Understanding Cultural Persistence and Change

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Abstract: When does culture persist and when does it change? We examine a determinant that has been put forth in the evolutionary anthropology literature: the stability of the environment. A prediction, which is standard in a variety of micro-founded models, is that following the customs of the previous generation is relatively more beneficial in stable environments. When the environment is stable, the culture of the previous generation provides valuable information that is relevant for the current generation. We test this hypothesis by measuring the stability of the average temperature across 20-year generations from 500-1900. Looking across countries, ethnic groups, and the descendants of immigrants, we find that groups with ancestors who lived in environments with more stability, place a greater importance in maintaining tradition today. These populations also exhibit more persistence in their traditions over time.

Key words: Cultural persistence, cultural change, tradition

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1. Introduction

Increasingly, we are coming to understand the role of culture and its importance for economic development (e.g., Nunn, 20012, Spolaore and Wacziarg, 2013). A number of studies have documented the persistence of cultural traits over very long periods of time (e.g., Voigtlaender and Voth, 2012). Strong cultural persistence that lasts for generations has been documented among migrants and their descendants (e.g., Fischer, 1989, Fernandez, 2007, Giuliano, 2007, Fernandez and Fogli, 2009, Algan and Cahuc, 2010). We also have accumulating evidence that vertically transmitted traits, such as culture or a common history, are important determinants of differences in economic development that are highly persistent overtime (Spolaore and Wacziarg, 2009, Comin, Easterly and Gong, 2010, Chanda and Putterman, 2014). Along these lines, numerous studies show how deep historical factors can shape persistent cultural traits (Giuliano and Nunn, 2013, Alesina, Giuliano and Nunn, 2013, Talhelm, Zhang, Oishi, Shimin, Duan, Lan and Kitayama, 2014, Becker, Boeckh, Hainz and Woessmann, 2016, Buggle and Durante, 2016, Guiso, Sapienza and Zingales, 2016).

On the other hand, there are also numerous examples of a lack of cultural persistence – namely, episodes of significant changes in culture. A well-studied episode of cultural change is the Protestant Reformation in Europe (e.g., Becker and Woessmann, 2008, 2009, Cantoni, 2012, 2014). Another example, though on a smaller scale, is the Puritan colony established in Providence Island, off of the coast of Nicaragua, in the early 17th century (Kupperman, 1995). Unlike the Puritan colony established in Massachusetts, this colony experienced significant cultural change. Abandoning their traditional values, the Puritans began large-scale use of slaves and engaged in privateering. Margaret Mead's (1956) ethnography of the Manus documents how, in a single generation, this society completely changed their culture, abandoning the previous practices of living on stilt houses on the sea to living on land, wearing European clothes, and adopting European institutional structures in the villages. Firth (1959) also documents similarly dramatic cultural changes that occurred within one generation among the Polynesian community of Tikopia.[1]

Given that we have numerous examples of cultural persistence and numerous examples of cultural change, a natural question arises: when does culture change and when does it persist? In

[1]Also related are studies that find evidence of a lack of economic persistence and even reversals. See for example Acemoglu, Johnson and Robinson (2002) and Olsson and Paik (2012).

particular, what determines a society's willingness to adopt new customs and beliefs rather than hold on to tradition? We consider this question here. In particular, we test for the importance of the stability of a society's environment, a determinant that is central in the theoretical evolutionary anthropology literature (e.g., Boyd and Richerson, 1985, Aoki and Feldman, 1987, Rogers, 1988, Feldman, Aoki and Kumm, 1996, Boyd and Richerson, 2005).

To see how the environment and its stability is an important determinant of cultural change, first consider a population living in a stable environment. In this setting, the customs and beliefs of one's ancestors are particularly helpful in deciding what actions are best in the current setting. Given that they had evolved and survived up until the prior generation, they likely contain valuable information that is relevant in the current generation. That is, there are potential benefits to a belief in the importance of following and maintaining the traditions of the previous generation.[2] The more similar the environment is across generations, the more likely it is that the traditions of the previous generation are useful for the current generation. Thus, for societies that live in stable environments, there are significant benefits to valuing tradition and placing importance on the continuity of cultural practices across generations.

Next, consider a population living in a very unstable environment, where the setting of each generation changes so much that the customs and beliefs of the previous generation may not be relevant for the current generation.[3] In this setting, the traditions of one's ancestors are less informative of the best actions for the current generation. Thus, a culture that strongly values tradition is less beneficial, and therefore we expect these societies to place less importance on maintaining tradition and to be more willing to adopt new practices and beliefs.

We take this hypothesis to the data and test whether societies that historically lived in environments with more environmental instability value tradition less, are more likely to adopt new cultural values, and exhibit less cultural persistence over time. To measure the stability of the environment historically, we use paleo-climatic data from Mann, Zhang, Rutherford, Bradley, Hughes, Shindell, Ammann, Faluvegi and Ni (2009a) that measures the average annual temperature of 0.5 degree by 0.5 degree grid-cells globally beginning in 500AD. For each grid-cell, we calculated variability (i.e., standard deviation) of the average temperature across 20-year

[2]See Henrich (2016) for evidence and examples of these benefits.

[3]For example, it is well-known that cooling during the Little Ice Age resulted in social unrest, increased conflict, and slower economic growth (e.g., Baten, 2002, Oster, 2004, Dalgaard, Hansen and Kaarsen, 2015, Waldinger, 2015, Iyigun, Nunn and Qian, 2017). As well, there is evidence that greater seasonal variability resulted in the neolithic transition, one of the most important social changes in human history (Matranga, 2016).

generations between 500 and 1900AD.

With these data, we undertake four different tests of the hypothesis of interest. Our first set of tests examines self-reported views on the importance of tradition from the *World Values Surveys*. Looking across countries, and across ethnic groups within countries, we find that greater historical variability is associated with a weaker self-reported belief in the importance of tradition today.

Our second strategy tests the effects of climatic instability on the importance of tradition by examining its effect on the persistence of two important cultural traits over time for which data are available. The first is gender values (measured by female labor force participation) and the second is beliefs about the acceptability of polygamy. Both cultural traits are observed in a large set of ethnicities and over long periods of time. Our analysis first documents the persistence of female labor force participation and polygamy over time. We then test whether the persistence is weaker in countries with more historical instability of the environment. We find that this is in fact the case. While most countries experience significant persistence, for the countries that have the most unstable climates, we find no persistence in the cultural practices over time.

Our third strategy is to examine a group's revealed preference for tradition as measured by its ability to refrain from adopting new customs and values. Specifically, we study the descendants of immigrants that have moved to the United States. Immigrants are a group that have traditional cultural values, but are also living in a new environment with new practices and beliefs. This creates natural forces that can lead to the erosion of traditional practices. Our analysis examines the extent to which the descendants of immigrants from different societies hold on to their traditional cultures. More specifically, we test whether individuals from societies that historically lived in unstable environments are less likely to hold on to traditional practices. We examine whether children of immigrants marry someone from the same ancestral group and whether they speak a foreign language (rather than English) at home. We find that children of immigrants from countries with a more unstable historical environment are less likely to marry someone from their own ancestral group and are more likely to speak English at home. In other words, a history of environmental instability is associated with less persistence of traditional cultural practices.

One concern with our analysis involving immigrants is that they are not necessarily a representative sample of the origin populations. The nature of selection of immigrants may be different for different countries. This is particularly problematic if the nature of selection varies systematically with the historical environmental stability of the origin country. Given these concerns, our fourth exercise examines a population that is faced with pressure to change their traditions and customs, but are not immigrants. These are the Indigenous populations of the United States and Canada. Like immigrants, Indigenous populations are minority groups with different cultural traditions and living within a dominant foreign population. However, unlike immigrants, the population of Indigenous populations does not reflect selection into migration. Our analysis examines the relationship between the climatic instability of the land historically inhabited by Indigenous groups and the extent to which they are able to speak their traditional language today. We find that, as with the descendants of immigrants, Indigenous populations with a history of greater environmental instability are less likely to speak their traditional language. They appear to have been more likely to abandon this cultural tradition and to adopt English as the language spoken at home.

Overall, each of our four strategies, which test for the importance of the stability of the environment for cultural persistence, yields the same conclusion. Tradition is less important and culture less persistent among populations with ancestors who were located in less stable environments.

Our results contribute to a deeper understanding of cultural persistence and change. Two previous studies use lab-based methods to test the prediction of the relationship between the stability of the environment and cultural persistence that arise from models of cultural evolution (McElreath, Lubell, Richerson, Waring, Baum, Edstein, Efferson and Paciotti, 2005, Toelch, van Delft, Bruce, Donders, Meeus and Reader, 2009).[4] McElreath et al. (2005) examine the behavior of 30–40 student participants (depending on the experiment). Students play the role of farmers, choosing which of two crops to plant over a sequence of twenty consecutive planting seasons. In one of the modules of the experiment, the so called "social learning" module, students can choose to learn the planting choices of participants during the previous season before making their decision. The social learning module is equivalent to cultural persistence, as students use the information acquired from another group. The authors find evidence that, within the experiment, reliance on social learning (or tradition) is lower when there is less stability in the payoffs to planting each crop. A subsequent experiment implemented by Toelch et al. (2009) with

[4]Prior to these studies, Galef and Whiskin (2004) had used rats to test for a relationship between the stability of the environment and social learning. Consistent with the models, they founds social learning to be stronger when the environment was more stable.

62 undergraduate students yielded the same finding. In the experiment, participants attempted to find a reward within a virtual maze. There were three treatment groups that varied in the probability that the location of the reward would change after each of 100 rounds. The authors found that more social learning occurred – that is, behavior was influenced by the actions and payoffs of others – when the environment was less variable.

The findings from a number of studies within economics provide important insights into the process of cultural change. Fouka (2015) studies the effects of language restrictions against German schools in the early 20th century United States. She finds that these restrictions actually strengthened the value placed on German culture and identity, and its transmission over generations. Specifically, she finds that the restrictions increased the rates of within-group marriage and the choice of distinctively German names for children. Along similar lines, Abramitzky, Boustan and Eriksson (2016) examine the naming practices of immigrants that arrived to the United States at the end of the Age of Mass Migration. The authors use the foreignness of child names to trace out the extent of cultural assimilation of immigrants over time. They find that parents tend to choose less foreign names the longer they are in the United States. They also find that the speed of assimilation varies significantly across origin-countries. Our study can be seen as testing one hypothesis that explains this variation in cultural assimilation.

Giavazzi, Petkov and Schiantarelli (2014) study the complementary question of which types of cultural traits tend to persist and which types of traits tend not to persist. The authors examine the children of immigrants to Europe and the United States and document that certain cultural traits show a high degree of persistence – e.g., religious values and political orientation – while others do not – e.g., attitudes towards cooperation, independence, and women's work. Voigtlaender and Voth (2012) show that the persistence of anti-Semitic attitudes in Germany over a 600-year period was weaker in towns that were more dynamic economically or were more open to external trade. Our findings are consistent with this prior evidence. One can interpret German towns with faster economic growth and greater openness to external trade as being inherently less stable, and therefore cultural persistence is weaker.

On the theoretical front, Greif and Tadelis (2010) examine the persistence of cultural values in a setting with an authority, such as a state or church, that is attempting to change the cultural values of the population. The authors allow for the population to engage in actions that differ from their true values, and to pass on values to their children that are different from those reflected in their actions. They examine how the persistence of cultural values differ depending on the extent to which the authority can detect and punish the presence of hidden beliefs. They also consider the possibility of direct socialization of the state through, for example, centralized state schooling.

In addition to providing a better understanding of when we expect culture to persist and when we expect it to change, our findings are also important because they provide empirical support for a class of models that predict the endogenous emergence of tradition and culture. Testing the predictions that arise from models of evolutionary anthropology is important since the current models of cultural evolution within economics implicitly built on a number of important outcomes of models from evolutionary anthropology. Within this class of models, under general circumstances, some proportion of the population finds it optimal to rely on social learning – i.e., culture – when making decisions. This result provides a justification for the assumption in models of cultural evolution that parents choose to (and are able to) influence the preferences of their children. Thus, our study provides empirical validation for a class of models from evolutionary anthropology that provide a foundation for the assumptions made in the models used in cultural economics (e.g., Bisin and Verdier, 2000, 2001, Hauk and Saez-Marti, 2002, Francois and Zabojnik, 2005, Tabellini, 2008, Greif and Tadelis, 2010).

The next section of the paper describes the hypothesis and its mechanisms using a simple model. The model shows, in the simplest possible terms, how a stable environment tends to favor a cultural belief in the importance of tradition and therefore cultural persistence. In section 3, we then turn to a description of our data. This is followed by a description of our empirical tests and results, which are found in sections 4–7. Section 8 reports tests of alternative effects of climatic instability, while section 9 concludes.

2. The model

We now present a simple model that highlights the intuition of how the stability of the environment can affect the extent to which individuals value the importance of tradition. The insight that emerges from the model is that it is relatively less beneficial to value the tradition of the previous generation, by following their actions, when the environment is less stable. Intuitively, this is because the traditions and actions that have evolved up to the previous generation are less likely to be suitable for the current generation when the environment changes frequently. This insight has been formally established in the evolutionary anthropology literature using a variety of different models and in a range of settings. Examples include Boyd and Richerson (1985, chpt. 4), Rogers (1988), and Boyd and Richerson (1988). The model that we present here illustrates the basic logic of Rogers (1988).

Players

The players of the game consist of a continuum of members of a society. Each period, a new generation is born, and the previous generation dies. There are two types of players, each type with a different strategy about how they choose which action to undertake. Each person's decision about their type is made once and for all. The two different types are described in further detail below.

Actions

In each period (i.e. one generation), individuals choose to undertake one of two possible actions, which we denote action 0 and action 1. Which of the two action is optimal depends on the state of the world. The payoffs of each combination of states and actions is given below. As shown, when the state is 0, then action 0 yields a higher payoff. When the state is 1, then action 1 yields a higher payoff.

		Environment	
		0	1
Action	0	$\pi + b$	$\pi - b$
	1	$\pi - b$	$\pi + b$

In each period, there is some probability $\Delta \in [0,1]$ that a shock is experienced. When a shock is experienced, there is a new draw and it is equally likely that the draw results in the new state being state 0 or state 1. The state of the world is unobserved unless one invests an amount c to learn the state of the world in the current period. When c is invested, the individual learns the state of the world with certainty.

Player Types

There are two types of players, each type with a different strategy about how they choose which action to undertake. One decision method is to choose the action by looking at the actions that were taken by the previous generation. Specifically, they follow the action of a randomly chosen person from the previous generation. We call individuals who use this method 'Traditionalists'. A second strategy is to ignore information about what actions were chosen by the previous generation, and to instead engage in a form of learning (which is costly) to determine the best action to choose. We call individuals who use this method 'non-traditionalists'.

1. **Traditionalists (T)**: They value tradition and place strong importance on the culture of the previous generation. They choose their action by following the action of a randomly chosen person from the previous generation.

2. **Non-Traditionalists (NT)**: They do not value tradition and ignore the traditions of the previous generation. Instead they invest an amount 0 to learn the optimal action for the current period. The best action is learned with certainty. It is assumed that the cost of effort, though positive is modest, and satisfies: $c \in (0, b)$.[5]

These two cultural types characterize two distinct strategies. One is to place significant importance on tradition and to therefore follow the actions of someone from the previous generation. The other strategy is to ignore tradition, and to learn, not from the advice of someone from your parents' generation, but based on your own opinion about what you think is optimal in this environment.

Let $p \in [0, 1]$ denote the proportion of traditionalists in the population.

Payoffs

First, consider a payoff to a non-traditionalist. In each generation, the non-traditionalists place no value in the actions (i.e., tradition) of the previous generation and instead engage in learning to determine what the best action is in their environment. Thus, they learn and choose the optimal action and receive $\pi + b$ every period. However, they also bear the cost of learning, which is equal

[5]If $c > b$, then the cost of learning is prohibitively high and there will never be non-traditionalists in the economy. We focus our attention here on the empirically relevant scenario that leads to the possibility for the presence of both types in the economy.

to c. Thus, the payoff to a non-traditionalist is given by:

$$\Pi^{NT} = \pi + b - c$$

Next, consider the payoff of a traditionalist who adopts the strategy of a randomly chosen person from the previous generation. To calculate the expected payoff of a traditionalist, we first begin by listing a sequence of ways in which a traditionalist can obtain the correct action. A traditionalist will choose the correct action if:

1. She copies a non-traditionalist from the previous generation; and environment hasn't changed since the last generation. This will occur with probability $(1-p)(1-\Delta)$.

2. She copies a traditionalist from the previous generation, who had copied a non-traditionalist from the previous generation; and the environment has not changed since then. This occurs with probability $p(1-p)(1-\Delta)^2$.

3. She copies a traditionalist, who copied a traditionalist, who copied a non-traditionalist; and the environment has not changed since then. This occurs with probability $p^2(1-p)(1-\Delta)^3$.

4. She copies a traditionalist, who copied a traditionalist, who copied a traditionalist, who copied a non-traditionalist; and the environment has not changed since then. This occurs with probability $p^3(1-p)(1-\Delta)^4$.

5. Etc, etc.

One can continue this sequence until infinity. Summing the sequence of probabilities gives: $\sum_{t=1}^{\infty} p^{t-1}(1-p)(1-\Delta)^t$.

Conversely, with probability $1 - \sum_{t=1}^{\infty} p^{t-1}(1-p)(1-\Delta)^t$, a traditionalist does not obtain the correct action with certainty. Instead, in these cases, at least one shock to the environment has occurred. Recall that when a shock to the environment is experienced, there is an equal probability of being in either state. Thus, a traditionalist still has a 50% chance of choosing the correct action for the state and receiving $\pi + b$ and a 50% chance of choosing the wrong action and receiving $\pi - b$, and the expected payoff in these cases is π.

Putting this all together, the payoffs to a traditionalist are given by:

$$\begin{aligned}
\Pi^T &= [\sum_{t=1}^{\infty} p^{t-1}(1-p)(1-\Delta)^t](\pi+b) + [1-\sum_{t=1}^{\infty} p^{t-1}(1-p)(1-\Delta)^t][\frac{1}{2}(\pi+b)+\frac{1}{2}(\pi-b)] \\
&= \pi + b(1-p)(1-\Delta)\sum_{t=1}^{\infty} p^{t-1}(1-\Delta)^{t-1} \\
&= \pi + \frac{b(1-p)(1-\Delta)}{1-p(1-\Delta)}
\end{aligned}$$

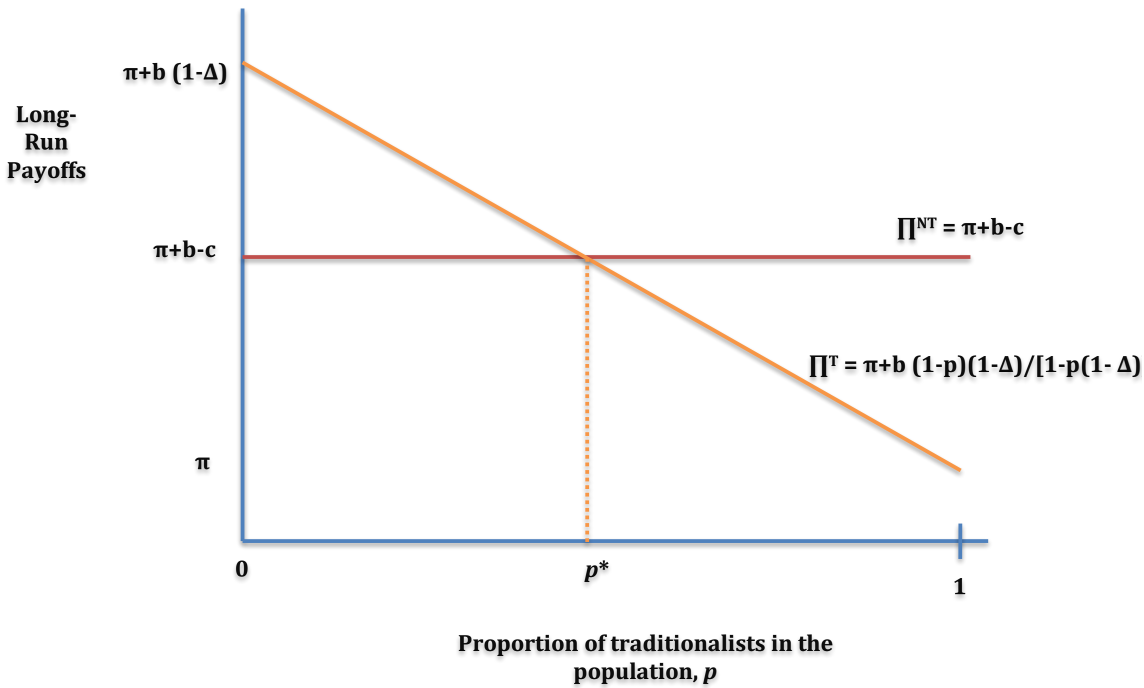
The payoffs to both traditionalists and non-traditionalists over all potential values of $p \in [0,1]$ (the proportion of traditionalists in the society) are shown in Figure 1a. As shown, the payoffs to a traditionalist Π^T is decreasing in p, the proportion of traditionalists in the society. Intuitively, this is because as the fraction of traditionalists increases, it is less likely that a traditionalist will copy the correct action. At the extreme, where every individual in the population is a traditionalist $p = 1$, each traditionalist effectively copies another traditionalist and the expected payoff is π. With 50% probability they receive $\pi + b$ and with 50% probability they receive $\pi - b$.

At the other extreme, where everyone in the society is a non-traditionalist $p = 0$, a traditionalist obtains the correct action from the previous period as long as the environment does not change from one generation to the next. Thus with probability $1 - \Delta$, a traditionalist's payoff is $\pi + b$. If the environment does change, which occurs with probability Δ, then there is equal probability that the environment is in either state and the expected payoff is π. Therefore, the expected payoff to a traditionalist when $p = 0$ is: $\Delta\pi + (1-\Delta)(\pi+b) = \pi + b(1-\Delta)$.

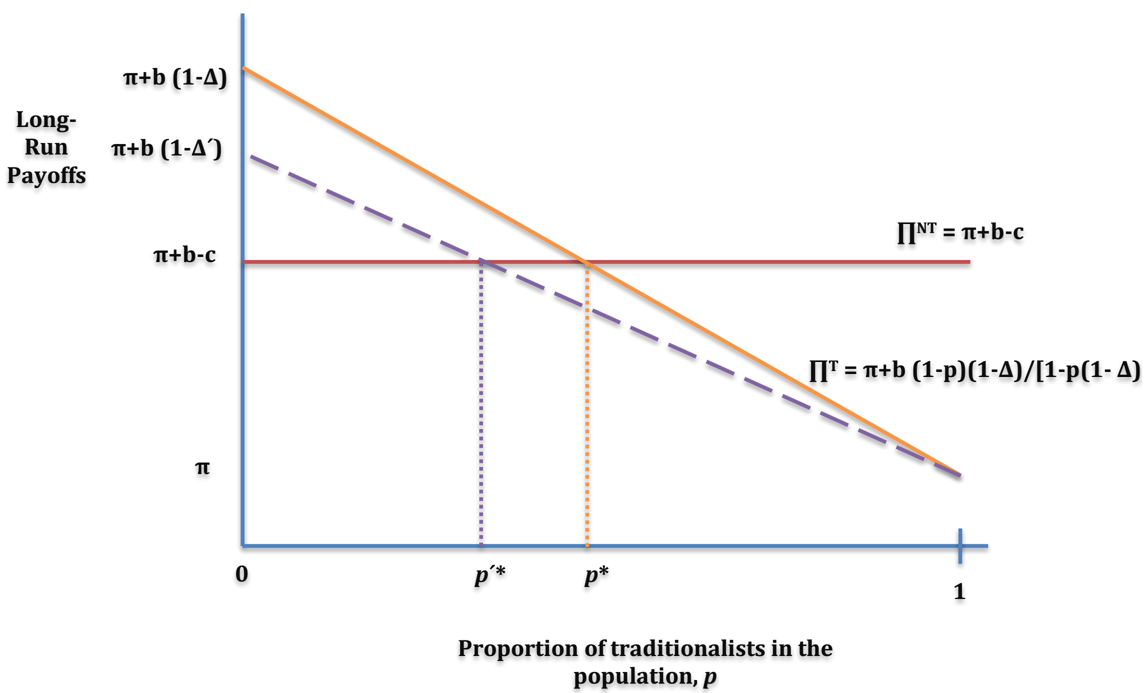
Figure 1b shows how the payoffs to traditionalists and non-traditionalists change as the environment becomes less stable – i.e., as Δ increases. More instability causes the payoffs of the traditionalists to decline by rotating downwards. By contrast, the payoffs of the non-traditionalists is unaffected. This results in a decline in the equilibrium proportion of traditionalists in the society, which we denote p^*.

Equilibrium and comparative statics

From figures 1a and 1b it is clear that if Δ is sufficiently high, then the society has no traditionalists, $p = 0$. This occurs if $\Delta > c/b$. When $\Delta < c/b$, then the equilibrium is polymorphic with both traditionalists and non-traditionalists present in the society. In such equilibria, the payoff of the two types must be equal. Using this condition, and solving for the equilibrium proportion of traditionalists in the economy, gives: $p^* = \frac{c-\Delta b}{c(1-\Delta)}$. Combining all parts provides a



(a) Payoffs to traditionalists and non-traditionalists as a function of the proportion of traditionalists in the economy.



(b) Effects of an increase in the instability of the environment.

Figure 1: The equilibrium proportion of traditionalists and non-traditionalists in the model.

full characterization of the equilibrium proportion of traditionalists:

$$p^* = \begin{cases} \frac{c-\Delta b}{c(1-\Delta)} & \text{if } \Delta \in [0,c/b] \\ 0 & \text{if } \Delta \in [c/b,1] \end{cases}$$

From this equation, it is clear that as the economy becomes less stable, i.e., as $\Delta \to 1$, then the proportion of the population that are traditionalists decreases. If instability increases to the point that it reaches the threshold c/b, then the proportion of traditionalists in the economy goes to zero.

The change in the equilibrium proportion of traditionalists as a function of environmental stability is given by:

$$\frac{\partial p^*}{\partial \Delta} = \begin{cases} \frac{c-b}{b(1-\Delta)^2} < 0 & \text{if } \Delta \in [0,c/b] \\ 0 & \text{if } \Delta \in [c/b,1] \end{cases}$$

Since $c < b$, then $\frac{\partial p^*}{\partial \Delta} < 0$, and greater instability in the environment results in less traditionalists in the population in equilibrium.[6] Thus, the model generates the following two predictions. First, if the environment is only moderately unstable, $\Delta < c/b$, then both traditionalists and non-traditionalists are present in the population. In such equilibria, as instability increases, the proportion of traditionalists p decreases. That is more instability results in less tradition. Second, if the environment is sufficiently unstable, such that $\Delta > c/b$, then the proportion of traditionalists in the economy is zero. In turn these two predictions result in a more general hypothesis that we bring to the data. The hypothesis is:

Hypothesis 1 *The greater the instability of the environment from one generation to the next, the smaller the proportion of traditionalists in the society will be, and the less important tradition will be in the society as a whole.*

We now turn to our empirical analysis, which tests for a relationship between greater instability of the environment across generations, the importance placed on tradition, and the observed persistence of cultural practices.

[6] If $c > b$ then for all values of Δ the population is comprised of traditionalists only, $p^* = 1$. Here, we assume the empirically relevant scenario where there is the potential for the presence of both types in the economy.

3. Data: Sources and their construction

A. *Motivating the measure of environmental instability*

When bringing the model and its predictions to the data, the primary decision is how one measures the variability of the environment, Δ. While there are many aspects of a society' environment one could measure, the strategy we undertake here is to focus on a measure that is exogenous (i.e., unaffected by human actions) and has plausibly important effects on the optimal decisions of daily life.

The measure of the environment that we use is temperature. As we explain in more detail below, we measure the historical variability of temperature across 20-year generations between 500 and 1900. During this time, temperature is clearly exogenous and it was not affected in any significant way by human actions. In addition, there is mounting evidence that weather and climate have important effects on societies. For example, a number of studies now show that cooling during the Little Ice Age resulted in worse health outcomes, social unrest, increased conflict, decreased productivity, and slower economic growth (e.g., Baten, 2002, Oster, 2004, Waldinger, 2015, Dalgaard et al., 2015, Iyigun et al., 2017). Also, there is evidence that increased seasonal variability in certain locations resulted in the Neolithic transition, one of the most important social changes in human history (Matranga, 2016). In a recent series of papers, Durante (2010) and Buggle and Durante (2016) show that within Europe, greater year-to-year variability in temperature and precipitation during the growing season is associated with greater trust, which increased trade, and prosperity.[7] Thus, there is ample evidence that weather and climate have significant effects on a society.

Although we cannot observe the relationship between the environment and the optimal action (or the payoffs to different actions), we have mounting evidence that changes in the environment affect important equilibrium outcomes like conflict, cooperation, trust, trade, and economic prosperity. This provides strongly suggestive evidence that the environment is an important determinant of the optimal actions for a society at that time. The evidence suggests that temperature has important effects on the returns to cooperation, the returns to trade, and the returns to conflict. Thus, it plausibly affects the optimal level of cooperation, entrepreneurship, conflict, etc.

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[7] Also relevant is the finding that other environmental shocks can have an effect on the society's cultural practices. For example, studies by Chaney (2013), Bentzen (2015), and Belloc, Drago and Galbiati (2016) find evidence that various environmental shocks have important effects on people's religiosity.

In addition, it directly and more mechanically, affects the optimal decisions in agriculture, the optimal intensity of agriculture, what crops should be planted and when, and what agricultural implements to use. Given the likely importance of temperature, our constructed variable then measures how average temperature (and therefore the optimal actions in a society) changes from one generation to the next.

An alternative strategy to the one we employ here would be to look at changes in more proximate variables, like income, population density, or innovation.[8] While such an exercise would be informative, the drawback is that these outcomes are themselves potential endogenous to human actions and omitted factors. To the extent that climatic variability affects these more proximate factors, the estimated relationship between climatic variability and the importance of tradition will capture these mechanisms.

B. ***The historical variability of the environment across generations***

We use data collected by Mann et al. (2009a) and covering the entire world. The original data set includes gridded average temperatures (0.5 degree by 0.5 degree grid-cells) annually from 500 to 1900. Mann et al. use a climate field reconstruction approach to reconstruct global patterns of surface temperature for a long historical period. The construction uses proxy data with global coverage that comprises 1,036 tree ring series, 32 ice core series, 15 marine coral series, 19 documentary series, 14 speleothem series, 19 lacustrine sediment series, and 3 marine sediment series (Mann, Zhang, Rutherford, Bradley, Hughes, Shindell, Ammann, Faluvegi and Ni, 2009b).

Let x_g be the average temperature of a given generation g. Generations are 20 years in length and, thus, there are 70 generations from 500–1900. Our measure of interest is the standard deviation of the average temperature across generations: $\left[\frac{1}{N^g}\sum_{g=1}^{70}(x_g-\overline{x})^2\right]^{1/2}$.

The average variability by grid-cell is shown in Figure 2, where yellow (a lighter shade) indicates less variability and brown (a darker shade) greater variability. From the figure, one can see that although there is variation between nearby cells, there are also some broad patterns. For example, cells that are further from the equator tend to have greater variability.

[8]See for example the exercise undertaken by Voigtlaender and Voth (2012). They show that the persistence of anti-Semitic attitudes in Germany over a 600-year period was weaker in towns that were more dynamic economically or were more open to external trade.

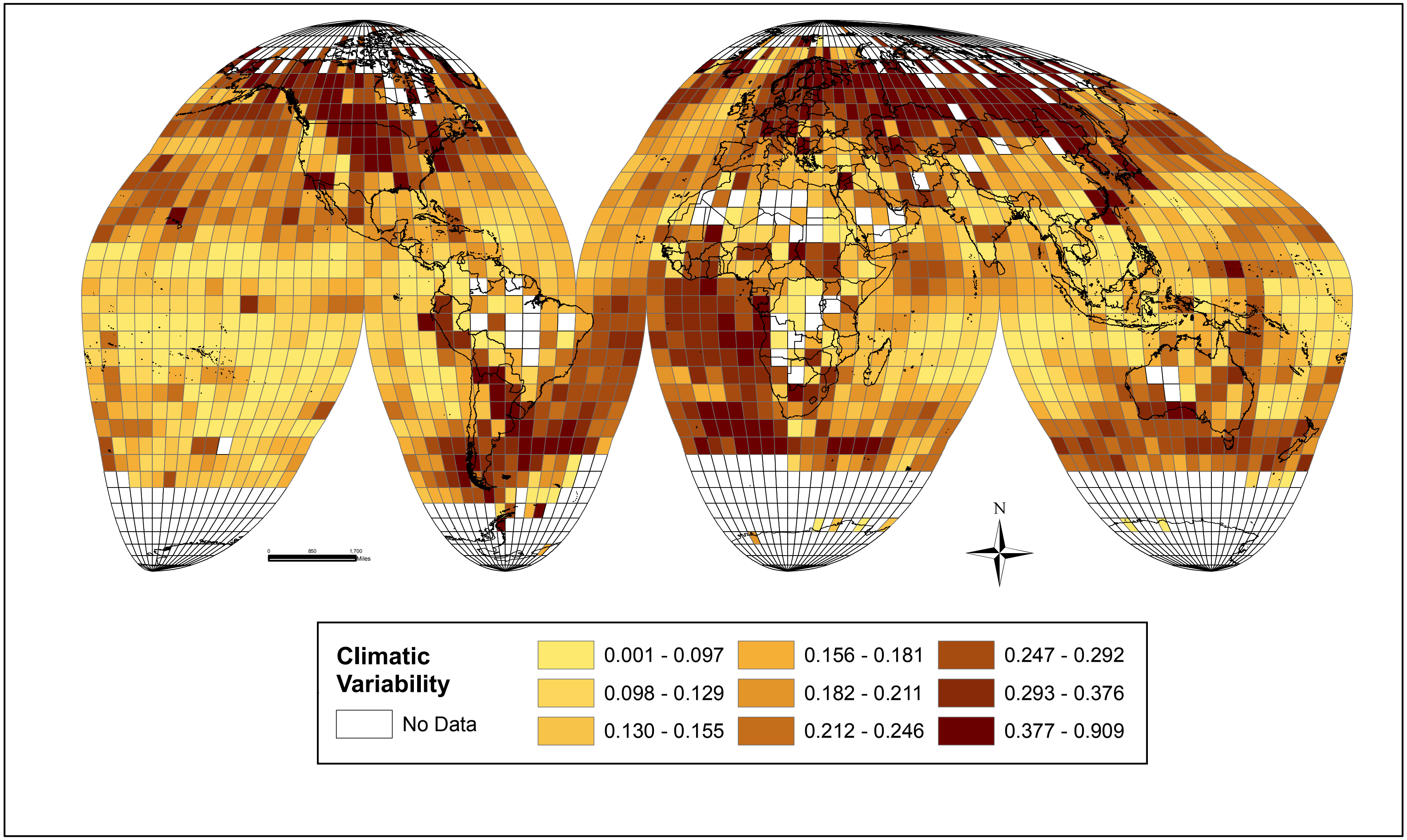


Figure 2: Map of grid-cell level historical temperature variability across generations from 500–1900.

Our analysis aims to examine measures of the importance of tradition using contemporary data. We are interested in measuring the climatic stability of the environment of an individual's ancestors. Thus, it is important to correctly identify the locations of an individual's ancestors historically. To do this, we rely on the historical location of the 1,265 ethnic groups reported in Murdock's (1967) *Ethnographic Atlas*. These ethnic groups are then linked to the historical climate data from Mann et al. (2009a) using the latitude and longitude of the centroid of the ethnic group. This allows us to construct a measure of the ancestral climatic variability of each ethnic group in the *Ethnographic Atlas*.

Following Giuliano and Nunn (2017), we extend the precision and coverage of the *Ethnographic Atlas* using alternative sources of ethnographic data. In particular, we augment the *Ethnographic Atlas* using two ethnographic samples that were published in Ethnology in 2004 and 2005. One is the *Peoples of Easternmost Europe*, which was constructed by Bondarenko, Kazankov, Khaltourina and Korotayev (2005), and includes 17 ethnic groups from Eastern Europe. The other is *Peoples of Siberia*, which was constructed by Korotayev, Kazankov, Borinskaya and Khaltourina (2004), and includes 10 Siberian ethnic groups. We use this extended sample of 1,292 ethnic groups as a second ethnographic sample in our analysis.

We also use a third, and even larger, sample. In 1957, prior to the construction of the *Ethnographic Atlas*, George Peter Murdock constructed the *World Ethnographic Sample*, which was published in a volume of the journal *Ethnology* (Murdock, 1957). Many of the ethnic groups that would later appear in the *Ethnographic Atlas* also appeared in the *World Ethnographic Sample*. However, the *World Ethnographic Sample* also included many ethnic groups that are not in the *Ethnographic Atlas*. These are ethnic groups for which information was more limited and so if they were included many variables would have missing values. In all, there are 17 ethnic groups that are in the *World Ethnographic Sample* but not in the *Ethnographic Atlas*. Thus, we also use a third extended sample, with 1309 ethnic groups, that includes all additional ethnographic sources including the *World Ethnographic Sample*.

As we will show, our estimates are very similar irrespective of which ethnographic sample we use. However, throughout the paper, we take as our baseline sample the extended sample of 1,292 ethnic groups. We do not use as our baseline the extension that includes the *World Ethnographic*

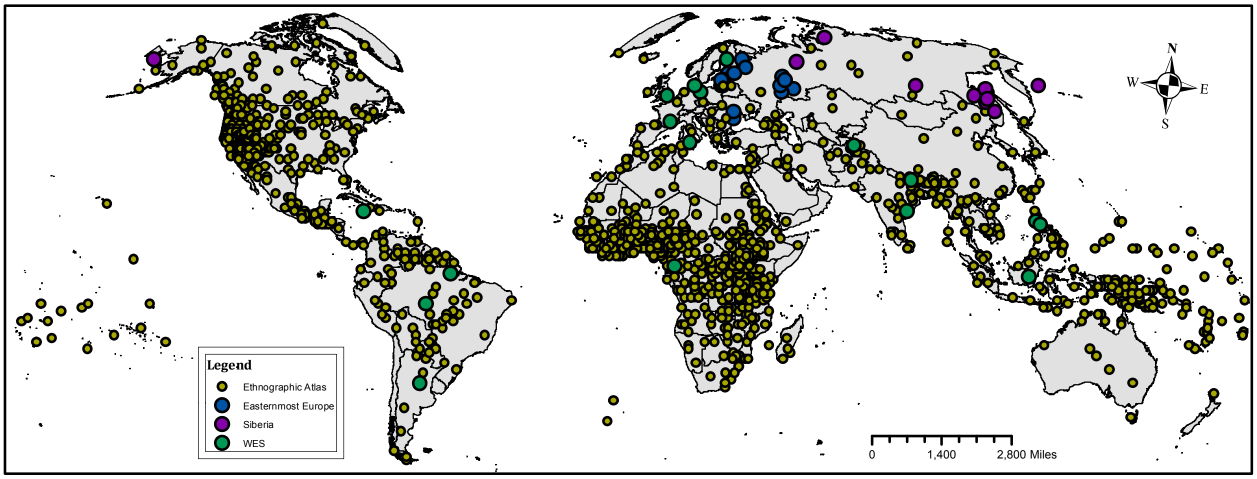


Figure 3: Map showing the locations of the centroids of ethnic groups in the *Ethnographic Atlas*, *Peoples of Easternmost Europe*, *Peoples of Siberia*, and *World Ethnographic Sample (WES)*.

Sample because of the significant missing information for the added observations.[9]

For each of the approximately 1,300 ethnic groups in our ethnographic samples, we know the coordinates of the centroid of their ethnic group's historical location. These are shown in Figure 3. By identifying the climatic grid-cell that each location falls within, we have an estimate of the climatic instability faced by each ethnic group historically. We then construct measures of average historical instability faced by the ancestors of those living in each country today using a procedure similar to that used in Alesina et al. (2013). First, we match each of the 1,300 ethnic groups in our ethnographic samples to one of the 7,000 languages and dialects that are present in the world today, as categorized and mapped by the *Ethnologue 16*. This, combined with 1km by 1km gridded population data from Landscan, provides us with an estimate of the identity of the ancestors of all populations in the world at a 1km resolution.[10] Through this match of languages to ethnicities, we have a measure of the estimated historical climatic variability faced by the ancestors of the individuals living in that location at a 1km resolution.[11]

With the gridded information, we are then able to construct historical climatic instability measures that are averages over a country. These will be used for the parts of our analysis

[9]In particular, one of the control variables for some specifications (the year in which the ethnic group was observed for the data collection) has missing information for 9 of the 17 ethnic groups in the *World Ethnographic Sample*. Thus, adding these observations adds more observations with missing data as observations with real data.

[10]Alesina et al. (2013) used Ethnologue 15 in their matching procedure, which was the most current version at the time.

[11]For the finer details on the construction of the data see Giuliano and Nunn (2016). For another application of the data construction procedure see Giuliano and Nunn (2013).

for which countries are the unit of observation. The country-level measures are shown visually in Figure 4. Analogous to the case for the grid-level variation, countries that are more distant from the equator tend to show more variability. In addition, some of the richer countries also appear to have greater variability. Given that these factors could independently affect our outcomes of interest, in our empirical analysis, we control for distance from the equator as well as average per capita income.

C. *Measuring the importance of tradition today*

We undertake a number of strategies to measure the importance of tradition today. Our first step is to test directly for a relationship between climate variability and the self-reported importance of tradition today. Our second strategy examines the persistence of cultural characteristics over long periods of time. In particular, we consider two important and measurable cultural traits: female gender roles (measured by female labor force participation) and the practice of polygamy. Our third strategy is to consider second-generation migrants to the United States and to measure the extent to which traditional customs persist across subsequent generations. In particular, we examine whether the children of immigrant parents marry someone from their same origin-group and whether the children speak their mother tongue language at home. We interpret both actions as a revealed belief about the importance of maintaining the traditions and customs of the mother country. We also examine the extent to which Indigenous populations in the United States and Canada continue to speak their native language.[12]

4. Instability and the self-reported importance of tradition: Evidence from the World Values Survey

We begin by examining a measure of tradition taken from the *World Values Survey*.[13] For the question, respondents are given the description of a person and then they are asked to report how similar they are to the person. For this measure the following description was used: "Tradition is

[12]One concern with the analysis involving immigrants is that they are not a representative sample of the origin populations. Therefore, we supplement this analysis by also examining the extent to which different Native American populations speak their ancestral language at home. Like immigrants, Native American populations are minority groups with different cultural traditions and living within a dominant foreign population. However, unlike immigrants, the population of Native Americans in the U.S. and Canada, does not reflect selection into migration.

[13]The survey has been conducted since 1981 (there are currently six waves: 1981-1984, 1989-1993, 1994-1998, 1999-2004, 2005-2009 and 2010-2014). Since our variable of interest has been added to the questionnaire only recently, we use only the last two waves.

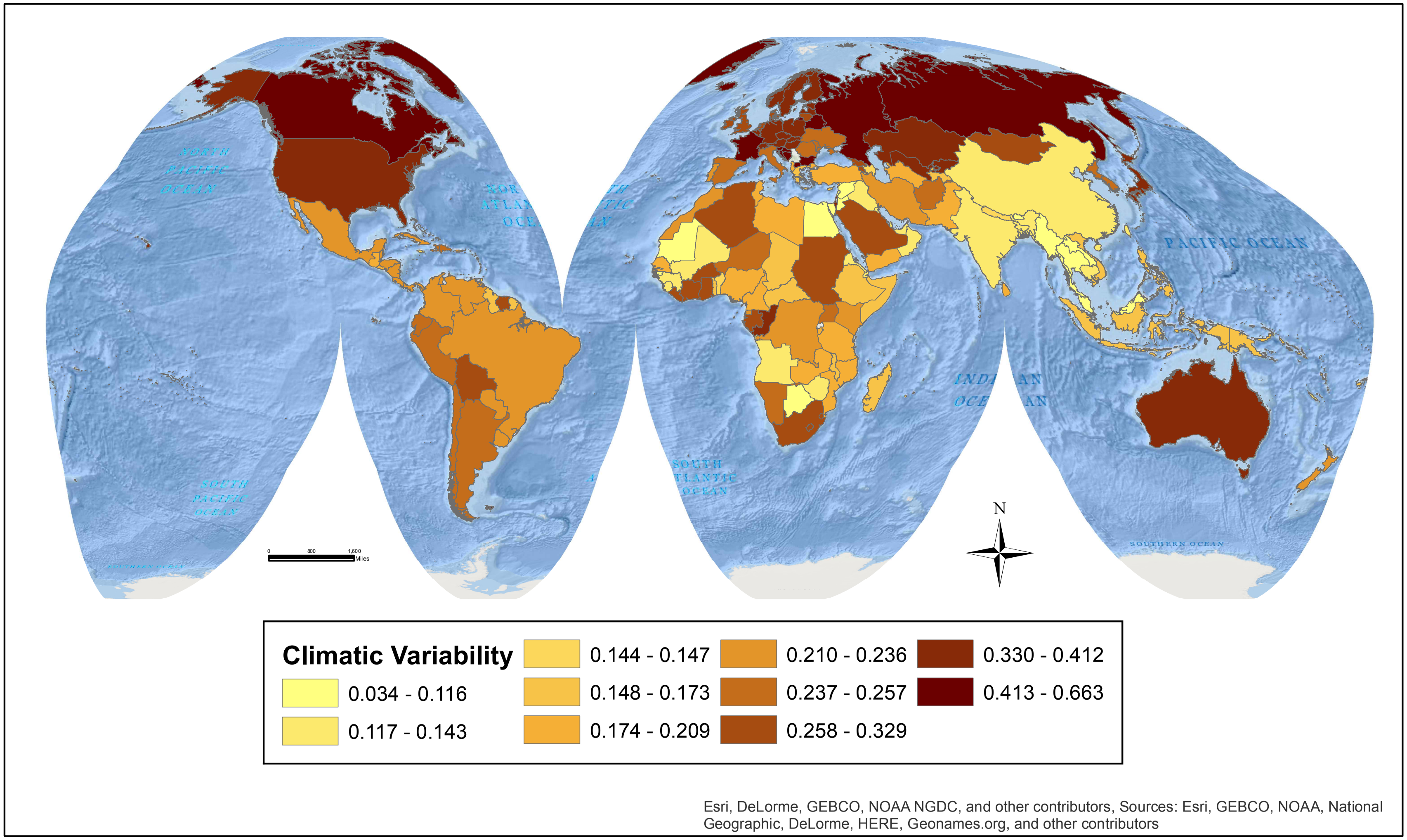


Figure 4: Map of country-level average historical temperature variability across generations from 500–1900.

important to this person; to follow the family customs handed down by one's religion or family." Respondents then choose the response that best described how similar this person/description was to them: (1) very much like me; (2) like me; (3) somewhat like me; (4) a little like me; (5) not like me; and (6) not at all like me. Since the original measure is decreasing in the extent to which the respondent values tradition, we transform the measure so that it is increasing in the value placed on tradition, ranging from 1 to 6.

Using the constructed measure, we first examine the country-level relationship between the self-reported measure on the importance of tradition and climatic instability. We study the relationship using each of our three different measures of average historical climatic instability measured at the country level. The odd numbered columns of Table 1 report the raw bivariate relationship between the average reported importance of tradition and average historical climatic instability across the 75 countries for which both measures are available. In the raw data, we find a negative and significant relationship between the two measures. Greater instability of the environment in the past is associated with less importance placed on tradition today. The relationship between the two is shown visually (for the specification from column 3) in Figure 5. As shown, the relationship appears to be very general and not driven by a small number of influential outliers.

We also examine the same relationship conditioning on a host of covariates. To do this, we estimate:

$$Tradition_c = \beta\, Climatic\, Instability_c + \mathbf{X}_c^H \boldsymbol{\Phi} + \mathbf{X}_c^C \boldsymbol{\Pi} + \varepsilon_c \tag{1}$$

where c denotes a country, $Tradition_c$ is the average at the country level of the self-reported importance of tradition, $Climatic\, Instability_c$ is our measure of historical temperature variability for each country c. $\mathbf{X}_c^H$ and $\mathbf{X}_c^C$ are vectors of historical ethnographic and contemporary controls, all measured at the country level. The ethnographic control variables capture historical differences between societies that could also be related to the importance of tradition. They include a measure of economic development, proxied by the density of settlement, a measure of political centralization, measured by the levels of political authority in the society, and the historical

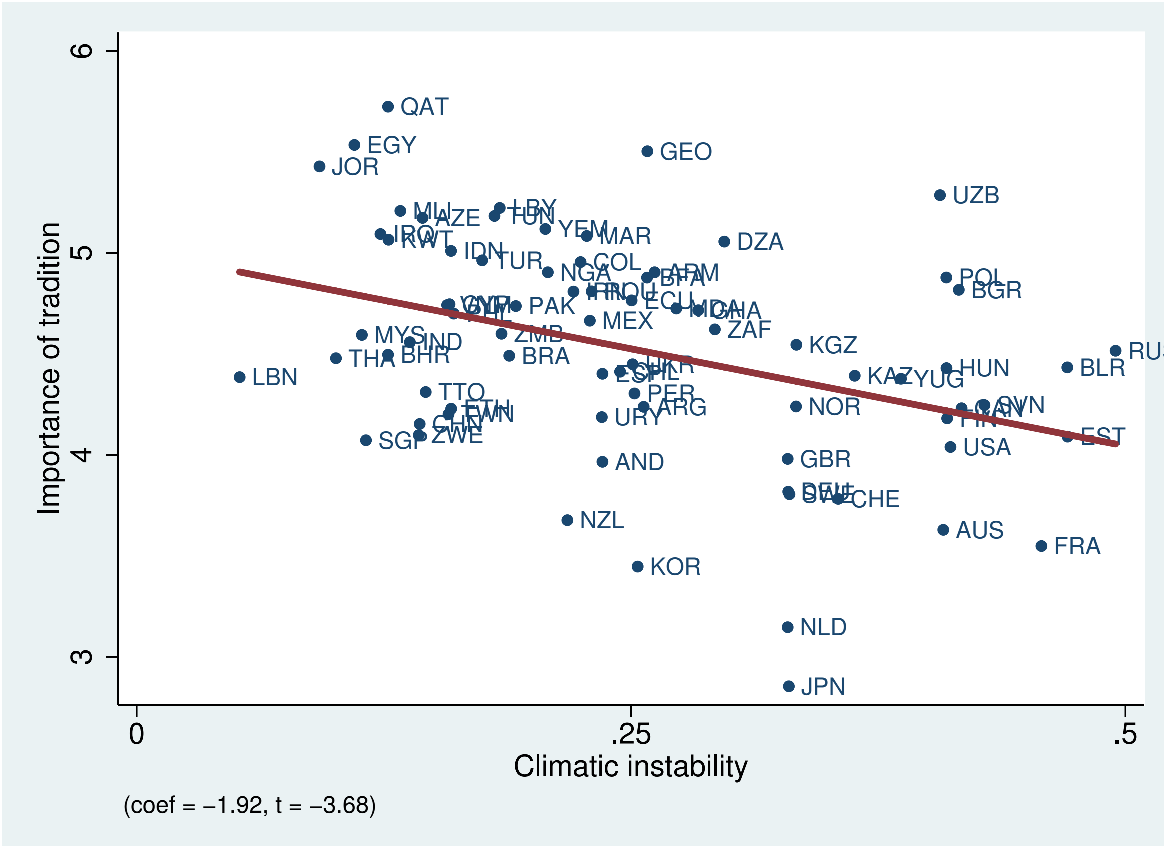


Figure 5: The bivariate cross-country relationship between average ancestral climatic instability and the average self-reported importance of tradition today.

distance from the equator (measured using absolute latitude).[14] To link historical characteristics, measured at the ethnicity level, with current outcomes of interest, we follow the same procedure used to construct our measure of weather variability. The contemporary control variable includes the natural log of a country's real per capita GDP measured in the survey year.

The estimates, which are reported in the even columns of Table 1, show that in countries with weather variability there is less respect for tradition. The estimated coefficients for the climatic instability variable are not only statistically significant, but their magnitudes are also economically meaningful. Based on the estimates from column 4, a one-standard-deviation increase in weather volatility (0.11) is associated with a reduction in the tradition index of $1.824 \times 0.11 = 0.20$, which

[14]Economic development is measured using the density of ethnic groups' settlements. Ethnicities are grouped into the following categories: (1) nomadic or fully migratory, (2) semi-nomadic, (3) semi-sedentary, (4) compact but not permanent settlements, (5) neighborhoods of dispersed family homesteads, (6) separate hamlets forming a single community, (7) compact and relatively permanent settlements, and (8) complex settlements. We construct a variable that takes on integer values, ranging from 1 to 8 and increasing with settlement density. Political complexity is measured by the levels of jurisdictional hierarchies in the society. Further details of the construction of these measures is provided in the data appendix.

is equal to 36% of a standard deviation of the tradition index.

Examining the coefficient estimates for the control variables, we see that the two measures of economic development – historical and contemporary – are significantly associated with the importance of tradition today. More economic development is associated with weaker beliefs about the importance of tradition. Given that all societies were initially at a similar level of economic development, these measures of income levels also capture average changes in the economic environment over time. Thus, the estimated relationships for the income controls are consistent with the predictions of the model. Countries that experience greater instability – i.e., growth in the economic environment in the past – today place less importance in maintaining tradition. This conclusion, however, is somewhat speculative. Unlike climatic instability, economic growth may be affected by omitted factors and forms of reverse causality. Thus, it is possible that societies that place less importance on tradition, both historically and today, were able to generate faster economic growth.

We also undertake a second strategy to examine the relationship between historical environmental instability and the importance of tradition today. Instead of examining country-level variation, we examine variation across individuals from the WVS and we measure historical climatic instability at the ethnicity-level. The *World Values Survey* contains information about the ethnicity of the respondent. We link the current ethnicity to the historical ethnicity from the *Ethnographic Atlas*, and run the following regression:

$$\mathit{Tradition}_{i,e,c} = \alpha_c + \beta\, \mathit{Climatic\ Instability}_e + \mathbf{X}_i \mathbf{\Pi} + \mathbf{X}_e \mathbf{\Omega} + \varepsilon_{i,e,c} \tag{2}$$

where i denotes an individual, belonging to the historical ethnic group e, and living in country c. $\mathit{Tradition}_{i,e,c}$ is the self-reported importance of tradition for individual i, which is measured on a 1–6 integer scale and increasing in the importance of tradition. $\mathit{Climatic\ Instability}_e$ is our measure of historical temperature variability among ethnic group e. The standard errors are clustered at the ethnicity level.

$\mathbf{X}_e$ denotes the vector of pre-industrial ethnicity-level covariates described above. $\mathbf{X}_i$ is the vector of individual-level covariates that includes: a quadratic in age, a gender indicator variable, eight educational attainment fixed effects, labor force participation fixed effects, a married indicator variable, ten income-category fixed effects, and fixed effects for the wave of the survey the individual was interviewed for. The specification also includes country fixed effects (α_c).

Table 1: Country-level estimates of the determinants of tradition

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Importance of Tradition, 1-6					
	Ancestral Characteristics Measures					
	Original EA		With Eastern Europe & Siberia Extension		Also with the World Ethnographic Sample Extension	
Climatic instability	**-1.951*** **	**-1.783** **	**-1.923*** **	**-1.824** **	**-1.837*** **	**-1.756** **
	(0.540)	**(0.696)**	**(0.523)**	**(0.696)**	**(0.493)**	**(0.667)**
Historical controls:						
Distance from equator		0.005		0.005		0.006
		(0.005)		(0.005)		(0.005)
Economic complexity		-0.069*		-0.065*		-0.064*
		(0.035)		(0.035)		(0.033)
Political hierarchies		0.025		0.013		0.013
		(0.099)		(0.097)		(0.110)
Contemporary controls:						
Ln (per capita GDP)		-0.164***		-0.165***		-0.164***
		(0.048)		(0.049)		(0.051)
Number of countries	75	74	75	74	75	74
Mean (st. dev.) of dep var	4.52 (0.55)	4.52 (0.55)	4.52 (0.55)	4.52 (0.55)	4.52 (0.55)	4.52 (0.55)
Observations	75	74	75	74	75	74
R-squared	0.147	0.388	0.148	0.388	0.144	0.384

Notes : The unit of observation is a country. The dependent variable is the average at the country level of a measure of the self-reported importance of tradition. The mean and st. dev. of Climatic Instability is 0.25 (0.11). ***, ** and * indicate significance at the 10, 5 and 1% levels.

Estimates of equation (2) are reported in Table 2. The odd numbered columns reports a version of equation (2) with a parsimonious set of covariates: gender, age, age squared, and survey-round fixed effects. In the even numbered columns, we estimate the version of equation (2) with all covariates. In all specifications, the estimated coefficients for $Climatic\,Instability_e$ are negative and significant. According to the magnitude of the estimates from column 4, a one standard deviation increase in climatic instability (0.12) is associated with a decreases the self-reported importance of tradition of approximately $0.12 \times 0.548 = 0.07$, which is equal to about 0.05 standard deviations of the tradition index.

As the estimates from Tables 1 and 2 show, we obtain very similar estimates irrespective of which version of the ethnographic data we use in the analysis. As discussed, because of the data limitations associated with the *World Ethnographic Sample* extension, for the remainder of the paper, we use the version of the data that includes the *Eastern Europe* and *Siberia* extensions of the

Table 2: Individual-level estimates of the determinants of tradition, measuring historical instability at the ethnicity level

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Importance of Tradition, 1-6					
	Ancestral Characteristics Measures					
	Original EA		With Eastern Europe & Siberia Extension		Also with the World Ethnographic Sample Extension	
Climatic instability	**-0.839*** **	**-0.582** **	**-0.742*** **	**-0.548** **	**-0.772*** **	**-0.561** **
	(0.268)	**(0.282)**	**(0.276)**	**(0.244)**	**(0.278)**	**(0.248)**
Historical ethnicity-level controls:						
Distance from equator		-0.003		-0.004		-0.004
		(0.004)		(0.003)		(0.003)
Economic complexity		-0.033***		-0.039***		-0.035***
		(0.012)		(0.012)		(0.012)
Political hierarchies		0.015		0.026		0.024
		(0.028)		(0.030)		(0.028)
Gender, age, age squared	yes	yes	yes	yes	yes	yes
Survey wave fixed effects	yes	yes	yes	yes	yes	yes
Other individual controls	no	yes	no	yes	no	yes
Country fixed effects	yes	yes	yes	yes	yes	yes
Number of countries	75	75	75	75	75	75
Number of ethnic groups	186	176	193	183	193	183
Mean (st. dev.) of dep var	4.50 (1.41)	4.49 (1.41)	4.50 (1.41)	4.49 (1.41)	4.50 (1.41)	4.49 (1.41)
Observations	140,629	127,667	140,681	127,685	139,583	126,630
R-squared	0.179	0.181	0.179	0.181	0.179	0.182

Notes: The unit of observation is an individual. The dependent variable is a measure of the self-reported importance of tradition. It ranges from 1 to 6 and is increasing in the self-reported importance of tradition. Columns 1, 3 and 5 include a quadratic in age, a gender indicator variable, and survey wave fixed effects. Columns 2, 4 and 6 additionally include eight education fixed effects, labor force participation fixed effects, an indicator variable that equals one if the person is married, and ten income category fixed effects. Standard errors are clustered at the ethnicity level. The mean and st. dev. of Climatic Instability is 0.27 (0.12). ***, ** and * indicate significance at the 10, 5 and 1% levels.

Ethnographic Atlas. All estimates that we report are similar if other versions are used instead.

5. Examining variation in the persistence of cultural traits over time

Our second strategy is to examine the persistence of particular cultural traits over time and to test whether the persistence differs systematically depending on the historical stability of a country's climate. We focus our attention to two outcomes that can be measured in a comparable manner over long periods of time: female labor force participation and the practice of polygamy.

We examine the differential persistence of these cultural practices by estimating the following regression equation:

$$\begin{aligned} \textit{Cultural Trait}_{c,t} &= \alpha_{r(c)} + \beta_1 \textit{Cultural Trait}_{c,t-1} + \beta_2 \textit{Cultural Trait}_{c,t-1} \times \textit{Climatic Instability}_c \\ &\quad + \mathbf{X}_{c,t}\mathbf{\Pi} + \mathbf{X}_{c,t-1}\mathbf{\Omega} + \varepsilon_{c,t} \end{aligned} \quad (3)$$

where c indexes countries and t indexes time periods. Period t is the contemporary period (measured in 2012) and period $t-1$ is a historical period. The dependent variable of interest, $\textit{Cultural Trait}_{c,t}$, is our measure of the cultural characteristic today. We are interested in the relationship between this variable and the cultural trait in the past, $\textit{Cultural Trait}_{c,t-1}$, and how this relationship differs depending on historical climatic stability, $\textit{Cultural Trait}_{c,t-1} \times \textit{Climatic Instability}_c$. Our interest is in whether the estimated coefficient β_2 is less than zero, which indicates that the cultural trait is less persistent among countries with greater historical climatic instability.

Equation (3) includes continent fixed effects, $\alpha_{r(c)}$, which capture broad regional differences in female labor force participation or polygamy. The vector $\mathbf{X}_{c,t}$ contains covariates that are measured in the contemporary period: log real per capita GDP as a measure of contemporaneous development (for FLFP we also include a quadratic term to account for the non-linear relationship between FLFP and income).[15] $\mathbf{X}_{c,t-1}$ denotes our vector of historical covariates: political development (measured by the number of levels of authority beyond the local community), economic development (measured by complexity and density of settlements), and the average distance from the equator of the ancestral homelands, in addition to climatic instability.

A. *Female Labor Force Participation*

Our first application of equation (3) examines the differential persistence of female labor force participation. We begin by examining average country-level female labor force participation in 1970 and in 2012.[16] The data are from the World Bank's *World Development Indicators*, and are measured as the percentage of women aged 15 to 64 who are in the labor force. Thus, it ranges from 0 to 100.

Estimates are reported in table 3. Column 1 reports estimates of equation (3), but without the interaction of interest, $\textit{Cultural Trait}_{c,t-1} \times \textit{Climatic Instability}_c$. We find a strong positive correlation between FLFP in 1970 and 2012.

[15] Allowing for a non-linear relationship is motivated by the observed U-shaped bivariate relationship between economic development and female labor force participation (Goldin, 1995).

[16] Female labor force participation has been used in literature as an objective proxy for gender roles. See for example Fernandez and Fogli (2009), Fogli and Veldkamp (2011), Alesina et al. (2013), and Fernandez (2013).

Table 3: The differential persistence of FLFP over time, 1970–2012

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Female labor force participation (FLFP) 2012						
FLFP 1970	0.330***	0.717***	0.704***	0.393	0.613**	-0.239	-0.768
	(0.079)	(0.161)	(0.161)	(0.590)	(0.267)	(0.879)	(1.100)
FLFP 1970 * Climatic instability		**-1.660****	**-1.813***	**-1.671****	**-1.667****	**-1.648****	**-1.088**
		(0.683)	**(0.933)**	**(0.698)**	**(0.689)**	**(0.698)**	**(1.206)**
Country-level controls:							
Climatic Instability		44.701	50.462	41.065	45.943	41.109	18.455
		(36.845)	(42.064)	(38.870)	(37.349)	(38.945)	(53.998)
Distance from equator	-0.174	-0.135	-0.201	-0.119	-0.137	-0.164	0.063
	(0.115)	(0.145)	(0.220)	(0.140)	(0.147)	(0.142)	(0.290)
Economic complexity	1.931	2.663*	2.682*	2.096	2.628*	2.193	1.781
	(1.253)	(1.546)	(1.570)	(1.839)	(1.553)	(1.591)	(1.886)
Political hierarchies	-1.606	-1.878	-1.948	-2.164	-3.119	-1.708	-2.101
	(1.567)	(1.397)	(1.479)	(1.335)	(2.980)	(1.301)	(3.419)
Ln (per capita GDP)	-71.614***	-67.906***	-67.966***	-66.913***	-67.867***	-83.558***	-90.795**
	(24.480)	(23.724)	(23.815)	(24.111)	(23.911)	(30.525)	(35.195)
Ln (per capita GDP) squared	3.822***	3.649***	3.652***	3.587***	3.648***	4.308***	4.608***
	(1.255)	(1.212)	(1.216)	(1.232)	(1.221)	(1.469)	(1.666)
FLFP 1970 * Distance from equator			0.002				-0.007
			(0.006)				(0.009)
FLFP 1970 * Economic complexity				0.049			0.008
				(0.082)			(0.089)
FLFP 1970 * Political hierarchies					0.029		0.016
					(0.061)		(0.079)
FLFP 1970 * Ln (per capita GDP)						0.104	0.155
						(0.089)	(0.124)
Continent fixed effects	yes	yes	yes	yes	yes	yes	yes
Mean (st. dev.) of dep. var.	50.7(13.7)	50.7(13.7)	50.7(13.7)	50.7(13.7)	50.7(13.7)	50.7(13.7)	50.7(13.7)
Observations	77	77	77	77	77	77	77
R-squared	0.599	0.633	0.634	0.635	0.634	0.645	0.649

Notes : OLS estimates are reported with robust standard errors in parentheses. The unit of observation is a country. Female labor force participation is the percentage of women in the labor force, masured in 2012 and 1970. Historical controls are defined in the appendix. The mean and standard deviation of climatic instability is 0.24 (0.09). ***, ** and * indicate significance at the 10, 5 and 1% levels.

Column 2 reports estimates of equation (3). The persistence of FLFP is weaker in countries with greater historical climatic instability. The estimates of columns 3-7 show that these results are robust to the inclusion of our control interactions, either one at a time or all together. When we include all variables together, the standard errors increase significantly, but the point estimate of our interaction of interest remains nearly identical.

We next turn to an examination of the persistence of gender norms over a much longer time span. We measure traditional female labor force participation during the pre-industrial period using variable v54 from the *Ethnographic Atlas*, where ethnicities are grouped into one of the following five categories that measure the extent of female participation in pre-industrial agriculture: (1) males only, (2) males appreciably more, (3) equal participation, (4) females appreciably more, and (5) females only.[17] To make the traditional FLFP variable (which ranges from 1 to 5) more comparable with the contemporary measures of FLFP, we normalize it to also range from 0 to 100.[18] Because traditional female participation in agriculture is measured in different years for different observations depending, in part, on when contact was made with the ethnic group, in these regressions we also control for the year in which the ethnographic data were collected, and we allow persistence to differ accordingly. If an observation's measure of female labor force participation in pre-industrial agriculture is from a more distant time period, then it is plausible that we may observe a weaker relationship between the historical and current measures.

We first examine the average relationship between traditional female participation in agriculture and FLFP in 2012. This is reported in column 1 of table 4. One observes a strong positive relationship between the two measures. The point estimate of 0.26 is slightly lower than the estimate when examining persistence from 1970–2012 (column 1 of table 3). This is not surprising since one would expect less persistence over a longer time horizon.

Column 2 then reports estimates of equation (3), which allows for differential persistence. We estimate a negative coefficient for the interaction term, suggesting weaker persistence in countries with greater historical instability of the climate. In columns 3–7, we include our set of historical covariates interacted with traditional female participation in agriculture one control at a time, and in column 8, we include all controls together. As shown, the coefficient of interest remains robust.

Within-country differences in the persistence of FLFP

We now turn to an analysis that examines the continuity of FLFP but using within-country variation rather than cross-country variation. For this we use another data source, IPUMS-International Census data, that records respondents' ethnic identity as well as female labor force participation. This allows us to examine female labor force participation and to link this to ancestral climatic variability using an individual's self-reported ethnicity. Although this can only be done for a much more limited set of countries, the presence of within-country variation across ethnic groups allows us to obtain estimates using finer variation.

[17]The original classification in the *Ethnographic Atlas* distinguishes "differentiated but equal participation" from "equal participation". Since this distinction is not relevant for our purposes, we combine the two categories into a single category of equal participation. In addition, for 232 ethnic groups, agriculture was not practiced and therefore there is no measure of female participation in agriculture. For an additional 315 ethnic groups, information for the variable is missing. These ethnic groups (547 in total) are omitted from the analysis.

[18]This is done by subtracting one, dividing by four, and then multiplying by 100.

Table 4: The differential persistence of FLFP over time, traditionally and today

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Female labor force participation, 2012							
Traditional female participation in agriculture	0.262***	0.642***	0.619***	0.696**	0.697***	1.013*	0.833**	1.324*
	(0.071)	(0.168)	(0.179)	(0.307)	(0.222)	(0.577)	(0.360)	(0.799)
Trad female part in agric * Climatic instability		**-1.703*** **	**-1.631*** **	**-1.686*** **	**-1.667** **	**-1.582** **	**-1.671*** **	**-1.453** **
		(0.598)	**(0.609)**	**(0.616)**	**(0.645)**	**(0.651)**	**(0.605)**	**(0.702)**
Country-level controls:								
Climatic instability		69.112***	67.528***	67.967***	67.474***	63.248**	66.664***	56.933**
		(21.545)	(21.597)	(22.740)	(23.583)	(24.715)	(22.818)	(28.365)
Distance from equator	-0.074	-0.150	-0.120	-0.150	-0.145	-0.154	-0.155	-0.137
	(0.109)	(0.116)	(0.123)	(0.116)	(0.119)	(0.117)	(0.115)	(0.134)
Economic complexity	0.834	0.717	0.695	1.237	0.683	0.754	0.786	1.357
	(1.198)	(1.259)	(1.259)	(3.053)	(1.216)	(1.257)	(1.310)	(2.993)
Political hierarchies	-0.529	-0.633	-0.865	-0.735	0.615	-0.778	-0.559	-0.331
	(1.795)	(1.883)	(2.075)	(1.841)	(4.670)	(1.945)	(1.882)	(5.160)
Ln (per capita GDP)	-72.562***	-58.820***	-59.243***	-58.533***	-58.947***	-50.445**	-59.999***	-52.331**
	(14.144)	(14.349)	(14.359)	(14.593)	(14.432)	(19.833)	(14.519)	(21.100)
Ln (per capita GDP) squared	3.883***	3.102***	3.118***	3.088***	3.107***	2.791***	3.173***	2.896***
	(0.768)	(0.779)	(0.779)	(0.791)	(0.783)	(0.929)	(0.791)	(0.966)
Year ethnicity sampled	2.554	0.292	0.512	0.415	0.401	1.015	3.258	5.312
	(1.586)	(1.858)	(1.957)	(1.879)	(1.907)	(2.261)	(5.039)	(5.934)
Female part in agric * Distance from equator			-0.022					-0.016
			(0.035)					(0.036)
Female part in agric * Economic complexity				-0.251				-0.262
				(1.185)				(1.172)
Female part in agric * Political hierarchies					-0.482			-0.241
					(1.621)			(1.829)
Female part in agric * Ln (per capita GDP)						-1.121		-1.090
						(1.706)		(1.956)
Female part in agric * Year ethnicity sampled							-0.003	-0.004
							(0.004)	(0.005)
Continent fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Mean (st. dev.) of dep. var.	53.2(15.4)	53.2(15.4)	53.2(15.4)	53.2(15.4)	53.2(15.4)	53.2(15.4)	53.2(15.4)	53.2(15.4)
Observations	166	165	165	165	165	165	165	165
R-squared	0.354	0.379	0.380	0.379	0.379	0.382	0.379	0.385

Notes: OLS estimates are reported with robust standard errors in parentheses. The unit of observation is a country. Female labor force participation is the percentage of women in the labor force, measured in 2012 and from the Ethnographic Atlas. Historical controls are defined in the appendix. The mean and standard deviation of climatic instability is 0.24 (0.10). ***, ** and * indicate significance at the 10, 5 and 1% levels.

Our estimating equation is:

$$FLFP_{e,c,t} = \alpha_{c,t} + \beta_1 FLFP_{e,c,t-1} + \beta_2 FLFP_{e,c,t-1} \times Climatic\,Instability_{e,c} + \mathbf{X}_{e,c,t-1}\mathbf{\Omega} + \varepsilon_{e,c,t} \quad (4)$$

where e denotes an ethnicity, and c denotes a country. $FLFP_{e,c,t}$ denotes the average female labor force participation rate among women belonging to ethnicity e and living in country c. $Climatic\,Instability_e$ is the climatic instability of the location historically inhabited by ethnic group e. $\mathbf{X}_{e,c,t-1}$ denotes historical controls measured at the ethnicity level and $\alpha_{c,t}$ denotes country-survey-year fixed effects. The sample includes all countries in IPUMS-International that report information on respondents' ethnicity at a sufficiently fine level and that have within-country variation in ancestral climatic instability. These are: Belarus, Cambodia, Malaysia, Nepal, Philippines, Sierra Leone, Uganda, and Vietnam.

Table 5: Ethnicity-level estimates of the differential persistence of FLFP over time, traditionally and today

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Average female labor force participation rate						
Traditional female participation in agriculture	0.157**	0.400***	0.406***	0.685***	0.372*	3.225	4.280*
	(0.069)	(0.127)	(0.149)	(0.214)	(0.200)	(2.436)	(2.501)
Trad female part in agric * Climatic instability		**-0.317****	**-0.314****	**-0.265***	**-0.317****	**-0.341****	**-0.261***
		(0.139)	**(0.145)**	**(0.142)**	**(0.139)**	**(0.140)**	**(0.149)**
Ethnicity-level controls:							
Climatic instability		0.869**	0.856**	0.683*	0.871**	0.947**	0.681
		(0.393)	(0.429)	(0.407)	(0.394)	(0.398)	(0.443)
Distance from equator	0.000	-0.001	-0.000	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)
Economic complexity	0.009	0.008	0.008	0.035*	0.008	0.006	0.047**
	(0.009)	(0.009)	(0.009)	(0.018)	(0.009)	(0.009)	(0.021)
Political hierarchies	-0.006	-0.002	-0.003	-0.007	-0.006	-0.001	-0.033
	(0.011)	(0.011)	(0.011)	(0.011)	(0.022)	(0.011)	(0.026)
Year ethnicity sampled	-0.034	0.000	-0.000	0.001	0.001	0.008	0.021
	(0.064)	(0.066)	(0.066)	(0.065)	(0.066)	(0.066)	(0.066)
Female part agric * Distance from equator			-0.000				-0.001
			(0.005)				(0.006)
Female part agric * Economic complexity				-0.052			-0.080**
				(0.032)			(0.037)
Female part agric * Political hierarchies					0.008		0.059
					(0.042)		(0.051)
Female part agric * Year ethnicity sampled						-1.452	-1.873
						(1.250)	(1.267)
Country-survey-year fixed effects	yes	yes	yes	yes	yes	yes	yes
Mean (st. dev.) of dep. var.	0.55(0.22)	0.55(0.22)	0.55(0.22)	0.55(0.22)	0.55(0.22)	0.55(0.22)	0.55(0.22)
Observations	211	211	211	211	211	211	211
R-squared	0.478	0.492	0.492	0.499	0.492	0.496	0.509

Notes: OLS estimates are reported with robust standard errors in parentheses. The unit of observation is an ethnicity. Female labor force participation is the percentage of women in the labor force. The countries included in the sample are Belarus, Cambodia, Malaysia, Nepal, Philippines, Sierra Leone, Uganda, Vietnam. The mean and standard deviation of the climatic instability variable is 0.19 (0.10). ***, ** and * indicate significance at the 10, 5 and 1% levels.

Estimates of equation (4), reported in Table 5, confirm our findings from the cross-country analysis. First, we find strong persistence between female labor force participation in agriculture historically and female labor force participation today (column 1). Second, we find that this persistence is weaker for those ethnicities with greater historical climatic instability (column 2). In addition, this finding is robust to the inclusion of the historical controls (measured at the ethnicity level) and also their interactions with historical female participation in agriculture. As shown in columns 3–7, our point estimate of interest remains stable when the controls are added individually or together as a group.

B. *Polygamy*

Our next estimates of equation (3) examine the differential persistence of the practice of polygamy over time. We view this as an informative complement to pro-equality gender attitudes because polygamy is a cultural practice that has been declining over time (unlike female labor force participation, which has been increasing over time).

We measure the traditional presence of polygamy using variable v9 from the *Ethnographic Atlas*.[19] We measure the prevalence of polygamy today using data from the *OECD Gender, Institutions and Development Database*. The variable we use is a country-level indicator that equals one if having more than one spouse is accepted or legal.

Estimates of the relationship between the traditional prevalence of polygamy and the practice today are reported in column 1 of table 6. In the remaining columns, we turn to the question of whether the persistence of polygamy depends on the instability of the climate and estimate the full version of equation (3). The controls are motivated by the concern that historical climatic instability may be correlated with these factors, which themselves could influence cultural persistence. We find that the coefficient for the interaction term, β_2, is negative and significant. The persistence of polygamy is weaker in countries where the climate faced by the populations' ancestors was more unstable.

Column 2 reports the baseline estimates. In columns 3–8, we include our covariates, each interacted with the historical measure of polygamy. Our estimate of interest remains robust to the inclusion of these additional interactions, either one at a time or all together.

6. Instability and the persistence of cultural traits: Evidence from U.S. immigration

Our next set of tests use immigration as a natural setting to examine the importance of tradition and the differential persistence of cultural traits. To do this, we study the behavior of the descendants of immigrants to the United States and examine the extent to which traditional practices persist and whether this persistence is predicted by the historical variability of the group's climate. The analysis examines two traditional practices that are universally prevalent

[19] The original classification in the *Ethnographic Atlas* uses the following classification: [1] independent nuclear monogamous, [2] polygyny, [3] preferential sororal living in the same dwelling, [4] preferential sororal living in a separate dwelling, [5] non-sororal living in separate dwelling, [6] non-sororal living in the same dwelling, [7] polyandry. Missing ethnic groups are omitted from the analysis.

Table 6: The differential persistence of polygamy over time, traditionally and today

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Indicator variable for the practice of polygamy today							
Traditional polygamy	0.330***	0.845***	0.863***	0.612**	1.786***	1.862***	3.159*	3.805**
	(0.121)	(0.212)	(0.219)	(0.290)	(0.368)	(0.666)	(1.683)	(1.771)
Traditional polygamy * Climatic instability		**-2.177****	**-2.157****	**-2.153****	**-2.071*****	**-1.805***	**-2.171****	**-1.797****
		(0.878)	**(0.877)**	**(0.864)**	**(0.765)**	**(0.914)**	**(0.877)**	**(0.761)**
Country-level controls:								
Climatic instability		2.363***	2.334***	2.399***	2.184***	1.975***	2.383***	1.975***
		(0.667)	(0.668)	(0.659)	(0.511)	(0.681)	(0.666)	(0.480)
Distance from equator	-0.004	-0.006*	-0.005	-0.006*	-0.005	-0.006**	-0.006*	-0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Economic complexity	-0.007	-0.013	-0.015	-0.042	-0.014	-0.014	-0.013	-0.044**
	(0.020)	(0.021)	(0.021)	(0.025)	(0.021)	(0.020)	(0.020)	(0.022)
Political hierarchies	-0.041	-0.033	-0.034	-0.034	0.186***	-0.030	-0.030	0.188***
	(0.038)	(0.036)	(0.036)	(0.036)	(0.059)	(0.035)	(0.036)	(0.060)
Ln (per capita GDP)	-0.032	-0.043	-0.044	-0.043	-0.042	0.065	-0.045	0.027
	(0.031)	(0.031)	(0.031)	(0.031)	(0.030)	(0.064)	(0.032)	(0.068)
Year ethnicity sampled	-0.102**	-0.109**	-0.111**	-0.109**	-0.108**	-0.118**	1.091	0.708
	(0.044)	(0.045)	(0.046)	(0.045)	(0.045)	(0.046)	(0.855)	(1.006)
Traditional polygamy * Distance from equator			-0.001					-0.000
			(0.003)					(0.003)
Traditional polygamy * Economic complexity				0.038				0.038
				(0.034)				(0.033)
Traditional polygamy * Political hierarchies					-0.262***			-0.260***
					(0.077)			(0.077)
Traditional polygamy * Log (per capita GDP)						-0.122*		-0.081
						(0.072)		(0.075)
Traditional polygamy * Year sampled							-0.001	-0.001
							(0.001)	(0.001)
Continent fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Mean (st. dev.) of dep. var.	0.44(0.41)	0.44(0.41)	0.44(0.41)	0.44(0.41)	0.44(0.41)	0.44(0.41)	0.44(0.41)	0.44(0.41)
Observations	110	109	109	109	109	109	109	109
R-squared	0.535	0.574	0.575	0.576	0.597	0.581	0.577	0.605

Notes: OLS estimates are reported with robust standard errores in brackets. The unit of observation is a country. Polygamy is variable indicating whether polygamy is accepted or legal in a country. The variable takes the value of one if having more than one spouse is an accepted practice. The measure is from the OECD Gender, Institutions and Development Database. The mean and st. dev. of climatic instability is 0.21 (0.09). ***, ** and * indicate significance at the 10, 5 and 1% levels.

among the origin countries: marrying someone from the same nationality and speaking one's mother tongue at home.

A. *Within-group marriage*

In all countries, the traditional practice is to marry someone from your own country. After migrating to the United States there are forces that make this more difficult for the children of immigrants. The importance of this traditional practice to both the parents and their children may affect the extent to which children of immigrants marry someone from a different heritage. Of course other factors will also affect this decision – e.g., the availability of potential partners from one's own cultural background. Thus, we are careful to control for these factors in our empirical analysis.

Our analysis examines the probability of the descendants of immigrants to the U.S. of marrying someone from the same country of origin. Information on the country of origin of married individuals is available for the recent period from the *March Supplement of the Current Population Survey (CPS)*. Beginning in 1994, the CPS began recording both parents' countries of origin for all individuals who were born in the United States. In our analysis, we use all of the 21 waves that are available.

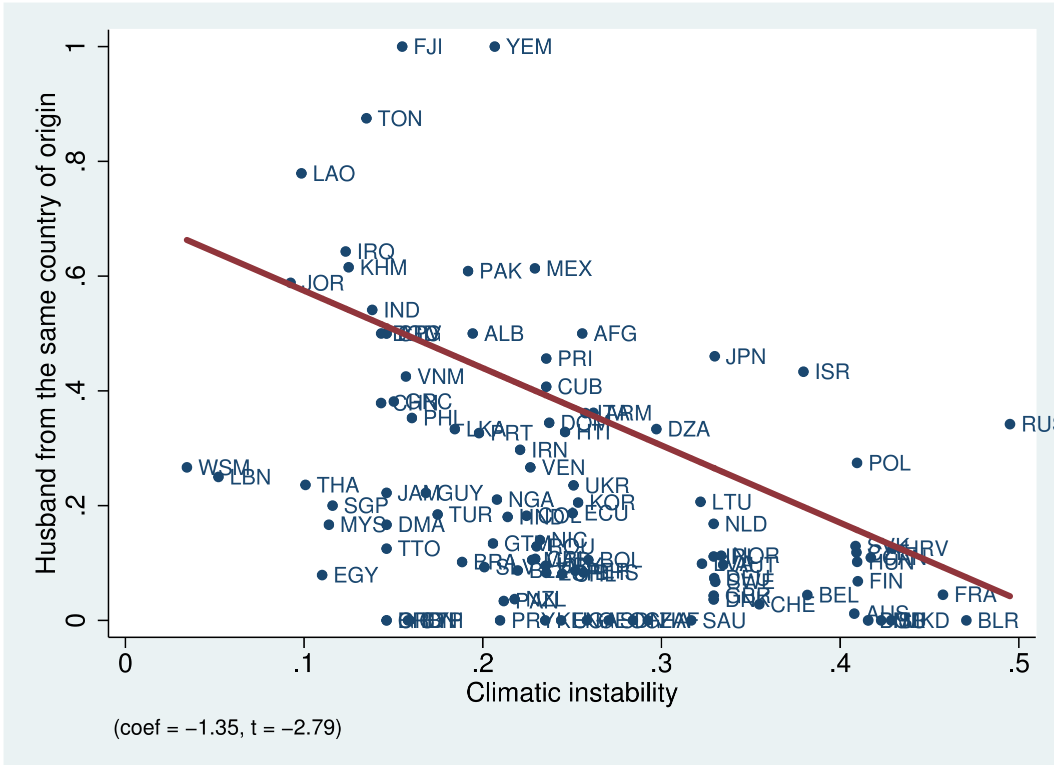
Before turning to our regression equation, we start by examining the raw data. We do this by aggregating observations in the sample to the origin country level. We then examine the relationship between the share of spouses that are from the same origin country and the ancestral climatic instability variable. The relationship is shown for wives (i.e., married daughters of immigrants) in figures 6a and 6b. Figure 6a shows the relationship with observations labelled with their 3-digit country iso code. Figure 6b reports the relationship with countries denoted by circles, where the size of the circle is proportional to the number of wives in the sample that are from that origin country.

A few points are clear from the figures. First, Mexico is the most common origin country. However, there are also many other countries represented in the sample. Second, in the raw data, there is a clear negative relationship between the two measures. Origin countries with more historical climatic instability are also countries where there is less marriage to a spouse from the same origin country. Finally, it is clear that Mexico is not driving this relationship. Removing Mexico, one still observes the pattern.

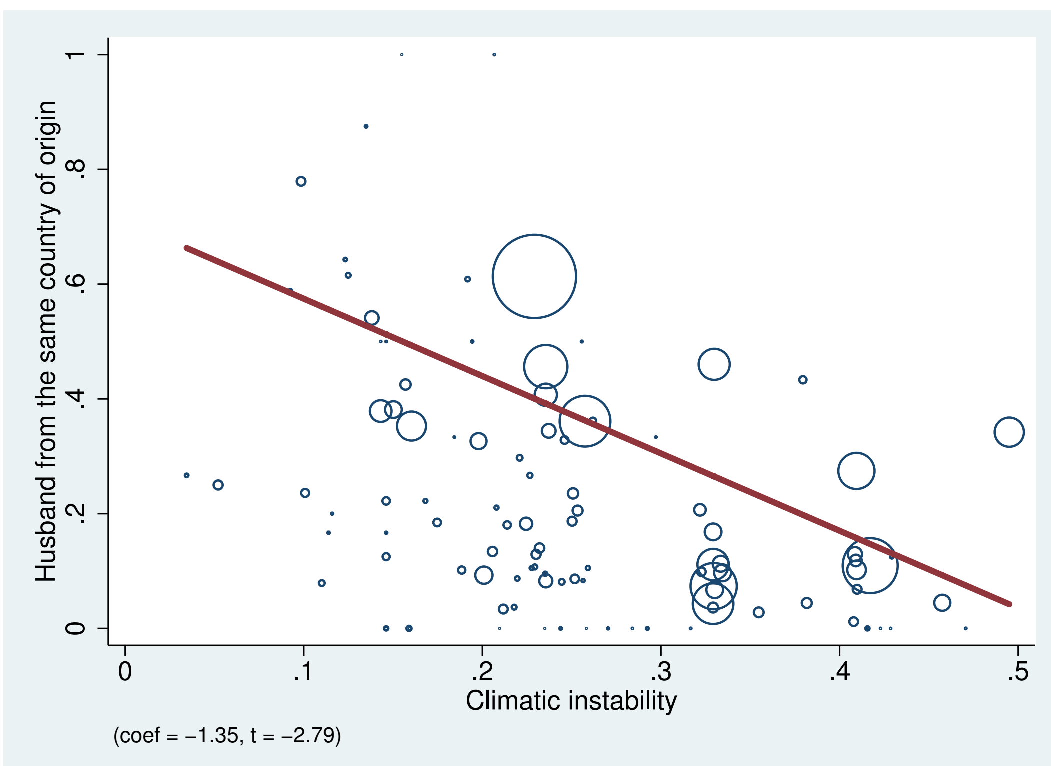
We now turn to our estimating equation, which is given by:

$$I_{i,c}^{\textit{Ingroup Marriage}} = \alpha + \beta\, Climatic\, Instability_c + \mathbf{X}_c \mathbf{\Pi} + \mathbf{X}_i \mathbf{\Phi} + \varepsilon_{i,c}, \tag{5}$$

where i indexes married women or men (depending on the sample) who were born in the U.S., but whose parents are immigrants who were born outside of the U.S.; c indexes the origin country of the individual's parents. The outcome of interest, $I_{i,c}^{\textit{Ingroup Marriage}}$, is an indicator variable that equals one if an individual's spouse has the same origin country. The spouse is coded as one if he/she was born in origin country c, or if either the mother or father were born in origin country c. $Climatic\, Instability_c$ is the measure of historical weather variability of the individual's origin country c. The vector of country-level covariates, $\mathbf{X}_c$ includes the natural log of the current per capita GDP in the country of origin (measured in the survey year), and all the historical ethnicity characteristics from the origin country (distance from the equator, a measure



(a) Bivariate relationship with names of country of origin shown



(b) Bivariate relationship where the circle size denotes the number of individuals from the country of origin in the sample

Figure 6: Bivariate relationship between women marrying men from the same country of origin and climatic instability

Table 7: Women and men marrying a spouse from the same origin country, from CPS 1994–2014

	(1)	(2)	(3)	(4)
	Dependent variable: Indicator varible for spouse being from the same origin country			
	Woman marrying a husband		Man marrying a wife	
	Origin of observation defined by father	Origin of observation defined by mother	Origin of observation defined by father	Origin of observation defined by mother
Climatic instability	**-0.274***	**-0.492*****	**-0.103**	**-0.250***
	(0.156)	**(0.178)**	**(0.138)**	**(0.148)**
Country-level controls:				
Distance from equator	-0.006**	-0.005	-0.008***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
Economic complexity	0.009	0.019	-0.010	-0.021
	(0.026)	(0.035)	(0.039)	(0.037)
Political hierarchies	0.089***	0.084***	0.092**	0.085**
	(0.027)	(0.029)	(0.037)	(0.037)
Ln (per capita GDP)	-0.005	-0.022	-0.003	-0.004
	(0.030)	(0.033)	(0.036)	(0.035)
Genetic distance from the United States	0.031	0.010	0.011	-0.010
	(0.046)	(0.053)	(0.043)	(0.044)
Fraction of population in location that are first- or second-generation immigrants from the same country of origin	3.314***	3.533***	3.071***	3.409***
	(0.489)	(0.627)	(0.504)	(0.483)
Individual level controls	yes	yes	yes	yes
Number of countries	108	105	110	105
Mean (st. dev.) of dependent variable	0.33 (0.47)	0.32 (0.47)	0.28 (0.45)	0.29 (0.45)
Observations	36,082	34,045	38,419	35,639
R-squared	0.239	0.254	0.223	0.245

Notes : OLS estimates are reported with standard errors in parentheses. In columns 1 and 2, the unit of observation is a daughter of at least one immigrant parent who is married at the time of the survey. In columns 1 and 2, the dependent variable is an indicator variable that equals one if the woman is married to someone with the same ancestry. In columns 3 and 4, the unit of observation is a son of at least one immigrant parent who is married at the time of the survey. The dependent variable is an indicator variable that equals one if the man is married to someone with the same ancestry. The country of origin of the spouse is defined by the country of birth of the father in columns 1 and 3, and of the mother in column 2 and 4. The following controls are included in all specifications: a quadratic in age, two indicator variables for education (less than high school and high school) for the individual, metropolitan area fixed effects, and survey-year fixed effects. Standard errors are clustered at the country-of-origin level. The mean and standard deviation of climatic instability is 0.29 (0.09). ***, ** and * indicate significance at the 10, 5 and 1% levels.

of economic complexity and a measure of political sophistication). We also include the genetic distance between the country of origin and the United States to account for cultural distance.[20]

The following individual-level covariates, $\mathbf{X}_i$, are included in all specifications: a quadratic in age, two indicator variables for education (less than high school and high school) for the individual, metropolitan area fixed effects, an indicator rural/urban, and survey-year fixed effects. We also control for the fraction of the population that are first- and second-generation immigrants from the individual's country of origin and living in the same metropolitan area as the individual.[21]

Estimates of equation (5) are reported in table 7. In columns 1 and 2, the unit of observation is a married woman, while in columns 3 and 4, it is a married man. In columns 1 and 3, we define

[20]The measure is taken from Spolaore and Wacziarg (2009).

[21]For individuals that do not live in a metropolitan area, we use the fraction of the non-metropolitan area population that is within the same state.

the origin country by the birthplace of the person's father, while in columns 2 and 4, we define it by the birthplace of the mother. Across all four specifications, we find a negative relationship between the historical climatic instability and the probability that one marries someone of their own heritage. However, the magnitudes and significance appear to be stronger for the sample of women than for the sample of men. Also, the effects also appear stronger when we define a person's origin county using the mother than when using the father. According to the estimates of column 2, a one-standard-deviation increase in climatic instability is associated with a decrease in the fraction of daughters of immigrants marrying someone from the same country of 0.044, which is equal to 13 percent of the mean of the independent variable and 9 percent of its standard deviation. When we look at the married sons of immigrants (in column 4), we find that a one-standard deviation increase in climatic instability is associated with a decrease in the fraction of sons of migrants who marry someone from the same country of 0.022, which is equivalent to 8 percent of the mean in the dependent variable and 5 percent of its standard deviation. This is about half the size of the effect for the sample of daughters of immigrants.

B. ***Is English spoken at home?***

The second indicator of the persistence of tradition that we use is whether or not English is spoken at home. In all origin countries, individuals speak one of the vernaculars of their country. However, since the children of migrants who are born in the U.S. are almost always fluent in English, they face the decision of whether to continue to also speak their traditional language. We thus examine, as a revealed measure of the importance of holding on to tradition, the extent to which a foreign language is spoken at home among the children of immigrants. If a language other than English is spoken at home, this indicates that the children of the immigrants were taught their origin language, which is a sign of the parents and children valuing their tradition.[22] It also means that the origin language is valued enough for it to be spoken within the household. Since the ease at which parents can learn English will be an important determinant of whether children speak English at home, we always include a proxy for the linguistic distance of the

[22]In practice we use a measure of whether the respondent speaks a language other than English at home. Theoretically, this language could be a language different from the mother tongue of the respondent's parents since which foreign language is spoken is not recorded. However, it seems highly likely that in nearly all cases the foreign language that is spoken at home will be a mother tongue of the parents.

ancestral language from English. Our sample only includes origin countries for which English is not an official language.

Information about the language spoken at home is available from the 2000 Census. Unfortunately, the Census does not report the country of origin of a respondent's parents.[23] Instead, it records individuals' self-reported 'ancestry'. Our sample includes all individuals who were born in the United States and report foreign ancestry from a country that does not have English as an official language. These are individuals who are second-generation immigrants or later. Thus, in contrast to the analysis of marriage, here we use reported ancestry rather than the parents' countries of birth to identify the individual's origin country. It is possible that ancestry is less precisely measured and potentially endogenous to the importance of tradition. These caveats should be kept in mind when interpreting the estimates. We will return to the issue below.

Figures 7a and 7b report the cross-country bivariate relationship between historical climatic instability and the proportion of individuals in our sample that speak a foreign language at home. Figure 7a shows observations and the country names, while Figure 7b shows the relationship but with observations given by circles that are of a size that is proportional to the number of observations in the sample from that country. In the raw data, one observes a significant negative relationship. Immigrant descendants from countries with more historical climatic instability are less likely to speak a non-English language at home.

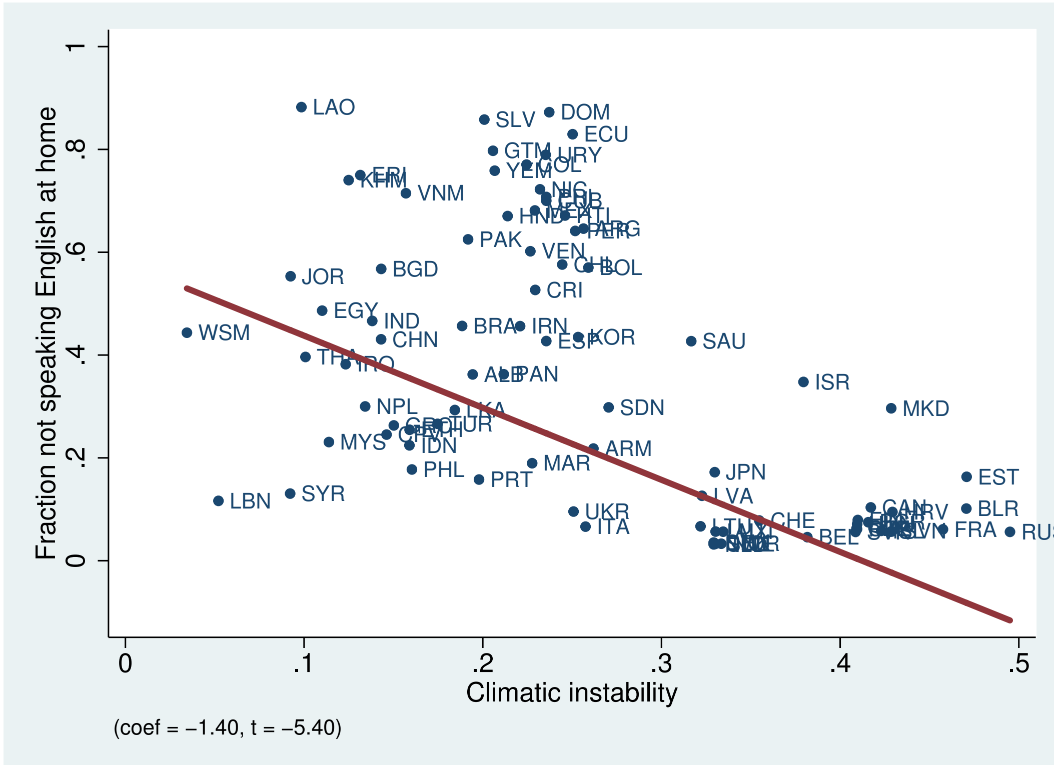
We examine this relationship more formally by estimating the following equation:

$$I_{i,c}^{\text{Foreign Lang}} = \alpha + \beta\, \text{Climatic Instability}_c + \mathbf{X}_c \boldsymbol{\Pi} + \mathbf{X}_i \boldsymbol{\Phi} + \varepsilon_{i,c}, \tag{6}$$

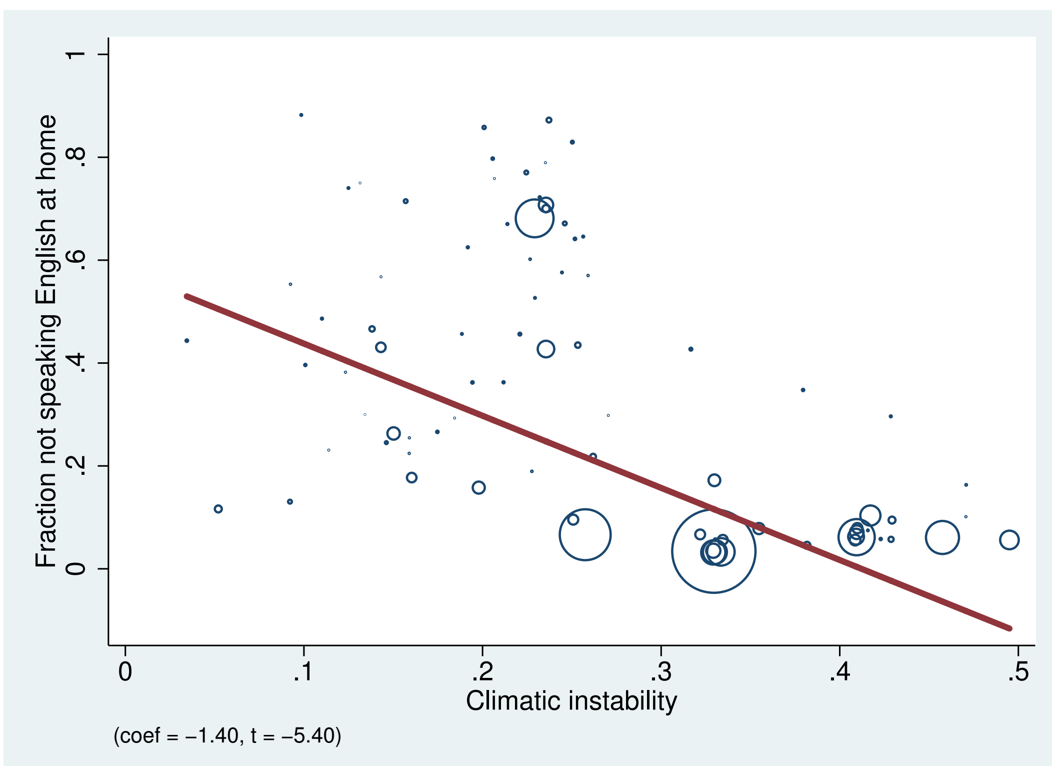
where i denotes an individual and c his/her ancestry. The dependent variable, $I_{i,c}^{\text{Foreign Lang}}$, is an indicator that equals one if a language other than English is the primary language spoken at home. $Climatic\,Instability_c$ is our measure of weather variability, $\mathbf{X}_c$ denote country controls: given by historical distance from the equator, historical economic development and political complexity, the GDP in the country of origin, and the genetic distance between the migrant's country of origin and the United States.[24] The vector of individual-level controls, $\mathbf{X}_i$, includes a quadratic in age, a gender indicator, an indicator for being married, educational attainment fixed effects (less than high school and high school, with the excluded group given by individuals with more than high

[23] The Census recorded the parental country of origin until 1970 only.

[24] Conceptually, linguistic distance is a more desirable control. This measure is very strongly correlated with genetic distance, but is available for fewer countries. Estimates with this measure are nearly identical to the estimates when using genetic distance, though estimated from a smaller sample.



(a) Bivariate relationship with names of country of origin shown



(b) Bivariate relationship where the circle size denotes the number of individuals from the country of origin in the sample

Figure 7: Bivariate relationship between climatic instability and speaking a foreign language at home.

Table 8: Speaking a foreign language at home, from 2000 Census

	(1)	(2)	(3)	(4)	(5)
	Dep variable: Indicator for speaking a foreign language at home				
	All 2nd gen+ individuals	Not living with parents	Living with parents		
			All ages	18 or younger	Over 18
Climatic instability	**-0.346****	**-0.279***	**-0.731*****	**-0.642*****	**-0.783*****
	(0.161)	**(0.162)**	**(0.195)**	**(0.188)**	**(0.202)**
Country-level controls:					
Distance from equator	-0.015***	-0.016***	-0.011***	-0.009***	-0.012***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Economic complexity	-0.164***	-0.160***	-0.172***	-0.147***	-0.189***
	(0.047)	(0.048)	(0.048)	(0.044)	(0.050)
Political hierarchies	0.122	0.105	0.169*	0.151*	0.183**
	(0.090)	(0.086)	(0.087)	(0.088)	(0.086)
Ln (per capita GDP)	0.017	0.016	0.012	0.004	0.016
	(0.021)	(0.019)	(0.025)	(0.025)	(0.026)
Genetic distance from the US	0.154**	0.144*	0.191***	0.202***	0.180**
	(0.075)	(0.076)	(0.066)	(0.060)	(0.069)
Fraction of population with the same ancestry	0.093	0.098	0.019	0.034	0.009
in the same location	(0.059)	(0.059)	(0.065)	(0.063)	(0.068)
Individual level controls	yes	yes	yes	yes	yes
Number of countries	84	84	84	84	84
Mean (st. dev.) of dependent variable	0.12 (0.33)	0.11 (0.31)	0.23 (0.42)	0.22 (0.42)	0.23 (0.42)
Observations	3,343,097	2,915,673	427,424	176,893	250,531
R-squared	0.304	0.278	0.383	0.367	0.399

Notes : The unit of observation is a person born in the United States with an ancestry from a non-English speaking country. The dependent variable is an indicator that equals one if the person does not speak English at home. All specifications include the following control varaibles: a quadratic in age, two indicator variables for education (less than high school and high school), labor force participation fixed effects, personal income, and location (i.e., MSA) fixed effects. Standard errors are clustered at the ancestry-country level. The mean and standard deviation of Climatic instability is 0.33 (0.07). ***, ** and * indicate significance at the 10, 5 and 1% levels.

school), labor force status fixed effects (employed, unemployed, and outside of the labor force), the natural log of annual income and indicator variables for rural/urban areas. Our regressions also control for metropolitan area fixed effects and the fraction of first generation migrants of the same ancestry of the respondent living in the same metropolitan area to rule out the possibility that the language is preserved only if the size of the first generation group is sufficiently large.

Estimates of equation (6) are reported in Table 8. Column 1 reports estimates using the full sample of individuals born in the United States but reporting a different ancestry. We find a negative and significant relationship between historical climatic instability and a non-English language being spoken at home. That is, descendants from places with more historical instability are less likely to continue speaking their mother tongue at home. According to the estimates, a one-standard deviation increase in climatic instability is associated with a reduction in the probability of speaking a non-English language at home of $0.07 \times 0.346 = 0.02$, which is equal to 20% of the sample mean and 7% of its standard deviation.

In columns 2 and 3, we split the samples in two groups: those not living with their parents (column 2) and those that live at home with their parents (column 3). The magnitude of the estimated effects appear to be larger among individuals living with their parents, although this is potentially explained by the fact that the mean of the dependent variable is higher for this group. In columns 4 and 5, we further split the sample of children living at home by age: those who are 18 or younger (column 4) and those who are older than 18 (column 5). We find that the negative relationship between climatic instability and speaking a foreign language at home is similar for both groups, although slight larger for the over-18 group.

In our baseline specification, we omit from the sample individuals whose ancestral country has English as an official language. As we report in appendix Table A7, the estimates are nearly identical if we include these observations.

Recall, that unlike our analysis of in-group marriage, for this sample we use reported ancestry rather than the parents' countries of birth to identify the individual's origin country. It is likely that self-reported ancestry is less precisely measured and potentially endogenous to the importance of tradition. It is not clear how this could bias the results. On the one hand, the estimates could be biased towards zero due to classical measurement error. On the other hand, if individuals who value tradition more are more likely to report their ancestry as being from their home country, then this could result in non-classical measurement error. Since the observed sample will tend to disproportionately include these observations, if the estimated effects of climatic instability is particularly strong for this group, then our estimates would be biased away from zero. Given this concern, we check the robustness of our estimates to equal weighting of observations. Appendix Table A8 reports estimates of a variant of equation (6), but where an observation is an origin-ancestry and location. The estimates are qualitatively identical to the baseline estimates.

Overall, the estimates provide evidence of our hypothesized link between historical environmental stability across generations and the importance placed on tradition today.

7. Instability and the persistence of cultural traits: Evidence from Indigenous Populations

One concern with our analysis involving immigrants is that they are not a representative subsample of the origin populations. Migrants are a selected group and the nature of selection may vary for different countries. This is problematic if this varies systematically with historical environmental stability of the origin country. Given this, we also undertake a fourth exercise that examines populations that are faced with pressure to change their traditions and customs, but are not immigrants. These are the Indigenous populations of the United States and Canada. Like immigrants, Indigenous populations are minority groups with different cultural traditions and living within a dominant foreign population. However, unlike immigrants, the population of Native Americans does not reflect selection into migration.

Our analysis examines the relationship between the climatic stability of the land historically inhabited by Indigenous tribes and the extent to which they are able to speak their traditional language today. Within the United States and Canada, there is significant variation in the extent to which Indigenous populations have maintained their language. In recent work, Arthur and Diamond (2011) discuss how among the several hundred Native American groups of North America, many have lost their original language completely, while others, such as the Navajo, have done well at retaining it.

As with our analysis of the children of immigrants, we also use whether the traditional language is spoken at home as a measure of the continuity and maintenance of tradition. The sample from the United States is taken from the U.S. Census. It includes all individuals who identify themselves as Native Americans. We link an individual to a Native American ethnic group (i.e., tribe) using their Census self-reported tribal affiliation.[25] We then link this to information on the traditional location of ethnic groups from the *Ethnographic Atlas*. Using the location, we then assign an ancestral climatic instability measure to each Census tribe. Figure 8 reports a map showing the ethnic groups in our sample (according to the *Ethnographic Atlas* classification). Also shown visually are the grid-cells and different categories of climatic instability. Within the United States one observes significant variation in climatic instability, making the Native American experience a useful setting to examine the persistence of our cultural tradition of interest.

We use data from all comparable Census years for which data are available (1930, 1990, and 2000)[26] to examine whether an Indigenous language is spoken by Indigenous populations. Our

[25]The Census records the name of the tribe in which the person is enrolled and, if the person is not enrolled in a tribe, the name of the principal tribe.

[26]The 1910 Census also contains information about the tribe to which the individual belongs. Although it also contains information about the language spoken, this information is not comparable with the other Census years since it only capture one's inability to speak English. For more details on the lack of comparability of the 1910 language variable with the variables from the other census years see `www.ipums.org`.

estimating equation is as follows:

$$I_{i,e,k}^{NativeLanguage} = \alpha_k + \beta \, \mathit{Climatic\,Instability}_e + \mathbf{X}_e \mathbf{\Pi} + \mathbf{X}_i \mathbf{\Phi} + \varepsilon_{i,e,k}, \tag{7}$$

where i denotes an individual, e his/her ethnic group, and k a location of residence (i.e., a metropolitan area). The dependent variable, $I_{i,e}^{NativeLanguage}$ is an indicator that equals one if the individual i reports speaking a Native American language at home.[27] The specification includes location (i.e., metropolitan area) fixed effects, α_k. Thus, the variation used to estimate β is across individuals from different Native American ethnic groups, but living within the same location. $Climatic\,Instability_e$ is our measure of weather instability, which is the temperature variability in the traditional location of the ethnic group as indicated in the *Ethnographic Atlas*. $\mathbf{X}_e$ denotes the vector of ethnicity-level covariates. The vector of individual-level controls, $\mathbf{X}_i$, includes: a quadratic in age, a gender indicator, an indicator for being married, labor force status fixed effects (employed, unemployed, and outside of the labor force), and an indicator for being educated.[28] Standard errors are clustered at the grid-cell level.

Estimates of equation (7) are reported in Table 9. The table reports the same set of specifications as in table 8: column 1 reports estimates using the full sample of self-reported Native Americans; column 2 examines the sample to individuals not living with their parents, and column 3–5 examines the sample of individuals living with their parents (all, 18 or younger, and over 18). In all samples, we find a negative and significant relationship between ancestral climatic instability and the likelihood of speaking an Indigenous language at home. In other words, ancestral instability of the environment is associated with less value placed on the tradition of speaking one's tribal language at home. Based on the estimates from column 1, a one-standard-deviation increase in climatic instability is associated with a reduction in the probability of speaking a Native American language of 0.106 percentage points, which is equal to 67% of the sample mean and 31% of its standard deviation.

A concern with the individual-level estimates is that whether an individual reports being Native American in the census may itself be affected by how much the individual values tradition. In particular, individuals from ethnic groups that place less importance on tradition will be less likely to report having a Native American ancestry, will not appear in our sample, and thus will

[27]The Census 1930, 1990 and 2000 asks the following question about language: "Does the person speaks a language other than English at home?" If yes, the person indicates which is the language spoken at home.

[28]In the 1990 and 2000 censuses, the indicator is constructed using information on school attainment. In the 1930 census, it is constructed using information on whether the individual is literate.

Table 9: Whether Indigenous populations of the United States speak their traditional language at home: Individual-level estimates

	(1)	(2)	(3)	(4)	(5)
	Dep variable: Indicator for speaking an Indigenous language at home				
		Not living with parents	Living with parents		
	All individuals		All ages	18 or younger	Over 18
Climatic instability	**-1.097***** **(0.358)**	**-1.195***** **(0.400)**	**-0.946***** **(0.300)**	**-0.856***** **(0.288)**	**-1.323***** **(0.352)**
Ethnicity-level controls:					
Distance from equator	-0.008** (0.004)	-0.009** (0.004)	-0.007** (0.003)	-0.006* (0.003)	-0.010** (0.004)
Economic complexity	-0.022 (0.014)	-0.024 (0.016)	-0.020* (0.011)	-0.018* (0.010)	-0.026 (0.016)
Political hierarchies	-0.118** (0.046)	-0.132** (0.049)	-0.097** (0.042)	-0.088** (0.042)	-0.137*** (0.044)
Individual controls	yes	yes	yes	yes	yes
Number of ethnic groups	83	83	79	78	67
Number of clusters (grid cells)	40	40	40	40	40
Mean (st. dev.) of dependent variable	0.18 (0.39)	0.20 (0.40)	0.15 (0.36)	0.13 (0.34)	0.25 (0.43)
Observations	128,005	79,235	48,770	39,800	8,970
R-squared	0.334	0.373	0.289	0.250	0.424

Notes : OLS estimates are reported with standard errors clustered at the level of the climatic grid cell in parentheses. The unit of observation is a person who identifies him/herself as a Native American. The dependent variable is an indicator that equals one if the person speaks an indiginous (i.e., Native American) language at home. All specification include the following covariates: a quadratic in age, a gender indicator, employment status fixed effects, an indicator for being married, metropolitan area fixed effects, an indicator for whether the individual has any education. The mean (and standard deviation) of Climatic instability is 0.27 (0.11).

be under-represented in our sample. Therefore, we also estimate a version of equation (7) that is at the ethnicity and location level, rather than the individual level. As we explain below, a benefit of this specification is that it can be replicated and compared to estimates using Canadian data that are not available at the individual level but are available at the ethnicity and location level. The ethnicity and location level estimating equation that we use is:

$$Frac\,Native\,Language_{e,k} = \alpha_k + \beta\, Climatic\,Instability_e + \mathbf{X}_e\mathbf{\Pi} + \varepsilon_{e,k}, \tag{8}$$

where e indexes a Native American ethnic group, and k a location of residence (i.e., a metropolitan area). The dependent variable, $Frac\,Native\,Language_{e,k}$, is the fraction of Native Americans belonging to ethnic group e and living in location k that speaks an Indigenous language at home. $Climatic\,Instability_e$ is our measure of weather instability, which is the temperature variability in the traditional location of the ethnic group. $\mathbf{X}_e$ denotes the vector of ethnicity-level covariates. The specification includes location (i.e., metropolitan area) fixed effects, α_k. Given the significant skew

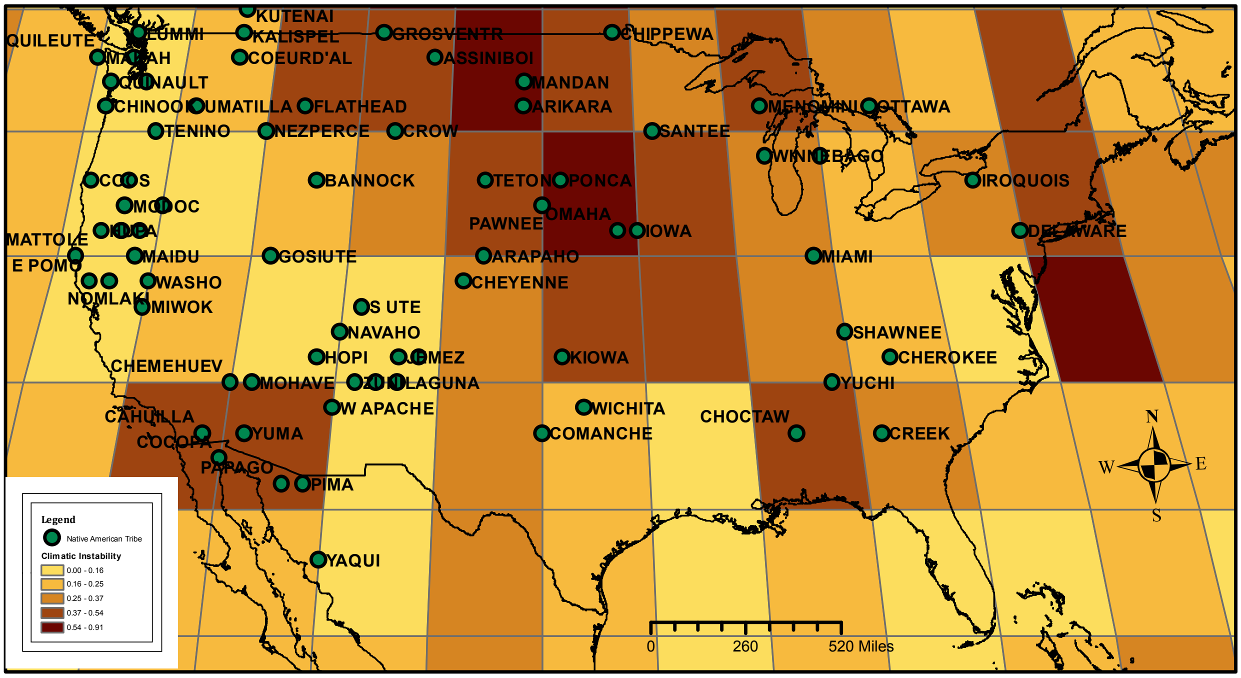


Figure 8: Map of climatic instability and the location of Native American populations that are in the Ethnographic Atlas and in the U.S. Census.

in the distribution of the outcome variable, we estimate equation (8) using a Poisson model.[29] Standard errors are clustered at the ancestral climatic grid-cell level.

We find a negative and significant relationship between historical climatic variability and the proportion of the population speaking a Native American language at home (columns 1of Table 10).[30]

We also undertake the same exercise, but for Canadian Indigenous populations using the 2001, 2006, and 2011 rounds of the *Census Aboriginal Population Profiles* available from Statistics Canada. The data include all Indigenous populations that are living on a reserve or a legal land base. Statistics Canada collects information on the proportion of the population who: (*i*) has an Indigenous language as their mother tongue (*ii*) has an Indigenous language spoken at home; and (*iii*) can conduct a conversation in at least one Indigenous language.

Figure 9 provides a map that shows the ethnic groups in our sample (according to the *Ethnographic Atlas* classification). Also shown are the grid-cells and different categories of climatic

[29]The histograms of the dependent variable for the U.S. and Canadian samples are shown in appendix Figures A1 and A2.

[30]The largest number of different ethnic groups is observed in 1930. In the Appendix, in Table A11, we report both the individual level regressions and the ethnicity level regressions only for this Census year.

Table 10: Whether Indigenous populations of Canada and the United States speak their traditional language: Ethnicity-level estimates

	(1)	(2)	(3)	(4)	(5)
	United States	**Canada**			**U.S. & Canada**
	Indigenous language is spoken at home	Indigenous language is mother tongue	Indigenous language is spoken at home	Conversational in Indigenous language	Indigenous language is spoken at home
Climatic instability	**-4.879****	**-2.486*****	**-2.394*****	**-1.957*****	**-4.668****
	(2.116)	**(0.754)**	**(0.890)**	**(0.623)**	**(1.889)**
Ethnicity-level controls:					
Distance from the equator	0.000	0.054***	0.058***	0.035***	0.003
	(0.023)	(0.010)	(0.012)	(0.009)	(0.020)
Economic complexity	-0.185***	-0.264***	-0.285***	-0.166***	-0.181***
	(0.072)	(0.048)	(0.068)	(0.033)	(0.067)
Political hierarchies	-0.069	0.058	-0.061	-0.002	-0.060
	(0.227)	(0.111)	(0.132)	(0.098)	(0.209)
Location FE	yes	yes	yes	yes	yes
Survey year FE	yes	yes	yes	yes	yes
Number of ethnic groups	83	36	36	36	108
Number of clusters (grid cells)	40	24	24	24	52
Mean (st. dev.) of dependent variable	0.039 (0.14)	0.29 (0.25)	0.25 (0.26)	0.34 (0.26)	0.07 (0.18)
Observations (ethnicity-year-location)	3,564	546	546	546	4110

Notes : Poisson estimates are reported with standard errors clustered at the grid cell level in parentheses. The unit of observation is an Indigenous ethnic group (from the U.S. and/or Canada), living in a location, and observed in a census survey. The dependent variables are different measures of the fraction of people that can speak their traditional language. The American sample includes data from the 1930, 1990, and 2000 Censuses. The Canandian sample includes data from the 2001, 2006, and 2011 Censuses. The mean (and standard deviation) of Climatic instability is 0.30 (0.11). ***, ** and * indicate significance at the 10, 5 and 1% levels.

instability. As with the United States, one also observes significant variation in climatic instability within Canada. Thus, Canada is an attractive setting to replicate the findings for the U.S. Indigenous populations.

Using the Canadian data, we re-estimate equation (8). The estimates, for each of the three available measures of language ability, are reported in columns 3–5 of Table 10. As with the U.S., in Canada we also find a negative relationship between ancestral climatic instability and the fraction of a population that speaks an Indigenous language. The final specification that we estimate pools the two samples together and use the fraction of individuals that speak an Indigenous language at home as the outcome variable. As reported in column 5, the estimates using this specification are similar.

Overall, our findings suggest that Indigenous populations, both the United States and Canada, with ancestors that lived in locations with greater climatic instability historically, today are less likely to continue to hold on to their tradition of speaking their Indigenous language within the

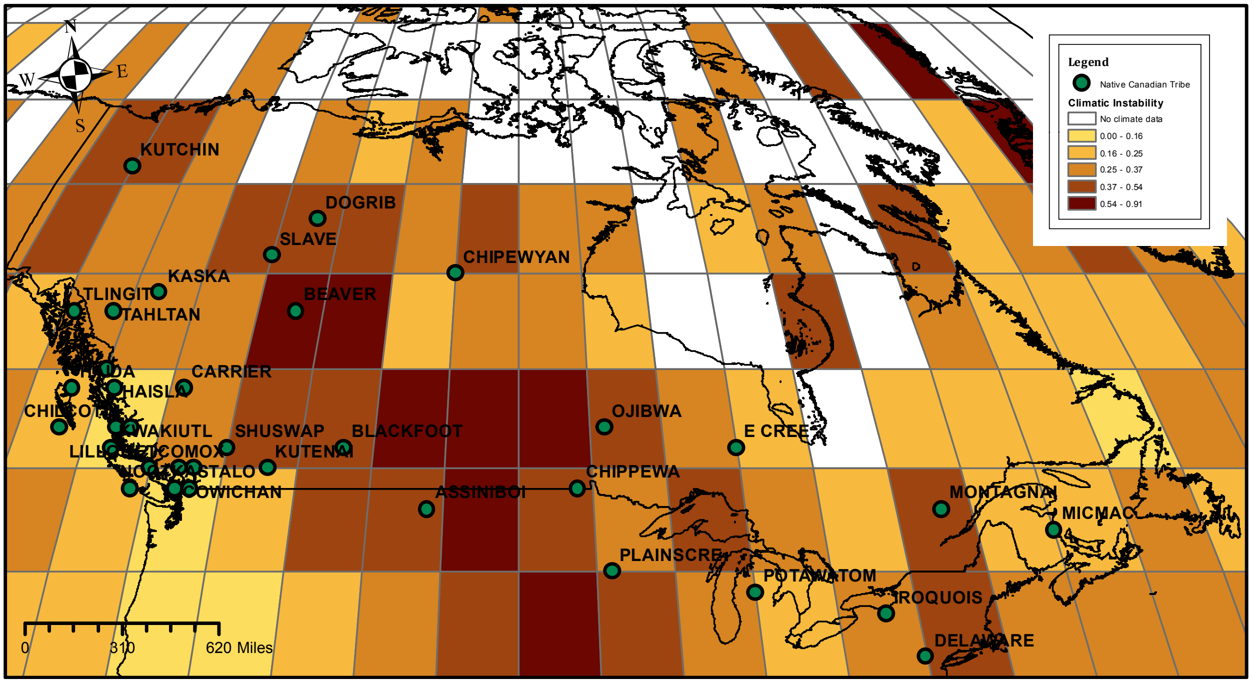


Figure 9: Map of climatic instability and the location of Native Canadian (i.e., First Nations) populations that are in the *Ethnographic Atlas* and in the *Canadian Aboriginal Census*.

home.

8. Other dimensions of weather and other correlates

While the focus of our analysis is on the change in the environment from one generation to another, other forms of temperature variability may also be important. In addition, these other aspects of weather may be correlated to our measure of climate variability. For example, using data from Europe, Durante (2010) finds that climatic risk (from year-to-year during growing months or across space) in pre-industrial Europe is associated with higher level of trust today. According to his findings, individuals living in more variable environments developed greater levels of trust and norms of cooperation to insure themselves against climatic risk. Therefore, it is possible that the higher frequency variability that is the object of Durante's analysis is correlated with the cross-generational variation of interest here. The Mann et al. climate data that we use do not have reliable annual precision, and because the Luterbacher et al. data that are used by Durante (2010) only extend back to 1500AD rather than 500AD. Thus, a direct comparison between the variability measures in the two papers is difficult. Thus, we undertake an alternative strategy to this and examine the extent to which our climatic instability measure is associated with trust.

We do this by re-estimating equations (1) and (2) with a 0-1 measure of trust, taken from the *World Values Survey* as the outcome of interest.[31]

Estimates are reported in appendix Table A12, where we report estimates without and with the baseline set of covariates. In general, the estimated relationship between climatic instability and trust is small and insignificant.[32] The estimates indicate that our dimension of climatic instability – unlike the year-to-year and spatial variation examine by Durante – appears uncorrelated with trust.

As a final check, we also test the robustness of our results to controlling for trust. Appendix Table A13 reports estimates of equations (1) and (2), but with the trust measure included as an additional covariate. In equation (1), the added control is average trust, measured at the country level, and in equation (2), the added control is trust, measured at the individual level. As reported, our estimates of interest are robust to the inclusion of this covariate.

9. Conclusion

Our analysis has examined a simple but still unanswered question. When does culture persist and when does it change? We contribute to a better understanding of this issue by testing an established hypothesis from the evolutionary anthropology literature (e.g., Boyd and Richerson, 1985, Rogers, 1988, Feldman et al., 1996, Boyd and Richerson, 2005). Populations with ancestors that lived in locations with greater stability, place more importance on maintaining traditions and customs. When the environment is stable, the culture of the previous generation provides valuable information that is applicable for the current generation. When the environment is less stable, the culture of the previous generation is less likely to be suitable for the current generation. Thus, relying on tradition is more beneficial in environments that are more stable from one generation to the next. At the extreme, if the environment changes completely every generation, then the actions of the previous generation hold no insight for the current generation.

[31]The measure is based on the following survey questions: "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" Respondents chose one of the following answers: "Most people can be trusted" (which we assign the value of 1) or "Cannot be too careful" (which we assign the value of zero).

[32]At the country-level, when one examines the raw data, one finds a positive relationship between climatic instability and average trust (column 1). However, this relationship disappears, becoming negative, small in magnitude, and statistically insignificant (column 2). When the analysis is at the individual level, we estimate a small, negative, and insignificant relationship between climatic instability and trust. This is true with or without the inclusion of our baseline country-level covariates (columns 3 and 4).

We have tested this hypothesis using grid-cell level paleo-climatic data on the average temperature across 20-year generations from 500–1900AD. Looking across countries, ethnicities, and immigrants, and performing four distinct tests of the hypothesis, we found that, consistent with the hypothesis, groups with ancestors that lived in more variable environments place less importance in maintaining tradition today. In addition, these populations also exhibit greater persistence in cultural traits over time today.

As well as providing a better understanding of when we expect culture to persist and when we expect it to change, our findings also comprise a test of a prediction that is common in a class of models from evolutionary anthropology. The core assumption of the models is that culture evolves systematically based on relative costs and benefits of the different cultural traits. An alternative hypothesis, is that culture is not systematic and cannot be explained. Our findings provide support for the systematic evolution of culture as modeled in this literature. Testing these models is important since the current models of cultural evolution within economics (e.g., Bisin and Verdier, 2000, 2001, Hauk and Saez-Marti, 2002, Francois and Zabojnik, 2005, Tabellini, 2008) implicitly built on a number of important outcomes of models from evolutionary anthropology. In particular, the presence of culture and social learning, which are typically assumed as being fundamentals of the model, are derived as outcomes. Recall, that a result of the Rogers's (1988) model presented in section 2, is that under general circumstances there is always some traditionalists in the population that engage in the use of culture in decision making. It is this result that provides a justification for the assumption in models of cultural evolution that parents choose to (and are able to) influence the preferences of their children. Thus, the findings of this study provide empirical validation for the models in evolutionary anthropology that provide a foundation for the assumptions made in the models used in cultural economics.

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