important in determining the allocation of high positions.

Wu (2021) considers instead a more decentralized environment where agents with two different cultural types can interact in production activities. Two types of matching mechanisms are compared. In the first one (so called *bargaining in match* (BIM)), agents negotiate the sharing of the surplus after matching, according to the value of their outside option associated to self-employment. The matching equilibrium is determined according to stable matching a la Gale and Shapley (1962). In the second mechanism (so-called *binding agreement in the matching market* (BAMM)), agents can commit to the sharing rule by signing binding contracts before the match is realized. The market determines the price that affects the sharing of the surplus. Equilibrium matches are Shapley and Shubik stable matches (Shapley and Shubik ,1971; and Becker, 1973).

The main conclusion of the analysis is the fact that cultural selection possibly leads to cultural homogeneity under BIM and long run cultural diversity under BAMM. Under BIM, the individual with the highest outside option payoff gets a larger share of the surplus in cross-cultural bargaining. That leads to cultural homogenization towards the trait providing such payoff.[32]

In contrast under BAMM, through the market, the payoffs of the two types of agents solely come from their respective group size, and the long-side of the market gets a lower payoff compared to the short-side. The diffusion rate of a cultural trait is consequently negatively related to the size of its group. Strategic substituability satisfying (20) obtains, ensuring long run cultural heterogeneity. This last result connects directly to the case of competitive walrasian markets where on the demand side, the long-side of the market suffers a negative relative price effect

[31] Rather than describing some explicit dynamics of the cultural evolutionary process, the analysis considers two well-known static solution concepts from evolutionary game theory: local evolutionary stability (ES) and local continuous stability (CS).

[32] Along the same line, Ellis et al. (2020) consider a cultural selection model with BIM bargaining, but allowing for random matching and the existence of coordination costs for cross-cultural matches. Cultural homogeneity again prevails in the long run when the difference between outside option payoffs across cultural groups is large enough.

compared to the short-side. This again implies strategic substituability for the transmission of traits affecting consumers' preferences, and it promotes the cultural persistence of the minority preference trait in the population (Bisin and Verdier 2014).

5.2 Culture and institutions

Several interesting recent 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 BV - i.e., it is represented by $\left[\tau^a(q, \Delta V^a(q,\beta)) - \tau^b(1-q, \Delta V^b(1-q,\beta)\right]$ 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.[33] In a political economy perspective, β summarizes the power structure across, e.g., two political groups. Institutional change then may take different forms, from incremental changes in the institutional bargaining structure,to open conflicts and abrupt changes in the political system.[34] 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 which plague social choice problems.

Bisin and Verdier (2017, 2021) provide a simple abstract set-up 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 socio-economic policies. The political groups are aligned with cultural groups in that they have possibly distinct cultural trait (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, i.e., the (Pareto) weights β of the social welfare function. Given institutions β, a set of policies $p = p(\beta, q)$ and agents' actions $x = x(\beta, q)$, characterize the equilibrium of the societal policy game between individuals and the public authority, which importantly, depend 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

[33] See Acemoglu et al (2006), and Acemoglu et al (2020) for surveys.

[34] Acemoglu and Robinson (2000, 2006) typically consider discrete phenomena like democratization, revolutions and coup regime changes.

equilibrium.

Institutional change can take different but related forms; see Bisin and Verdier (2021) for a unitarian framework. In Bisin and Verdier (2017) institutions - that is, the distribution of political power - 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.[35] Power weights therefore change continuously, according to an endogenous dynamic law, $\dot{\beta} = \phi(\beta, q)$ (in the continuous time approximation.[36]

Bisin and Verdier (2017, 2021) apply this set-up to analyze the interactions between the evolution of a *bourgeois* culture and the sustainability of extractive institutions, the formation of civic capital and empowerment of civil society, or 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. In a series of papers, Besley and Persson (2019, 2020,a,b,c, 2021) study various interesting applications of this set-up, with applications to political economy (democratic institutions and values, state capacity and the social contract, 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 and 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 is the equilibrium to one group, the faster is the spread of this group's trait in the population (according to cultural dynamics as in BV). This is, for instance, the main mechanism underlying Doepke and Zilibotti (2008)'s study of bourgeois cultural values and skill accumulation in Britain's industrialization process. In Bidner and Francois (2011), on the other

[35] It is generally not the case however that the stationary state of such process is efficient, see for instance Acemoglu, Egorov, Sonin (2010), Bisin and Verdier (2017).

[36] Acemoglu and Robinson (2003, 2006) 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 the β is effectively discrete and hence it cannot be represented by a dynamic law. Besley and Persson (2009, 2011a,b) also study institutional change along related lines.

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; and Alesina et al., 2015); workers' culture of autonomy and industrial take-off (Hiller, 2011); risk attitudes and the process of economic development .(Doepke and Zilibotti, 2014; Klasing, 2014; Chakraborty et al., 2016); culture of individualism, and protection against the risk of expropriation (Gorodnichenko and Roland, 2017); preferences for cooperation and social capital (Salazar and Szentes, 2021).

Several papers focus specifically on the relationship between culture and political institutions. In Besley (2017) the complementarity between aspirations and income redistribution may induce an aspirational poverty trap in which political groups are locked into a low aspiration culture which inhibits economic development. Similarly, in Besley (2019) 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.[37] Besley and Persson (2021) study the dynamics of identity politics and nationalism, in a context in which voters have multidimensional cleavages, with redistributive policies along a rich/poor dimension, and immigration policies along a nationalist/cosmopolitan dimension. The embedded complementarity between culture and institutions leads to political hysteresis: large enough temporary shocks to class polarization and immigration salience may have long-run consequences on nationalism and immigration policy.[38] In Touré (2021) the dynamics of a culture of entrepreneurship in a societal elites interact with the institutional set-up providing public goods increasing workers' productivity, all through a general equilibrium structure of market interactions with labor and intermediate inputs as complement factors in the production of a final good. An institutional change process as in Bisin and Verdier (2017) internalizes the externality due to the lack of commitment of public good policies, tilting the power structure in favor of workers. The coevolution between culture and political and economic institutions, in the model, is characterized by strong complementarities. It follows 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.[39] These complementarities, between culture and technology naturally lead to the ex-

[37] A related form of complementarity is also investigated in Ticchi et al. (2013), and Besley and Persson (2019) in their analysis of the coevolution between democratic values and democratic institutions.

[38] Alesina, Giuliano and Reich (2021) also propose a model of national identity formation but without explicit dynamics of cultural homogenization.

[39] See also Bezin (2015) and Schumacher (2015) for models of socialization into an environmental culture. externalities, capital accumulation and socialization to environmental attitudes;

istence of path dependency, an important feature of sustainable innovation processes. In this context, then, politically sustainable environmental tax is shown to exist only when the cost of socialization to environmental preferences is low enough, highlighting the key role of e.g., environmental education in the process. Relatedly, Besley and Persson (2019, 2020) consider a political economy model where environmental cultural values are transmitted in the population according to their relative role in the political process and the political process is in turn essentially driven by the interests of the average swing voter. These complementarities move society towards extreme cultural distribution of cultural values (the fraction of environmentalists being either 1 or 0). As for institutional dynamics, in Besley and Persson (2019), the political process tends to tilt the political power towards agents with an environmental culture. This is because a majoritarian process is not able to internalize the dynamics of values induced by policy, while delegating decision rights to the environmentalists does, along the lines of the institutional change mechanism in Bisin and Verdier (2017). Besley and Persson (2020) then extend this model to allow for technological innovations, as in Bezin (2019). In this context, a climate trap may arise as a result of the induced dynamic interactions, but various political elements impact the institutional policy context, and consequently the dynamics of environmental cultural values and the likelihood of a climate trap. Specifically, a higher salience of environmental outcomes may increase the environmentalists influence as swing voters; also, environmental politics may involve "engaged" environmental citizens such as motivated scientists who decrease the cost of green innovations, or NGO activists who engage in private politics. Conversely, firms may also lobby and invest into political influence.

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 and Verdier, 2017). Some papers explicitly emphasize this dimension to model critical historical junctures in specific comparative historical contexts.

Greif and Tabellini (2017) compare 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 the model, individuals with different cultural traits (individualized or generalized morality) choose their affiliation, to either their clan or to 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 theoretical models that center on

institutional change and on the interaction (in italic) of culture and institutions are a first step towards... transmission mechanism. In this context, dynamic complementarities generate multiple steady states, reached from different initial conditions. Two otherwise identical societies that differ only in the initial distributions of cultural traits could evolve along divergent self-reinforcing trajectories of value systems, organizational forms, and enforcement institutions. The model is used to formally compare 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 reduce the transactions costs associated with the implementation of their policy choices. But the capacity of the religious clerics to supply legitimacy to the elites relies fundamentally on how 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 in Bisin and Verdier (2017), when the legitimacy effect is sufficiently strong, institutional change pushes for a shift in the structure of power towards religious clerics, internalizing various social externalities associated to religious activity.[40] 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. Culture and institutions are then complementary. As in Greif and Tabellini (2017), these effects give rise to multiple stationary states with joint diverging dynamic trajectories, converging towards a *religious state* or alternatively, a *secular state*. The model is used to formally compare 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 Substituability between culture and institutions

While complementarity between culture and institution is a feature of most models of their dynamics, dynamic substitutability also plays a role in this literature. Early on in this literature, Tabellini (2008) notes that legal systems based on localized external enforcement are likely to undermine the transmission of cooperative cultural values, in a BV transmission model. 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 from imposing negative externalities on the market.[41] More recently, Bisin and 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

[40] See Benabou, Ticchi and Vindigni (2015) and Seror (2018) for a discussion of these externalities.

[41] Carlin et al. (2009) argue that substitutability in this context depends on the extent of social capital in the society.

complements or substitutes depending on technological fundamentals of the social environment.

In a setting of spatial transmission and diffusion of a cooperative cultural trait, Migliaccio and 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 some random spatial noise in socialization.[42] Social segregation is an institution allowing cooperators to limit their social interactions with non-cooperators. The degree of segregation is endogenous, costly to implement, and decided collectively at the local community level. In this context, relatively 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 overtime and spatially with the equilibrium degree of segregation following a non-monotonic path along the diffusion process in space. Places with initially no cooperators and no local institution of segregation, thanks to the diffusion process, are 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.[43]

6 Future avenues for research

As testified by the literature reviewed above, substantial advances has 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 embedded into models aimed at better understanding e.g., economic growth and development, political economy, long-run historical phenomena, and environmental sustainability issues. 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

[42]The use of spatial diffusion on a continuum space, allows the application of mathematical techniques from partial differential reaction-diffusion equations theory, and the derivation of specific analytical results.

[43]In Asano (2018), also, the qualitative characteristics of the relationship between trust and legal institutions can be time varying, in a model of competitive credit markets plagued by asymmetric information.

an approach excludes cultures as systems of traits, whose combinations and interactions are essential to generate new and different cultural meanings. This contrasts with other approaches in social sciences which 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, changing 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; and 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 socio-economic context. Similarly, cultural sociology acknowledges the associative properties of culture, viewed as a "tool-kits" of attributes, on which people draw on to accomplish, and legitimize particular strategies of action (Swidler 1986, Alexander (2003), DiMaggio and Markus 2010). Following this perspective, Acemoglu and Robinson (2022) propose 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 and 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.

Population dynamics of cultural systems can bring new and interesting insights on the dynamics of culture and its interactions with socio-economic contexts. It may identify conditions for the emergence of cultural clusterings, self-organisation, and path dependency. It may also illustrate how connections between traits contribute modulating rates of cultural change, in turn providing a better understanding of slow-moving cultural change (Roland 2004) as opposed to fast-moving fads and fashions.[44]

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 spatially diffuse, whether directly through cultural contacts of the population carrying the trait, or indirectly through trade and exchange of goods implicitly embodying cultural information. Few economic models of cultural transmission focus explicitly on these spatial and geographic dimensions.

As already discussed, Migliaccio and Verdier (2018) is an example applying the theory of reaction-diffusion models to analyze the spatial transmission and diffusion of a cooperative cul-

[44] In the terminology of Acemoglu and 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 socio-economic environment, at different time scales.

tural trait. In this set-up, the spatial dispersal of the trait evolves according to a simple random walk process. This leaves aside any relevant economic aspect related to geographic mobility or location decisions. Specifically, an important insight from economic geography and urban economics has been to identify the source of agglomeration and diffusion forces which affect the spatial distribution of socio-economic 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 Bezin and Moizeau (2017), and Bezin,Verdier and Zenou (2022) in the context of education and crime, respectively. They provide examples of models of neighborhood formation and cultural transmission, showing how the tension between culture preservation and socioeconomic integration drives the pattern of segregation in the city.[45]

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 socio-economic activities, and the transmission of cultural traits that are functional (or not) to these activities. Such 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 and Tabellini (2017) and Bisin et al. (2020), are the main examples of this approach. More generally, however, after the pathbreaking contributions on endogenous growth theory by Robert Lucas, Paul Romer, Philippe Aghion, Peter Howitt, and many others,[46] studies of the determinants of long-run growth and development in economics have i) widened in focus, to account for various relevant socio-economic activities characterizing economic development - like the formation of democratic and autocratic institutions, voting participation, public health, gender and racial equality, ethnic fractionalization, ... - besides economic growth; ii) are searching for explanatory factors of long-run growth in persistent cultural and institutional factors.[47] In this context, theoretical models

[45] In the context of international labor mobility, Rapoport, Sardoschau, and Silve (2020) also present a theoretical model of migration-based cultural change that investigates how migration affects cultural proximity between home and host countries.

[46] See e.g., Aghion and Howitt (2008) and Acemoglu (2009) for book-length treatments of the subject.

[47] Inspiration for these analyses are found, e.g., in the early work of Douglas North (North and Thomas, 1973) and Avner Greif (Greif, 1989, 1993). But this literature in its current form has its origin in Acemoglu et. al (2001) and the subsequent work of the work of Daron Acemoglu, James Robinson and coauthors; see Bisin and Federico

that center on institutional change and on the interaction of culture and institutions are a first step towards a novel theory of long-run growth and development. What these models are missing is a fully integrated study of the dynamics of culture and institutions with the dynamics of the various relevant socio-economic activities characterizing economic development. Of course, theoretical contributions along these lines are challenging, if only because of the dimensionality of the dynamical system to be studied. On the other hand, these contributions should produce useful representations of qualitative dynamics to be matched with historical narratives and, most importantly, quantitative empirical implication 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, quantitative implications regarding the mechanisms driving the total and relative effects of culture and institutions on development would be of great importance.

(2021) for detailed analyses and discussions of this approach.

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