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Revisiting “The Agricultural Origins of Time Preference”: a Replication and Extension with New Data

Prof. Luigi Pascali

SUPERVISOR

Sofia Leonardi

CANDIDATE

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I. Introduction

In the attempt of explaining the origins of differences in economic growth across countries, many economists developed theories sustaining a prominent role played by geographical characteristics. Factors independent of human impact, such as land productivity, specific environments and climate conditions, latitude, and accessibility of regions, may have triggered the development of certain behaviours and cultural traits conducive to faster economic growth. In this paper we focus on the relationship between historical agricultural productivity of land and differences in time preference of societies.

Time preference constitutes a cultural trait intergenerationally transmitted by parents to their children, alongside genetic characteristics, wealth, human capital, and other specific cultural values (Bisin & Verdier, 2001). The ability to delay gratification, as a form of future-oriented self-control, has been associated with a wide range of benefits, both at the individual and societal level. More long-term oriented individuals tend to attain higher educational outcomes, maintain better physical and psychological health, and exhibit higher financial stability (Figlio et al., 2019; Mischel et al., 1989; Moffitt et al. 2011; Mincer, 1958; Becker, 1964; Cadena & Keys, 2015). At the aggregate level, these individual-level advantages contribute to the development of human and physical capital. Together with technological advancement and sustained economic growth, these factors play a crucial role in determining the wealth and long-term prosperity of nations. For instance, as long-term orientation at the individual level is among the values that guide decisions related to occupational aspirations, financial priorities and consumption behaviours (Rokeach, 1973), differences may arise in consumers' frugality, credit abuse, and the tendency to engage in planned purchasing (Lastovicka et al., 1999). The aggregation of these behaviours consequently characterizes societies by higher rates of saving, investment, and productivity-enhancing activities, thereby contributing to cross-national differences in GDP.

It is thus evident the relevance of our study as an attempt to identify the origins of the distribution of time preference across countries and regions, verifying whether they can be linked to historical disparities in land productivity. To this purpose, we are going to revise a prominent theory empirically established by two economists, Oded Galor and Ömer Özak, in the paper "*The Agricultural Origins of Time Preference*". Their hypothesis is that geographical differences in the natural return to agricultural investments have produced a long-lasting impact on the distribution of time preference across societies. In regions where the ancestral population was exposed to higher crop yield (for a given growth cycle), more rewarding agricultural investments fostered processes of selection, adaptation, and learning. Over time, these behaviours increased the prevalence of traits associated with greater long-term orientation, ultimately leading to a higher representation of long-term oriented individuals within the population (Galor & Özak, 2016). To empirically test this theory, the authors exploited an exogenous source of variation in potential crop yield and growth cycle across the globe: the pervasive exchange of crops for cultivation between the new and the old world in the post-1500 period, known as the Columbian Exchange. This natural experiment has been instrumental to analyse the effect of pre-industrial crop yields on various measures of long-term orientation at the country, region, and individual levels. While the research presented in "*The Agricultural Origins of Time Preference*" extensively explores the agro-climatic effects on time preference across various layers, our investigation concentrates on the country level, as it already provides us with sufficient evidence for the validity of our claims.

Our attentive analysis of the data structure and methodology employed in the paper revealed a critical flaw in the theoretical framework: the variable intended to capture time preference in main cross-country analysis was imprecisely constructed, thereby calling into question the reliability of the theoretical claims. Galor and Özak's country-level measure of time preference relied on Hofstede, Hofstede, and Minkov (2010) definition of long-term orientation. Their dataset drew upon the scores of the Chinese Value Survey and World Values Survey questionnaires, whose answers were collected with respect to three main dimensions: (1) Thrift as a desirable trait for children, (2) National pride, and (3) Importance of service to others (Hofstede et al., 2010). We argue that, in the specific context of Galor and Özak's empirical analysis, the final two items of the questionnaire are irrelevant for the definition of a measure of long-term orientation (LTO). While promoting "Thrift" as a desirable trait in children clearly reflects a future-oriented perspective, "National pride" and "Service to others", as forms of self-enhancement, do not reflect the essence of long-term orientation. Therefore, the inclusion of such items may have potentially led the author's analysis to biased or misleading results.

To further investigate the issue and assess whether their findings remained robust despite such potential bias, we retest the theory employing three redefined measures for the LTO variable. All three alternatives used to replicate the analysis had been tailored to be more closely aligned with the theoretical construct of time preference. The first two build on the scores of the same WVS, though limited to its first item "Thrift", for two subsequent waves of collected responses.

The third measure, instead, relies upon a completely different dataset on country level estimates of “Patience (time preference)”, retrieved from the Global Preferences Survey (GPS) (Falk et al. 2018).

Our findings confirm the initial intuition. Galor and Özak’s theory no longer holds, as the noise introduced by the biased measure seems to have significantly distorted the results, thus potentially leading to misleading conclusions. The origins of differences in time preference across countries appear to be no longer correlated with historical variations in land productivity, with the exception of one restricted sample analysis specification. We explore several possible interpretations of our findings and the few patterns that emerge. A potential explanation of the impact of the identified bias on the analysis’ outcome may lie in in Galor and Ozak’s failure to account for cultural transformation processes within their theoretical framework. This limitation becomes particularly relevant in light of the substantial temporal gap between pre-Colombian agricultural productivity and the contemporary outcome under investigation (long-term orientation). We conclude that any attempt to understand the origins of cross-country differences in economic development must incorporate the role of cultural change and the cumulative effects of historical social disruptions over the centuries.

The structure of this paper is the following. Section II provides a brief overview on the theoretical model and historical background of the natural experiment underlying the empirical analysis of the paper “*The Agricultural Origins of Time Preference*”. Then, in Section III we delve deeper into the data and methodology. We describe the original LTO measure employed by Galor and Özak, the identified fallacy, and the three redefined measures as alternative solutions. In Section IV we present the empirical analysis, describing our findings and discussing some possible interpretations. Finally, Section V concludes.

II. Theoretical and Historical Background

To contextualize our analysis of the relationship between land productivity and time preferences, it is necessary to first outline the main model for the evolution of time preference developed by Galor and Özak in the paper we are revisiting. Moreover, in this section we will present a brief overview of the key historical background underpinning the natural experiment of our analysis: the Columbian Exchange.

The model for the evolution of time preference

In "*The Agricultural Origins of Time Preference*" the authors present a dynamic model capturing the evolution of time preferences built under the assumption of a Malthusian economy, where the individuals generating more resources have larger reproductive success, therefore transmitting their cultural traits to a larger offspring (Ashraf & Galor, 2011; Dalgaard & Strulik, 2015; Vollrath, 2011). In the so-called agricultural stage of development, the evolution of time preference is based on four elements. The first element consists in occupational choices reflecting time preferences. Accordingly, long-term oriented individuals are defined as the ones choosing agricultural practices that allow for higher but delayed return. Second, the learning process. It reflects the progressive understanding by individuals of the benefits stemming from delayed gratification. It is therefore a fundamental factor mitigating individuals' tendency to discount future reward while fostering their engagement in profitable investment ventures. The third element, reproductive success, arises as a direct consequence of the superior economic outcome experienced by individuals with a more long-term perspective. Closely tied to this is the fourth element, intergenerational transmission, which underlies the characterization of societies as more long-term oriented. Indeed, long-term oriented individuals' tendency to engage in occupations associated with higher returns, resulting in greater reproductive success, is what gradually increases their representation within the population. This dynamic contributes to a broader societal shift toward a higher long-term orientation (Galor & Özak, 2016).

It is important to notice that additional mechanisms that may have governed the evolution of time preference have been explored. In particular, they had been related to natural selection favouring traits beneficial for reproductive success (Galor & Moav, 2002; Galor & Michalopoulos, 2012), cultural transmission and the influence of economic institutions (Bowles, 1998), and parental investments motivated by economic incentives (Doepke & Zilibotti, 2008) or as a form of endogenous self-investments (Rapoport & Vidal, 2007). From an empirical standpoint, it has been established the intergenerational transmission of attitudes, in particular of willingness to take risks and to trust others, as well as the impact of the social environment on this process (Dohmen et al., 2011).

The Columbian Exchange

We will now discuss the main historical developments underlying the natural experiment of our empirical investigation. As previously mentioned, the Columbian Exchange is the natural experiment of history exploited in the analysis, as it provides an exogenous source of variation in potential crop yield and growth cycle across the globe.

The Columbian Exchange refers to the pervasive exchange of crops, disease, and populations between the New World and the Old World. Initiated by Christopher Columbus's voyage to the Americas in 1492, this historical event profoundly reshaped global agriculture and demographics. The Old World (intended as the entire Eastern Hemisphere) benefited significantly from the introduction of new highly productive staple crops, like potatoes, maize, and cassava, as well as less caloric foods, such as coffee, tomatoes, chili peppers, cacao, and peanuts. At the same time, the availability of many Old World crops, such as sugar and coffee, increased, as they turned out being particularly well-suited for the soils of the New World. This biological shock altered the comparative productivity of land and redefined the agricultural advantage of crops (Nunn & Qian, 2010).

Yet, alongside the described benefits, the Columbian Exchange produced considerable adverse effects. European sailors spread across the Americas diseases for which Native American populations had no immunity, like smallpox and measles, therefore suffering immense losses (Denevan, 1992). On the other hand, when returning home, they also brought to Europe other less deadly diseases, such as syphilis, which yet contributed to a major social disruption for the entire globe (Sherman, 2007). The effects of the Columbian Exchange extended well beyond the regions directly involved, ultimately reaching Asia and Africa. The expansion of cultivation of highly productive crops and the negative impact of the spread of disease on population numbers triggered a sudden increase in the demand for labour. This demand led to the forced displacement of over 12 million Africans between the sixteenth and nineteenth centuries, marking the rise of the transatlantic slave trade (Lovejoy, 2000; Manning, 1990).

Therefore, given the breadth of its impact and historical importance discussed so far, it is unsurprising that the Columbian Exchange has been widely used by economists and researchers as a compelling natural experiment for empirical investigations.

III. Methodology and Data

The dataset used in this paper builds upon the replication package of Galor and Özak's "*The Agricultural Origins of Time Preference*". All variables included in our empirical specifications are constructed following the approach adopted by Galor and Özak, except for the outcome variable capturing time preference. The construction of three alternative definitions for this measure lies at the heart of our empirical investigation. We integrated the baseline dataset with three additional datasets. This integration allowed us to retain the original empirical framework while enabling more precise and theoretically consistent measurement of long-term orientation. To support the interpretability of our findings, in this section we offer a more detailed account of the construction of the key variables used in our empirical specifications.

Independent variables: Potential Crop Yield and Growth Cycle

The empirical analysis of "*The Agricultural Origins of Time Preferences*" employed innovative, globally consistent measures of historical potential crop yield and growth cycles, as developed by Galor and Özak. These indicators provided an accurate depiction of potential agricultural productivity worldwide, expressed in terms of calories produced per hectare annually, thereby addressing the shortcomings inherent in weight-based agricultural productivity metrics. These measures are anchored in two main elements: (i) estimates of potential crop yield and growth cycle under conditions of minimal input levels and reliance on rain-fed methods (typical of early agricultural practices), and (ii) agro-climatic factors that are independent of human activity. To generate these historical indicators of crop productivity and growth periods, data from the Food and Agriculture Organization's (FAO) Global Agro-Ecological Zones (GAEZ) initiative are employed. The GAEZ provides worldwide estimates of yields and growth cycle for multiple crops, structured on a grid system with cells of size 5'×5' (approximately equivalent to 100 square kilometres). To recognize the nutritional variability among different crops, and thus enhance the comparability of crop yield data, the figures from the GAEZ (in tons per hectare per year) are translated into caloric yield (in millions of kilocalories per hectare per year). This conversion relies on the caloric value of crops, sourced from the USDA Nutrient Database for Standard Reference. Moreover, given the expansion of available crops resulting from the Columbian Exchange (Crosby, 1972), the constructed indicators differentiate between caloric suitability before and after 1500, as well as their change over time. Specifically, the pre-1500 measures are derived from crops recorded in the GAEZ/FAO database that were present in various world regions prior to 1500 CE.[1] By contrast, the post-1500 measures assume that all regions could potentially cultivate any crop included in the dataset. For each grid cell, the methodology assigns the crop with the greatest potential yield for both the pre- and post-Columbian Exchange periods. Consequently, three sets of metrics are established: (i) the crop yield and growth cycle for the crop maximizing output before the Columbian Exchange; (ii) the corresponding figures after the Columbian Exchange; and (iii) the changes in the dominant crop's yield and growth cycle attributable to the Columbian Exchange. These data are then aggregated to estimate the average crop yield and average growth cycle at the regional level, reflecting the mean values for those crops that maximize the caloric yield in each area (Galor & Özak, 2016).

By using potential crop yield as a proxy for actual crop yield Galor and Özak aimed at addressing any issue of reverse causality that may potentially arise. The positive correlation between these two measures validates this approach. Moreover, the potential yield has been further proved to be positively related to agricultural reliance, the intensity of agricultural activity, and the contribution of farming to sustenance across ethnicities (Galor & Özak, 2016).

Outcome variable: Long-Term Orientation

Galor and Özak's Measure

In their cross-country analysis of the effect of crop yield on long-term orientation, Galor and Özak relied on the cultural dimension identified by G. Hofstede as long-term orientation (LTO). G. Hofstede (1991) based his original analysis on data gathered from interviews of IBM employees across the world. This initial dataset was subsequently expanded through contributions by G.J. Hofstede and M. Minkov, incorporating additional data from the Chinese Values Survey (CVS) and the World Values Survey (WVS). Indeed, after publishing his analysis of the WVS data, in 2007 Minkov expanded the dataset to include those items that were conceptually similar to the ones included in the LTO-CVS, and at the same time significantly correlated with them. The WVS items that best satisfied these conditions therefore became the basis for the newly built LTO-WVS dataset (Hofstede et al., 2010).

[1] according to Crosby (1972), and Diamond (1997).

Below, we report the selected items as they were presented in the survey administered to respondents across countries, including the exact wording of each question posed:

1. **Thrift as a desirable trait for children.**
   "Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important? Please choose up to five." – measured was the percentage choosing "*thrift*". [2]

2. **National pride.**
   "How proud are you to be (name of your nationality)?" – measured was the percentage choosing "very proud" [3], which scored negatively

3. **Importance of service to others.**
   "For each of the following, indicate how important it is in your life: family, friends, leisure time, politics, work, religion, service to others." – measured was the percentage choosing "very important" for "service to others". [4]

In line with the conditions established by Minkov (2007), the above three items were mutually correlated, as well as significantly correlated with LTO-CVS across all the available countries.

Long-term orientation was defined as "the cultural value that stands for the fostering of virtues oriented toward future rewards, perseverance, and thrift. Its opposite pole, short-term orientation, stands for the fostering in a society of virtues related to the past and the present, such as national pride, respect for tradition, preservation of "face", and fulfilling social obligations." (Hofstede et al., 2010)

Galor and Özak built on this basis their measure for long-term orientation (LTO) varying between 0 (short-term orientation) and 100 (long-term orientation), while being "positively correlated with the importance ascribed to future profits, savings rates, investment in real estate, and math and science scores" (Hofstede et al., 2010) and with "income per capita, education, and economic growth" (Galor & Özak, 2016).

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[2] Respondents could select an answer between: "independence", "hard work", "feeling of responsibility", "imagination", "tolerance and respect for other people", "thrift" (saving money and things), "determination" (perseverance), "religious faith", "unselfishness", and "obedience".
[3] The choice was between "very proud", "quite proud", "not very proud", "not at all proud"
[4] The possible ranking options were "very important", "rather important", "not very important", or "not at all important"

The Issue

We argue that the measure for long-term orientation adopted by Galor and Özak is conceptually imprecise, as it relies on the LTO-WVS index, which includes items not directly capturing individuals' time preferences. While Hofstede's model of cultural dimensions has been credited as a key model of cross-cultural differences, such time preferences, and widely used in predicting national cultures and examining its effects (Shi & Wang, 2011; Venaik & Brewer, 2010; Beugelsdijk, Maseland & van Hoorn, 2015), several studies have questioned some of its conceptual and methodological issues (Sivakumar & Nakata, 2001; McSweeney, 2002; Yeh & Lawrence, 1995).

By including in the WVS the items "National Pride" and "Service to Others", Hofstede et al. (2010) argue that self-enhancement values form a component of short-term orientation. They state that "national pride supports a lack of interest in and understanding of other countries", and "too much national pride is a recipe for economic disaster". However, it is not clearly established their relevance for the determination of time preferences. Therefore, we contend that the inclusion of these items in the measurement of Long-Term Orientation (LTO), used as a proxy for time preference in Galor and Özak's analysis, lacks conceptual accuracy, and thus may have undermined the validity of the research findings. By contrast, "Thrift" (interpreted as saving money and things) emerged as a highly relevant dimension. Indeed, several studies have proven a strong correlation between time-discounting behaviours and saving decisions (Finke & Huston, 2013; Choi & Han, 2018).

Hofstede et al. (2010) performed a further analysis to understand whether their LTO-WVS index could explain economic growth across countries and over a longer timeframe.[5] In particular, they focused on trying to explain the East Asian economic miracle to answer the question of why East Asia did not achieve strong economic growth much earlier. Investigating the relationship between LTO-WVS and the increase in GNI per capita, they were able to confirm the theoretical foundations of their index. Most importantly, the analysis identified "Thrift" as the most important item of LTO, being strongly associated with economic growth.

Following studies integrated Hofstede et al. (2010) results with a further categorization of the WVS items most strongly correlated with economic growth into two separate cultural

[5] In the analysis performed by Hofstede, Hofstede, and Minkov (2010), they divided their sample of eighty-four countries for which they had both LTO-WVS and GNI growth data into two categories of poor and wealthy cases, based on each country's GNI per capita in 1995. The ratio of GNI per capita in 2005 over GNI per capita in 1995 plotted against LTO-WVS for eighty-four countries, revealed for fifty-four poor countries a significantly positive correlation, while for thirty wealthy countries a significantly negative one.

dimensions: one based on thrift and low importance of leisure, the other on educational achievement and female participation in the workforce (Minkov & Blagoev, 2009). We may therefore conclude that LTO is mainly underpinned by a high importance of thrift, low importance of some aspects of personal relationships (reciprocation of gifts and favours), and high importance of persistence (equivalent to a low importance of leisure). It is evident how an adequate measure for long-term orientation, and more broadly, for the rate of time preference of individuals, should incorporate mainly thrift-related items, rather than the self-enhancement behaviours included in the WVS.

Our Solution

To rectify this issue, a more rigorous construction of the outcome variable was necessary. We selected three measures which allowed us to isolate only those elements strictly relevant for a definition of long-term orientation consistent with our theoretical construct. The adoption of multiple alternative measures was intended to strengthen the robustness of our findings as well as to provide a more credible assessment of the validity of our claims.

The first two measures, referred to as *Thrift_W6* and *Thrift_W7*, represent the weighted average of country-level responses relative to the first item only of the LTO-WVS index: "Thrift" (Hofstede, Hofstede, and Minkov, 2010). These measures are based on data collected from individuals surveyed in waves 6 and 7 of the World Values Survey, respectively.

The third variable, referred to as *Patience*, is derived from an entirely separate dataset: country-level assessments of "*Patience (time preference)*" collected through the Global Preferences Survey (GPS). These values are reported in terms of standard deviations relative to the worldwide distribution, where zero represents the global mean. Scores above zero indicate greater patience compared to the international average (Falk et al., 2018).

The Global Preferences Survey gathers preference data from nationally representative samples across 76 countries, including 15 nations from the Americas, 25 from Europe, 22 in Asia and the Pacific, and 14 from Africa. Collectively, these countries account for 90% of the global population and income. The median sample size per country is 1,000 individuals, and the survey includes data from over 80,000 respondents in total.

Patience is defined by Falk et al. (2018) as "willingness to give up something that is beneficial for you today in order to benefit more from that in the future". The index of patience (or time preference) combines two components: one quantitative item and one qualitative item.

The quantitative measure employs a set of five interrelated binary choices between immediate and future monetary rewards, using the “staircase” (or “unfolding brackets”) approach. In these questions, participants are asked to select between a fixed amount available immediately and a larger sum available after one year. While the immediate payout remains the same across questions, the size of the delayed reward is adjusted depending on the participant’s earlier responses. To ensure comparability across countries, the amounts used for these questions are expressed in local currency and are scaled according to the median household income in each respective country.

The qualitative dimension is based on respondents’ self-rated willingness to wait, measured on an 11-point Likert scale with the question: “How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?” Higher values represent a greater tendency towards patience relative to the global average. In constructing the final patience (time preference) index, the quantitative item contributes 71% to the overall measure.

IV. Empirical analysis

This section presents the findings of our Empirical analysis, replicating Galor and Özak's presented in the paper "*The Agricultural Origins of Time Preference*". Our goal is to determine whether the effect of the return to agricultural investment on contemporary variations in the rate of time preference remains consistent when replacing the original long-term orientation measure developed by Galor and Özak with our redefined alternatives. Although the authors' research covered multiple layers, we narrow the focus of our empirical investigation to the Cross-Country Analysis. This level of analysis is sufficiently comprehensive to rigorously assess the robustness of our claims while effectively challenging the validity of the authors' findings. By concentrating on country-level data, we aim at isolating the core relationship between long-term orientation and potential crop yield, while accounting for country fixed effects and thus for unobserved time-invariant country-specific factors.
Accordingly, our empirical analysis is structured into two parts: the Baseline Analysis and the Natural Experiment Analysis. In each, a unique empirical specification is estimated three times, sequentially employing the three distinct measures of Long-Term Orientation (LTO) we had developed in Section III. Together, the analyses provide compelling evidence supporting our hypothesis of a critical flaw in Galor and Özak's theoretical framework.

A. Baseline Analysis

In the Baseline Analysis we are focusing on the effect of crop yield on long-term orientation (LTO), accounting for the confounding effects of a large number of geographical controls, the onset of the Neolithic Revolution, and continental fixed effects (FE). This analysis serves as the fundamental test of the theory's core propositions, therefore, it constitutes the core of our investigation.

The following is the empirical specification estimated via ordinary least squares (OLS):

$$(1) \quad LTO_i = \beta_0 + \beta_1 \, \text{yield}_i + \beta_2 \, \text{growth cycle}_i + \sum_j \gamma_{0j} X_{ij} + \gamma_1 \, \text{YST}_i + \sum_c \gamma_c \delta_c + \epsilon_i$$

where LTO_i denotes the level of long-term orientation in country i, alternatively captured by the three measures *Thrift_W6*, *Thrift_W7*, and *Patience* (each employed separately in successive model estimations); $yield_i$ and $growth\ cycle_i$ are the post-1500CE measures of crop yield and crop growth cycle of country i ; X_{ij} is the geographical characteristic j of country i;

YST_i is the number of years elapsed since country *i* transitioned to agriculture; $\{\delta_c\}$ is a complete set of continental fixed effects; and ϵ_i is the error term of country *i*.

Galor and Özak's theory suggests that $\beta_i > 0$. Instead, our hypothesis is that, by introducing the new definitions of LTO, the coefficient becomes non-significant.
In Tables A.1-3 we present our findings for the effect of potential crop yield and growth cycle on long-term orientation, based on the full set of available crops in the contemporary era. Each table summarizes the results for the model estimations employing the measures *Thrift_W6, Thrift_W6*, and *Patience*, respectively. However, the underlying structure remains identical.

Column 1 examines the association between crop yield and long-term orientation while controlling for continental fixed effects. This specification helps to mitigate the influence of unobserved, time-invariant regional characteristics at the continental level. Across all model estimations, the coefficient of interest fails to reach statistical significance, immediately pointing to potential weaknesses in the original results when examined with a conceptually stronger variable. Column 2 extends the baseline model by incorporating a series of geographic covariates, including absolute latitude, mean elevation, terrain roughness, mean distance to the sea or a navigable river, and indicators for landlocked or island status. Once these geographical dimensions and continental heterogeneity are accounted for, the crop yield coefficients in both Table A.1 and Table A.2 become positive and statistically significant at the five per cent and one per cent levels, respectively. A one standard deviation increase in crop yield corresponds to an increase in long-term orientation of 4.9 and 3.3 percentage points, respectively. Consistent with Galor and Özak's findings, this is the largest association of any of the variables included in the analysis. In contrast, the estimates from the model specification employing *Patience* variable remain stable at non-significant values, negative and non-statistically different from zero. Column 3 introduces a variable capturing the time elapsed since the onset of agriculture, to control for the possible confounding role of the advent of sedentary agriculture in shaping time preferences. Specifically, this effect is captured by a variable for the number of years since the Neolithic Revolution. Across all Tables, the introduction of this variable leads to not significant estimates. In column 4 the model is extended to include the effect of crop growth cycle on long-term orientation. Again, the estimates for the β_i coefficient on our variable of interest are neither statistically significant, nor consistent with prior estimates.

To address the potential bias introduced by post-1500CE migration, according to Galor and Özak's approach, Column 5 presents a model specification with ancestry-adjusted versions of the original variables for crop yield, crop growth cycle, and timing of transition to agriculture.

This adjustment is motivated by the possibility that migration may have weakened the relationship between the geographic characteristics of present-day countries and those to which ancestral populations were historically exposed. Such a mismatch could undermine the validity of estimates based solely on current country level data. The ancestry-adjusted variables are designed to capture the environmental conditions experienced by a population's ancestors rather than by its current geographic location. These measures were constructed by weighting the historical geographic characteristics of other countries according to the ancestral composition of each modern population.[6] As Galor and Özak (2016) describe, "for each country the adjusted crop yield is the weighted average of crop yield in the countries where the ancestral populations resided." As established in column 5, the estimated effect of crop yield is similar to the estimates of Column 2 in Table A.1 and A.2, though significant only in the latter case. Column 6 presents a comparative specification (so-called "horse-race") including both adjusted and unadjusted variables for crop yield and growth cycle. However, given the consistent lack of statistical significance of the previous estimates, this specification offers no meaningful insight and is ultimately uninformative.

Columns 7 and 8 restrict the analysis to countries in the Old World, where intercontinental migration and population turnover were less pronounced. In this subsample, both Table A.1 and Table A.2 reveal markedly stronger and statistically significant associations between crop yield and long-term orientation. In Column 7, which omits the crop growth cycle, coefficients are significant at the one per cent level. A one standard deviation increase in crop yield corresponds to an increase in long-term orientation of 7.2 and 6.1 percentage points, respectively. Column 8, which does account for Crop Growth Cycle, presents coefficients still statistically significant, this time at ten per cent and five per cent level, respectively. A one standard deviation increase in crop yield generates an 8.6 and 6.5 percentage point increase in long-term orientation, respectively. Overall, these results for the Old World sample specifications display a similar pattern to that observed in Galor and Özak's original analysis.

Results of Table A.3, relative to the model estimation employing the *Patience* measure for long-term orientation, lack of statistical and economic significance across all the specifications.

[6] Putterman & Weil, 2010

Table A.1: Crop Yield, Growth Cycle, and Long-Term Orientation

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield	3.17	4.88**	3.50	0.66		-3.81	7.16***	8.75*
	(1.90)	(2.20)	(2.58)	(3.66)		(3.58)	(2.59)	(4.51)
Crop Growth Cycle				2.37		4.02*		-1.05
				(1.66)		(2.34)		(1.79)
Crop Yield (Anc.)					4.87	7.66		
					(3.84)	(5.45)		
Crop Growth Cycle (Anc.)					0.07	-3.89		
					(2.12)	(2.97)		
Absolute Latitude		-7.10*	-6.69*	-5.79	-5.93*	-5.20	-5.03	-5.24
		(3.59)	(3.56)	(3.61)	(3.00)	(3.45)	(3.51)	(3.76)
Mean Elevation		1.92	2.64	2.35	2.71	2.44	2.35	2.32
		(2.00)	(1.94)	(1.87)	(1.83)	(1.88)	(1.76)	(1.84)
Terrain Roughness		-3.92*	-3.54	-3.81	-4.36**	-5.34**	-6.15**	-6.14**
		(2.27)	(2.37)	(2.42)	(2.13)	(2.40)	(2.35)	(2.35)
Distance to Coast or River		1.92	1.24	0.41	1.44	0.70	1.99	2.43
		(1.24)	(1.42)	(1.52)	(1.56)	(1.80)	(1.35)	(1.67)
Landlocked		0.82	0.08	0.09	0.19	0.45	0.79	0.87
		(2.23)	(2.44)	(2.36)	(2.42)	(2.50)	(2.27)	(2.39)
Island		-2.11	-3.52	-3.75	-2.80	-2.34	-2.15	-1.78
		(2.35)	(2.29)	(2.36)	(2.16)	(2.24)	(1.91)	(1.95)
Neolithic Transition Timing			-5.81	-6.41*		2.89	-3.56	-3.07
			(3.45)	(3.58)		(6.72)	(3.58)	(4.06)
Neolithic Transition Timing (Anc.)					-4.83	-6.82		
					(2.88)	(4.55)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.27	0.34	0.38	0.39	0.42	0.41	0.52	0.51
Observations	56	56	56	56	56	56	43	43

(Source: author's own elaboration)

Table A.2: Crop Yield, Growth Cycle, and Long-Term Orientation

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield	2.20	3.26*	3.07	1.81		-2.96	6.06***	6.50**
	(1.53)	(1.91)	(1.92)	(2.83)		(2.91)	(1.40)	(2.76)
Crop Growth Cycle				2.04		0.05		-0.62
				(3.07)		(4.41)		(3.65)
Crop Yield (Anc.)					4.31*	7.61*		
					(2.40)	(4.39)		
Crop Growth Cycle (Anc.)					0.46	-0.29		
					(3.55)	(6.67)		
Absolute Latitude		-1.22	-1.36	-0.77	-0.12	0.41	-0.39	-0.57
		(2.47)	(2.43)	(2.51)	(2.29)	(2.23)	(2.73)	(2.99)
Mean Elevation		-2.09	-1.94	-1.74	-1.92	-2.15	-1.89	-1.98
		(1.49)	(1.56)	(1.58)	(1.43)	(1.40)	(1.36)	(1.44)
Terrain Roughness		1.17	1.39	1.21	1.18	0.88	-0.10	-0.06
		(1.62)	(1.71)	(1.70)	(1.60)	(1.68)	(1.72)	(1.68)
Distance to Coast or River		2.04	1.88	1.69	2.33*	2.31*	2.86**	2.95**
		(1.29)	(1.35)	(1.50)	(1.23)	(1.31)	(1.17)	(1.28)
Landlocked		2.09**	2.03*	2.10*	1.87*	1.88*	2.36**	2.35**
		(1.02)	(1.06)	(1.09)	(1.06)	(1.07)	(1.03)	(1.03)
Island		-1.70	-2.09	-2.35	-1.86	-1.45	-1.01	-0.93
		(1.64)	(1.66)	(1.78)	(1.42)	(1.62)	(1.54)	(1.62)
Neolithic Transition Timing			-1.44	-1.90		3.47	0.06	0.22
			(1.78)	(2.06)		(3.93)	(1.61)	(1.99)
Neolithic Transition Timing (Anc.)					-1.38	-3.63		
					(1.50)	(2.84)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.13	0.15	0.14	0.13	0.19	0.17	0.21	0.19
Observations	81	81	81	81	81	81	65	65

(Source: author's own elaboration)

Table A.3: Crop Yield, Growth Cycle, and Long-Term Orientation

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield	-0.03	-0.02	-0.04	-0.05		-0.41**	-0.03	-0.04
	(0.05)	(0.05)	(0.04)	(0.06)		(0.18)	(0.05)	(0.07)
Crop Growth Cycle				0.03		0.22		0.02
				(0.08)		(0.19)		(0.09)
Crop Yield (Anc.)					-0.03	0.37*		
					(0.06)	(0.19)		
Crop Growth Cycle (Anc.)					0.01	-0.25		
					(0.09)	(0.24)		
Absolute Latitude		0.15**	0.13*	0.13*	0.14**	0.14**	0.17**	0.17**
		(0.06)	(0.07)	(0.07)	(0.06)	(0.07)	(0.08)	(0.08)
Mean Elevation		0.09	0.11	0.11	0.12*	0.13*	0.10	0.10
		(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
Terrain Roughness		-0.13**	-0.13**	-0.13**	-0.13**	-0.14**	-0.13*	-0.13*
		(0.05)	(0.06)	(0.06)	(0.06)	(0.05)	(0.07)	(0.07)
Distance to Coast or River		-0.10***	-0.11***	-0.11***	-0.10***	-0.12***	-0.11***	-0.11***
		(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
Landlocked		0.02	0.01	0.01	0.00	-0.01	0.01	0.01
		(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Island		0.07*	0.04	0.04	0.03	0.05	0.06	0.05
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Neolithic Transition Timing			-0.07	-0.08		0.18	-0.06	-0.07
			(0.09)	(0.08)		(0.17)	(0.09)	(0.09)
Neolithic Transition Timing (Anc.)					-0.09	-0.24*		
					(0.06)	(0.14)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.31	0.39	0.39	0.38	0.39	0.41	0.24	0.22
Observations	73	73	73	73	73	73	58	58

(Source: author's own elaboration)

B. Natural Experiment Analysis

In the Natural Experiment Analysis we focus on the effect of crop yield on long-term orientation (LTO), when exploiting the natural experiment of history generated by the Columbian Exchange. This analysis serves as a further confirmation of our findings established in the Baseline Analysis.

By leveraging this natural experiment Galor and Özak address three unresolved issues concerning the observed relationship between crop yield and long-term orientation: (i) whether the link is historical rather than contemporary; (ii) the possible influence of omitted variables at the country level; and (iii) the relative impact of cultural evolution compared to the sorting of individuals with high long-term orientation into more regions with higher land productivity. First, the Columbian Exchange helps demonstrate that the effect of caloric productivity on long-term orientation has historical roots. By focusing only on crops available before 1500 CE, the analysis excludes possible contemporary connections between geography, development, and time preferences. Second, this natural experiment helps mitigate concerns about omitted regional variables. An increase in potential crop yield occurs only if a newly introduced crop surpasses the yield of the previously dominant one. Therefore, conditional on pre-1500CE crop productivity, the assignment of crops due to the Exchange should be unrelated to other grid-specific attributes, making it unlikely that omitted characteristics are driving the estimated causal effect. Third, the Columbian Exchange enables analysis of the respective roles of cultural evolution and sorting in the post-1500 period. The association between agricultural productivity and time preference might be partially due to long-term oriented individuals moving to high-yield regions. Although this sorting would not change the observed relationship, since it would still reflect differences in the return from agricultural investments, it would challenge the cultural interpretation of the tested relationship. However, if crop yield changes caused by the Columbian Exchange affect time preferences even after controlling for migration, then the mechanism is more likely cultural evolution than sorting. To test this last point, Galor and Özak implemented two strategies. They first analysed countries in the Old World that experienced changes in crop yield and growth cycles but did not undergo major post-1500 migration, thereby isolating cultural evolution effects. Then, compared results from the whole world sample, where migration was more prevalent, to the Old World sample, assessing the potential role that sorting may have played in the transmission of more long-term orientation (Galor & Özak, 2016).

To explore the effect of crop yield, growth cycle, and their changes on long-term orientation, in our analysis we estimate the following empirical specification via OLS:

$$\text{(2)}\quad LTO_i = \beta_0 + \beta_1^{1500}\,\text{yield}_i + \beta_1^{ch}\,\Delta\text{yield}_i + \beta_2^{1500}\,\text{growth cycle}_i + \beta_2^{ch}\,\Delta\text{cycle}_i + \sum_j \gamma_{0j} X_{ij} + \gamma_1\,\text{YST}_i + \sum_c \gamma_c \delta_c + \epsilon_i$$

where LTO_i denotes the level of long-term orientation in country *i*, alternatively captured by the three measures *Thrift_W6*, *Thrift_W7*, and *Patience* (each employed separately in successive model estimations); $yield_i$ and $growth\ cycle_i$ are the post-1500CE levels of crop yield and crop growth cycle of country *i* ; $\Delta yield_i$ and $\Delta cycle_i$ are their post-1500 changes generated in the course of the Columbian Exchange; X_{ij} is the geographical characteristic *j* of country *i*; YST_i is the number of years elapsed since country *i* transitioned to agriculture; $\{\delta_c\}$ is a complete set of continental fixed effects; and ϵ_i is the error term of country *i*.

Galor and Özak's theory suggests that $\beta_1^{1500} > 0$ and $\beta_1^{ch} > 0$. Our hypothesis is that, by introducing the new definitions of LTO, the coefficients become non-significant.
In Tables B.1-3 we present our findings for the effect of pre-1500CE crop yield and growth cycle and their changes in the course of the Columbian Exchange on long-term orientation. Following the same approach employed in the Baseline Analysis, each table summarizes the results for the model estimations employing the measures *Thrift_W6, Thrift_W6,* and *Patience,* respectively. However, the underlying structure remains identical.

According to Column 1, when accounting solely for continental fixed effects, none of our model estimations presents a coefficient for the effect of pre-1500CE crop yield on long-term orientation that is statistically and economically significant. Column 2 incorporates the variable capturing the post-1500CE expansion of crops available. We observe an additional increase in long-term orientation. Interestingly, the estimated coefficient is large and statistically significant at the one per cent level, but only in the empirical specification employing the measure *Thrift_W6* (Table B.1). Specifically, a one standard deviation increase in crop yield change is associated with a 10.8 percentage points increase in long-term orientation. Nevertheless, the estimates for the coefficient representing the effect of crop yield pre-1500CE, which are the most relevant for Galor and Özak's theory, remain statistically insignificant, reinforcing our claims. Column 3 extends the model by including controls for additional geographical factors and the timing of the agricultural transition, following the same approach of the Baseline Analysis. Once again, the estimates for β_1^{1500} fail to reach statistical significance. In both Tables B.1 and Table B.2 estimates for β_1^{ch} are positive and statistically significant at one per cent and five per cent level, respectively. A one standard deviation increase in crop yield change increases long-term orientation by 10.3 and 3 percentage points, respectively. Column 4 accounts for the pre-1500CE crop growth cycle and its transformation following the Columbian Exchange. Estimates are not significant, except for the β_1^{ch} coefficient in Table B.1. Column 5 adjusts for historical population replacement and migration, by incorporating controls for the ancestral composition of contemporary populations. Under this specification, Table B.2 shows that the estimated effect of pre-1500CE crop yield attains statistical significance at the ten per cent level. In contrast, in Table B.1 the estimate remains not significant, with, again, only the coefficient on the crop yield change being significant at the ten per cent level. In column 6 it is reported a comparative specification (a "horse race") between ancestry-adjusted and unadjusted variables capturing crop yield and crop growth cycle, along with their respective changes. However, given the consistent lack of statistical significance of the previous estimates, this specification does not produce any meaningful insight and is ultimately uninformative.

As in the Baseline Analysis, columns 7 and 8 restrict the sample to countries in the Old World to test the robustness of findings across geographical subsamples. Table B.2 reports larger and statistically significant coefficients, significant at the one per cent and five per cent levels, respectively. In contrast, Table B.1 continues to yield statistically significant estimates only for the coefficients for the crop yield change, at the ten and five per cent level, respectively. Overall, also our findings for the Old World sample specifications present clear evidence against the robustness of Galor and Özak's analysis, therefore backing our argument.

Notably, in Table B.3, which reports model estimates using the *Patience* measure of long-term orientation, estimates lack of statistical and economic significance across all the specifications, in line with the Baseline Analysis.

Table B.1: Crop Yield, Growth Cycle, and Long-Term Orientation:
Exploiting the Columbian Exchange

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield (pre-1500)	0.79	0.52	0.53	-1.74		-1.83	3.25	3.33
	(1.71)	(1.26)	(1.48)	(1.99)		(2.27)	(2.12)	(4.37)
Crop Yield Change (post-1500)		10.81***	10.30***	9.57***		11.89**	8.96***	9.57**
		(2.34)	(2.54)	(2.59)		(5.49)	(3.15)	(3.49)
Crop Growth Cycle (pre-1500)				1.85		2.99		-0.18
				(1.32)		(1.85)		(1.89)
Crop Growth Cycle Change (post-1500)				-1.25		-2.32		-0.96
				(1.78)		(3.34)		(2.13)
Crop Yield (Anc., pre-1500)					0.71	0.82		
					(2.96)	(4.72)		
Crop Yield Change (Anc., post-1500)					7.01**	-1.75		
					(2.73)	(4.47)		
Crop Growth Cycle (Anc., pre-1500)					0.72	-2.43		
					(1.84)	(2.31)		
Crop Growth Cycle Change (Anc., post-1500)					-0.66	1.03		
					(2.07)	(3.21)		
Absolute Latitude			-5.33*	-3.77	-4.90*	-4.01	-5.10	-4.53
			(2.76)	(2.91)	(2.88)	(3.02)	(3.22)	(3.71)
Mean Elevation			0.95	1.40	2.53	1.06	1.44	1.70
			(1.78)	(1.87)	(2.20)	(2.32)	(1.87)	(2.00)
Terrain Roughness			-2.61	-3.28	-3.60	-3.45	-4.48**	-4.60*
			(2.05)	(2.15)	(2.48)	(2.53)	(2.17)	(2.25)
Distance to Coast or River			0.19	-0.27	0.37	-0.21	0.98	1.07
			(1.17)	(1.22)	(1.48)	(1.66)	(1.20)	(1.49)
Landlocked			2.26	2.36	1.48	2.31	2.04	2.14
			(2.43)	(2.64)	(2.65)	(2.86)	(2.40)	(2.63)
Island			-3.11	-2.90	-3.50	-2.17	-1.97	-1.63
			(1.90)	(1.92)	(2.19)	(2.06)	(1.64)	(1.91)
Neolithic Transition Timing			-5.91*	-6.91**		-4.67	-4.87	-5.08
			(3.02)	(2.98)		(7.64)	(3.28)	(4.05)
Neolithic Transition Timing (Anc.)					-5.43*	-1.66		
					(2.72)	(5.12)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.22	0.47	0.57	0.57	0.48	0.52	0.59	0.56
Observations	56	56	56	56	56	56	43	43

(Source: author's own elaboration)

Table B.2: Crop Yield, Growth Cycle, and Long-Term Orientation: Exploiting the Columbian Exchange

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield (pre-1500)	1.84	1.82	2.41	2.21		-3.07	7.02***	7.74**
	(1.69)	(1.63)	(2.05)	(2.76)		(3.04)	(1.79)	(2.99)
Crop Yield Change (post-1500)		2.18	3.06**	2.25		-3.83	2.10	2.03
		(1.37)	(1.44)	(1.72)		(5.41)	(1.46)	(2.18)
Crop Growth Cycle (pre-1500)				0.10		-1.07		-1.81
				(3.40)		(5.18)		(4.49)
Crop Growth Cycle Change (post-1500)				1.21		-6.30		0.94
				(1.42)		(3.82)		(1.52)
Crop Yield (Anc., pre-1500)					4.06*	7.16*		
					(2.15)	(3.83)		
Crop Yield Change (Anc., post-1500)					1.87	5.01		
					(1.69)	(5.27)		
Crop Growth Cycle (Anc., pre-1500)					-0.75	0.14		
					(3.56)	(6.28)		
Crop Growth Cycle Change (Anc., post-1500)					1.23	7.38		
					(1.65)	(4.55)		
Absolute Latitude			-1.28	-1.48	-0.71	0.38	-0.10	-1.35
			(2.33)	(2.71)	(2.41)	(2.46)	(2.85)	(3.84)
Mean Elevation			-2.04	-1.85	-1.88	-2.36*	-1.88	-1.77
			(1.48)	(1.44)	(1.32)	(1.28)	(1.38)	(1.32)
Terrain Roughness			1.46	1.39	1.27	0.85	-0.28	-0.29
			(1.71)	(1.69)	(1.64)	(1.70)	(1.77)	(1.68)
Distance to Coast or River			1.68	1.44	2.18*	2.69**	3.19***	3.02**
			(1.44)	(1.54)	(1.21)	(1.15)	(1.10)	(1.18)
Landlocked			2.31**	2.15*	1.63	1.43	2.11*	1.92*
			(1.11)	(1.21)	(1.17)	(1.16)	(1.06)	(1.13)
Island			-1.98	-2.05	-1.90	-1.69	-0.94	-0.81
			(1.61)	(1.70)	(1.34)	(1.54)	(1.56)	(1.60)
Neolithic Transition Timing			-1.66	-1.82		11.42**	0.52	0.66
			(1.85)	(2.09)		(4.97)	(1.65)	(2.02)
Neolithic Transition Timing (Anc.)					-1.31	-9.59***		
					(1.51)	(3.52)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.12	0.12	0.14	0.11	0.17	0.16	0.20	0.18
Observations	81	81	81	81	81	81	65	65

(Source: author's own elaboration)

Table B.3: Crop Yield, Growth Cycle, and Long-Term Orientation:
Exploiting the Columbian Exchange

	Long-Term Orientation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop Yield (pre-1500)	-0.03	-0.03	-0.04	-0.09		-0.56**	-0.03	-0.10
	(0.04)	(0.04)	(0.04)	(0.06)		(0.22)	(0.05)	(0.07)
Crop Yield Change (post-1500)		-0.02	-0.01	-0.02		-0.51**	-0.01	-0.02
		(0.06)	(0.05)	(0.06)		(0.24)	(0.05)	(0.07)
Crop Growth Cycle (pre-1500)				0.10		0.33*		0.12
				(0.10)		(0.20)		(0.11)
Crop Growth Cycle Change (post-1500)				-0.03		0.05		-0.04
				(0.04)		(0.13)		(0.04)
Crop Yield (Anc., pre-1500)					-0.06	0.40**		
					(0.06)	(0.20)		
Crop Yield Change (Anc., post-1500)					-0.01	0.46**		
					(0.05)	(0.22)		
Crop Growth Cycle (Anc., pre-1500)					0.09	-0.31		
					(0.11)	(0.25)		
Crop Growth Cycle Change (Anc., post-1500)					-0.03	-0.08		
					(0.04)	(0.13)		
Absolute Latitude			0.13*	0.18**	0.18**	0.15*	0.17**	0.24**
			(0.07)	(0.08)	(0.08)	(0.08)	(0.08)	(0.11)
Mean Elevation			0.11	0.12	0.13*	0.14*	0.10	0.11
			(0.07)	(0.08)	(0.07)	(0.07)	(0.08)	(0.09)
Terrain Roughness			-0.13**	-0.13**	-0.13**	-0.14**	-0.13*	-0.13*
			(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.08)
Distance to Coast or River			-0.11***	-0.10***	-0.10***	-0.11***	-0.11***	-0.10***
			(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Landlocked			0.01	0.02	0.01	-0.01	0.01	0.01
			(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Island			0.04	0.04	0.01	0.03	0.06	0.04
			(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
Neolithic Transition Timing			-0.07	-0.10		0.19	-0.06	-0.10
			(0.09)	(0.08)		(0.18)	(0.09)	(0.09)
Neolithic Transition Timing (Anc.)					-0.11	-0.26*		
					(0.07)	(0.14)		
Continent FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old World Sample	No	No	No	No	No	No	Yes	Yes
Adjusted-R^2	0.30	0.29	0.38	0.38	0.38	0.40	0.22	0.22
Observations	73	73	73	73	73	73	58	58

(Source: author's own elaboration)

Interpretation

The evidence presented so far reveals a critical flaw in the empirical analysis conducted by Galor and Özak in "*The Agricultural Origins of Time Preference*". According to our predictions, once the measure for the variable LTO is redefined, the originally reported correlation between historical land productivity and contemporary rate of time preference no longer holds. In both the Baseline Analysis and Natural Experiment Analysis, the majority of the estimated coefficients for the effect of crop yield and crop growth cycle on long-term orientation are statistically insignificant. Beyond failing to support the authors' original hypothesis, our results lack internal consistency, which fundamentally undermines their interpretability.

Few are the patterns that we may observe, and only in the model specifications employing the definitions of long-term orientation based on the World Values Survey item "Thrift". The specifications based on the alternative measure of *Patience* do not appear statistically different from zero. This discrepancy may likely reflect the differing data sources from which our variables are derived. Variations in structure and collection methods may introduce measurement inconsistencies and potential biases. However, addressing these methodological concerns would require a separate, dedicated inquiry, which lies beyond the scope of the present study.

It is important to acknowledge that, while certain patterns emerge, as previously noted, their explanatory power remains limited. Further research is required to investigate each relationship summarized by the specific coefficients, in order to be able to derive useful insights. Nevertheless, we proceed exploring one particular trend in greater detail, as it already offers a promising basis for drawing meaningful interpretations.

The pattern we are going to examine is the statistical significance of estimates for the effect of pre-1500CE crop yield on LTO when the sample is restricted to the Old World. A possible initial explanation for this result could be attributed to the variation in sample size. A smaller sample is typically associated with increased variability and reduced statistical significance. However, this rationale does not apply to our case, as the opposite is observed: restricted Old World sample yields statistically significant results.

A more plausible interpretation considers these results in light of the empirical strategy behind the introduction of the Old World restricted sample analysis. According to Galor and Özak (2016), the Old World consists of "a sample of nations that did not see major numbers of migrants after 1500 but nevertheless witnessed a change in crop productivity and growth cycle".

Thus, the significance of the estimated coefficients suggests that higher pre-industrial caloric yield is positively associated with modern long-term orientation (LTO) only in countries where intercontinental migration and population replacement were less prevalent. In this study, through the definition of new LTO measures based on the WVS dataset excluding the items "National Pride" and "Service to others", we claimed that Galor and Özak's findings were biased. The lack of statistical significance in our estimates for the whole world sample challenged the validity of the authors' original findings and proved the presence of such bias. In contrast, the persistence of significance within the Old World sample suggests that this bias may have been less pronounced in those countries. According to this interpretation, individual behaviours associated with the excluded WVS items were likely more prevalent in countries that experienced larger migration inflows.

Existing literature provides support for the above interpretation. Previous studies have found that stronger national identity and pride are associated with a reduced propensity to migrate (Chuvashov, 2014; Hoong & Soon, 2012). In countries that have been exposed to larger migration inflows, the share of population with weaker "National Pride" is often higher. Arguably, this may have generated a larger bias in Galor and Özak's original LTO measure. Furthermore, altruism has been linked to higher migration intention through evidence on remittances (Antoniades et al., 2018; Wolff et al., 2007) and concern for future generations' welfare (Tcha, 1996). By interpreting the value that individuals attribute to "Service to Others" as a form of altruism, we may argue that its inclusion in the original LTO measure may have disproportionately biased results in migration-heavy regions belonging to the whole world sample.

While our interpretation provides a plausible explanation for the observed patterns, we recognize that further empirical investigation is necessary to confirm these hypotheses and address the limitations.

As part of another attempt to explain how our findings relate to the fallacy identified in Galor and Özak's theoretical model, we may argue that the temporal distance between pre-Colombian agricultural productivity of land and contemporary behavioural traits is simply too vast for the theoretical assumptions to remain valid (Chun et al., 2020). Over the centuries many historical developments have shaped the transmission of cultural traits, such as time preference, introducing fundamental distortions into the baseline relationship posited by the authors.

This failure to account for cultural transformation echoes a major criticism advanced by several studies contesting Hofstede's theoretical framework (Kirkman et al., 2006; Beugelsdijk &

Welzel, 2018). Critics have highlighted that Hofstede's model is rooted in his assumption of long-term cultural stability. Hofstede himself asserts: "Cultures, especially national cultures, are extremely stable over time… Differences between national cultures at the end of the last century were already recognizable in the years 1900, 1800, and 1700, if not earlier. There is no reason they should not remain recognizable until at least 2100" (2001, 34–36). However, since Hofstede's original study was conducted, a series of transformative global events have taken place, ranging from the fall of the USSR to the economic rise or decline of various nations. Moreover, the acceleration of globalization and technological change, in particular through the rise of the internet, personal computing, and mobile technologies, has significantly amplified the exchange of cultural values and information across borders. Even in societies with strict information regulation, exposure to external cultural influences has grown. Each of these developments may have potentially reshaped individuals' cultural values and perceptions of what is important. These shifts suggest that Hofstede's cultural dimensions may require re-evaluation to account for the evolving nature of cultural traits. In addressing questions about the origins of cross-country differences in time preference, it is therefore essential to consider the dynamic nature of cultural traits and the historical events that have shaped them over time. The invalidation of Galor and Özak's results by our analysis may indeed reflect a fundamental limitation in the theoretical framework underlying the definition of the LTO measure: its failure to account for the possibility that intervening historical forces have significantly altered the cultural landscape.

V. Conclusions

This research constitutes a strong challenge to the empirical framework underlying Galor and Özak's paper "*The Agricultural Origins of Time Preference*". After identifying a fundamental flaw in the construction of the outcome variable, we proposed three alternative measures designed to better capture the concept of long-term orientation. Employing these refined variables in a replication of the authors' cross-country analysis effectively invalidated the authors' original results. We demonstrated that the original hypothesis linking historical land productivity to contemporary time preferences does not hold when more precise and theoretically consistent measures of the LTO variable are used.

Our findings emphasize the critical importance of measurement choices in comparative economic research. In particular, the impact of redefining the LTO variable underscores how biases in variable construction can substantially distort empirical results and lead to potentially misleading conclusions. We interpreted such bias as indicative of a deeper limitation within Galor and Özak's theoretical framework: its reliance on the assumption of long-term cultural stability. This assumption, rooted in Hofstede's model (2001), overlooks the significant role played by historical transformations, migration dynamics, and global cultural shifts in shaping time preferences over the centuries.

While we have offered several plausible interpretations of the patterns observed in our analysis, the scope of the present study does not allow for exhaustive testing of these hypotheses. Accordingly, we encourage future research to investigate the established empirical patterns more thoroughly, ideally incorporating more dynamic models of cultural transmission and historical change. Such efforts would contribute meaningfully to a more robust understanding of the origins of time preference and, more broadly, of cultural traits relevant to economic development.

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