

Urbanization, Changing Values, and the Politics of Environmental Protection

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Abstract

How will urban growth affect the long-run environment? This paper focuses on an overlooked channel: how urbanization shapes environmental values and, with them, political support for environmental protection. Our theory combines two mechanisms: the extinction of experience documented by conservation science, whereby reduced contact with nature erodes attachment to it, and a cultural transmission process involving rational socialization decisions. Both are embedded in an overlapping-generations model with rural–urban migration and voting over environmental policy. When the extinction of experience dominates, urbanization erodes support for environmental protection. However, when socialization is effective, the picture reverses: the interaction between location and socialization choices gives rise to a process of cultural dissemination through which urbanization raises environmental values. Our main theoretical predictions are consistent with a set of stylized facts on environmental preferences, residential location, and policy support that we document using data from the International Social Survey Programme.

Keywords: Urbanization, political economy, environmental values, cultural transmission, extinction of experience

JEL classification: Q58, D72, Z13, R11

What is the extinction of the condor to a child who has never seen a wren? (R. Pyle 1993, *The Thunder Tree*, p. 147)

If a child is to keep alive his inborn sense of wonder [...] he needs the companionship of at least one adult who can share it. (R. Carson 1965, *The Sense of Wonder*, p. 65)

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1 Introduction

Is urban growth compatible with environmental sustainability? The question can be approached from several angles—by examining how urbanization affects spatial organization, consumption patterns, production processes, or innovation. In this paper, we adopt a political economy perspective, asking how urbanization shapes citizens’ support for protecting the global environment.

One potentially significant yet overlooked channel is the evolution of environmental values. Empirical evidence shows that non-material motivations—social norms, perceptions, and values—predict support for environmental policies above and beyond economic and sociodemographic factors (Andre et al. 2024; Dechezleprêtre et al. 2025; Enke et al. 2023). In particular, environmental values and nature-oriented attitudes stand out as key drivers of environmental policy, affecting not only public demand for environmental protection (Drews and Van den Bergh 2016; Gugushvili et al. 2025) but also its actual implementation (Berman et al. 2025). These attitudes matter all the more because, as we argue below, they are themselves shaped by the process of urbanization. In this paper, we examine how the interaction between urbanization and the formation of environmental values influences the long-term relationship between urbanization and environmental sustainability.

According to conservation scientists, rising urbanization—from 29% of the world’s population in 1950 to 58% in 2025, and projected to reach 67% by 2050 (United Nations 2025, pp. 44-45)—has substantially altered people’s opportunities to interact with nature, with potentially significant consequences, especially for the young. In a notable study, Balmford et al. (2002) found that British children could identify far more Pokémon characters than common wildlife species. If people no longer experience or know their natural environment, how can they be expected to care for it? This is the “extinction of experience” argument (Pyle 1993).

In evolutionary anthropology and economics, an extensive literature argues that values evolve culturally and are endogenous to the socio-economic environment (Bisin and Verdier 2001; Cavalli-Sforza and Feldman 1981). While urbanization undoubtedly alters the physical surroundings in which children are raised, it also substantially reshapes the socio-economic context in which they live. By transforming patterns of social interaction and economic incentives, urban growth is likely to shape the cultural transmission of environmental values and attitudes.

Our theory integrates these different perspectives. We model intergenerational value change through two distinct mechanisms: an adoption by exposure to nature channel and a cultural transmission process sensitive to socio-economic conditions. The former captures the idea that children raised in the countryside are more likely to develop preferences for nature as adults, having interacted more with the natural environment during childhood.¹ The latter allows children to

1. Throughout the paper, we use interchangeably “environmental values”, “environmental preferences”, “preferences for nature” and “connectedness to nature” (CTN).

acquire environmental values through cultural transmission, which combines rational socialization by the family (vertical transmission) and imitation of role models encountered in their living area (oblique transmission).

The intergenerational evolution of values is embedded in a general equilibrium model of urban–rural migration in which individuals choose whether to live in the rural or urban area, trading off income against proximity to nature. A single final good is produced in each location using labor with decreasing returns to scale. The two areas differ in two respects. First, labor productivity is higher in the city. Second, there is a global stock of environmental *quality*, from which urban residents benefit less, due to their more limited access to nature. The model features two types of agents. Some care about the environment they can access and therefore have a higher willingness to pay for environmental protection; we refer to them as “connected” agents. All else equal, higher urban labor productivity raises both types’ incentives to live in the city. Connected agents have a stronger incentive than non-connected ones to remain in the countryside, where they value the greater access to nature. The stock of environmental quality is raised by income taxes devoted to environmental protection—set by majority voting—and depleted by production of the final good.²

A key feature of the model is the joint determination of the spatial equilibrium – characterized by the size of each area and the spatial distribution of cultural traits – and the prevalence of these traits in the population. In each period, the fraction of connected agents shapes the spatial equilibrium, which in turn affects the evolution of cultural traits through the adoption-by-exposure mechanism and the socialization process.

Benchmark We first analyze the model under a fixed distribution of preferences; this benchmark allows us to show how endogenous value formation qualitatively alters the relationship between urbanization and the long-run environment. In each period there exists a unique spatial equilibrium in which individuals sort according to their preferences for nature. Three types of equilibrium arise depending on the current distribution of preferences: either each cultural type clusters in a distinct area—connected agents in the countryside, non-connected agents in the city—or one area is mixed while the other is homogeneous in cultural composition. In this benchmark, the spatial distribution of cultural traits has no effect on environmental quality; only the size of each area matters. This baseline case reveals a non-monotonic relationship between connectedness to nature and long-run environmental outcomes. The non-monotonicity arises from two opposing forces: a larger share of connected individuals raises aggregate willingness to pay for environmental protection (the “pure-preference effect”), but also disperses population away from the cities where residents are wealthier, lowering total environmental spending (the “dispersion effect”).

2. Note that we consider environmental policies whose costs are geographically uniform, unlike instruments such as pigouvian taxes. We discuss this distinction further in Section 3.1.

Endogenous values In a second step, we integrate the intergenerational evolution of values driven by adoption by exposure and cultural transmission. The strength of adoption by exposure relative to socialization incentives is critical for both the long-run prevalence of environmental values and the spatial configuration.

When adoption by exposure is strong, the cultural clusters formed by connected agents in the countryside and non-connected agents in the city are persistent. Strong urbanization is then incompatible with a sustainable level of environmental quality, and a non-monotonic relationship between urbanization and long-run environmental quality can emerge. This pattern reflects the interplay of two opposing forces. As in the benchmark, urbanization raises total spending on environmental protection through a positive income effect.³ At the same time, urbanization acts negatively through the adoption-by-exposure mechanism: more children are deprived of contact with nature, reducing the future share of connected agents. Because of decreasing returns to labor, the income effect dominates the adoption-by-exposure effect if and only if urbanization remains sufficiently low.

When socialization incentives are strong, there exist multiple long-run spatial configurations. If the initial fraction of connected agents is low, geographic cultural clusters remain persistent, as in the previous case. When the initial fraction is sufficiently high, however, environmental culture spreads across space. The reason is that, when socialization forces are strong enough, the interplay between the spatial socio-economic structure and cultural transmission generates dynamic complementarities: a two-way positive interaction emerges between the prevalence of environmental values and the sorting of connected individuals into the city. First, a rise in the prevalence of connected agents strengthens their incentive to self-select into the city — a positive static effect — both by widening the wage differential and by raising the rate of oblique transmission in the urban area. Second, changes in the spatial distribution of cultural traits generate a positive *dynamic* effect on the prevalence of environmental values. As connected parents relocate to the city, they substitute away from a favorable location decision (in terms of socialization) toward stronger parental socialization efforts. This behavior increases the transmission of environmental values in the city and then in the population as a whole. We refer to this mechanism as “cultural dissemination”.

In this case, strong urbanization is compatible with a sustainable level of environmental quality and, in some cases, necessary to preserve the long-run environment. Although urbanization reduces contact with nature, it fosters stronger cultural dissemination. Urbanization reinforces the dynamic complementarities between the transmission of environmental values and the spatial

3. Urbanization is an equilibrium outcome, not a primitive: by “strong urbanization” we mean urbanization driven by a high urban labor productivity, our exogenous agglomeration force. Higher urban productivity also raises income directly, through aggregate output; the result stated here does not rely on that channel.

socio-economic structure by strengthening the self-selection of connected individuals into the city. Provided that socialization forces are sufficiently strong, the cultural dissemination effect outweighs the negative effect of reduced exposure to nature. The result is striking when the initial fraction of connected agents is low: a sustainable environment is then reached *if and only if urbanization is strong*.

A political economy perspective on green education In a third step, we adopt a political economy perspective on socialization. We assume that parents can compensate for the lack of direct contact with nature in urban environments by voting to invest collective resources in centralized socializing institutions. We consider a setting in which adoption-by-exposure is strong, so that high urbanization erodes long-run environmental values and, in turn, environmental sustainability. We focus on policies capable of sustaining a positive long-run level of environmental quality. We ask under which conditions such policies are politically self-sustaining, in the sense that a majority of individuals supports their implementation in every period.

We show that such policies exist. This result rests on a two-way positive interplay between spending on the socialization policy and the prevalence of connected agents. A rise in the share of connected agents encourages their selective migration into the city, for the reasons discussed above. This compositional shift increases the electoral weight of urban individuals holding the connected trait, which in turn raises public spending on centralized socialization. Higher spending then promotes the intergenerational transmission of the connected trait in the city, further increasing the future share of connected agents. We term this self-reinforcing process “cultural influence through political leverage”. Two factors are critical for this mechanism to operate: parents’ incentives to socialize their children toward environmental values, and labor productivity in the city.

1.1 Related literature

Household location decision and natural amenities. The impact of exogenous location-specific amenities (primarily natural amenities) on location choices has been well established at both the city level (see, e.g., Brueckner et al. 1999; Lee and Lin 2017; Gaigné et al. 2022) and the regional level (Davis and Weinstein 2002; Rappaport and Sachs 2003).

The idea that individuals trade off economic incentives against amenities in their location choices originates from Roback (1982) and Rosen (1974), who show that lower amenity endowments are offset by higher equilibrium wages. Consistent with our approach, some works have emphasized, more precisely, that individuals sort into different locations because of different preferences for natural amenities (Chen and Rosenthal 2008; Albouy et al. 2016; Sinha et al. 2018). Chen and Rosenthal (2008) provide evidence that households prefer non-metropolitan areas and warm, coastal cities. Albouy et al. (2016) and Sinha et al. (2018) show that Americans have heterogeneous preferences for climate amenities and sort accordingly. We complement this literature by integrating

the feedback effect of past location choices on the formation of preferences for natural amenities. Relatedly, a recent paper by Obolensky et al. (2024) reveals that both historical and present migration patterns in the US are influenced by ‘climate matching’: migrants value the similarity in climate between origin and destination as an amenity. This empirical evidence is in line with our theory in which childhood exposure to environmental amenities shapes preferences and, in turn, location choices in adulthood.

Cultural transmission of environmental values Several papers have examined sustainability in contexts where environmental values evolve endogenously and interact with the socio-economic environment (Besley and Persson 2023; Bezin 2015, 2019; Schumacher 2015). For instance, Bezin (2019) and Besley and Persson (2023) show that the interplay between value transmission and sustainable technological change can generate dynamic complementarities with critical implications for long-run sustainability. We add, to the standard cultural transmission framework used in these papers, another channel for values formation which are childhood experiences into nature. In this setting, we focus on interactions with urbanization by examining an endogenous spatial distribution of individuals and cultural traits arising from a trade-off between agglomeration economies (higher labor productivity in cities) and dispersion forces (including environmental values). The interplay between the spatial socio-economic structure and the values transmission process may, or may not, generate dynamic complementarities, depending on the relative strength of socialization and location forces. We thereby determine the conditions under which geographic cultural clusters persist or environmental culture diffuses spatially, and what these cultural dynamics imply for the preservation of long-run environmental quality.

The second important contribution compared to this literature is to propose a theory of the political economy of green education. In this respect, our paper contributes to a theoretical literature which has investigated the role of centralized socializing agents in cultural dynamics (Carvalho 2016; Verdier and Zenou 2018; Carvalho et al. 2024; Carvalho and Sacks 2024). Verdier and Zenou (2018) analyze cultural dynamics with a forward-looking cultural leader identifying a group-size threshold above which the leader actively promotes its culture. Carvalho et al. (2024) add a socializing institution (the education system) and study how people (individually or collectively) resist its influence. They highlight conditions under which the use of the education system to transmit certain values can backfire. Compared to this literature, the novelty is to adopt a political economy perspective to determine the conditions under which a cultural group has the willingness and the capacity to establish its own socializing institution but also, critically, to maintain it over time.

Migration and cultural influence Our theoretical findings complement a recent literature documenting how population migration can give rise to cultural influence, that is, situations in which migrants shape the culture of their destination communities (for a survey, see Bazzi and Fiszbein

2025). Giuliano and Tabellini (2020) document a long-run effect of historical European immigration on preferences for redistribution and liberal ideology in the United States. Their evidence points to two channels of cultural transmission: vertical socialization within immigrant communities, complemented by horizontal transmission from immigrants to natives. They further show that as the size of European migrant groups grew, their political incorporation strengthened, which proved key to sustaining the process of cultural diffusion. Bazzi et al. (2026) investigate the impact of Southern white migration following the Civil War on the spread of Confederate culture across the United States. They show that migrants from the Confederate diaspora settled preferentially in malleable destinations, i.e., places with weaker state institutions or limited cultural opposition. In these communities, their outsized presence in positions of authority enabled them to embed their cultural norms in nascent institution and among their new neighbors.

A related theoretical contribution is Rapoport et al. (2020), who examine whether international migration leads to cultural convergence or divergence. Our approach differs as we abstract from cross-regional spillovers and focus on a single mechanism, cultural influence, characterizing when it operates and persists. By modeling the joint determination of migration choices and parental socialization effort – within which residential location and direct socialization emerge as substitutable transmission instruments – this framework generates a novel mechanism through which even small migrant groups can exert cultural influence (Bazzi et al. 2026). Furthermore, by introducing endogenous socializing institutions, we show that group size and power – shaped by agglomeration economies – are critical determinants of cultural influence, echoing the findings of Giuliano and Tabellini (2020). Our theory further provides conditions under which these pull factors are sufficient to sustain long-run cultural influence.

The political economy of environmental policies. As discussed above, a growing literature establishes that values and norms drive support for environmental policies (Andre et al. 2024; Cherry et al. 2017; Dechezleprêtre et al. 2025; Drews and Van den Bergh 2016; Enke et al. 2023; Gugushvili et al. 2025), and that nature-oriented cultural traits shape actual policy implementation. Berman et al. (2025) show that the environmental culture of political leaders’ ethnic group, proxied by folklore narratives transmitted orally across generations, affects deforestation in Sub-Saharan Africa. They find lower deforestation when leaders originate from ethnic groups with strong forest-related culture, driven by greater implementation of land conservation policies. We add to this literature in several ways. First, we propose a unified theory that jointly incorporates how cultural values affect the environment and how environmental conditions shape values – two channels that existing work has examined separately (Berman et al. 2025; Giuliano and Nunn 2021). Second, we provide a new explanation for the positive correlation between urbanization and support for environmental policies. Dechezleprêtre et al. (2025) argue that this correlation may be driven by higher education levels in large cities through better knowledge of environmental issues,

although they find limited support for this channel. We propose an alternative mechanism based on spatial sorting: individuals with strong CTN sort into large, productive cities where higher incomes compensate for lower natural amenities. Third, we provide novel evidence suggesting that preferences for natural amenities predict support for environmental policies—above and beyond standard socio-demographic characteristics—across a broad set of countries, thereby broadening the geographical scope of the existing literature on this topic.

Section 2 documents the stylized facts. Section 3 presents the benchmark model with fixed preferences, Section 4 endogenizes preferences, Section 5 studies the political feasibility of green education, and Section 6 concludes.

2 Connectedness to nature: stylized facts

In this section, we document the relationship between urbanization, connectedness to nature and the support for environmental protection policy.

2.1 The extinction of experience

The idea that people are progressively losing contact with the natural world was introduced by Pyle (1993), who coined the term *extinction of experience*. Pyle argued that direct contact with nature is essential for fostering emotional attachment to the natural world. As opportunities for such contact decline, attachment to nature weakens, further reducing individuals' willingness to seek nature experiences and, ultimately, to protect the environment.

Evidence reviewed by Soga and Gaston (2016) strongly supports this hypothesis. The authors document a marked decline in the frequency and intensity of human-nature interactions across generations, illustrated by a sharp drop in childhood play in nature across cohorts in Japan. They attribute this trend to two mutually reinforcing mechanisms. First, urbanization reduces opportunities for contact with nature by reducing access to natural environments (see, e.g., Neuvonen et al. 2007, for a case study in Helsinki). Second, reduced exposure weakens emotional attachment to nature, making individuals less likely to seek nature experiences even when opportunities remain available: for instance, the use of urban green spaces appears to depend more on individuals' connectedness to nature than on green space availability itself (Lin et al. 2014). A growing body of evidence further indicates that experiences with nature shape long-run environmental preferences: childhood exposure to nature has lasting positive effects on adult environmental attitudes and pro-environmental behavior (Wells and Lekies 2006; Collado et al. 2015; Otto and Pensini 2017; Rosa et al. 2018).

2.2 Extinction of experience: what do the data tell us?

We use large-scale survey data from the 2020 Environment module (wave IV) of the International Social Survey Programme (ISSP) to document three stylized facts that motivate our theory. First, human-nature interactions become less frequent as residential environments become more urbanized. Second, CTN is higher in rural areas than elsewhere. Third, however, it does not decline monotonically with urbanization: it seems to persist more strongly in large cities than in towns. As we argue below, our theory is consistent with all three patterns.⁴ We further show that CTN translates strongly into support for environmental protection policies, a premise of our model.

Urbanization and the loss of human-nature interactions. We first examine whether urbanization is associated with fewer interactions with nature. We proxy human-nature interactions using respondents' self-reported frequency of leisure activities in nature over the previous twelve months. Urbanization is measured using the ISSP classification of respondents' place of residence, ranging from rural areas to big cities.

Table 1 reports OLS regressions of the frequency of leisure activities in nature on the degree of urbanization of respondents' place of residence. Individuals living in more urbanized areas engage less frequently in nature-related activities (Column 1). This relationship remains virtually unchanged after controlling for age, gender, education, income, and employment status (Column 2), indicating that it is not driven by socio-demographic composition.

In column (3), we additionally control for individuals' connectedness to nature, which is measured through a question asking how much, if at all, respondents enjoy being outside in nature. As expected, CTN is strongly and positively associated with the frequency of outdoor activities, suggesting that such activities partly reflect individuals' preferences for nature. At the same time, the negative association between urbanization and outdoor activities persists, consistent with the idea that outdoor activities reflect both individual preferences and access to natural amenities in the residential environment. This result is in line with the extinction-of-experience hypothesis, according to which human–nature interactions decline with urbanization.

Urbanization and connectedness to nature. In a second step, we examine the predictors of CTN. We first explore the role of residential location. Columns (1) and (2) of Table 2 report regressions of CTN on respondents' residential location, controlling for country fixed effects only (column (1)) and additionally for socio-demographic characteristics (column (2)). In both specifications, individuals living in towns or large urban areas report lower levels of CTN than rural inhabitants.

4. Although our formal model features a binary rural-urban structure, the size of the urban area is an equilibrium object that varies with the exogenous relative urban labor productivity. Towns and large cities can therefore be mapped to different points along the productivity spectrum, corresponding respectively to urban areas of moderate and high productivity. The sorting of connected agents into large rather than small cities also obtains in a three-region extension, once a congestion cost generates, as is standard in urban economics, a wage gradient across cities of different sizes: the large-city wage premium then compensates connected agents for the lower access to nature.

Table 1: Estimates of OLS regressions for frequency of outdoor activities and residential location

	Frequency of activities in nature		
	(1)	(2)	(3)
A town or a small city	−0.208*** (0.039)	−0.223*** (0.037)	−0.190*** (0.032)
A big city or its suburbs	−0.281*** (0.048)	−0.309*** (0.044)	−0.272*** (0.043)
High school graduate		0.114*** (0.029)	0.075*** (0.028)
Undergraduate		0.139*** (0.040)	0.079** (0.038)
Master/PhD		0.154*** (0.037)	0.070** (0.034)
2nd income quartile		0.048* (0.029)	0.047 (0.034)
3rd income quartile		0.060** (0.028)	0.058* (0.032)
4th income quartile		0.136*** (0.039)	0.118*** (0.040)
Age		−0.001 (0.001)	−0.001 (0.001)
Female		0.055* (0.031)	0.036 (0.025)
CTN=2			0.406*** (0.092)
CTN=3			0.831*** (0.109)
Country FE	Yes	Yes	Yes
Employment status FE	No	Yes	Yes
Observations	28,805	28,805	28,805
R ²	0.292	0.299	0.357
Adjusted R ²	0.291	0.298	0.356

Note:

*p<0.1; **p<0.05; ***p<0.01

Standard errors clustered at the country-level.

Estimates are generated using sampling weights.

Both spatial sorting – whereby individuals with a stronger connectedness to nature choose to live in less urbanized places, holding economic opportunities constant – and the extinction of experience are consistent with this observation. However, CTN does not decline monotonically with the degree of urbanization – the estimated reduction is of similar magnitude in towns and in large urban areas – despite the lower access to natural amenities (as documented above). Such a pattern is not consistent with either a sorting mechanism or the extinction of experience.⁵

We would ideally control for access to natural amenities in order to examine whether differences in CTN across residential locations persist. As access is not directly observed, we use the frequency of outdoor activities as a proxy, which captures actual interactions with nature and therefore reflects both accessibility and preferences. Controlling for it attenuates the estimated effect, as expected, but does not eliminate it: CTN is no longer statistically different between large urban areas and rural areas whereas it remains significantly lower in towns.⁶ A significant penalty on CTN thus

5. Once economic opportunities, proxied by income and education, are held constant, spatial sorting operates purely through preferences for natural amenities and predicts that CTN should be lower in large urban areas than in towns.

6. This result holds whether or not we control for socio-demographic characteristics, that is, whether or not we

remains in towns that has no counterpart in large urban areas. This suggests that mechanisms other than spatial sorting on preferences and the extinction of experience may be at stake.

Our theory offers one possible interpretation of the observed patterns by introducing an additional, dynamic channel linking residential location to CTN: the spatial sorting of previous generations on the basis of their own preferences shapes the CTN of the current generation through cultural transmission.⁷ When this cultural channel is sufficiently strong, the relationship between CTN and the degree of urbanization need not be monotonic. If the economic premium offered by large cities, unlike that of towns, is large enough to compensate high-CTN individuals for the loss of natural amenities, past inflows into towns may have been drawn from a more strongly low-CTN pool, and average CTN may end up lower in moderately urbanized areas than in large cities.

2.3 From connectedness to nature to support for environmental policies

Our model assumes that preferences for nature translate into support for environmental protection through voting. Using the ISSP survey, we confirm this premise: CTN is a significant determinant of policy support — the most important one when it comes to protection of natural areas.

To measure the support for environmental policies, we rely on four different questions from the 2020 Environment IV ISSP survey. The first three questions ask respondents how willing they would be to (i) pay much higher prices, (ii) pay much higher taxes, and (iii) accept cuts in their standard of living in order to protect the environment. The fourth question is about the willingness to accept a reduction in the size of national protected nature areas in order to open them up for economic development. Answers are based on a Likert scale from 1= very unwilling to 5= very willing (reversed for protected areas). CTN is measured by the same proxy as before. We also control for respondents' characteristics that are likely to influence policy support, including their age, gender, income, education level, and political leaning, as well as for country fixed effects. Because the dependent variables are ordered categorical, we estimate ordered logit models to examine the association between the degree of preferences for nature and the probability of supporting environmental policies.

Figure 1 reports the results.⁸ Support is measured by the cumulative probability of answering "willing" or "very willing" ("unwilling" or "very unwilling" for protected areas). All else equal, the probability of refusing a reduction in protected nature areas is 15.0 percentage points higher for individuals who enjoy being outside in nature to a very great extent, and 5.2 points higher for those

account for the economic opportunities driving location choices.

7. Such a channel can be detected in cross-sectional data provided that residential mobility is moderate. Sprung-Keyser et al. (2022) document that, at age 26, 30% of US residents still live in the census tract in which they resided at age 16, and six in ten have moved less than 10 miles. Bosquet and Overman (2019) find that, in the UK, 43.7% of individuals have always worked while living in the place where they were born.

8. The online appendix provides details on the estimation method and a range of robustness tests varying control variables, model specifications, and the use of sampling weights.

Table 2: Estimates of OLS regressions for CTN and residential location

	CTN			
	(1)	(2)	(3)	(4)
A town or a small city	−0.079*** (0.025)	−0.094*** (0.026)	−0.029* (0.016)	−0.041** (0.017)
A big city or its suburbs	−0.065** (0.026)	−0.100*** (0.025)	0.003 (0.020)	−0.029 (0.019)
High school graduate		0.118*** (0.032)		0.100*** (0.028)
Undergraduate		0.169*** (0.042)		0.145*** (0.039)
Master/PhD		0.228*** (0.035)		0.202*** (0.030)
2nd income quartile		0.011 (0.030)		0.004 (0.033)
3rd income quartile		0.012 (0.029)		0.003 (0.032)
4th income quartile		0.071** (0.029)		0.047 (0.031)
Age		−0.0001 (0.001)		−0.0004 (0.001)
Female		0.043 (0.031)		0.027 (0.027)
Freq:Monthly			0.256*** (0.087)	0.238*** (0.086)
Freq:Weekly			0.526*** (0.102)	0.513*** (0.100)
Freq:Daily			0.781*** (0.102)	0.779*** (0.098)
Country FE	Yes	Yes	Yes	Yes
Employment status FE	No	Yes	No	Yes
Observations	28,805	28,805	28,805	28,805
R ²	0.275	0.282	0.325	0.332
Adjusted R ²	0.274	0.281	0.325	0.331

Note:

*p<0.1; **p<0.05; ***p<0.01

Standard errors clustered at the country-level.

Estimates are generated using sampling weights.

who enjoy it to a great extent, relative to those who enjoy it to some extent at most. The willingness to pay higher prices rises by 10.8 and 5.6 percentage points respectively. Results are comparable for cuts in the standard of living, and smaller for higher taxes, plausibly reflecting tax aversion. CTN ranks among the most important determinants of environmental policy support: comparable to education and political leaning on the monetary measures, and dominant — above ideology and education, with income playing no role — on the protection of natural areas. These results suggest that the formation and persistence of this preference deserve attention in their own right: they are of first-order importance for the long-run support for environmental policy, and hence for long-run environmental quality.

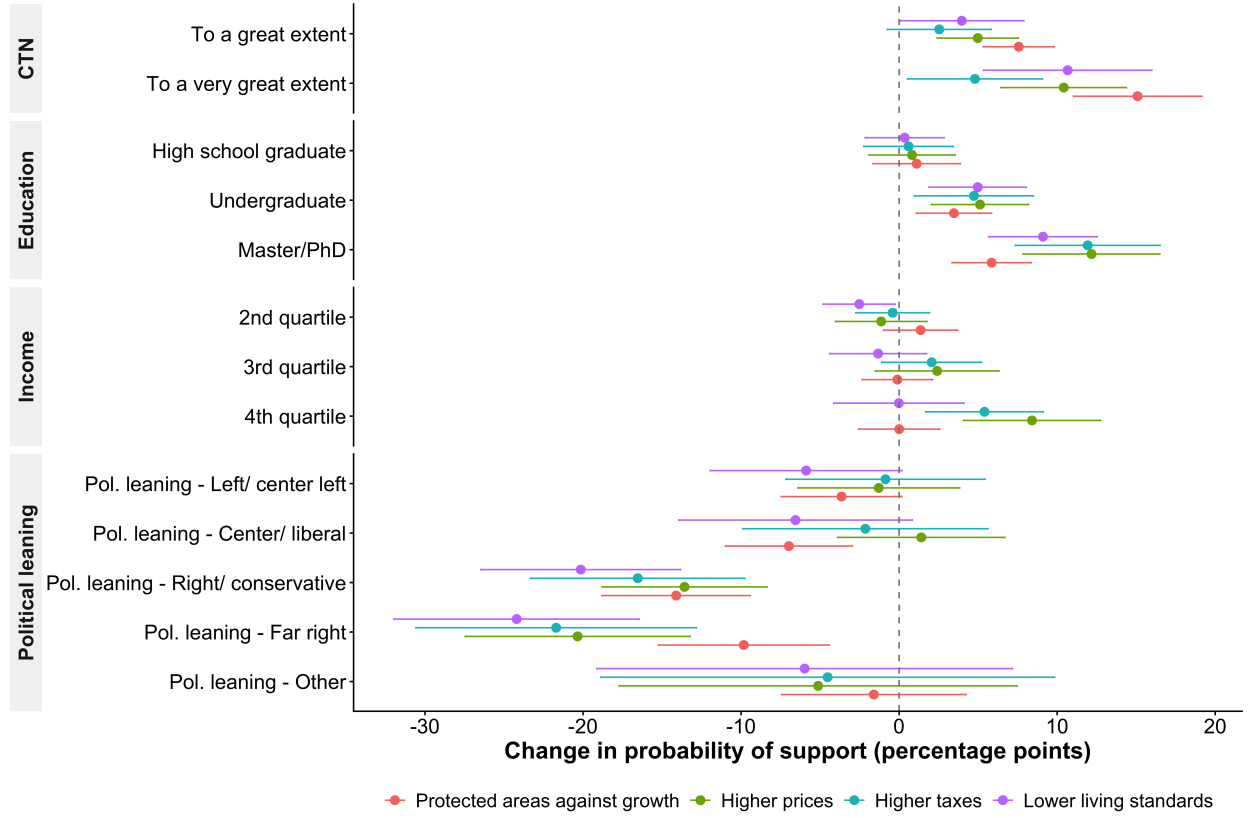


Figure 1: Characteristics of respondents and support for environmental policies.
Note: The figure shows the average marginal effects from an ordinal logit model.

3 Spatial sorting and voting on environmental protection: a benchmark with fixed preference

3.1 Set up

Consider an overlapping generations economy in which individuals live for two periods: the first is childhood and the second is adulthood. Each parent has one child so that population is constant with mass equal to $P > 0$. Time is discrete and indexed by $t = 0, 1, 2, \dots$. The economy has two regions: a rural area (r), and an urban area (u). Individuals can live in either area, and decide where to reside at the beginning of adulthood. In each period, adults first choose the household's location, then vote on an environmental tax, firms then produce, and finally environmental quality is updated.

Populations. The population $P > 0$ consists of a mass P_t^C of individuals who are connected to nature and a mass P_t^N who are not connected. Throughout the paper, we refer to these two types of individuals as type-C and type-N, respectively. In this benchmark, preferences are automatically

transmitted from parents to children, so that the distribution of types is constant over time, $P_t^C = P^C$ and $P_t^N = P^N$ for all t . Section 4 endogenizes this transmission.

The urban and rural population at time t are respectively denoted P_{ut} and $P_{rt} = P - P_{ut}$. Type-C individuals who live in the rural and urban areas are respectively denoted by $P_{rt}^C \in [0, P^C]$ and $P_{ut}^C \in [0, P^C]$, with $P_{ut}^C + P_{rt}^C = P^C$. Similarly, type-N individuals who live in the rural and urban areas are respectively denoted by $P_{rt}^N \in [0, P^N]$ and $P_{ut}^N \in [0, P^N]$, with $P_{ut}^N + P_{rt}^N = P^N$.

We define q , q_{ut} , and q_{rt} as the share of type-C individuals in the total population, urban area, and rural area, respectively: $q_{ut} = P_{ut}^C / (P_{ut}^C + P_{ut}^N)$, $q_{rt} = P_{rt}^C / (P_{rt}^C + P_{rt}^N)$, and $q = P^C / P$.

Production. There is a single consumption good in the economy which can be produced in both the rural and urban areas. Production in each area is carried out by competitive firms. In the rural area, the technology uses labor and a constant factor, primarily land, which is normalized to one. In the urban area, the production technology relies on labor and a constant factor, representing capital, also normalized to one. The aggregate production function in the rural and the urban area are respectively given by $Y_r = A_r(P_{rt}^C + P_{rt}^N)^\alpha$ and $Y_u = A_u(P_{ut}^C + P_{ut}^N)^\alpha$ where $A_r > 0$ and $A_u > 0$ are the total factor productivity in each area and $\alpha \in (0, 1)$ is the partial output elasticity of labor, reflecting decreasing returns to scale. In both areas, we abstract from ownership and bequests by assuming that property rights on the fixed factor are evenly distributed among workers, so that each worker receives both a wage equal to the marginal product of labor and an equal share of rents on the fixed factor, yielding a total income equal to average productivity: $w_{rt} = A_r(P_{rt}^C + P_{rt}^N)^{\alpha-1}$, and $w_{ut} = A_u(P_{ut}^C + P_{ut}^N)^{\alpha-1}$.⁹ We assume a higher total factor productivity in the city, i.e., $A_u > A_r$, which is an agglomeration force.

Preferences for consumption and environmental quality. Type-C individuals have preferences for both consumption and natural amenities while type-N individuals derive utility only from consumption. Both types earn an income w_{rt} in the rural area and w_{ut} in the urban area, and spend their after-tax income $w_{it}(1 - \tau_t)$ entirely on consumption, where $\tau_t \in [0, 1]$ is a proportional income tax. Type-C individuals additionally enjoy natural amenities whose value combines a quality component $E_t \geq 0$, common to both areas, and a quantity component normalized to 1 in the rural area and $\gamma \in (0, 1)$ in the urban area, reflecting the lower access to nature in the urban area. The overall amenity value is thus E_t in the rural area and γE_t in the urban area. While γ is exogenous, E_t is endogenously determined by the environmental policy, as described below. Parameter γ captures the relative availability of natural habitats accessible to residents, whereas E_t captures their ecological quality (e.g., biodiversity or water quality).¹⁰

9. Another interpretation is that there are no property rights within each area. We could also alternatively assume that property rights are evenly distributed in the population across areas and automatically transmitted to the child. It would complicate the calculations but the results would hold.

10. Such habitats include forests, meadows, rivers, wetlands, and coastal zones. The rural area offers a higher density and continuity of these habitats, whereas the city provides only fragmented or artificial substitutes, such as small parks

The utility of type- N individuals living in the area $i \in \{u, r\}$ at time t is given by $U_{it}^N = \ln(w_{it}(1 - \tau_t))$.

The utility of type- C individuals at time t when they live in the urban and rural area are respectively given by

$$U_{ut}^C = b \ln(w_{ut}(1 - \tau_t)) + (1 - b) \ln(\gamma E_t), \quad U_{rt}^C = b \ln(w_{rt}(1 - \tau_t)) + (1 - b) \ln(E_t),$$

where $b \in (0, 1)$ reflects relative preferences for material consumption.

Ceteris paribus, this setup provides individuals with a potentially higher income in the city and greater environmental amenities in the countryside. The actual distribution of income across regions is determined by individuals' location decisions.

Environmental Quality. The quality of natural amenities at time t , captured by E_t , is negatively affected by total production in the previous period $Y_{t-1} = w_{ut-1}P_{ut-1} + w_{rt-1}P_{rt-1}$, with marginal damage given by $c > 0$. Environmental quality can be improved by protection expenditures whose marginal productivity is $m > 0$, financed through taxes proportional to income at time t , total income being Y_t . Examples of such protection policies are environmental conservation laws (such as the Endangered Species Act in the United States or the Biodiversity Law in France) or protected-area policies. Our dynamic equation characterizing the law of motion for environmental quality is given by

$$E_t = \max\{E_{t-1} - cY_{t-1} + m\tau_t Y_t, 0\}. \quad (1)$$

Environmental quality is therefore bounded below by zero.¹¹ We interpret this lower bound as the minimum feasible level of environmental quality. We also define $S_t = E_t - cY_t$.

Voting mechanism. In each period, individuals vote over their preferred tax rate, which is used to finance environmental protection. The proportional income tax is determined by majority voting among the adult population. Type- N individuals, who do not derive utility from environmental quality, vote for a zero tax rate, $\tau_t = 0$. By contrast, the preferred tax rate of connected individuals is given by

$$\tilde{\tau}_t = \max\{(1 - b) - \frac{bS_{t-1}}{mY_t}, 0\}. \quad (2)$$

The preferred tax rate is positive when the inherited stock is low relative to current income; it increases with the strength of environmental preferences (a lower b), decreases with the environmental quality inherited from the previous generation, and increases with current aggregate income.

or botanical gardens.

11. At $E_t = 0$, we posit that the utility function is equal to its limit as E_t tends to zero. Since the model is overlapping-generations, each agent evaluates the amenity term $\ln(E_t)$ only at the date of its own decisions. Along any trajectory on which environmental quality remains strictly positive, spatial equilibria, and voting outcomes are therefore well-defined. We treat the bound $E_t = 0$ as an absorbing, terminal state: once environmental quality has collapsed, no further location, consumption, or voting decision is taken. The resulting distinction between trajectories that *sustain* a strictly positive E and trajectories that collapse to the irreversible, *unsustainable* state $E = 0$ parallels the notion of an “environmental disaster” in Acemoglu et al. (2012).

The equilibrium tax rate in society is then given by

$$\tau_t^* = \begin{cases} 0, & \forall P^C < P/2 \\ \tilde{\tau}_t, & \forall P^C \geq P/2. \end{cases} \quad (3)$$

Under majority voting, the tax rate is zero when type- C individuals are in the minority, whereas once they constitute a majority, the equilibrium tax rate coincides with their preferred level.

From this, we can already derive two preliminary insights. First, environmental quality converges to zero if the share of type- C individuals in the economy is below one half. In this case, too few individuals vote for a positive tax and environmental quality declines over time. Second, if type- C individuals are sufficiently numerous in the long run, steady-state environmental quality will be proportional to income, $E_\infty \propto (m - c)Y$. As a consequence, if the marginal productivity of environmental protection expenditures is lower than the marginal damage from production ($m < c$), long-run environmental quality converges to its minimum level. We henceforth assume that society has the ability to improve environmental quality, i.e., $m > c$.

Location choices. At the outset of adulthood, individuals choose their place of residence with perfect foresight over the equilibrium tax rate. Location decisions are based on payoff comparison across regions. Define the functions $\Delta U^N : [0, P^C] \times [0, P^N] \rightarrow \mathbb{R}$ and $\Delta U^C : [0, P^C] \times [0, P^N] \rightarrow \mathbb{R}$ which capture the relative incentive to live in the urban area for individuals of type N and C respectively, i.e., this is the difference $U_{ut}^i - U_{rt}^i$. Type- N individuals choose their place of residence based solely on relative incomes, whereas type- C individuals also care about the amount of natural amenities, i.e., their access to nature. Lower natural amenities in the urban area ($\gamma < 1$) reduce the incentive of connected agents to live there. We define $\varphi \equiv (A_u/A_r)^{\frac{1}{1-\alpha}} > 1$, and $\delta \equiv (\gamma)^{\frac{1-b}{b(1-\alpha)}} < 1$ and drop the time subscript whenever it does not lead to confusion. This allows us to define the spatial equilibrium.

Definition 1. For any $(P^C, P^N) \in [0, P]^2$, a spatial equilibrium is a vector (P_u^C, P_u^N) such that

$$\begin{aligned} (P^C - P_u^C)\Delta U^C(P_u^C, P_u^N) &\leq 0 \leq P_u^C\Delta U^C(P_u^C, P_u^N), \text{ and} \\ (P^N - P_u^N)\Delta U^N(P_u^C, P_u^N) &\leq 0 \leq P_u^N\Delta U^N(P_u^C, P_u^N). \end{aligned}$$

Discussion. Before turning to the analysis of the model, a few remarks on the structure of the model are useful.

First, given the preference specification, the equilibrium tax rate is independent of the spatial equilibrium: connected individuals vote for the same environmental tax regardless of where they live. As a result, we abstract from the static channels through which location may affect environmental policy, such as differences in income or other location-specific characteristics that influence voting. By construction, this allows us to isolate the long-run effects of urbanization on

environmental quality – those operating through its impact on the intergenerational transmission of environmental preferences. Allowing for static effects would likely reinforce the positive relationship between urbanization and environmental policy. Nevertheless, we show that urbanization can improve environmental quality in the long run even in the absence of these channels.

Second, the stock of environmental quality E_t does not feed back into the spatial equilibrium: connected agents' location decisions depend only on differences in access to natural amenities across areas. As a result, the spatial equilibrium can be characterized independently of environmental quality. Beyond simplifying the analysis, this specification captures the idea that location choices respond to local access to nature (our parameter γ) rather than to the global state of the environment.¹² One consequence is that environmental quality does not shape the evolution of preferences. However, we introduce such a feedback in Section 5, where the green education policy makes the transmission of preferences responsive to environmental quality.

Third, the parameter γ captures the differential in opportunities to access nature between rural and urban areas, an assumption consistent with our analysis of international survey data. To be closer to the gradient observed in the ISSP between the degree of urbanization of the place of residence and the frequency of interactions with nature, one would let γ be a decreasing function of the urbanization rate P_u/P : the larger the urban area, the scarcer the opportunities to experience nature within it. Such a specification would strengthen the dispersion forces of the model. Given the sustained process of urbanization observed across countries over the past decades, however, it is clear that agglomeration forces – driven by economic opportunities – dominate dispersion forces, at least up to a relatively high threshold. Under this assumption, the results that follow would remain qualitatively unchanged with an endogenous γ . Intuitively, as long as the agglomeration force dominates over the relevant range, the spatial equilibrium remains interior and the comparative statics with respect to A_u are preserved. Since endogenizing γ would complicate the analysis, we opt for parsimony.

Fourth, the environmental policy captured by our specification has a geographically uniform cost, borne equally by all households regardless of where they live. It thus corresponds to measures financed through a lump-sum levy or through general taxation, such as the funding of natural protected areas, the ecological restoration of rivers and wetlands, or the abatement of pollution in marine and other aquatic ecosystems. Spending of this kind accounts for a substantial share of environmental protection effort worldwide.¹³

We now characterize the spatial equilibrium, defined by individuals' location choices, and the

12. When deciding whether to move to a city, individuals weigh the availability of parks and green spaces, not the global state of biodiversity.

13. Governments spend an estimated USD 68 billion per year on domestic biodiversity, three-quarters of total biodiversity finance (OECD 2020); in the EU, public environmental protection expenditure reached EUR 148 billion (0.8% of GDP) in 2024, including 0.1% of GDP for biodiversity and landscape (Eurostat 2025).

long-run environmental quality when the distribution of cultural traits is fixed. This benchmark case also allows us to isolate the effects of urbanization and the distribution of cultural traits on the long-run environmental quality.

3.2 Spatial equilibrium

Diminishing marginal returns to labor generate competition in the labor market. This competition makes individuals' location choices strategic substitutes: the larger the number of residents in an area, the lower the wage in that area, and therefore the lower the incentives to locate there. This feature ensures the uniqueness of the spatial equilibrium. The spatial equilibrium is formally characterized in the following proposition.

Proposition 1. *There exists a unique spatial equilibrium given by (i) $P_u^C = 0$ and $P_r^N = P(1/(1 + \varphi) - q)$ if $q < 1/(1 + \varphi)$, (ii) $P_u^C = P_r^N = 0$ if $q \in [1/(1 + \varphi), 1/(1 + \varphi\delta)]$, (iii) $P_r^N = 0$ and $P_u^C = P(q - \frac{1}{1 + \varphi\delta})$ if $q > 1/(1 + \varphi\delta)$.*

Proposition 1 establishes that there exist three types of spatial equilibrium depending on the share of type- C individuals, q : either each cultural type clusters in a distinct area – connected agents in the countryside, non-connected agents in the city – or one area is mixed while the other is homogeneous in cultural composition.

When q is low, a mixed equilibrium arises with type- N agents located in both areas and type- C agents clustered in the rural area. To see why, suppose all type- N agents were to locate in the urban area. Urban wages would then fall below rural wages, inducing type- N agents to relocate to the rural area until wages are equalized across the two areas. When q takes intermediate values, each cultural type clusters in a distinct area. This equilibrium is associated with a positive urban-rural wage gap, but this differential is insufficient to compensate for lower natural amenities in the city. As a result, connected agents have no incentive to migrate to the city. Finally, when q is high, another mixed equilibrium arises, with type- C agents in both areas and type- N agents clustered in the urban area. In this case, if all connected agents were to cluster in the rural area, the rural wage would fall to the point where the urban-rural wage gap more than compensates for lower natural amenities in the city. Some connected agents therefore choose to locate in the city. The spatial equilibria are depicted in Figures 2a and 2b.

Using Proposition 1, the urbanization rate in each equilibrium is given by (i) $P_{ut}/P = \varphi/(1 + \varphi)$ if $q < 1/(1 + \varphi)$, (ii) $P_{ut}/P = 1 - q$ if $q \in [1/(1 + \varphi), 1/(1 + \varphi\delta)]$, (iii) $P_{ut}/P = \varphi\delta/(1 + \varphi\delta)$ if $q > 1/(1 + \varphi\delta)$. We deduce the following Corollary.

Corollary 1. *At the spatial equilibrium, the urbanization rate P_{ut}/P is non-increasing in q and increasing with urban productivity A_u .*

Corollary 1 indicates that a lower share of connected agents reduces the attractiveness of natural amenities at the aggregate level, thereby raising urbanization. Moreover, a higher urban productivity increases the wage differential between the rural and urban areas, which strengthens incentives to locate in the city for both types. These comparative statics are illustrated in Figures 2a and 2b.

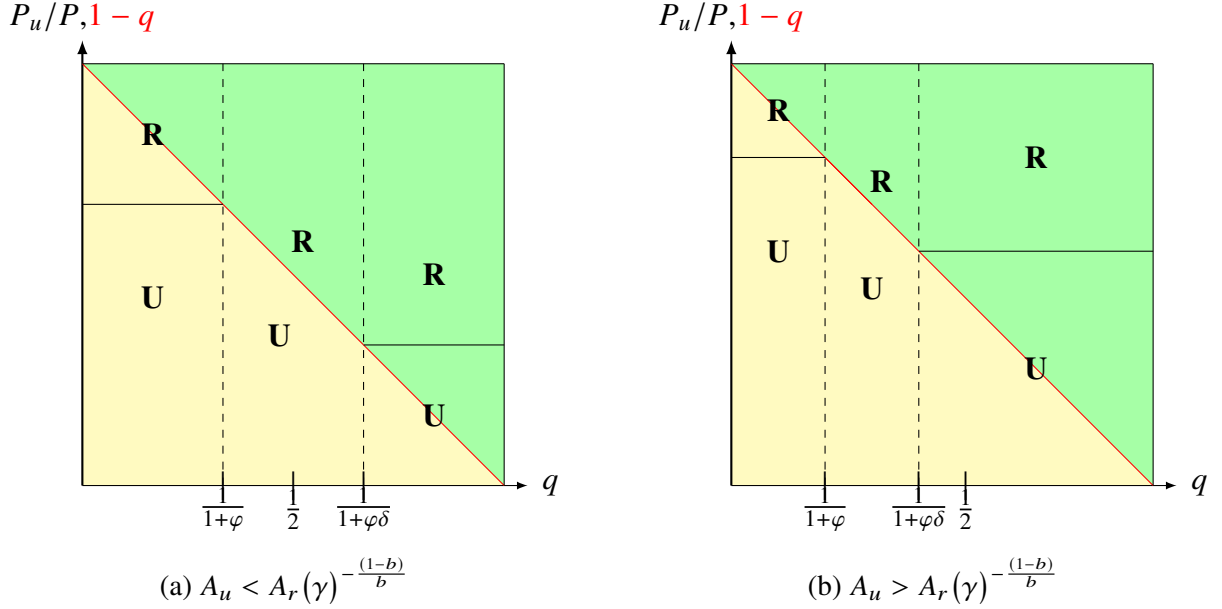


Figure 2: Spatial equilibrium: non-connected agents in yellow, connected agents in green (U: urban area, R: rural area).

3.3 Dynamics of environmental quality

As the distribution of cultural traits is given, the thresholds defined in Proposition 1 are therefore independent of any state variable and the spatial equilibrium persists over time. As a consequence, the dynamics of environmental quality only depend on the spatial equilibrium and the equilibrium tax. Combining the law of motion (1) with the equilibrium tax (3) and Proposition 1, we can characterize the long-run level of environmental quality.

Proposition 2. (1) When $q < 1/2$, the stock of environmental quality E_t converges to $E = 0$. (2) When $q \geq 1/2$, there exists a function $E : [0, 1] \rightarrow \mathbb{R}^+$, given by $E(x) = \frac{1-b}{b}(m-c)(P)^\alpha (A_u(1-x)^\alpha + A_r x^\alpha)$ such that (a) if $A_u/A_r \geq (\gamma)^{-\frac{(1-b)}{b}}$, E_t converges to $E(1/(1+\varphi\delta))$, (b) if $A_u/A_r \leq (\gamma)^{-\frac{(1-b)}{b}}$, either $q \in [\frac{1}{2}, 1/(1+\varphi\delta)]$ and E_t converges to $E(q)$, or $q \geq 1/(1+\varphi\delta)$ and E_t converges to $E(1/(1+\varphi\delta))$.

Proposition 2 delivers two results. First, a positive level of environmental quality is sustained only if connected individuals form a majority. When they are in the minority, the equilibrium tax rate is zero and environmental quality converges to zero through pollution accumulation. Second,

when connected individuals form a majority, long-run environmental quality is positive but depends on the spatial equilibrium. Since environmental protection is financed by a proportional income tax, it depends on aggregate production, which is itself determined by the spatial distribution of individuals: it increases with the size of the urban area. Two cases then arise. When the urban–rural productivity gap is large relative to the natural amenities gap (case 2a), the urban area is large for any $q > 1/2$ – its size equals $\varphi\delta/(1 + \varphi\delta)$ – so that aggregate production and long-run environmental quality are high and independent of q . When instead the productivity gap is small relative to the amenities gap (case 2b), the size of the urban area depends on q : because connectedness acts as a dispersion force, a rise in q shrinks the urban area, lowering aggregate production and, in turn, long-run environmental quality.

Before introducing the endogenous evolution of environmental preferences, we propose a comparative statics exercise to disentangle the effect of urbanization from that of the distribution of cultural traits on long-run environmental quality – two effects that will become intertwined with endogenous preferences.

Proposition 3. (i) If $q \geq 1/2$, the long-run environmental quality is increasing in urban labor productivity A_u . (ii) If $A_u \leq A_r\gamma^{-\frac{(1-b)}{b}}$, the long-run environmental quality varies non-monotonically with the share of connected agents q . If $A_u \geq A_r\gamma^{-\frac{(1-b)}{b}}$, the long-run environmental quality is increasing in the share of connected agents q .

According to Proposition 3, a rise in urban productivity increases long-run environmental quality. Two mechanisms underlie this result. First, higher urban productivity directly raises aggregate income and, in turn, environmental expenditure and long-run environmental quality.¹⁴ Second, urban productivity acts as an agglomeration force: it strengthens urbanization, which raises aggregate income further since urban residents are wealthier. In what follows, we refer to the combined impact of these two channels as the *income effect*.

Proposition 3 also establishes that the effect of q on long-run environmental quality is non-monotonic when the urban-rural productivity gap is low. This result is driven by two opposing forces. First, an increase in the share of connected individuals raises the aggregate support for environmental protection, a *pure preferences effect*.¹⁵ Second, it acts as a dispersion force, reducing urbanization and aggregate income, a *dispersion effect*.

14. For a given spatial distribution, a higher productivity also increases production-related damage. However, whenever $m - c > 0$, the net effect on long-run environmental quality is positive.

15. This result is not due to the majority voting mechanism. If the tax instead maximized the sum of welfare (e.g., under probabilistic voting), long-run environmental quality would be $E_\infty = ((1-b)/b) (m - c) q_\infty (A_u(1 - q_\infty)^\alpha + A_r q_\infty^\alpha)$, whose derivative with respect to q_∞ is the sum of a positive preferences term and a negative income term, the latter dominating when q_∞ is low, i.e., when urbanization is high. The same logic applies to the results of Section 4: environmental spending then declines linearly with the share of connected agents as urbanization increases, and for high urbanization the erosion of preferences outweighs the income effect.

4 Endogenous values: adoption by exposure and cultural transmission

We now assume that an adult's connectedness to nature increases with her exposure to natural environments during childhood (the adoption-by-exposure channel) and is also influenced by a socialization process involving parents and role models encountered in her local environment (the cultural transmission channel). The second channel is supported by a literature in economics and environmental psychology which documents the intergenerational transmission of environmental values (Berman et al. 2025; Cheng and Monroe 2012; Collado et al. 2017; Grønhøj and Thøgersen 2009). A key feature of the model is that the spatial distribution of cultural traits and the prevalence of environmental preferences are jointly determined. This richer framework deepens our understanding of how urbanization affects the protection of global environmental goods. For instance, urbanization can lead to the persistence of geographic cultural clusters undermining long-run environmental protection. However, it can allow environmental culture to diffuse across space, ultimately becoming a necessary condition for long-run environmental sustainability.

Preference formation. Each parent has one child, who is born without a predefined preference type. Children (C or N) acquire their cultural trait through both exposure to nature and socialization by parents and role models. The child is first exposed to their physical environment. With probability β_j , they become connected (resp. non-connected) to nature if they are born in the rural (resp. urban) region.¹⁶ If this exposure channel leaves the child's trait undetermined (which occurs with probability $1 - \beta_j$), then the child adopts their trait through a socialization process which involves family and role models.¹⁷ The socialization mechanism follows Bisin and Verdier (2001), with the important difference that it depends on the region in which the child grows up. In region j , a child, born at time t , is directly socialized into their parent's trait with probability d_{jt}^i , where $i \in \{C, N\}$. If parental socialization fails, the child picks up the trait of a role model drawn at random from the local population. At time t the probability of meeting a type i role model in region j is equal to that type's population share, i.e., P_{jt}^i/P_{jt} , with $P_{jt}^C/P_{jt} = q_{jt}$. Figure 3 illustrates the process through which a child born to a type- C parent adopts either trait, depending on whether they are raised in the urban region (left) or in the rural region (right).

The transition probabilities in the urban and rural regions are respectively given by

16. We will suppose $\beta_r \neq 0$ in order to rule out long-run equilibria in which both types of agents coexist in the rural area. Such equilibria are of limited interest for the purposes of this paper but note that their characterization can be easily derived.

17. We consider a setting in which children's exposure to nature is the primary force shaping preferences, implying that direct environmental exposure plays a larger role than cultural transmission. Interestingly, we show that even in this critical case, integrating socialization qualitatively impacts the predictions regarding the long-run impact of urbanization on the environment.

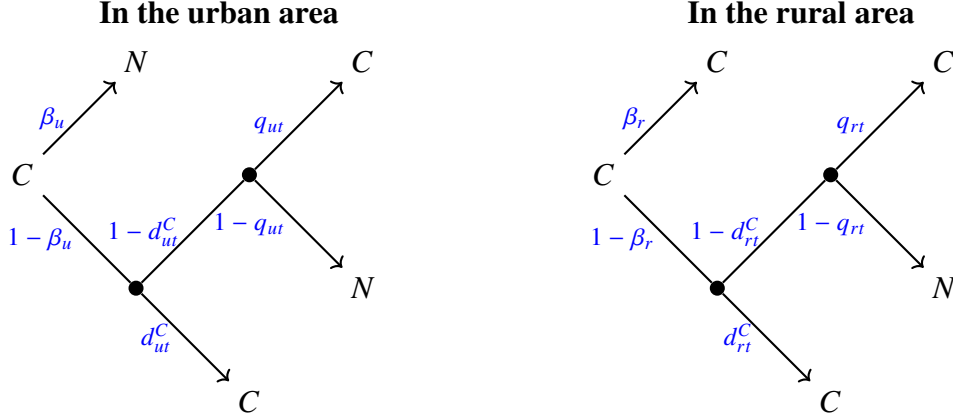


Figure 3: Preference transmission process when the child is born to a type-C parent.

$$Q_{ut}^{CC} = (1 - \beta_u) \left(d_{ut}^C + (1 - d_{ut}^C) \frac{P_{ut}^C}{P_{ut}} \right) = 1 - Q_{ut}^{CN}, \quad (4)$$

$$Q_{ut}^{NN} = \beta_u + (1 - \beta_u) \left(d_{ut}^N + (1 - d_{ut}^N) \left(1 - \frac{P_{ut}^C}{P_{ut}} \right) \right) = 1 - Q_{ut}^{NC}, \quad (5)$$

$$Q_{rt}^{CC} = \beta_r + (1 - \beta_r) \left(d_{rt}^C + (1 - d_{rt}^C) \frac{P_{rt}^C}{P_{rt}} \right) = 1 - Q_{rt}^{CN}, \quad (6)$$

$$Q_{rt}^{NN} = (1 - \beta_r) \left(d_{rt}^N + (1 - d_{rt}^N) \left(1 - \frac{P_{rt}^C}{P_{rt}} \right) \right) = 1 - Q_{rt}^{NC}. \quad (7)$$

As in economic models of cultural transmission, direct vertical socialization within the family is a choice of parents. Accounting for this additional decision, the timing is now as follows: the parent (i) gives birth to a child, (ii) decides the place of residence of the household, (iii) votes for a tax, and (iv) chooses their socialization effort. At the next period, children become adults with trait C or N .

Socialization choice Following Bisin and Verdier (2001), we assume that connected parents prefer having connected children and denote by V^C (resp. V^N) the gain when they have a connected (resp. non-connected) child with $V^C > V^N$. Parents can exert an effort e which increases the probability to directly transmit their connectedness to nature. Assume $d^C = d(e)$ where $d(e) = e$ if $e \geq d$, $d(e) = d$ otherwise, where d is the probability that the connected parent passively transmits CTN to its child. Unlike connected parents, non-connected parents are assumed to be indifferent between having connected and non-connected children so that they only passively transmit their preferences to their child.¹⁸ The socialization effort entails a disutility cost $C(e)$, with $C(e) = \frac{\chi}{2} (e^2 - d^2)$ for $e \geq d$ and $C(e) = 0$ otherwise. The first d units of socialization

18. Note that this assumption is not necessary for our results. We could assume that both types of parents exert a socialization effort. In that case, the following results would hold, only the thresholds would be affected.

are costless: everyday family interactions passively provide exposure d as a by-product of family life, and only socialization efforts above this passive level are costly. At time t , a connected parent chooses e so as to maximize the expected gain associated with the type of the child minus the cost, that is

$$Q_{jt}^{CC}V^C + Q_{jt}^{CN}V^N - C(e_t),$$

where Q_{jt}^{CC} and Q_{jt}^{CN} are given in equations (4) and (6) above. The optimal effort of a connected parent at time t living in region j , e_{jt}^* , is given by

$$e_{jt}^* = \begin{cases} (1 - \frac{P_{jt}^C}{P_{jt}})(1 - \beta_j)\Delta & \text{if } (1 - \frac{P_{jt}^C}{P_{jt}})(1 - \beta_j)\Delta \geq d \\ 0 & \text{otherwise,} \end{cases} \quad \text{with } \Delta = \frac{(V^C - V^N)}{\chi} = \frac{\Delta V}{\chi}.$$

We assume $d/(1 - \beta_u) < \Delta \leq 1$. The first inequality allows for interior socialization efforts; the second ensures that the interior effort which is a direct transmission probability, never exceeds one.

As in Bisin and Verdier (2001), there exists cultural substitutability: as the proportion of type- C individuals in a given region increases, parental socialization effort declines. The intuition is that a greater prevalence of connected agents enhances the effectiveness of socialization through role models, thereby reducing the need for parents to exert costly effort to transmit their trait. The probability that a type- C parent residing in region j transmits her trait to her child is $d_{jt}^* = d(e_{jt}^*)$.

Spatial equilibrium Socialization modifies location incentives relative to the benchmark. Connected agents now care not only about consumption and access to natural amenities, but also about their child's expected trait, making their location choice sensitive to the cultural composition of each area.

Before characterizing the spatial equilibrium, we define a threshold on q analogous to the upper threshold in the benchmark, which now depends on the benefits and costs of socialization:

$$\tilde{q} = \frac{1}{1 + \varphi \delta e^{-\frac{1}{b(1-\alpha)}} \left(\Delta V \left(1 - \frac{(1-\beta_u)^2 \Delta V}{2\chi} \right) - \frac{\chi d^2}{2} \right)}.$$

Assumption 1. $\Delta V(1 - \min\{d, \beta_u\}) < b(1 - \alpha)$.

Assumption 1 states that location incentives are driven primarily by economic motives rather than by socialization concerns.¹⁹ The spatial equilibrium can now be established.

Proposition 4. *Suppose that Assumption 1 holds. At every time t there exists a unique spatial*

19. This assumption guarantees the uniqueness of the spatial equilibrium (Proposition 4). It also ensures that the cultural dynamics never jump from the mixed to the segregated regime in a single period (Lemma C.2 in the Online Appendix).

equilibrium with the same three-regime structure as in Proposition 1, with the upper threshold $1/(1 + \varphi\delta)$ replaced by $\tilde{q} > 1/(1 + \varphi\delta)$, and with $P_{ut}^{C\star} > 0$ in the mixed urban regime $q_t > \tilde{q}$.

Endogenous preferences introduce two differences relative to the benchmark (the equilibria are again depicted in Figures 2a and 2b). First, uniqueness of the spatial equilibrium requires that $-b(1 - \alpha) + \Delta V(1 - \beta_u) < 0$, a condition implied by Assumption 1. Location choices are no longer driven solely by wage differentials and environmental quality. Parents also take into account the expected cultural type of their child in each region. Decreasing returns to scale in production yield substitutability between location choices. However, the likelihood of transmitting the connected trait rises with the share of type-C individuals in a given area, introducing strategic complementarity among connected parents' location decisions. The condition stated in Proposition 4 ensures that the wage differential effect dominates, so that location choices are substitutes overall.

Population dynamics Given the location equilibrium at time t , we derive the fraction of connected agents at time $t + 1$ as a function of q_t .

$$q_{t+1} = \begin{cases} q_t + \beta_r(\frac{1}{1+\varphi} - q_t) + q_t(1 - \beta_r)(d_r^* - d)(1 - q_t(1 + \varphi)) & \text{if } q_t < \frac{1}{1+\varphi}, \\ q_t & \text{if } q_t \in [\frac{1}{1+\varphi}, \tilde{q}], \\ \frac{P_{ut}^{C\star}}{P} \left((1 - \beta_u)(d_{ut}^* + (1 - d_{ut}^*)\frac{P_{ut}^{C\star}}{P_{ut}}) \right) + \frac{P_{ut} - P_{ut}^{C\star}}{P} \left((1 - \beta_u)(1 - d)\frac{P_{ut}^{C\star}}{P_{ut}} \right) + q_t - \frac{P_{ut}^{C\star}}{P} & \text{if } q_t > \tilde{q} \end{cases}$$

Before examining the long-run dynamics of preferences, let us define $\tilde{\beta}_1 \equiv \max\{0, 1 - \frac{-(2-d) + ((2-d)^2 + 4\Delta)^{\frac{1}{2}}}{\Delta}\}$, and $\tilde{\beta}_2 \equiv 1 - \frac{-(1-d) + ((1-d)^2 + 4\Delta)^{\frac{1}{2}}}{2\Delta}$. Note that $\tilde{\beta}_1 < \tilde{\beta}_2$. We can now state the following proposition.

Proposition 5. (i) Suppose that $\beta_u \geq \tilde{\beta}_2$. If $q_0 < 1/(1 + \varphi)$, the sequence q_t converges to $\frac{1}{1+\varphi}$. If $q_0 \in [1/(1 + \varphi), \tilde{q}]$, $q_t = q_0 \forall t \in \mathbb{N}$. If $q_0 > \tilde{q}$, the sequence q_t converges to $\tilde{q}$. (ii) Suppose that $\beta_u < \tilde{\beta}_2$. The first two cases are as in (i), while for $q_0 > \tilde{q}$ the sequence q_t converges to some $q^* \in (\tilde{q}, 1)$.

Part (i). Consider first the case where adoption by exposure - or lack thereof - is strong relative to socialization incentives (i.e., $\beta_u > \tilde{\beta}_2$). Regardless of the initial distribution of cultural traits and the associated spatial equilibrium, the economy converges to a single type of spatial configuration characterized by cultural clustering: connected agents concentrate in the countryside, while non-connected agents reside in the city.

In this case, the two-way interplay between the spatial equilibrium and the distribution of cultural traits generates dynamic substitutability. Suppose, for instance, that the initial fraction of connected agents is high. Connected individuals then have strong incentives to move to the city, both because the wage differential widens and because the rate of oblique transmission in the

urban area rises. Yet, this spatial reallocation has a negative effect on the future prevalence of connectedness to nature. Children raised in the city are deprived of regular contact with the natural environment, and urban socialization is not sufficiently strong to offset this lack of exposure. Urban children therefore become non-connected adults with high probability. As a result, in subsequent periods, the fraction of connected individuals in the city gradually declines until the city comprises only non-connected individuals.

Part (ii). Consider now the case where adoption by exposure is weak relative to socialization incentives (i.e., $\beta_u < \tilde{\beta}_2$). There exist multiple long-run spatial configurations. If the initial fraction of connected agents is small, the long-run equilibrium mirrors the previous case: geographic cultural clusters form. If the initial fraction is sufficiently high, however, environmental culture diffuses spatially.

When socialization incentives are strong enough, the interplay between the spatial socio-economic structure and the cultural transmission process generates dynamic complementarities. Namely, a two-way positive interaction emerges between the prevalence of environmental preferences and the selection of individuals who hold these preferences into the city. First, a rise in the prevalence of connected agents produces a positive static effect through the spatial equilibrium: a larger share of connected agents strengthens the incentives for connected individuals to self-select into the city. Second, and in contrast to case (i), changes in the spatial distribution of cultural traits generate a positive dynamic effect on the prevalence of environmental preferences. As connected parents relocate to the city, they substitute away from a favorable location - in terms of cultural transmission - toward stronger parental socialization effort. Socialization then compensates for the lack of exposure, allowing environmental connectedness to rise in the city and, consequently, in the population as a whole.²⁰ We refer to this mechanism as “cultural dissemination”.

This mechanism echoes the evidence of Bazzi et al. (2026) on the Confederate diaspora discussed in Section 1.1: a minority of migrants, who retained strong attachment to their identity, reshaped the culture of their destinations through socialization within families and transmission to their neighbors.

The result stated in part (ii) of Proposition 5 is illustrated in Figure 4 where the thick curve (the graph of the function Ω) represents the set of points (q_t, P_{ut}^C) at the spatial equilibrium while the thin solid line (the graph of Γ) is the set of points such that $q_{t+1} = q_t$. The steady state (q^*, P_u^{C*}) is at the intersection of these two curves. For any $q_0 > \tilde{q}$, the variables converge to that steady state value.

Let us now examine the dynamics of environmental quality. Define $q^{min} \equiv \min\{\tilde{q}, 1/2\}$,

20. The positive variation in the city dominates the aggregate dynamics, as cultural change in the countryside remains negligible.

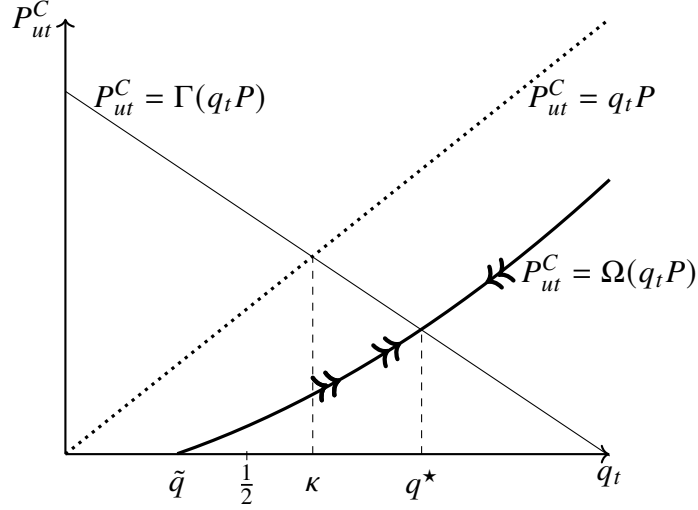


Figure 4: Steady state equilibrium when $\beta_u \leq \tilde{\beta}_1$ and $q_0 > \tilde{q}$.

$$q^{max} \equiv \max\{\tilde{q}, 1/2\}, \text{ and } \bar{A} \equiv A_r \gamma^{-\frac{(1-b)}{b}} e^{\frac{1}{b} \left(\Delta V \left(1 - \frac{(1-\beta_u)^2 \Delta V}{2\chi} \right) - \frac{\chi d^2}{2} \right)}.$$

Proposition 6. (i) For any $q_0 < q^{min}$, the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to 0; the same holds at $q_0 = q^{min}$ when $q^{min} = \tilde{q} < 1/2$. (ii) For any $q_0 > q^{min}$, and also at $q_0 = q^{min}$ when $q^{min} = 1/2$, (1) if $A_u \leq \bar{A}$, (a) if $q_0 < q^{max}$, the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to $E(q_0)$; (b) if $q_0 > q^{max}$, or if $q_0 = q^{max} = 1/2$, then for $\beta_u < \tilde{\beta}_2$ the sequence converges to $E(q^* - \Omega(q^* P)/P)$, and for $\beta_u \geq \tilde{\beta}_2$ it converges to $E(\tilde{q})$. (2) If $A_u > \bar{A}$, (a) if $\beta_u \leq \tilde{\beta}_1$ the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to $E(q^* - \Omega(q^* P)/P)$; (b) if $\beta_u \in (\tilde{\beta}_1, \tilde{\beta}_2)$, there exists $\tilde{A}$ such that $\forall A_u \in (\bar{A}, \tilde{A}]$, the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to $E(q^* - \Omega(q^* P)/P)$, $\forall A_u > \tilde{A}$, the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to 0; (c) if $\beta_u \geq \tilde{\beta}_2$, the sequence $\{E_t\}_{t \in \mathbb{N}}$ converges to 0.

Proposition 6 characterizes the steady-state level of environmental quality. First, this outcome depends on the initial fraction of type-C agents. A positive level of environmental quality can be sustained only if the initial fraction of connected agents is sufficiently high, i.e., $q_0 > q^{min}$.

Consider item (i). When the initial fraction of connected agents is low (i.e., $q_0 < q^{min}$), the spatial configuration is characterized by cultural clustering, giving rise to path dependency. A low initial share of connected agents remains low over time, as transmission of this trait is confined to a small rural population. Consequently, the aggregate willingness to pay for environmental protection remains low, and environmental quality converges to its minimum level through pollution accumulation.

Consider item (ii). When the initial fraction of connected agents is sufficiently high, i.e., $q_0 > q^{min}$, the long-run stock of environmental quality depends on the interplay between agglomeration-dispersion forces and the relative strength of adoption by exposure versus socialization incentives.

When agglomeration forces are moderate relative to dispersion forces, urbanization remains limited and geographically distinct cultural clusters emerge and persist. Because the rural area is large, environmental preferences continue to be transmitted to a substantial share of the population. The fraction of connected-to-nature individuals remains high over time, ensuring sustained majority support for environmental protection policies. Consequently, a sustainable level of environmental quality is reached. This case is characterized in cases (1) and (2)-(b) with $A_u < \tilde{A}$ of Proposition 6.

When agglomeration forces are strong, urbanization is high, and whether this is compatible with a sustainable level of environmental quality depends on the relative strength of adoption by exposure and socialization incentives. In contrast to the benchmark, urbanization here feeds back into preference dynamics through two opposing channels. On the one hand, greater urbanization reduces contact with nature and therefore weakens the intergenerational transmission of environmental preferences. On the other hand, it promotes cultural influence through parents' socialization which fosters the transmission of environmental preferences. Intuitively, urbanization reinforces the positive feedback between the transmission of environmental culture and the spatial socio-economic structure, by encouraging the self-selection of connected individuals into the city.

If adoption by exposure is strong relative to socialization incentives, the first effect dominates: strong urbanization erodes environmental preferences, protection policies lose majority support, and environmental quality converges to its minimum (cases (2)-(b) with $A_u > \tilde{A}$ and (2)-(c) of Proposition 6). If adoption by exposure is weak, the second mechanism dominates: strong urbanization diffuses environmental culture, preferences remain prevalent enough to sustain protection policies, and the economy converges to a positive long-run environmental quality (case (2)-(a) of Proposition 6).

We finally characterize the variations of the long-run stock of environmental quality in response to a change in urban productivity.

Proposition 7. (1) If $\beta_u \leq \tilde{\beta}_1$, $\forall q_0 > 0$, the long-run environmental quality is an increasing function of urban productivity. (2) If $\tilde{\beta}_1 < \beta_u \leq \tilde{\beta}'_1$, where $\tilde{\beta}_1 < \tilde{\beta}'_1 < \tilde{\beta}_2$, the long-run environmental quality is a non-monotonic function of urban productivity. (3) If $\beta_u > \tilde{\beta}'_1$, either $q_0 < 1/2$ and the long-run environmental quality is constant with urban productivity, or $q_0 > 1/2$ and the long-run environmental quality is a non-monotonic function of urban productivity.

This proposition characterizes how the long-run environment changes when agglomeration forces rise, i.e., when urbanization strengthens. This relationship is critically shaped by the relative strength of the adoption-by-exposure and socialization incentives. Figures 5a to 5d, depict the joint evolution of long-run environmental quality and the long-run urbanization rate as urban labor productivity A_u varies.

Consider the case in which adoption by exposure is strong relative to socialization incentives, as illustrated in Figures 5a and 5b (i.e., $\beta_u > \tilde{\beta}_1$ or $\beta_u > \tilde{\beta}'_1$). When the initial fraction of connected

agents is low, a positive level of environmental quality cannot be sustained, as established in Proposition 6 (Figure 5a).²¹ When this initial fraction is higher (Figure 5b), the relationship between urbanization and long-run environmental quality becomes non-monotonic. For low values of A_u , rising urbanization is accompanied by improvements in environmental quality; for larger values, further urbanization instead leads to environmental degradation. This pattern reflects the interplay between two opposing forces. As in the benchmark case, urbanization generates a positive income effect. At the same time, it exerts a negative influence through the adoption-by-exposure mechanism, as a larger urban population deprives more children of contact with nature, reducing the future fraction of connected agents.

When urbanization remains moderate, the positive income effect dominates the negative exposure effect, sustaining improvements in environmental quality. However, this relationship reverses once urbanization becomes sufficiently high. This outcome hinges on decreasing returns to labor: as urbanization intensifies, the urban labor supply expands, so that the marginal benefit from urbanization (in terms of income) falls. At the same time, the erosion of environmental preferences lowers support for environmental taxation. Beyond a certain level of urbanization, the income effect becomes negligible and the decline in the tax rate dominates, resulting in long-run environmental degradation.

Consider the case $\beta_u \leq \tilde{\beta}_1$, i.e., adoption by exposure is weak relative to socialization incentives, as illustrated in Figures 5c and 5d. Results differ markedly from the previous case. Regardless of the initial distribution of cultural types, higher urban productivity – and hence greater urbanization – has a positive effect on long-run environmental quality.

Consider Figure 5c, i.e., $q_0 < 1/2$. In the benchmark, starting from a low initial fraction of connected agents, aggregate willingness to pay for environmental protection would remain weak, and environmental quality would converge to its minimum level. In the present setting, by contrast, a positive level of environmental quality is sustained *if and only if urbanization is strong*.

This result arises because, in this parameter configuration, urbanization can exert a positive effect on environmental preferences through the cultural dissemination mechanism – in addition to its standard income effect. This mechanism emerges when agglomeration forces (captured either by a high share of connected agents or high urban productivity) are sufficiently strong. By favoring selection of connected agents in the city, stronger agglomeration forces reshape the spatial distribution of cultural traits, which in turn generates a positive dynamic effect on the prevalence of environmental preferences.

When the initial fraction of connected agents is low (Figure 5c), the incentives for connected

21. Figure 5a depicts the case $\beta_u > \tilde{\beta}_1$. In the intermediate case $\tilde{\beta}_1 < \beta_u \leq \tilde{\beta}_1'$, the relationship between urban productivity and long-run environmental quality is non-monotonic even when $q_0 < 1/2$, a pattern qualitatively similar to that displayed in Figure 5b; we therefore do not display this case separately.

agents to migrate to the city are relatively weak. If urban labor productivity is insufficiently high, cultural clustering emerges and generates path dependence: the fraction of connected agents remains low while environmental quality steadily deteriorates. Beyond a critical threshold, however, urbanization intensifies enough to reshape the spatial distribution of cultural traits. This shift activates the cultural-dissemination mechanism, driving the diffusion of environmental values across the population. Environmental culture then gradually becomes dominant, enabling the economy to converge to a sustainable level of environmental quality.

Overall, when urbanization is high, a decrease in β_u or in the socialization cost (which raises the threshold $\tilde{\beta}_1$) has a profound effect on environmental quality. These results point to a role for non-monetary policies such as green education at school – which can lower parents' socialization cost – or measures increasing urban children's contact with nature. The feasibility of such policies is the focus of the next section.

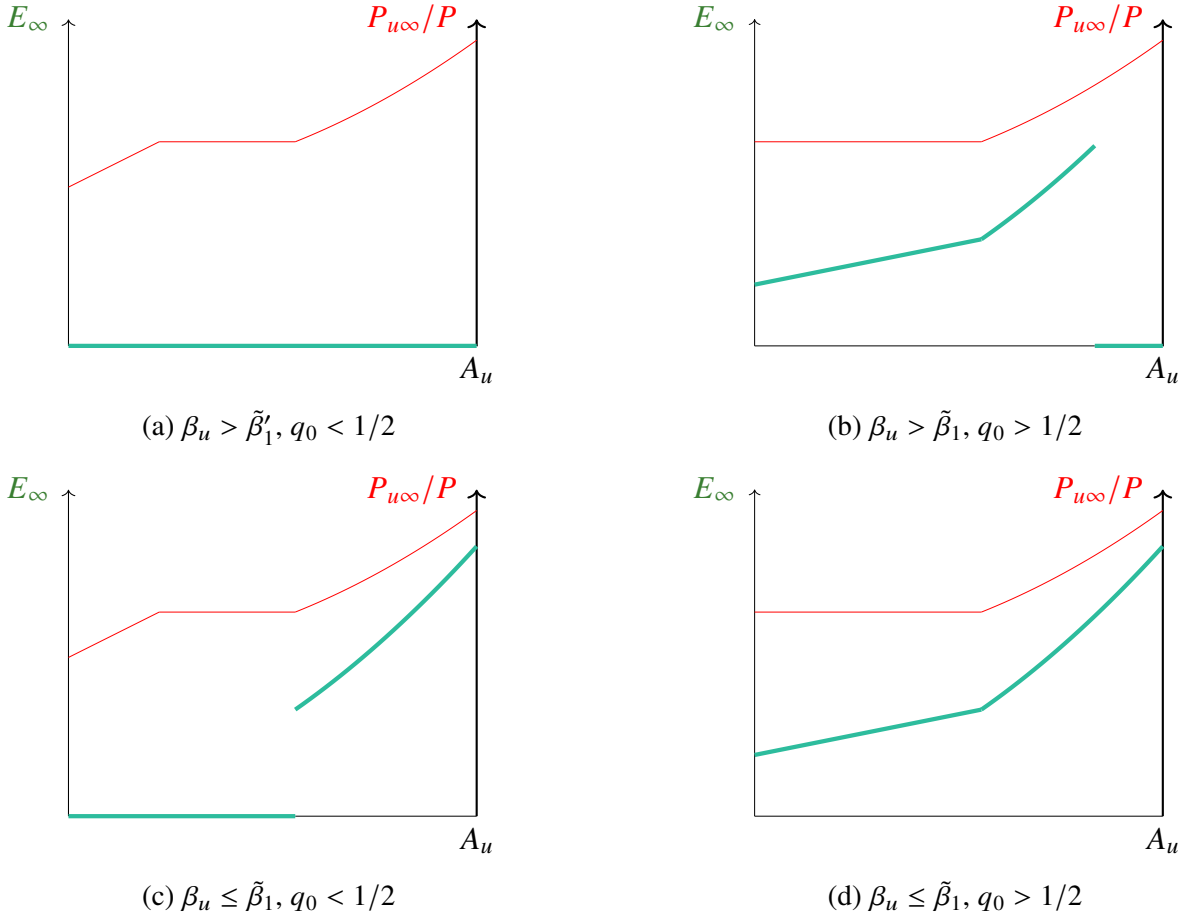


Figure 5: Long-run environmental quality E_∞ and urbanization rate $P_{u\infty}/P$ as functions of urban productivity A_u , depending on the strength of adoption by exposure β_u and on the initial share of connected agents q_0 .

5 The political feasibility of a green education policy

The previous section suggested that green education policies, understood as policies that foster the transmission of CTN, are critical to breaking the vicious circle between urbanization and environmental preferences. In what follows, we adopt a political economy perspective on these policies. We start from a setting in which strong urbanization erodes long-run environmental preferences, thereby hindering environmental sustainability, and we focus on policies that make it possible to reach a sustainable long-run level of environmental quality. We then investigate the conditions under which such policies are politically feasible, in the sense that a majority of individuals supports their implementation. This approach draws on Bierbrauer et al. (2021).

We consider a budget-balanced policy financed through a proportional income tax.²² Let $\lambda_t \in [0, 1]$ be the green education tax rate at time t . Consumption in region j is now given by $w_j(1 - \tau_t - \lambda_t)$ and total spending in green education equals $\lambda_t Y_t$.

Central to our analysis is the mechanism of adoption by exposure, measured by β_u . We therefore suppose that spending in green education can reduce the strength of this effect. This is the purpose of various education programs implemented across countries which promote CTN through increased interactions with nature (e.g., outdoor education in “Forest schools” in the UK, schoolyard greening through the “Cour Oasis” program in Paris, nature kindergartens in Northern Europe). Consistent with our approach, some empirical work has shown that institutionalized green education can change attitudes and behaviors toward the environment (see, e.g., Jaime et al. 2023).

Formally, let $G : \mathbb{R}^+ \rightarrow [0, 1]$ denotes the function capturing the effectiveness of green education. The probability that a child born in the city becomes non-connected is now given by $\beta_u(1 - G(\lambda_t Y_t))$. There exist several alternative ways to integrate the green education policy into the transmission process (e.g., it could reduce parental socialization costs, or be added as an additional vector of socialization allowing the adoption of trait C). Since these alternatives lead to similar results, we adopt the most parsimonious specification.

The utility of a connected agent living in region j is now measured by $U_{jt}^C(\tau_t, \lambda_t, e_{jt})$ where $U_{jt}^C : [0, 1]^3 \rightarrow \mathbb{R}$ is given by

$$U_{jt}^C(\tau_t, \lambda_t, e_{jt}) = b \ln(w_j(1 - \tau_t - \lambda_t)) + (1 - b) \ln \gamma_j E_t + Q_{jt}^{CC} V^C + (1 - Q_{jt}^{CC}) V^N - C(e_{jt})$$

where E_t and Q_{rt}^{CC} are given as before, while $Q_{ut}^{CC} = (1 - \beta_u(1 - G(\lambda_t Y_t))) (d_{ut}^C + (1 - d_{ut}^C) q_{ut})$. As in the previous section, connected agents choose their socialization effort and vote for the level of the environmental tax rate so as to maximize their utility function. We define $e_{jt}^* \equiv \operatorname{argmax}_{e_{jt} \in [0, 1]} U_{jt}^C(\tau_t, \lambda_t, e_{jt})$ and $\tau_t^* \equiv \operatorname{argmax}_{\tau_t \in [0, 1]} U_{jt}^C(\tau_t, \lambda_t, e_{jt})$.

22. This modeling choice ensures consistency with the specification adopted for environmental taxes and simplifies the analysis of the spatial equilibrium at time t for reasons analogous to those discussed in the end of Section 3.

The decision to live in the urban region now depends on the sign of $\Delta U^C(P_{ut}^C, P_t^C, \lambda_t)$ where $\Delta U^C : [0, P_t^C] \times [0, P] \times [0, 1] \rightarrow \mathbb{R}$ is given by $\Delta U^C(P_{ut}^C, P_t^C, \lambda_t) = U_{ut}^C(\tau_t^*, \lambda_t, e_{ut}^*) - U_{rt}^C(\tau_t^*, \lambda_t, e_{rt}^*)$.

The following proposition characterizes the spatial equilibrium for any $\lambda_t \in [0, 1]$.

Proposition 8. *Suppose that $-b(1 - \alpha) + \Delta V(1 + \beta_u) < 0$.²³ At every time t and for any $\lambda_t \in [0, 1]$, there exists a unique spatial equilibrium with the same three-regime structure as in Proposition 4, where the endogenous threshold $\tilde{q}(\lambda_t)$ and the urban connected mass $P_{ut}^{C*} = \Omega_g(P_t^C, \lambda_t)$ now depend on the policy and are implicitly given by $\Delta U^C(0, P\tilde{q}(\lambda_t), \lambda_t) = 0$ and $\Delta U^C(\Omega_g(P_t^C, \lambda_t), P_t^C, \lambda_t) = 0$.*

The proof follows arguments similar to those used in the proof of Proposition 4. The uniqueness condition differs because the spatial allocation of individuals has an additional effect on utilities through its impact on total policy spending.

We can now examine the dynamics of the fraction of connected agents. For tractability, we henceforth assume that $G(x) = x/(1 + x)$.

Proposition 9. *Suppose that $\tilde{\beta}_2 \leq \beta_u < \tilde{\beta}_2(1 + A_u(P - P\tilde{q}(1))^\alpha + A_r(P\tilde{q}(1))^\alpha)$.²⁴ There exists a threshold $\tilde{\lambda}$ such that, for all $\lambda \in (\tilde{\lambda}, 1]$, the sequence q_t converges as in part (i) of Proposition 5, with $\tilde{q}$ replaced by $\tilde{q}(\lambda)$, except that for $q_0 > \tilde{q}(\lambda)$ it converges to $q^*(\lambda) \in (\tilde{q}(\lambda), 1)$ rather than to $\tilde{q}(\lambda)$.*

The left inequality is the maintained assumption of strong urban exposure; the right inequality ensures that the green education policy can be effective. It states that, at the segregation threshold $\tilde{q}(1)$ and at maximal policy intensity, the urban penalty on the transmission of trait C – due to reduced exposure to nature, and net of the green socialization policy that counteracts it – falls below the critical threshold $\tilde{\beta}_2$.

The dynamics when $q_0 \leq \tilde{q}(\lambda)$ are similar to the results obtained in Proposition 5. The novelty comes from the case when $q_0 > \tilde{q}(\lambda)$, which establishes that a sufficiently large green education policy ($\lambda > \tilde{\lambda}$) can sustain CTN in the city even when the urban penalty from reduced exposure to nature is strong: the transmission effort of connected parents is then strong enough for the connected population to grow in the city. This naturally raises the question of the political feasibility of such a policy, which we examine below.

Define $W_t : [0, 1] \rightarrow \mathbb{R}$, the indirect utility of a connected agent living in the urban area, when $q_t > 1/2$, which is given by $W_t(\lambda_t) = U_{ut}^C(\tilde{\tau}_t, \lambda_t, e_{ut}^*)$. Now, we formalize the definition of political feasibility in our setting.

23. This condition strengthens Assumption 1, since $1 + \beta_u > 1 - \min\{d, \beta_u\}$.

24. The term in parentheses is aggregate output at $\tilde{q}(1)$.

Definition 2. For any $q_t \in [0, 1]$, a politically feasible green education policy at time t is a value of $\lambda_t \in (0, 1]$ such that (i) $\Delta U^C(P/2, Pq_t, \lambda_t) \geq 0$, (ii) $W'_t(\lambda_t) \geq 0$.

This definition states that the policy must be welfare improving (ii), for a majority of the population (i).²⁵ Only connected individuals living in the city benefit from the green education policy since connected individuals living in the countryside do not suffer from a negative adoption by exposure effect. Item (i) is equivalent to $P_{ut}^{C\star} \geq P/2$ which imposes that the group of individuals who can benefit from the policy forms a majority. Item (ii) imposes that these individuals actually benefit from the policy, which is true when their indirect utility increases with the policy. Condition (ii) writes as²⁶

$$\beta_u \frac{Y_t}{(1 + \lambda Y_t)^2} \left(d_{ut}^{\star} + (1 - d_{ut}^{\star}) \frac{P_{ut}^{C\star}}{P - P_t^C + P_{ut}^{C\star}} \right) \Delta V - \frac{b}{(1 - \lambda_t - \tilde{\tau}_t)} \geq 0.$$

The first term is the cultural benefit from green education, while the second term is the opportunity cost in units of consumption.²⁷ Using the first-order condition defining $\tilde{\tau}_t$ in this setting, $(1 - b)mY_t/(S_{t-1} + mY_t\tilde{\tau}_t) = b/(1 - \lambda_t - \tilde{\tau}_t)$ (so that $\tilde{\tau}_t = \max\{(1 - b)(1 - \lambda_t) - bS_{t-1}/(mY_t), 0\}$), this condition rewrites as

$$\begin{cases} \beta_u \frac{Y_t}{(1 + \lambda Y_t)^2} \left(d_{ut}^{\star} + (1 - d_{ut}^{\star}) \frac{P_{uct}}{P_{ut}} \right) \Delta V - \frac{1}{1 - \lambda_t + S_{t-1}/mY_t} \geq 0 & \text{if } (1 - b)(1 - \lambda_t) - b \frac{S_{t-1}}{mY_t} \geq 0 \\ \beta_u \frac{Y_t}{(1 + \lambda Y_t)^2} \left(d_{ut}^{\star} + (1 - d_{ut}^{\star}) \frac{P_{uct}}{P_{ut}} \right) \Delta V - \frac{b}{1 - \lambda_t} \geq 0 & \text{if } (1 - b)(1 - \lambda_t) - b \frac{S_{t-1}}{mY_t} \leq 0. \end{cases}$$

The overall opportunity cost of the socialization policy depends on both consumption and the state of environmental quality, S_{t-1} . In particular, when past environmental quality is lower, the marginal benefit of environmental protection increases which raises the opportunity cost of the socialization policy. Hence, there is a two-way interaction between the green education policy and the state of environmental quality: past environmental quality affects the feasibility of the policy and the policy in turn impacts the future state of environmental quality by raising the share of connected individuals in the city.

Following the proof of Proposition 8, one can show that condition (i) is equivalent to $q_t \geq \hat{q}(\lambda)$ where $\hat{q} : [0, 1] \rightarrow [\tilde{q}(\lambda), 1]$ is implicitly given by $\Delta U^C(P/2, P\hat{q}(\lambda), \lambda) = 0$. Type-C individuals living in the city form a majority if and only if the share of type-C agents in the population is sufficiently large. An increase in q not only widens the pool of potential urban residents of type-C,

25. Following Bierbrauer et al. (2021), political feasibility is explicitly defined through local marginal-utility conditions, rather than specifying a global voting game over an entire policy space.

26. We do not analyze the case $\tau_t^{\star} = 0$, as it requires $q_t < 1/2$ which in turn implies that condition (i) does not hold.

27. Note that individuals do not internalize general-equilibrium effects when assessing the welfare impact of the policy—in particular, the marginal effect of λ on $P_{ut}^{C\star}$. This reflects the policymaker's lack of commitment: the policy is set simultaneously with, rather than ahead of, individuals' choices. It thus corresponds to a Nash—rather than a Stackelberg—equilibrium of the game between the policymaker and households. This distinction is formalized in Bisin and Verdier (2024).

it also strengthens the incentives for CTN individuals to self-select into the city as explained in Section 4.

Characterizing political feasibility along the entire transition path is challenging as the dynamical system involves interactions between three variables q_t , E_t and P_{ut}^C . To keep the analysis tractable, we concentrate on long-run feasibility by considering an economy at steady state under a given policy, and asking whether that policy is feasible. We call such a policy *politically self-sustaining*. Define

$$Y_\lambda = P^\alpha \left(A_u \left(1 - q^*(\lambda) + \frac{\Omega_g(Pq^*(\lambda), \lambda)}{P} \right)^\alpha + A_r \left(q^*(\lambda) - \frac{\Omega_g(Pq^*(\lambda), \lambda)}{P} \right)^\alpha \right)$$

which is the long-run value of the output when the sequence q_t has converged to $q^*(\lambda)$.

Definition 3. Let $\lambda \in [0, 1 - c/m)$ be the value of the green education policy and $(q_0, E_0) \in [0, 1] \times \mathbb{R}^+$ the vector of initial conditions. Suppose that $q_0 = q^*(\lambda)$, $E_0 = Y_\lambda(m(1-\lambda)-c)(1-b)/b$. In the long run ($t = +\infty$), the green education policy λ is politically self-sustaining if and only if (i) $\Delta U^C(P/2, Pq^*(\lambda), \lambda) \geq 0$ and (ii) $\lim_{t \rightarrow +\infty} W'_t(\lambda) \geq 0$.

Condition (i) of Definition 3 ensures that connected agents living in the city form a majority once the fraction of connected agents has converged to its steady state level. This condition holds if and only if $q^*(\lambda) \geq \hat{q}(\lambda)$. To analyze this condition more closely, we first characterize the following objects.

As shown in Appendix C.11, the dynamics of q_t critically depend on the function $\kappa_g : [0, 1] \rightarrow (-\infty, 1]$ given by $\kappa_g(x) = 1 - (d + (d^2 + 4\Delta x)^{\frac{1}{2}})/(2\Delta(1-x))$. An increase in $\kappa_g(x)$ strengthens the transmission of trait C for a given level of oblique transmission in the city. This quantity is increasing in parents' preferences for having connected children, and is decreasing in the extent of passive transmission by non-connected parents. Furthermore, it is decreasing in x , where x is a generic variable to be evaluated at $\beta_u(1 - G(\lambda Y))$, which captures the combined opposite effects of adoption by exposure (or rather, the absence of exposure in the city) and green socialization policy. Define $Y_{min} \equiv A_u(P/2)^\alpha + A_r(P/2)^\alpha$, which is the aggregate output when the population P is split equally between the city and the countryside.

Lemma 1 (Sorting, transmission, and majority formation). Suppose that $\frac{1}{\varphi\delta} \exp\left[\frac{\Delta V}{b(1-\alpha)}\right] + 1 < 2\kappa_g(\beta_u(1 - G(Y_{min})))$. There exists $\lambda^1 \in (0, 1)$, such that $\lambda \geq \lambda^1$ implies that condition (i) of Definition 3 holds.

This assumption imposes a joint restriction on the distribution of traits at the spatial equilibrium and on the efficiency of the transmission of trait C in the city.

The left-hand side is inversely related to the incentives for connected individuals to locate into the city. Condition (i) is more likely to hold when these incentives are strong, that is, when the

left-hand side is small. The right-hand side captures the efficiency of trait- C transmission in the city, which, as noted above, increases with spending on the green socialization policy. For condition (i) to hold, transmission of trait C in the city must be sufficiently efficient when the policy is implemented at its maximal level ($\lambda = 1$) and when income has reached its long-run value. Since no closed-form expression for long-run income exists, we impose a sufficient condition by substituting the long-run income level with its lowest possible value, Y_{min} . Note that when incentives to sort into the city strengthen, reducing the left-hand side, the required efficiency of the trait- C transmission falls, and conversely. This result hinges on the two-way positive interaction between the prevalence of environmental preferences and the spatial sorting of individuals who hold these preferences into the city.

Let us investigate whether condition (ii) holds. This condition now writes as

$$\beta_u \frac{Y_\lambda}{(1 + \lambda Y_\lambda)^2} \left(d_{u\infty}^* + (1 - d_{u\infty}^*) \frac{P_{uc\infty}}{P_{u\infty}} \right) \Delta V - \frac{b}{(1 - \lambda - c/m)} \geq 0$$

This condition weighs the cultural benefit of the socialization policy against its *long-run* opportunity cost. That cost is increasing in the taste for consumption, b , and decreasing in the ratio m/c , which measures the relative efficiency of environmental protection. A higher ratio raises long-run environmental quality and thereby lowers the opportunity cost of the policy. It follows that the condition can hold only if $E_\infty > 0$. Taken together, conditions (i) and (ii) imply that, in the long run, *a politically self-sustaining education policy always brings environmental quality to a sustainable level*.

Lemma 2 (Strict preference for policy over the status quo). *Suppose that $\beta_u Y_{min} d \Delta V - b / (1 - c/m) > 0$, there exists $\lambda^2 \in (0, 1 - c/m)$ such that $\lambda \leq \lambda^2$ implies that condition (ii) of Definition 3 holds.*

The condition of Lemma 2 requires that the welfare of urban connected agents be increasing in the socialization policy at $\lambda = 0$, that is, in the absence of any socialization policy. In other words, urban connected agents strictly prefer a positive level of investment in the socialization policy over the status quo. The left-hand side provides a lower bound on the cultural benefit of the policy. The cultural benefit also varies with aggregate output Y , and the condition evaluates it at its lower bound Y_{min} .

From Lemmas 1 and 2, we deduce that any politically self-sustaining tax rate λ , if it exists, must take intermediate values. A rise in λ produces two opposing effects.

1. Majority formation (positive). The green education policy promotes the transmission of connectedness to nature in urban areas. If λ is too low, the transmission of connectedness to nature in the city through decentralized socialization remains too weak for urban connected agents to form a majority in the long run. A sufficiently large λ is therefore necessary to sustain a long-run majority of urban connected individuals.

2. Welfare improving policy (negative). A rise in λ , however, negatively affects the indirect utility of urban connected agents through two channels. First, due to decreasing returns in policy investment, a rise in λ reduces the marginal cultural benefit of the policy. Second, a higher λ depresses both consumption and investment in environmental protection, thereby raising the opportunity cost of the policy. It follows that only sufficiently low values of λ can be welfare-improving for urban connected individuals.

We now turn to the existence of the set of politically self-sustaining policies.

Proposition 10. *Suppose that $\Delta \leq 2d$. There is no value of the green education policy which is politically self-sustaining. Suppose that $\Delta > 2d$. There exists a threshold $\tilde{A}_g$ such that $\forall A_u > \tilde{A}_g$, the set of politically self-sustaining policy is non-empty.*

Mechanism: cultural influence through political leverage. A politically self-sustaining policy owes its persistence to a self-reinforcing interplay between spending on the socialization policy and the prevalence of connected agents. First, a rise in the share of connected agents encourages their selective migration into the city (for reasons detailed above). This compositional shift increases the electoral power of urban individuals who hold the connected trait, which in turn raises public spending on centralized socialization. Higher spending on that policy then promotes the intergenerational transmission of the connected trait in the city, further increasing the future share of connected agents. We term this self-reinforcing mechanism “cultural influence through political leverage”.

This mechanism is consistent with the findings of Giuliano and Tabellini (2020) discussed in Section 1.1: in US counties where European immigrants were more numerous, their political incorporation was stronger, which fostered the diffusion of their ideology, notably through the establishment of socializing institutions such as newspapers. In our setting, this mechanism does not always operate. Proposition 10 establishes that cultural influence through political leverage emerges when both labor productivity in the city and the incentives for connected parents to transmit their trait are high.

Urban productivity as a pull factor: size effect (positive or negative). As a pull factor, a rise in urban labor productivity generates two opposing forces. On the positive side, it strengthens the selection of connected individuals into the city, enlarging the group in favor of centralized socialization and amplifying cultural influence through political leverage. On the negative side, a larger share of connected agents in cities reduces decentralized socialization through a cultural substitution effect: as oblique transmission becomes stronger in the urban area, connected parents reduce their own socialization efforts which negatively affects the future fraction of connected agents in the city. This decentralized socialization effect undermines the persistence of political power over time. For the positive political effect to dominate the negative decentralized socialization effect,

the transmission of the connected trait must remain strong even when the fraction of connected agents in the city is large. Two additional conditions must be satisfied for this property to hold.

Incentives for connected parents to transmit their trait (positive). First, cultural substitution must be weak, which requires that incentives for connected parents to transmit their trait are sufficiently strong, i.e. $\Delta > 2d$.

Urban productivity as a growth factor: income effect (positive). Second, transmission through the socializing institution must be strong, which requires total policy spending, λY , to be large. This is true when A_u is high. Here again, a rise in A_u generates two opposing effects. On the positive side, it raises aggregate income Y , increasing total policy spending for a given λ (equivalently, it lowers the threshold λ^1 defined in Lemma 1). On the negative side, it reduces the level of λ that connected urban parents are willing to accept, as higher productivity diminishes the marginal benefit of the policy due to the concavity of G (equivalently, it lowers the threshold λ^2 defined in Lemma 2). Overall, the first effect dominates: when urban productivity becomes sufficiently high, total spending on the socialization policy necessarily becomes large enough (or equivalently, the decline in λ^2 is smaller than the decline in λ^1). The intuition is that total spending λY grows proportionally with income Y whereas λ itself falls less than proportionally with Y , owing to the concavity of G .²⁸

6 Conclusion

This paper has examined the relationship between urbanization and the global environment through a channel that has received comparatively little attention in the economic literature: public support for environmental policies. Support for costly environmental policies is driven by many factors: education, income, and political affiliation all matter. We have focused on Connectedness to Nature as a complementary and largely overlooked dimension. ISSP data reveal that CTN is a significant predictor of support for environmental policies – the dominant one when it comes to the protection of natural areas, ahead of both ideology and education. What makes this channel distinctive is not only that connectedness shapes support, but that evidence suggests that connectedness is itself shaped by urbanization. This two-way relationship is what gives the channel its importance: its dynamics may come to dominate the long-run relationship between urbanization and the environment.

The paper has modeled this two-way interplay explicitly. It brings together two mechanisms: the extinction of experience documented by conservation science, whereby urban life erodes the direct contact with nature that fosters environmental attachment, and the cultural transmission of preferences central to the economics of value formation. Combining them yields non-trivial

28. Formally, for a given λY the marginal benefit of λ , $YG'(\lambda Y)$, scales with Y . If λ fell proportionally with Y , λY would be bounded, so that $G'(\lambda Y)$ would stay bounded away from zero and $YG'(\lambda Y)$ would diverge; urban connected parents would then never choose λ close to zero, a contradiction. Hence λY diverges with urban productivity.

implications for the long-run urbanization–environment link. When the extinction of experience dominates, urbanization erodes connectedness to nature and, with it, the support for environmental protection. But when socialization is effective, the picture reverses. Urbanization then sets in motion a process of cultural dissemination: individuals with strong connectedness to nature sort into large cities for economic reasons and compensate for the reduced opportunities for direct nature experiences through stronger socialization efforts toward the next generation. Consequently, urbanization no longer weakens environmental preferences; instead, it reinforces them over time.

The analysis highlights the importance of institutions involved in the transmission of environmental values. Even when decentralized socialization by parents and peers is relatively ineffective, urbanization may still foster connectedness to nature by making centralized socialization institutions (schools, environmental education programs, urban conservation initiatives) more feasible and effective. In either case, what looks like a force of environmental decline can become, in the long run, a force for improvement.

These results point toward several avenues for future research. On the empirical side, a particularly promising direction would be to identify the causal effect of childhood interactions with nature on connectedness later in life and, ultimately, on support for environmental policies. A number of local and national policy initiatives explicitly designed to increase such interactions – from the forest kindergartens that have spread across Germany and Scandinavia since the 1990s, to school-based programs such as the Natural Connections project in England (2012–2016), to the French *aires éducatives* scheme generalized in 2018 – may provide promising natural experiments for this purpose. On the theoretical side, we have proposed a new framework for studying the interaction between urbanization and value formation, which we have applied here to connectedness to nature. The same setting could be applied to other values that matter for policy formation: trust, but also civic-mindedness or attitudes toward redistribution. This opens the way to a new research agenda – a political economy of urbanization – in which cities are not merely the outcome of economic forces but active sites of preference formation and sorting, whose interplay shapes the values on which future policies rest.

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A Proofs of the Propositions

Proof of Proposition 1 First, $\Delta U^C < \Delta U^N$ leaves only three possible configurations—full segregation, a mixed city, or a mixed countryside. Then $\partial \Delta U^i / \partial P_j < 0$ makes the thresholds on q unique, and, within each mixed regime, it pins down a unique interior population allocation. Existence follows from $\lim_{P_j \rightarrow 0} \Delta U^i = +\infty$. $\square$

Proof of Proposition 2 When $t \rightarrow \infty$, if $q < 1/2$ we have $\tau_t^* = 0$, and the result follows directly from the law of motion of environmental quality (1). If $q \geq 1/2$, the tax is positive and E_t converges to an interior steady state $E_\infty = \frac{1-b}{b}(m-c)Y_\infty > 0$, an increasing function of Y_∞ . The value of Y_∞ then follows from the spatial equilibrium of Proposition 1: it depends on the population split between the two regions, which is pinned down by q and by whether urban productivity exceeds the sorting threshold $A_r \gamma^{-(1-b)/b}$. Convergence follows from the monotonicity of the one-period map governing E_t . $\square$

Proof of Proposition 3 Suppose $q \geq 1/(1+\delta)$. Then, for all $A_u \in (A_r, +\infty)$, $q > 1/(1+\varphi\delta)$. By Proposition 2, E_t converges to $E(1/(1+\varphi\delta))$. Suppose $q < 1/(1+\delta)$. Define $\tilde{A}_u \equiv A_r \left(\frac{1-q}{q} \frac{1}{\delta} \right)^{(1-\alpha)}$. When $A_u \leq \tilde{A}_u$ (equivalent to $q \leq 1/(1+\varphi\delta)$), Proposition 2 implies that E_t converges to $E(q)$. When $A_u \geq \tilde{A}_u$, E_t converges to $E(1/(1+\varphi\delta))$. Both quantities $E(1/(1+\varphi\delta))$ and $E(q)$ are increasing in A_u .

The second item of Proposition 3 is easily deduced from Proposition 2 and using the fact that $\partial E / \partial x < 0$. $\square$

Proof of Proposition 4 The argument follows that of Proposition 1. Relative to the benchmark, ΔU^C carries an additional term reflecting parents’ socialization incentives, which shifts the segregation threshold upward, from $1/(1+\varphi\delta)$ to $\tilde{q}$. The three-regime structure and the uniqueness of the segregated splits are otherwise as in Proposition 1; we only establish here the existence and uniqueness of the interior equilibrium in the mixed urban regime. Differentiating,

$$\frac{\partial \Delta U^C}{\partial P_u^C} = \frac{P}{P_u^C + P^N} \left(-\frac{b(1-\alpha)}{P^C - P_u^C} + \Delta V(1-\beta_u)(1-d_u^*)(1-q) \frac{1}{P_u^C + P^N} \right).$$

Using $1/(P^C - P_u^C) > 1/P^C$ and $(1 - q)/(P^N + P_u^C) < 1/P$, a sufficient condition for this derivative to be negative is $b(1 - \alpha)/P^C > \Delta V(1 - \beta_u)/P$, i.e. $b(1 - \alpha) > \Delta V(1 - \beta_u)P^C/P$, which holds under $-b(1 - \alpha) + \Delta V(1 - \beta_u) < 0$. Since ΔU^C is continuously differentiable in a neighborhood of (P_u^{C*}, P^C) with $\partial \Delta U^C / \partial P_u^C \neq 0$, the implicit function theorem yields a function $\Omega : [P\tilde{q}, P] \rightarrow [0, P^C]$ implicitly defined by $\Delta U^C(\Omega(P^C), P^C) = 0$. $\square$

Proof of Proposition 5 For $q_t \leq \tilde{q}$ the dynamics are immediate. We focus on the mixed regime $q_t > \tilde{q}$. Writing the law of motion of q_t and simplifying, $q_{t+1} - q_t \geq 0$ is equivalent to

$$\Lambda(q_{ut}) = (1 - q_{ut})(1 - \beta_u)(d_{ut}^* - d) - \beta_u \geq 0.$$

In the corner regime ($d_{ut}^* = d$) $q_{t+1} - q_t < 0$; in the interior regime, we show that $q_{t+1} \geq q_t$ if and only if $q_{ut} \leq \kappa$, with $\kappa = 1 - \frac{d+(d^2+4\Delta\beta_u)^{1/2}}{2\Delta(1-\beta_u)}$.

Since $\kappa \leq 0$ is equivalent to $\beta_u \geq \tilde{\beta}_2$, the sign of κ splits the analysis. If $\beta_u \geq \tilde{\beta}_2$, then $q_{ut} > \kappa$ throughout the mixed regime, so that $q_{t+1} < q_t$: the sequence decreases and, remaining above $\tilde{q}$ by Lemma C.2 (in the Online Appendix), converges to $\tilde{q}$. If $\beta_u < \tilde{\beta}_2$, the condition $q_{ut} \leq \kappa$ is equivalent to $P_{ut}^{C*} \leq \Gamma(P_t^C)$.²⁹ The steady states are the crossings of Γ with the location-equilibrium locus Ω . Since Γ is decreasing while Ω is increasing with $\Omega(\tilde{q}P) = 0 < \Omega(P)$, the two curves cross exactly once, at an interior point $q^* \in (\tilde{q}, 1)$. Convergence to q^* follows from Lemmas C.2 and C.4 together with Coppel's theorem (details in the Online Appendix).

Proof of Proposition 6 In the long run q_t is constant, so the argument of Proposition 2 applies: environmental quality converges to zero if $q_\infty < 1/2$ and to $E(P_{u\infty}/P) > 0$ if $q_\infty \geq 1/2$. Since $1/(1 + \varphi) < 1/2$, the proof amounts to locating q_∞ relative to $1/2$, using the three convergence regimes of Proposition 5.

If $q_0 < \min\{\tilde{q}, 1/2\}$, then $q_\infty < 1/2$ and $E_t \rightarrow 0$. If $q_0 > \min\{\tilde{q}, 1/2\}$, there are several cases. If $q_0 \in [1/2, \tilde{q}]$, the sequence is constant, so $q_\infty = q_0 \geq 1/2$. If $q_0 > \tilde{q}$, $q_\infty = \tilde{q}$ (when $\beta_u \geq \tilde{\beta}_2$) or $q_\infty = q^*$ (when $\beta_u < \tilde{\beta}_2$).

The position of these limits relative to $1/2$ is governed by urban relative productivity: $\tilde{q} \geq 1/2$ is equivalent to $A_u \leq \bar{A}$, and, for $\beta_u > \tilde{\beta}_1$, $q^* \geq 1/2$ is equivalent to $A_u \leq \tilde{A}$, while $q^* \geq 1/2$ always holds when $\beta_u \leq \tilde{\beta}_1$. The long-run level of E then follows from Proposition 2; the boundary cases are immediate. $\square$

Proof of Proposition 7 We track how E_∞ varies with urban productivity A_u , for a fixed β_u . Two forces oppose each other: a higher A_u raises urbanization and hence aggregate output and E ; but the rise in the long-run urbanization rate lowers the CTN share, which lowers E . The proof determines which force dominates by locating, in the (A_u, β_u) plane, the boundaries between the convergence regimes of Proposition 6.

29. Note that the region $P_{ut}^{C*} > \Gamma(P_t^C)$ includes the corner regime

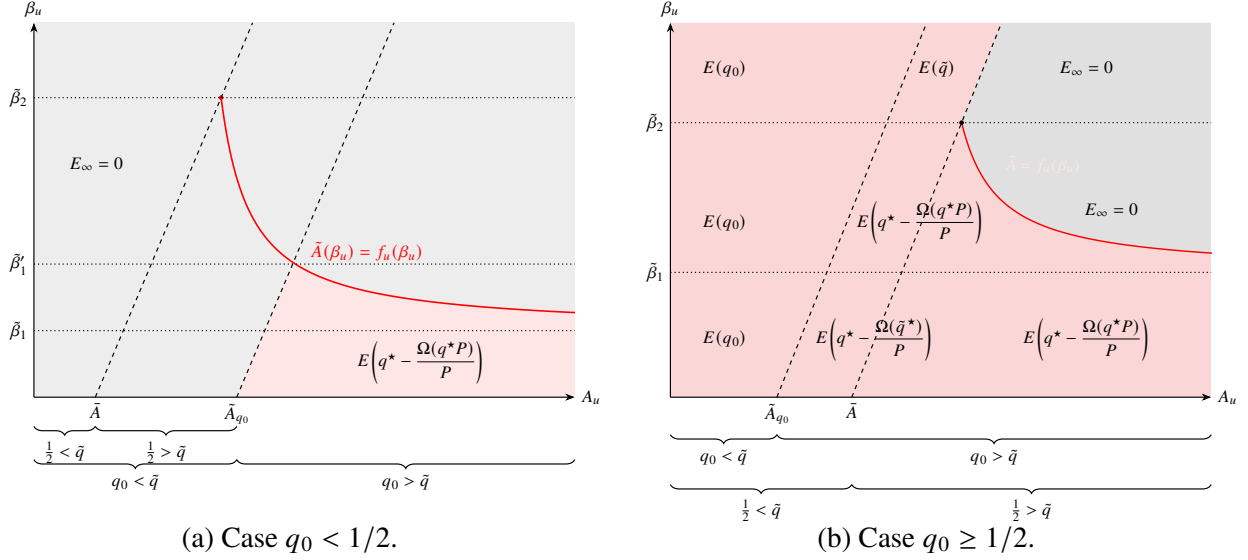


Figure 6: Long-run environmental quality E_∞ in the plane (A_u, β_u) . Grey: $E_\infty = 0$; red: $E_\infty > 0$.

Three productivity thresholds organize the analysis: $\tilde{A}_{q_0}$, above which $\tilde{q} < q_0$; $\bar{A}$, above which $\tilde{q} < 1/2$; and $\tilde{A}$, above which $q^* < 1/2$. The first two are the values of A_u solving $f_{\tilde{q}}(A_u) = q_0$ and $f_{\tilde{q}}(A_u) = 1/2$ respectively, where $f_{\tilde{q}}$ is continuously decreasing; the third is $\tilde{A} = f_u(\beta_u)$, defined in Lemma C.5. Their *ordering* depends on the sign of $q_0 - 1/2$ and on β_u , as depicted in Figures 6a–6b. When $q_0 < 1/2$ (Figure 6a), $\tilde{A}_{q_0}$ (increasing in β_u) and $\tilde{A} = f_u(\beta_u)$ (decreasing, Lemma C.5) cross at $\tilde{\beta}_1'$.

Combining these thresholds with Proposition 6 yields $E_\infty(A_u)$ region by region. Wherever the limit is the interior steady state, $E(q^* - \Omega/P)$ is *increasing* in A_u :

$$\frac{\partial E(q^* - \Omega(q^*P)/P)}{\partial A_u} = \frac{1-b}{b}(m-c)P^\alpha(1-q^* + \Omega(q^*P)/P)^\alpha + \frac{\partial E}{\partial x} \frac{\partial(q^* - \Omega(q^*P)/P)}{\partial A_u},$$

which is positive since $\partial(q^* - \Omega(q^*P)/P)/\partial A_u < 0$ (Corollary C.1 in the Online Appendix) and $\partial E/\partial x < 0$. Elsewhere E_∞ is either constant ($E(q_0)$ or $E(\tilde{q})$) or zero. The qualitative conclusion follows. $\square$

Proof of Proposition 8 The argument follows that of Proposition 4; we only highlight what the policy changes. The three-regime structure and the uniqueness of the segregated splits are as in Proposition 1. The novelty is that urban exposure is now endogenous, $\beta_g = \beta_u(1 - G(\lambda Y_g))$, so establishing the existence and uniqueness of the mixed-regime equilibrium requires controlling an additional channel.

Differentiating ΔU^C in P_u^C produces an additional term in $\partial \beta_g / \partial P_u^C$. Under the assumption $G'(x) < G(x)/x$ (satisfied, e.g., by $G(x) = x/(1+x)$), this policy term is bounded by $\beta_u G(\lambda Y_g)$, giving

$$\frac{\partial \Delta U^C}{\partial P_u^C} < \frac{1}{P_u^C + P - P^C} \left(-b(1 - \alpha) + \Delta V(1 - \beta_u + 2\beta_u G(\lambda Y_g)) \right) \leq \frac{-b(1 - \alpha) + \Delta V(1 + \beta_u)}{P_u^C + P - P^C},$$

where the last inequality uses $G \leq 1$. Symmetrically, $\partial \Delta U^C / \partial P^C > 0$.

Existence and uniqueness then follow from the implicit function theorem, applied twice. First, since $\Delta U^C(0, P^C, \lambda)$ increases continuously from a negative value at $P^C = P/(1 + \varphi\delta)$ to $+\infty$ as $P^C \rightarrow P$, it has a unique zero, defining the segregation threshold $\tilde{q}(\lambda)$ through $\Delta U^C(0, P\tilde{q}(\lambda), \lambda) = 0$; where $\partial \tilde{q} / \partial \lambda < 0$. Second, for $q \geq \tilde{q}(\lambda)$, $\Delta U^C(P_u^C, Pq, \lambda)$ is strictly decreasing in P_u^C and diverges to $-\infty$ as $P_u^C \rightarrow Pq$, so it has a unique interior zero, defining the urban connected mass $\Omega_g(P^C, \lambda)$, with $\partial \Omega_g / \partial P^C > 0$, $\Omega_g(P\tilde{q}(\lambda), \lambda) = 0$ and $\Omega_g(P, \lambda) > 0$. $\square$

Proof of Proposition 9 The argument parallels that of Proposition 5, with the urban exposure parameter now policy-dependent. We write $Y_g(\cdot) \equiv Y_g(P_u^C, P^C) = A_u P_u^\alpha + A_r P_r^\alpha$ and $\beta_g(\cdot) \equiv \beta_g(P_u^C, P^C, \lambda) = \beta_u / (1 + \lambda Y_g(\cdot))$. For $q_t \leq \tilde{q}(\lambda)$ the dynamics are as in Proposition 5. In the mixed regime $q_t > \tilde{q}(\lambda)$, $q_{t+1} \geq q_t$ if and only if $P_{ut}^{C*} \leq K(P_{ut}^{C*}, P_t^C)$, where

$$K(P_u^C, P^C) = (P - P^C) \frac{\kappa_g(\beta_g(\cdot))}{1 - \kappa_g(\beta_g(\cdot))}$$

and κ_g is the policy-dependent analogue of κ . We define $\Theta : [P\tilde{q}(\lambda), P] \rightarrow \mathbb{R}$ given by $\Theta(P^C) = \Omega_g(P^C, \lambda) - K(\Omega_g(P^C, \lambda), P^C)$. Then $q_{t+1} \geq q_t$ if and only if $\Theta(P^C) \leq 0$.

Existence of an interior steady state follows from the boundary values: $\Theta(P\tilde{q}(\lambda)) = -K(0, P\tilde{q}(\lambda))$, which is negative if and only if $\kappa_g(\beta_g(\cdot)) > 0$ at the segregation threshold, i.e. $\lambda > \tilde{\lambda}$ (the policy must be effective enough there); and $\Theta(P) = \Omega_g(P, \lambda) > 0$ since $K(\cdot, P) = 0$. Uniqueness is the delicate step, because a higher P^C raises both Ω_g and, through urban output and the policy's effectiveness, K . We show that $\Theta' > 0$ at every zero of Θ : there, $\kappa_g(\beta_g(\cdot))$ equals the urban share of connected agents, and combining $\Omega'_g > 1$ (Proposition 8) with an explicit bound on $\partial K / \partial P_u^C$ yields the result. Hence Θ has a unique zero $Pq^*(\lambda)$, with $q^*(\lambda) \in (\tilde{q}(\lambda), 1)$ and $q_{t+1} \geq q_t$ if and only if $q_t \leq q^*(\lambda)$. Convergence then follows from the continuity and monotonicity of the one-period map, established in the online Appendix. $\square$

Proof of Lemma 1 Condition (i) holds if and only if $q^*(\lambda) > \hat{q}(\lambda)$, equivalently $\Theta(P\hat{q}(\lambda)) < 0$, i.e. $P/2 < K(P/2, P\hat{q}(\lambda))$. Substituting the equilibrium values, this reduces to $A - 2\kappa_g(X) + 1 < 0$, where $A > 0$ collects the location differential and X is the policy-adjusted exposure at $(P/2, P\hat{q}(\lambda))$.

The left-hand side is decreasing in Y , tending to $A - 1 + 2d/\Delta$ as $Y \rightarrow \infty$; hence the condition can hold only if $2d/\Delta < 1$, which we assume. Bounding A from above by $\frac{1}{\varphi\delta} e^{\Delta V/(b(1-\alpha))}$ and using that $\kappa_g(X)$ increases with Y while Y_g is minimized at $Y_{\min}$ (since Y_g decreases in P^C over the relevant range), we obtain a sufficient condition for (i) that depends on λ only through $\kappa_g(\beta_u(1 - G(\lambda Y_{\min})))$: $\frac{1}{\varphi\delta} e^{\frac{\Delta V}{b(1-\alpha)}} - 2\kappa_g(\beta_u(1 - G(\lambda Y_{\min}))) + 1 < 0$.

The left-hand side is continuous and decreasing in λ . At $\lambda = 0$ it is positive since $\beta_u \geq \tilde{\beta}_2$. Provided it holds at $\lambda = 1$, there exists a threshold $\lambda^1 \in (0, 1)$ above which condition (i) holds. Whether $\lambda^1 \leq \tilde{\lambda}$ depends on the sign of the same expression evaluated at $\tilde{\lambda}$. $\square$

Proof of Lemma 2 Under condition (i), $P_{u\infty} \geq P/2$, and at any mixed-regime equilibrium $P_u/P_r \leq \varphi\delta < \varphi$, so that $P_{u\infty} < \varphi P/(1 + \varphi)$; as aggregate output increases with P_u on this range, Y_λ lies between $Y_{\min} = (P/2)^\alpha (A_u + A_r)$ and $Y_{\max} = P^\alpha (A_u \frac{\varphi^\alpha}{(1+\varphi)^\alpha} + A_r \frac{1}{(1+\varphi)^\alpha})$. We derive a sufficient condition for (ii). Bounding the transmission term below by d and the factor $Y/(1 + \lambda Y)^2$ below by its minimum over $[Y_{\min}, Y_{\max}]$, attained at $\bar{Y}(\lambda) \in \arg \min_{Y \in [Y_{\min}, Y_{\max}]} Y/(1 + \lambda Y)^2$, condition (ii) holds whenever

$$\beta_u \frac{\bar{Y}(\lambda)}{(1 + \lambda \bar{Y}(\lambda))^2} d\Delta V - \frac{b}{1 - \lambda - c/m} \geq 0.$$

Since $Y \mapsto Y/(1 + \lambda Y)^2$ is unimodal, $\bar{Y}(\lambda)$ is one of the two endpoints $Y_{\min}, Y_{\max}$, so the left-hand side is the minimum of two strictly decreasing functions of λ net of a strictly increasing one—hence strictly decreasing and continuous in λ (continuous despite the possible jump of $\bar{Y}$, since the two branches coincide at a switch).

Provided the condition holds at $\lambda = 0$ (equivalently $\beta_u Y_{\min} d\Delta V > b/(1 - c/m)$), monotonicity yields a threshold $\lambda^2 \in (0, 1 - c/m)$ such that (ii) holds if and only if $\lambda \leq \lambda^2$. $\square$

Proof of Proposition 10 Recall that condition (i) holds for $\lambda \geq \lambda^1$, condition (ii) for $\lambda \leq \lambda^2$, and CTN persists for $\lambda > \tilde{\lambda}$; the policy is feasible on the interval $(\max\{\lambda^1, \tilde{\lambda}\}, \lambda^2]$, which is non-empty if and only if $\max\{\lambda^1, \tilde{\lambda}\} < \lambda^2$. We show this holds for large values of A_u .

Each threshold is defined implicitly and exists once A_u exceeds some level: λ^1 and $\tilde{\lambda}$ require $1 - 2d/\Delta > 0$, and λ^2 exists once output is large enough for the policy to be beneficial at $\lambda = 0$.

The crux is the following. As $A_u \rightarrow \infty$, the definition of λ^2 implies $\lambda^2 Y_{\min} \rightarrow \infty$. Using this, both comparisons $\lambda^1 < \lambda^2$ and $\tilde{\lambda} < \lambda^2$ reduce to $1 - 2d/\Delta > 0$, which holds by assumption.

Finally, each threshold is a continuous function of $A_u - \lambda^1$ and $\tilde{\lambda}$ by the implicit function theorem (the defining maps being C^1), and λ^2 by monotonicity (its defining map is only piecewise C^1) – so the strict inequalities obtained in the limit persist for all A_u above some $\tilde{A}_g$. Hence $\max\{\lambda^1, \tilde{\lambda}\} < \lambda^2$ for $A_u > \tilde{A}_g$. $\square$