Geographical Origins of Language Structures*

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Abstract

This research explores the geographical origins of the coevolution of cultural and linguistic traits in the course of human history, relating the geographical roots of long-term orientation to the structure of the future tense, the agricultural determinants of gender bias to the presence of sex-based grammatical gender, and the ecological origins of hierarchical orientation to the existence of politeness distinctions. The study advances the hypothesis and establishes empirically that: (i) variations in geographical characteristics that were conducive to higher natural return to agricultural investment contributed to the existing cross-language variations in the structure of the future tense, (ii) the agricultural determinants of gender gap in agricultural productivity fostered the existence of sex-based grammatical gender, and (iii) the ecological origins of hierarchical societies triggered the emergence of politeness distinctions.

Keywords: Comparative Development, Cultural Evolution, Language Structure, Future Tense, Politeness Distinctions, Long-Term Orientation, Grammatical Gender, Gender Bias, Hierarchy, Emergence of States

JEL Classification: D01, D03, J16, Z10, Z13

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1 Introduction

The origins of the vast inequality in the wealth of nations have been largely attributed to the persistent effect of an uneven distribution of pre-industrial geographical, cultural, institutional and human characteristics across the globe.[1] In particular, evidence suggests that regional variations in the geographical environment in the distant past have contributed to the differential formation of cultural traits and their lasting effect on comparative economic development across countries, regions and ethnic groups.[2] In light of the apparent coevolution of cultural and linguistic characteristics in the course of human history, emerging linguistic traits have conceivably reinforced the persistent effect of cultural factors on the process of development.[3] Nevertheless, the significance of these joint evolutionary processes, and their potential common geographical roots, for the understanding of the process of development and the uneven distribution of wealth of nations, has remained obscured.

This research explores the geographical origins of the coevolution of cultural and linguistic traits. It advances the hypothesis and establishes empirically that geographical characteristics that were conducive to the emergence and the persistence of certain cultural traits, triggered the evolution of complementary linguistic traits that have fostered and reinforced the diffusion and the intergenerational transmission of these cultural traits in the course of human history.[4]

The research identifies the common geographical roots of cultural and linguistic traits, associating long-term orientation to the structure of the future tense, gender bias to the presence of sex-based grammatical gender, and hierarchical orientation to the existence of politeness distinctions. The study establishes that geographical characteristics that were conducive to higher natural return to agricultural investment, and thus to the emergence of long-term orientation, contributed to the emergence of a structure of the future tense that complements long-term oriented behavior. It demonstrates that suitability of land for the adoption of agricultural technologies that generated a gender gap in productivity has been conducive to the emergence of sex-based grammatical gender, and it further suggests that ecological diversity that had been pivotal to specialization, trade, and thus to the emergence of hierarchical societies, fostered the presence of politeness distinctions.

The proposed hypothesis rests upon several fundamental building blocks. First, in light of the pivotal role of languages in the diffusion of knowledge and the transmission of values, emerging linguistic characteristics in the course of human history have conceivably affected the diffusion of cultural values, reinforcing existing cultural traits and their intergenerational transmission.[5] Second, the forces of natural selection across language structures have plausibly generated an evolutionary advantage to linguistic traits that reflected and reinforced the dominating cultural traits. Third, regional differences in geographical characteristics that have contributed to the emergence of variations in cultural traits

[1] Gallup et al. (1999), Guiso et al. (2004, 2006), Tabellini (2010), Acemoglu et al. (2001), Glaeser et al. (2004), and Ashraf and Galor (2013b).

[2] Alesina et al. (2013) and Galor and Özak (2016).

[3] Cavalli-Sforza et al. (1994), Cavalli-Sforza (2000), and Richerson et al. (2010).

[4] This hypothesis is in line with the Linguistic Niche Hypothesis (LNH), which "proposes that, just as the structure of biological organisms are affected by their ecological niche, the structure of society affects the evolutionary pressures on language structures" (Roberts and Winters, 2012).

[5] In particular, socio- and anthropological linguistics, have argued that language usage is central for social expression (Brown and Levinson, 1987).

have conceivably contributed to the evolution of cross-language variations in complementary linguistic traits. Forth, cultural traits that have been reflected in language structures have been more persistent across time and space, reflecting the view that deviations from existing language structures, rather than from the prevailing cultural traits, are less likely to occur in light of their adverse effect on the feasibility of communication across individuals.

The common geographical origins of cultural and linguistic traits are explored in three distinct settings. Consider historical hierarchical societies characterized by hierarchical orientation (e.g., obedience, conformity, and power distance). Linguistic traits that had reinforced existing hierarchical structures and cultural norms had conceivably emerged and persisted in these stratified societies in the course of human history. In particular, politeness distinctions in pronouns (e.g., the differential use of "tu" and "usted" in the Spanish language, "Du" and "Sie" in German, and "tu" and "vous" in French) had conceivably appeared and endured in hierarchical societies.[6] Thus, geographical characteristics, such as ecological diversity that had been conducive to the emergence of hierarchical societies (Fenske, 2014), may have contributed to the emergence of politeness distinctions.

Alternatively, consider ancient civilizations that had been characterized by a sexual division of labor and consequently by the existence of gender bias. Linguistic traits that had fortified the existing gender biases have plausibly emerged and persisted in these societies over time.[7] In particular, geographical characteristics that had been associated with the suitability of land for the adoption of agricultural technology that had contributed to a gender gap in productivity and thus to the emergence of distinct gender roles in society (e.g., the suitability of land for the usage of the plow (Pryor, 1985; Alesina et al., 2013)), may have fostered the emergence and the prevalence of sex-based grammatical gender in the course of human history.

Finally, in societies characterized by long-term orientation in the distant past, a structure of the future tense that has reinforced long-term oriented behavior may have emerged and persisted over time. In particular, pre-industrial agro-climatic characteristics that were conducive to higher return to agricultural investment and therefore to the prevalence of long-term orientation (Galor and Özak, 2016), may have triggered the emergence and the prevalence of a long-term oriented structure of the future tense.

The empirical analysis explores the geographical origins of three language structures: the structure of the future tense, the presence of sex-based grammatical gender systems, and the existence of politeness distinctions in pronouns. Moreover, it further examines the proposed mediating channels that may have governed the associations between these geographic and linguistic traits. The first part of the empirical analysis examines whether agro-climatic characteristics that have governed the return to agricultural investment, and have been associated with the emergence of long-term orientation (Galor and Özak, 2016), have contributed to the structure of the future tense. Consistent with the view that periphrastic future tense reflects an intentional, future-orientated behavior, the analysis establishes that periphrastic future tense is more prevalent in languages that originated in geographical regions

[6]Politeness distinctions may have emerged in order to mitigate the coordination cost in the interaction between individuals from various social strata (Brown and Levinson, 1987; Brown and Gilman, 1989; Helmbrecht, 2003, 2005).

[7]Indeed, linguists as well as other scholars have argued that gender bias can be reinforced by a sex-based grammatical gender system (Lakoff, 1973; Eckert and McConnell-Ginet, 2003; Stahlberg et al., 2007).

that have been characterized by higher potential crop returns. Furthermore, the analysis suggests that long-term orientation is more prevalent in communities whose languages are characterized by periphrastic future tense. Moreover, the findings further indicate that the intensity of agriculture of ethnic groups in the geographical homeland of each language appears to be the mediating channel through which the return to agricultural investment has affected the presence of periphrastic future tense.

The empirical analysis exploits the well-established observation that daughter languages within a language family originated in a common proto-language (Bouckaert et al., 2012; Pagel et al., 2013) to mitigate potential concerns about the effect of sorting on the observed relationship between crop return and the emergence of periphrastic future tense, while establishing the historical depth of this association. In particular, the findings suggest that higher potential crop return in the ancestral homeland of each language family, rather than the potential return in the current geographical location of each daughter language, has been the trigger for the presence of periphrastic future tense in daughter languages.

The empirical analysis advances several strategies to mitigate potential concerns regarding the role of reverse causality, omitted variables, and sorting in the observed association between crop return and the emergence of periphrastic future tense. First, overcoming potential concerns about reverse causality (i.e., the effect of periphrastic future tense and the associated long-term orientation on cultivation methods, the choice of technologies, and thus the actual crop returns), the analysis exploits potential crop return (associated with agro-climatic conditions that are orthogonal to human intervention), rather than the, potentially endogenous, actual crop return. Second, mitigating the potential role of omitted institutional, cultural, geographical and human characteristics in the observed relationship, the analysis mirrors the epidemiological approach to cultural diffusion and identifies the geographical origins of the structure of the future tense based on variation across languages located outside the ancestral homeland of their proto-language, accounting for the host region fixed-effects, and thus capturing unobserved time-invariant heterogeneity at the regional level. Furthermore, the empirical analysis accounts for confounding geographical characteristics in the homelands of the proto-language and the daughter languages, as well as for spatial auto-correlation, and establishes that selection on unobservables is insignificant. Third, alleviating concerns about the potential role of sorting of individuals who use periphrastic future tense into regions with high crop return, the analysis establishes that potential crop return in the proto-language's homeland, rather than the current geographical location of the daughter language, are associated with the presence periphrastic future tense.

The second part of the empirical analysis examines whether geographical characteristics that had been associated with the suitability of land for the adoption of an agricultural technology, which had contributed to a gender gap in productivity, and thus to the emergence of distinct gender roles in society, have contributed to the prevalence of sex-based grammatical gender. Consistent with the view that the emergence of the plow was associated with an increase in a gender gap in productivity (Pryor, 1985; Alesina et al., 2013), the analysis establishes that sex-based grammatical gender is more prevalent in languages that originated in geographical regions that have been characterized by greater suitability of land for the usage of the plow. Mitigating potential concerns about the effect of sorting,

while establishing the historical depth of this association, the findings further suggest that higher suitability of land for the usage of the plow in the ancestral homeland of each language family, rather than in the current geographical location of each daughter language, has been the dominating force in the presence of sex-based grammatical gender in each of the daughter languages. Furthermore, the findings suggest that gender bias is more prevalent in communities whose languages are characterized by sex-based grammatical gender. Moreover, the findings further indicate that the actual usage of the plow within ethnic groups in the geographical homeland of each language appears to be the mediating channel through which suitability of land for the usage of the plow have affected the presence of sex-based grammatical gender.

Overcoming concerns about the role of reverse causality (i.e., the effect of sex-based grammatical gender, and the associated gender role, on the adoption of the plow), the analysis is based upon the potential use of the plow (as captured by potential agro-climatic yield of crops suitable for the usage of the plow), rather than the actual usage. Moreover, mitigating the potential role of omitted variables, the analysis identifies the geographical origins of sex-based grammatical gender based on variation across languages located outside the ancestral homeland of their proto-language (mirroring the epidemiological approach to cultural diffusion), accounting for host region fixed-effects, confounding geographical characteristics in the homelands of the proto-language and the daughter languages, and spatial auto-correlation, and it establishes that selection on unobservables is insignificant. Furthermore, alleviating concerns about the potential sorting of individuals who use sex-based grammatical gender into regions suitable for the usage of the plow, the analysis establishes that the suitability of land for the usage of the plow in the proto-language's homeland, rather than in the current geographical location of the daughter language, is associated with sex-based grammatical gender.

The third part of the empirical analysis examines whether geographical characteristics, such as ecological diversity, that had been conducive to the emergence of hierarchical societies (Fenske, 2014), have contributed to the emergence of politeness distinctions. Consistent with the view that the presence of politeness distinctions has reinforced existing hierarchical structures and cultural norms (e.g., obedience, conformity, and power distance), the findings suggest that the presence of politeness distinctions in pronouns is more prevalent in languages that originated in geographical regions that have been characterized by greater ecological diversity. Mirroring the epidemiological approach to cultural diffusion, the analysis identifies the relationship based on variation across languages located outside the ancestral homeland of their proto-language, accounting for the host region fixed-effects, confounding geographical characteristics in the homelands of the proto-language and the daughter languages, and spatial auto-correlation, and it establishes that selection on unobservables is insignificant. Furthermore, the finding suggests that hierarchical orientation is more prevalent in communities whose languages are characterized by politeness distinctions. Moreover, the findings indicate that jurisdictional hierarchy of ethnic groups in the geographical homeland of each language appears to be the mediating channel through which ecological diversity has affected the presence of politeness distinctions.

Consistent with evidence about the greater adaptability of politeness distinctions to environmental and political changes, in comparison to the structure of the future tense and sex-based grammati-

cal gender, the findings suggest that while geographical characteristics in the ancestral homeland of the proto-language are associated with the existence of the periphrastic future tense and sex-based grammatical gender, the geographical characteristics in the homeland of the daughter languages are associated with the existence of politeness distinctions.

This research is the first to explore the geographical determinants of the coevolution of cultural and linguistic traits in the course of human history.[8] It contributes to the growing literature on the evolution of language (Pinker and Bloom, 1990; Christiansen and Kirby, 2003a,b; Bickerton, 2007), providing evidence for the origins of language structures.[9] Moreover, it sheds a new light on the stability of some language structures (Wichmann and Holman, 2009; Greenhill et al., 2010; Dediu and Levinson, 2012; Dediu and Cysouw, 2013; Greenhill et al., 2017), underlying the dominance of geographical conditions at the homeland of the proto-language in observed contemporary structures. Furthermore, it proposes geographical foundations for the link between linguistic traits and socio-economic behavior as explored by Brown and Gilman (1960), Brown and Levinson (1987), Hellinger and Bufimann (2001), Eckert and McConnell-Ginet (2003), Roberts and Winters (2012), Chen (2013) and Davis and Abdurazokzoda (2016).

The analysis sheds additional light on the geographical roots of comparative development (Diamond, 1997; Ashraf and Galor, 2013b), the interaction between the evolution of human traits and the process of development (Galor and Moav, 2002; Spolaore and Wacziarg, 2013), and the geographical origins of cultural traits as well as the determinants of their persistence in the course of human history (Bisin and Verdier, 2000; Nunn and Wantchekon, 2011; Fernández, 2012; Alesina et al., 2013; Galor and Özak, 2016).

2 Data

This section presents the data that is used in the empirical analysis of the geographical origins of language structures and the methodology that guided its construction. In particular, it introduces the data on cross-language variations in the structure of the future tense, the presence of sex-based grammatical gender, and the existence of politeness distinctions in pronouns, as well as the data on cross-regional variations in the hypothesized geographical determinants of these language structures.

The linguistic characteristics of each language are linked to: (i) the geographical characteristics of the linguistic homeland (i.e., the characteristics of the indigenous regions that spoke the language in the pre-colonial as well as in the post-colonial era),[10] and (ii) the ethnographic characteristics of

[8] In contrast, the literature on the evolution of languages has focused on the spatial origin of this evolutionary process. More generally, existing economic research predominantly views languages as an identifier of cultural and ethnic groups. Linguistic fractionalization as well as linguistic distance have been extensively used as a proxy for cultural fractionalization and cultural distance in the exploration of the effect of ethnic diversity on economic growth and the impact of cultural distance on the diffusion of development (Easterly and Levine, 1997; Fearon, 2003; Alesina et al., 2003; Alesina and Ferrara, 2005; Desmet et al., 2012; Harutyunyan and Özak, 2016). In particular, Michalopoulos (2012) and Ashraf and Galor (2013a) explore the geographical origins (i.e., diversity of soil quality and migratory distance from Africa) of existing variation in the number of languages within a geographical region.

[9] Earlier literature explored the spatial origins of languages, rather than the geographical determinants, of language structures.

[10] This focus on the linguistic homeland is designed to capture the historical geographical roots of each language. For instance, Spain, rather than regions in Latin America and elsewhere that had adopted the Spanish language in the

the groups that speak the language in the linguistic homeland. In particular, the linguistic data is mapped to the *Ethnologue* (Lewis et al., 2009) in order to identify the geographical characteristics of the linguistic homeland, and to the Ethnographic Atlas (Murdock, 1967) and the Standard Cross Cultural Sample (Murdock and White, 1969) in order to identify the ethnographic characteristics of the aboriginal speakers of each language. Furthermore, in order to explore the deep historical roots of language structures, each language is mapped to its ancestral origin – its *Urheimat* (i.e., the geographical region where the language family or proto-language emerged, according to linguists).

2.1 Dependent Variables: Language Structures

This subsection introduces the three language structures whose geographical origins will be explored: (i) periphrastic future tense, (ii) sex-based grammatical gender systems, and (iii) politeness distinctions in pronouns. In particular, it presents the data about the existence of each of these structures across languages, as reported by The World Atlas of Language Structures (WALS) – the most comprehensive database of language structures (Dryer, 2013).

The existence of a language structure S in language ℓ, S_ℓ, is encoded such that:

$$S_\ell = \begin{cases} 1 & \text{if the structure exists in language } \ell \\ 0 & \text{if the structure does not exist in language } \ell. \end{cases}$$

2.1.1 Periphrastic Future Tense

Languages differ in the structure of their future tense. In particular, linguists distinguish between languages that are characterized by an *inflectional* versus *periphrastic* future tense (Dahl, 1985, 2000; Dahl and Velupillai, 2013). Inflectional future tense is associated with verbs that display morphological variation (i.e., a change in the verb form that is associated with the future tense). In contrast, periphrastic future tense is characterized by roundabout or discursive phrases, such as 'will', 'shall', 'want to', 'going to' in the English language (Bybee and Pagliuca, 1987; Bybee and Dahl, 1989; Bybee et al., 1994).

Bybee and Dahl (1989) argue that, unlike the inflectional future tense, the periphrastic future tense is formed by terms that express a desire, an intention, an obligation, a commitment as well as a movement towards a goal. In particular, in the English language, *"*shall *has developed from a main verb meaning 'to owe',* will *from a main verb meaning 'to want', and the source of* be going to *is still transparent"*(Bybee and Dahl, 1989, p.90). Moreover, *"intention and prediction are most commonly expressed by the periphrastic future, while the synthetic one is more common in generic statements, concessives, and suppositions"* (Bybee et al., 1994, p.235). Inflectional futures *"also appear systematically (often obligatorily) in sentences which express clear predictions about the future (which are independent of human intentions and planning), whereas less grammaticalized constructions [i.e., periphrastic] often tend to be predominantly used in talk of plans and intentions – a fact which is explainable from the diachronic sources of future tenses"*(Dahl and Velupillai, 2013, p.270). Thus,

post-colonial era, is considered the linguistic homeland of the Spanish language.

these views suggest that periphrastic future tense conceivably reflects long-term oriented behavior.

The dataset on the existence of periphrastic future tense includes 275 contemporary languages, originated from 76 language families.[11] The classification of 222 of the languages in the sample is based on Dahl and Velupillai (2013), as reported in WALS, and the remaining 53 languages are classified based on Dahl (1985, 2000).[12] Figure 1 and Table D.1 describe the prevalence and the spatial distribution of the structure of future tense in the dataset, portraying wide variations within regions in the existence of periphrastic future tense. In particular, in most regions about 50% of the languages in the sample are characterized by periphrastic future tense.

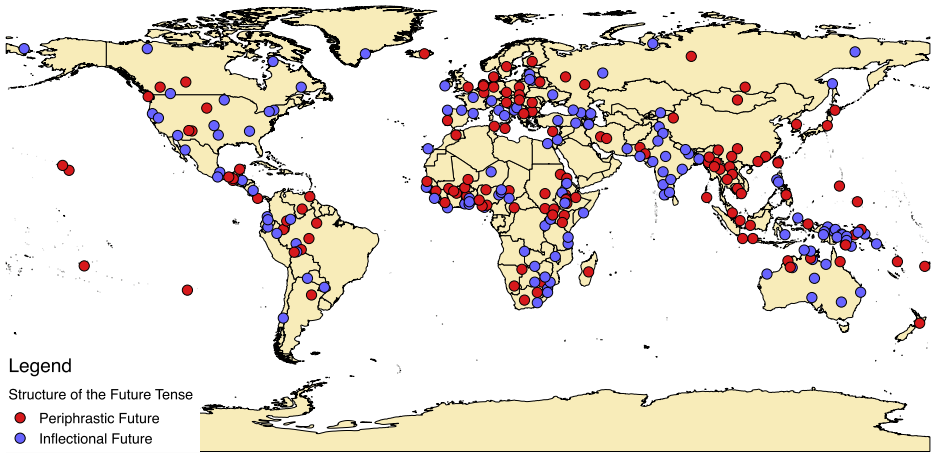

Figure 1: Global Distribution of Periphrastic Future Tense

2.1.2 Sex-Based Grammatical Gender Systems

Languages differ in the existence and the form of grammatical gender. In particular, languages that are characterized by sex-based grammatical gender classify nouns according to biological gender. The presence of sex-based grammatical gender induces speakers to highlight gender distinctions even in situations in which gender may not play an intrinsic role. Moreover, linguists have argued that the presence of "masculine generics" in some languages (e.g., the use of the noun "adam" to describe "man" as well as "human being" in the Hebrew and Turkish languages) has reinforced gender biases in the course of human history, equating "maleness and humanness" (Stahlberg et al., 2007, p.169). Thus, perhaps not surprisingly, linguists as well as other scholars have persistently argued that gender biases have been reinforced by languages characterized by sex-based grammatical gender systems (Lakoff, 1973; Eckert and McConnell-Ginet, 2003; Stahlberg et al., 2007).

The study explores the geographical origins of sex-based grammatical gender based upon the existence of this language structure in 227 contemporary languages, originated from 76 language families (Corbett, 2013b). Figure 2 and Table D.2 describe the prevalence and the spatial distribution of sex-based grammatical gender systems in the dataset, demonstrating wide regional and cross-regional

[11] Importantly, 90% of the languages in the Ethnologue belong to these 76 language families.

[12] These classifications identify languages that are characterized by an inflectional future tense. Languages that are not characterized by an inflectional future tense are considered to be characterized by a periphrastic future tense.

variations in the existence of these language structures. In particular, 37% of the languages in the sample are characterized by the presence of a sex-based grammatical gender system.

Two alternative aspects of grammatical gender are considered: (i) the existence of gender distinctions in independent personal pronouns (Siewierska, 2013), and (ii) the intensity of the grammatical gender system (combining information on the number of genders, the existence of sex-based grammatical gender, the system of gender assignment, and the existence of gender distinctions in independent personal pronouns) based on Corbett (2013a,b,c) and Siewierska (2013). As established in Appendix B, the qualitative findings are independent of the measure used.

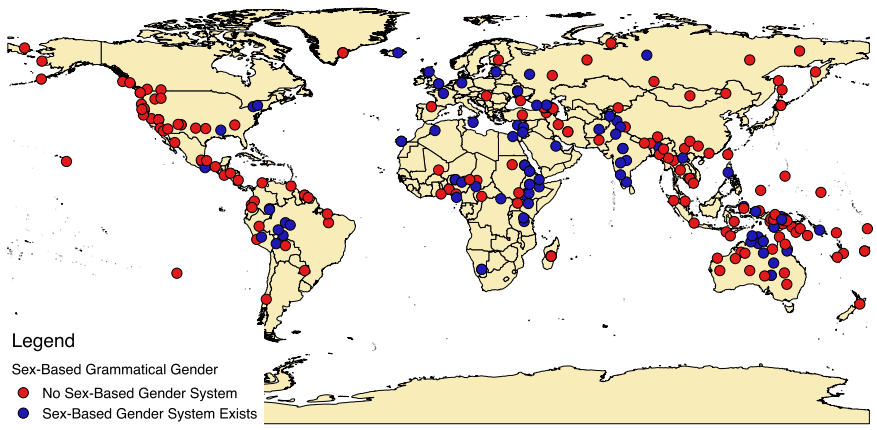

Figure 2: Global Distribution of Sex-Based Grammatical Gender System

2.1.3 Politeness Distinctions in Pronouns

Languages differ in the existence and the form of politeness distinctions. In particular, politeness distinctions in pronouns are present in some languages (e.g., the differential use of "tu" and "usted" in the Spanish language, "Du" and "Sie" in German, and "tu" and "vous" in French) while being absent from others. Moreover, linguists have underlined that the differential use of these pronouns is associated with the speakers social class and is closely associated with power distance (Brown and Gilman, 1960).[13]

The study explores the geographical origins of politeness distinctions in pronouns based on the existence of second-person politeness distinctions in 207 contemporary languages, originated from 69 language families (Helmbrecht, 2013).[14] Figure 3 and Table D.3 describe the prevalence and the spatial distribution of politeness distinctions in the dataset, demonstrating wide regional and cross-regional variations in the existence of these language structures. In particular, 34% of the languages in the sample are characterized by the presence of politeness distinctions. Moreover, two alternative specifications of politeness distinctions are considered: (i) the degree (rather than the existence) of

[13]In some languages, earlier linguistic forms predated politeness distinctions. In particular, in the Spanish language "usted" evolved from "vuestra merced" – your grace (Solé, 1970; del Castillo Mathieu, 1982; Bentivoglio, 2003).

[14]Helmbrecht (2013) classifies politeness distinctions, as reflected in second person pronouns, into four categories: (i) no politeness distinction, (ii) binary politeness distinction, (iii) multiple politeness distinctions, and (iv) dominantly avoided for politeness reasons. Hence, politeness distinctions are present if either one of the categories (ii)-(iv) are present.

politeness distinction, and (ii) the existence of a high degree of politeness distinctions.[15] As established in Appendix C, the qualitative findings are independent of the classification used.

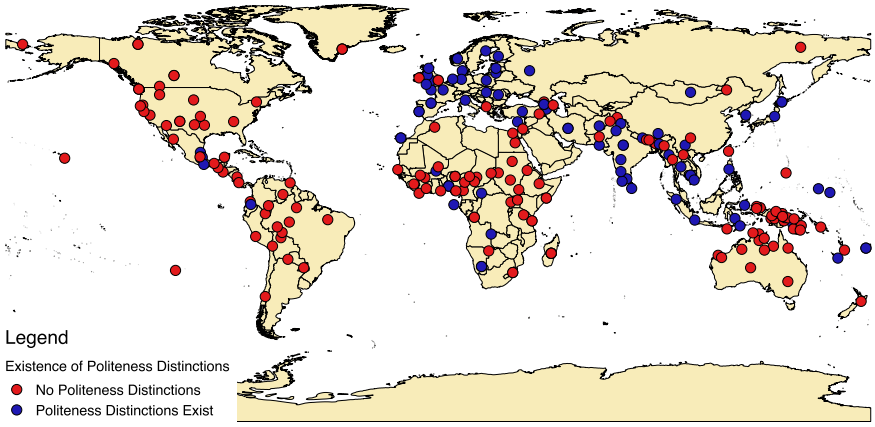

Figure 3: Global Distribution of Politeness Distinctions

2.2 Main Independent Variables

In view of the hypothesized geographical origins of language structures (i.e., the structure of the future tense, the presence of sex-based grammatical gender, and the existence of politeness distinction), this subsection introduces the data on cross-regional variations in the hypothesized geographical determinants of these structures: (i) the historical potential crop return, (ii) the potential suitability of the land for the use of the plow, and (iii) the extent of ecological diversity.

2.2.1 Return to Agricultural Investment in the Linguistic Homeland and Urheimat

The historical potential crop return in the homeland of each language, as well as in the homeland of the proto-language from which the language descended (Urheimat), is used in order to establish the geographical determinants of the structure of the future tense.

The historical potential crop return in the homeland of a language, following the methodology advanced by Galor and Özak (2016), is measured by the potential daily calories that could be generated by cultivating the crops that would maximize potential caloric yield in each cell of the homeland, in the pre-1500CE era, given the crop growth cycle. The estimates of potential crop yield (measured in tons, per hectare, per year) and crop growth cycle (measured as the number of days elapsed from planting to harvesting), for each $5' \times 5'$ grids across the globe (i.e., approximately 100 square kilometers), are provided by the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization (FAO). These measures are based on agro-climatic estimates, under low level of inputs and rain-fed agriculture, capturing conditions that prevailed in early stages of development.[16] The

[15] Using the classification of Helmbrecht (2013), the degree of politeness distinctions are captured by its assigned category, ranging from the lowest category – (i) to the highest by category – (iv). Similarly, high degree of politeness distinctions are defined as being associated with categories (iii) or (iv).

[16] For each crop, GAEZ provides estimates for crop yield based on three alternative levels of inputs – high, medium, and low - and two possible sources of water supply – rain-fed and irrigation. Moreover, for each input-water source category,

conversion of these crop yields into caloric yield (measured in millions of kilo calories, per hectare, per year), produces comparable estimates of crop yields, permitting the identification of the caloric maximizing crop in each grid, and thus given the crop growth cycle, the caloric daily return.[17]

These estimates have several virtues in identifying the effect of crop return in the language's homeland on the structure of the future tense. First, the focus on the potential crop return, rather than the actual one, assures that the effect of time preference, and thus conceivably the effect of the structure of the future tense, on the choice of technology has no impact of the estimated crop return. Second, the use of the agro-climatic estimates, which are arguably orthogonal to human intervention, mitigates potential concerns about the exogeneity of these estimates. Third, the use of estimates based on low level of inputs and rain-fed agriculture assures that the level of agricultural inputs, the irrigation method, and soil quality, do not reflect endogenous choices that could be potentially correlated with the structure of the future tense.

Hence, the average pre-1500CE daily caloric return (per hectare), R_ℓ, in the homeland or in the Urheimat of a language, ℓ, is

$$R_\ell = \frac{1}{|C_\ell|} \sum_{c \in C_\ell} \left(\frac{y_c}{g_c} \right), \tag{1}$$

where y_c is the cell specific pre-1500CE potential caloric yield of the crop that maximizes caloric output in cell c, g_c is this crop's growth cycle, C_ℓ is the set of cells in the language's homeland (or in the Urheimat), and $|C_\ell|$ is the cardinality of this set. Figure 4 depicts the global distribution of the potential pre-1500CE crop return at the cell level.

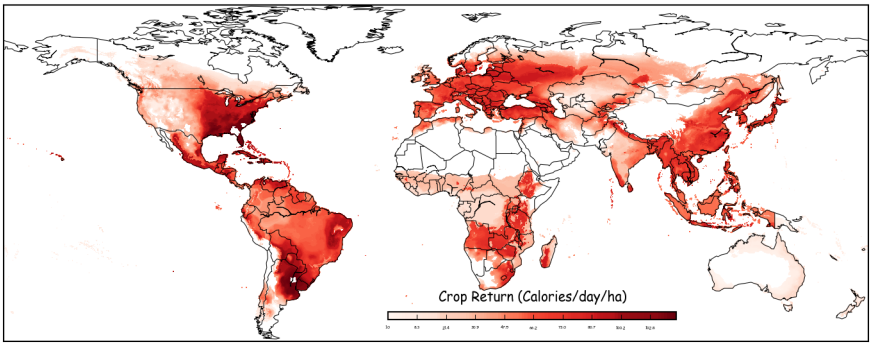

Figure 4: The Global Distribution of Potential Crop Return (Pre-1500CE)

it provides two separate estimates for crop yield, based on agro-climatic conditions, that are arguably unaffected by human intervention, and agro-ecological constraints, that could potentially reflect human intervention. The FAO dataset provides for each cell in the agro-climatic grid the potential yield for each crop . These estimates account for the effect of temperature and moisture on the growth of the crop, the impact of pests, diseases and weeds on the yield, as well as climatic related "workability constraints". In addition, each cell provides estimates of the growth cycle for each crop, capturing the days elapsed from the planting to harvesting.

[17]The caloric content of each crop is based on the United States Department of Agriculture Nutrient Database for Standard Reference.

2.2.2 Land Suitability for the Use of the Plow in the Linguistic Homeland and Urheimat

The historical potential suitability of the land for the usage of the plow in the homeland of each language, as well as in the homeland of the proto-language from which the language descended (Urheimat), is used in order to establish the geographical determinants of sex-based grammatical gender.

The historical potential suitability of the land for the usage of the plow is captured by either the maximal potential caloric yield attainable by crops that are suitable for the use of the plow in the pre-1500CE period (i.e., plow positive crops), or those that are unsuitable for the use of the plow in the pre-1500CE period (i.e., plow negative crops), as classified by Pryor (1985).[18] Since these two measures are highly negatively correlated, and since plow negative crops are characterized by larger regional variations, the analysis will focus on the role of plow negative crops.[19]

The potential pre-1500CE caloric yield (per hectare) across plow negative crops in the homeland or in the Urheimat of a language, ℓ, P_ℓ, is

$$P_\ell = \frac{1}{|C_\ell|} \sum_{c \in C_\ell} y_c, \tag{2}$$

where y_c is the potential pre-1500CE caloric yield of plow negative crops in cell c, C_ℓ is the set of cells in the language's homeland (or in the Urheimat), and $|C_\ell|$ is the cardinality of this set. Figure 5 depicts the global distribution of of the potential pre-1500CE average caloric yield (per hectare) across plow negative crops.

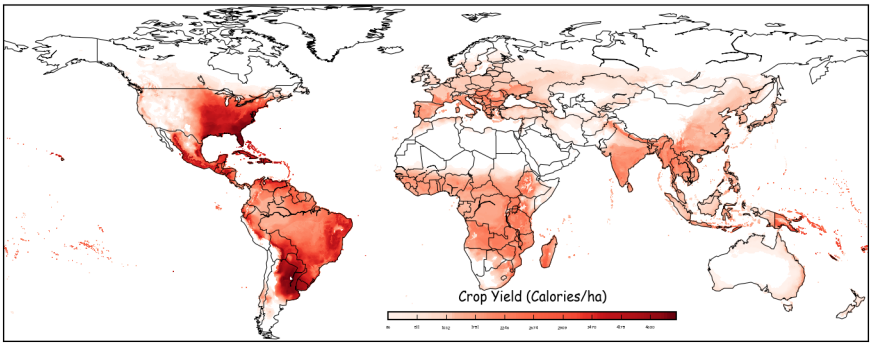

Figure 5: The Global Distribution of Potential pre-1500CE Caloric Yield (per Hectare) Across Plow Negative Crops

[18] Plow positive crops include wheat, barley, rye, buckwheat, teff, and wet rice, while plow negative crops include grains (such as millet, sorghum, dry rice, and maize), as well as all root and tree crops. Measures of the (non-caloric) suitability of the land for the use of the plow were first introduced by Alesina et al. (2013). The conversion of the crop yields of plow negative and plow positive crops into caloric yield (measured in millions of kilo calories, per hectare, per year), produces comparable estimates of crop yields and permits the construction of an index of soil suitability for the usage of the plow.

[19] In particular, since plow positive crops are absent from the Americas this measure cannot capture any of the existing variation in sex-based grammatical gender in these continents.

2.2.3 Ecological Diversity in the Linguistic Homeland and Urheimat

The extent of ecological diversity in the homeland of each language, as well as in the homeland of the proto-language from which the language descended (Urheimat), is used in order to establish the geographical determinants of politeness distinctions.

The extent of ecological diversity, following Fenske (2014), is measured as a Herfindahl index of the share of each territory that is occupied by different ecological zones. In particular, ecological diversity, E_ℓ, in the homeland or in the Urheimat of a language, ℓ, is

$$E_\ell = 1 - \sum_{j=1}^{16} \left(\theta_{\ell j}\right)^2 \tag{3}$$

where $\theta_{\ell j}$ is the share of the homeland of language ℓ that is located in ecological zone j, $j = 1, \ldots, 16$.[20]

2.3 Potentially Confounding Factors

The exploration of the geographical determinants of language structures accounts for the potentially confounding effects of a wide range of geographical factors, in the homeland of each language as well as in the homeland of the proto-language from which the language descended. These factors may have affected the evolution of the structure of the future tense, sex-based grammatical gender, and politeness distinctions. In particular, it accounts for absolute latitude, average elevation, terrain ruggedness, coast length, as well as climatic conditions captured by the average, standard deviation, volatility, and spatial correlation of temperature and precipitation.[21]

The analysis further accounts for the length of the period in which no yield could be expected from the feasible set of crops (i.e., the expected number of days elapsed between the last potential harvest and the subsequent one). This unproductive period may have been central in the formation of cultural and linguistic characteristics since it had conceivably affected: (i) planning, intertemporal decisions, and therefore long-term orientation, (ii) the intensity of the use of the plow, during the year as a whole, and its implications for the emergence of gender roles, and (iii) cooperation in the development of storage technologies and its impact on the emergence of social hierarchy.

3 The Structure of the Empirical Analysis

This section presents the empirical strategy for the exploration of the relation between language structures and their hypothesized geographical determinants: (i) the historical potential return to agriculture investment, in the language's homeland and its Urheimat, and the existence of periphrastic future tense, (ii) the historical potential suitability for plow-based agriculture, in the language's homeland

[20] Olson et al. (2001) provide a global dataset of biomes with 16 ecological zones: Boreal Forests/Taiga; Deserts and Xeric Shrublands; Flooded Grasslands and Savannas; Inland Water; Mangroves; Mediterranean Forests, Woodlands and Scrub; Montane Grasslands and Shrublands; Rock and Ice; Temperate Broadleaf and Mixed Forests; Temperate Conifer Forests; Temperate Grasslands, Savannas and Shrublands; Tropical and Subtropical Coniferous Forests; Tropical and Subtropical Dry Broadleaf Forests; Tropical and Subtropical Grasslands, Savannas and Shrublands; Tropical and Subtropical Moist Broadleaf Forests; Tundra.

[21] The description of all variables used in the analysis and their summary statistics is provided in Table D.4.

and its Urheimat, and the existence of sex-based grammatical gender, and (iii) the extent of ecological diversity, in the language's homeland and its Urheimat, and the existence of politeness distinctions.

3.1 The Empirical Model

The empirical analysis estimates the effect of the geographical determinants of linguistic traits using a linear probability model, given the binary nature of the dependent variables. In particular, it estimates the following empirical model using ordinary least squares (OLS):

$$S_\ell = \beta_0 + \beta_1 D_{\ell S} + \sum_j \gamma_{0j} X_{\ell j} + \sum_c \gamma_c \delta_{\ell c} + \varepsilon_\ell, \tag{4}$$

where S_ℓ indicates whether structure S =(periphrastic future tense, sex-based grammatical gender, politeness distinctions) exists in language ℓ, $D_{\ell S}$ is the hypothesized geographical determinant (i.e., pre-1500CE potential crop return, R_ℓ, pre-1500CE potential caloric yield of plow negative crops, P_ℓ, extent of ecological diversity, E_ℓ) of structure S in the homeland of language ℓ and in its Urheimat, $\{X_{\ell j}\}$ is a set of potentially confounding geographical characteristics in the homeland of language ℓ and in its Urheimat, $\{\delta_{\ell c}\}$ is a complete set of regional fixed-effects in the homeland of language ℓ and in its Urheimat, and ε_ℓ is a language-specific error term.

Moreover, given the binary coding of each language structure, an alternative specification is considered and estimated using a Probit model. As reported in the Appendix, this alternative estimation model generates qualitatively similar results.

3.2 The Empirical Strategy

The empirical analysis of the geographical determinants of language structures advances several strategies to mitigate potential concerns regarding the role of reverse causality, omitted variables, and sorting in the observed association between: (i) variations in geographical characteristics that were conducive to higher natural return to agricultural investment and the existing cross-language variations in the structure of the future tense, (ii) agricultural determinants of gender gap in agricultural productivity and the existence of sex-based grammatical gender, and (iii) the ecological origins of hierarchical societies and the emergence of politeness distinctions.

First, the observed associations between the hypothesized geographical determinants of linguistic traits and observed language structures may reflect reverse causality from language structures, and their associated cultural traits, to these geographical attributes. In particular, the conceivable effect of periphrastic future tense, and the associated long-term orientation, on the choice of agricultural technologies, may affect crop returns. Moreover, sex-based grammatical gender, and the associated gender bias, may have conceivably affected the adoption of the plow. Hence, in order to overcome these potential concerns about reverse causality, the empirical analysis exploits variations in potential crop return (associated with agro-climatic conditions that are orthogonal to human intervention), rather than the, potentially endogenous, actual crop return. Furthermore, the analysis is based upon the potential use of the plow (as captured by potential agro-climatic yield of crops suitable for the usage

of the plow), rather than the actual usage.

Second, the associations between geographical and linguistic traits may be governed by omitted institutional, cultural, geographical and human characteristics. Thus, in order to mitigate these concerns, the empirical analysis mirrors the epidemiological approach to cultural diffusion and identifies the geographical origins of linguistic traits based on variation across languages located outside the ancestral homeland of their proto-language, accounting for the host region fixed-effects and thus capturing unobserved time-invariant heterogeneity at the regional level. Moreover, the analysis accounts for the potentially confounding effects of a wide range of geographical factors, in the homeland of each language, as well as in the homeland of the proto-language from which the language descended, factors which may have affected the evolution of the structure of the future tense, sex-based grammatical gender, and politeness distinctions (e.g., absolute latitude, average elevation, terrain ruggedness, coast length, as well as climatic conditions captured by the average, standard deviation, volatility, and spatial correlation of temperature and precipitation). Furthermore, the empirical analysis accounts for spatial auto-correlation and explores whether selection on unobservables is significant.[22]

Third, the observed associations between geographical and linguistic traits may reflect the sorting of individuals into geographical niches that complement their linguistic and cultural traits. While sorting would not affect the nature of the association between these geographical and linguistic characteristics (i.e., variations in geographical characteristics across the globe would still be the origin of cross-language variation in linguistic traits), it would weaken the cultural interpretation of the underlying mechanism. Hence, to alleviate concerns about the potential sorting of individuals who use periphrastic future tense into regions with high crop return, the analysis explores whether potential crop return in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence periphrastic future tense. Moreover, to mitigate concerns about the potential sorting of individuals who use sex-based grammatical gender into regions suitable for the usage of the plow, the analysis explores whether the suitability of land for the usage of the plow in the proto-language's homeland, rather than in the current geographical location of daughter languages, is associated with sex-based grammatical gender.[23]

Fourth, the hypothesized associations between geographical and linguistic traits may reflect a broader association between each of these geographical factors and a wide range of linguistic traits, rather than a unique association between each of these geographical characteristics and its hypothesized corresponding linguistic trait, weakening the proposed hypothesis. Hence, in order to overcome this potential concern, the empirical analysis explores whether alternative language structures (as reported by WALS), such as the existence of other temporal structures (e.g., the past tense and the perfect tense), as well as non-temporal structures (e.g., possessive, evidentiality, and the number of consonants and colors), are associated with each of the proposed geographical roots.

Fifth, the proposed hypothesis suggests that the evolution of linguistic traits is a by-product

[22]It should be noted that since the available data for a large fraction of linguistic families consists of only a few languages, a meaningful analysis based on variations in language structures within a linguistic family is precluded.

[23]In light of the evidence about the greater adaptability of politeness distinctions to environmental and political changes (Wichmann and Holman, 2009; Greenhill et al., 2010; Dediu and Levinson, 2012; Dediu and Cysouw, 2013; Greenhill et al., 2017), this strategy cannot be exploited to mitigate concerns on the role of sorting in the observed association between ecological diversity and politeness distinctions.

of the coevolution of cultural and linguistic traits in the course of human history, as governed by deeply rooted, culturally-embodied, common geographical roots. Hence, the proposed hypothesis rests upon the importance of the culturally-embodied effect of geographical characteristics. In order to explore the culturally-embodied effect, the empirical analysis examines whether the geographical characteristics in the proto-language's homeland, rather than the current geographical location of daughter languages, are the significant factors that govern the evolution of periphrastic future tense and sex-based grammatical gender. In particular, it analyzes whether the potential crop return in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence of periphrastic future tense, and suitability of land for the usage of the plow in the proto-language's homeland, rather than in the current geographical location of daughter languages, is associated with sex-based grammatical gender. Thus, it explores whether the culturally-embodied geographical determinants in the Urheimat, rather than the direct effect of geography (as would have reflected by the significance of the geographical characteristics in linguistic homeland of daughter languages), governed the evolution of linguistic traits.

4 Geographical Origins of Periphrastic Future Tense

The hypothesized coevolution of long-term orientation and the structure of the future tense suggests that in societies characterized by higher long-term orientation in the distant past, periphrastic future tense, and its associated future orientation, have emerged and persisted over time, reinforcing existing long-term oriented behavior. Thus, in view of the established positive effect of the natural return to agricultural investment, as captured by caloric crop return, on long-term orientation (Galor and Özak, 2016), crop return is hypothesized to affect the existence of periphrastic future tense.

This section analyzes the relation between the existence of periphrastic future tense across contemporary languages and the historical potential crop return of their geographical homelands (i.e., the indigenous regions that spoke the language in the pre-colonial as well as in the post-colonial era). In particular, Table 1 explores the effect of pre-1500CE crop return on the existence of periphrastic future tense.[24] As established in column (1), the unconditional correlation between pre-1500CE crop return in the language's homeland and the existence of periphrastic future tense is positive and statistically significant at the 5% level, suggesting that a one standard deviation increase in crop return in the language's homeland is associated with a 6 percentage points increase in the probability that the language is characterized by a periphrastic future tense. Furthermore, as established in column (2) the estimated relationship remains stable once the potentially confounding effects of the geographical characteristics (i.e., absolute latitude, mean elevation, terrain ruggedness, and the length of its sea coast) in the homeland of each language, are accounted for.

Moreover, since crop return is estimated based on agro-climatic conditions, its effect might be capturing the potentially direct impact of climatic conditions on the existence of periphrastic future. In particular, variability of climatic conditions may affect the riskiness of agricultural investment, and therefore the effective crop return, while their spatial correlation may affect the potential for

[24]Table A.1 explicitly shows all estimated coefficients in Table 1 .

spatial diversification of risk. Nevertheless, as established in columns (3) and (4), accounting for the potentially confounding effects of average temperature and precipitation, as well as their standard deviations, volatility, and spatial correlation, does not alter the qualitative results.

Table 1: Geographical Origins of the Future Tense (OLS)

	Existence of Future Tense					
	(1)	(2)	(3)	(4)	(5)	(6)
Crop Return (pre-1500CE)	0.06**	0.06**	0.07**	0.07**	0.09***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Precipitation Controls	No	No	Yes	Yes	Yes	Yes
Temperature Controls	No	No	No	Yes	Yes	Yes
Unproductive Period	No	No	No	No	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.02	0.02	0.06	0.07	0.11
Observations	275	275	275	275	275	275

Notes: This table establishes the positive, statistically, and economically significant effect of a region pre-1500CE potential crop return on the existence of periphrastic future tense in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Furthermore, the length of the period within each year in which the land is not suitable for agriculture – the unproductive period – may have conceivably triggered planning (e.g., storage and intertemporal trade) and may have therefore reinforced long-term orientation and the existence of periphrastic future tense. Nevertheless, as indicated by column (5), accounting for the length of the unproductive period, reinforces the findings and the coefficient on crop return increases and becomes highly statistically significant.[25] Finally, as reported in column (6), accounting for regional fixed-effects, and therefore for unobserved time-invariant heterogeneity at the regional level, reinforces the magnitude and the statistical significance of the association between pre-1500CE crop return and the existence of periphrastic future tense. In particular, a one standard deviation increase in pre-1500CE crop return in the language's homeland is associated with an 11 percentage points increase in the probability that the language is characterized by a periphrastic future tense.

4.1 Robustness

The findings in Table 1 lend credence to the hypothesis that the natural return to agricultural investment in the language's homeland, and its effect on time preference and long-term oriented behavior, contributed to the emergence of periphrastic future tense. Nevertheless, the results conceivably might

[25]Interestingly, as shown in the Appendix, the length of the unproductive period, as well, is significantly associated with the probability of existence of the periphrastic future tense. However, unlike the crop return, the relation between the unproductive period and the existence of periphrastic future tense is not robust to the other specifications and its semi-partial R^2 is smaller than the one of crop return.

be biased due to omitted institutional, cultural, and human characteristics, precluding a causal interpretation of the estimated coefficients. While concerns about omitted variable will be directly addressed and mitigated in the next subsection, the remaining analysis in this section establishes the robustness of the results to: (i) an alternative estimation method, (ii) spatial autocorrelation, and (iii) clustering of standard errors, while demonstrating that the findings are unlikely to be driven by selection on unobservables.

4.1.1 Estimation Method, Spatial-Autocorrelation and Selection on Unobservables

Table A.2 (Panel A) establishes that the estimated average marginal effects of the Probit model are nearly identical to the estimated effects using OLS. Furthermore, Table A.2 (Panel B) establishes the robustness of the results to the clustering of the standard errors at the level of the language genus (i.e., a group of phylogenetically related languages inside a linguistic family), as well as spatial autocorrelation. In particular, the statistical significance is unaffected by the various methods used to mitigate the potential violation of the independence assumption.

Table A.2 (Panel B) further explores the potential bias that could be generated by omitted variables. In particular, using statistics on selection on observables and unobservables (Altonji et al., 2005; Nunn and Wantchekon, 2011; Oster, 2014), it establishes that the degree of omitted variable bias is low and is unlikely to explain the magnitude of the estimated effect of crop return on the existence of periphrastic future tense. In particular, omitted factors would need to be 2-3 times more strongly and negatively correlated with crop return, in order to account for the estimated effect of crop return on the emergence of periphrastic future tense. Thus, the estimated coefficients could be considered as the lower bound of the true effect. The bias-adjusted estimated effect of pre-1500CE crop return is strictly positive and larger than the OLS estimate. In particular, as reported in column (6), following Oster (2014), the bias-corrected effect of crop return, assuming that the unobservables are as strongly correlated with pre-1500CE crop return as the set of observables that are accounted for, implies that a one standard deviation increase in crop return in the language's homeland is associated with a 13 percentage points increase in the probability of the existence of periphrastic future tense in the language.[26]

4.1.2 Crop Return and Other Language Structures

The associations between the return to agricultural investment in the language's homeland, as captured by pre-1500CE crop return, and the existence of periphrastic future tense may reflect a broader association between crop return and a wide range of linguistic traits, rather than its unique association with periphrastic future tense, weakening the proposed hypothesis. Moreover, the association between crop return in the language's homeland and the existence of periphrastic future tense in the language may reflect a broader association between a whole range of linguistic traits and long-term orientation.

[26] If the unobservables were assumed to explain all the remaining variation in the probability of existence of periphrastic future tense, then the estimated bias-adjusted effect of crop return would be even larger, implying that a one standard deviation increase in crop return in the language's homeland would be associated with 40 percentage points increase in the probability of existence of periphrastic future tense in the language.

Table A.3 establishes, however, that alternative language structures (as reported by WALS), such as the existence of other temporal and non-temporal structures, are largely uncorrelated with the natural return to agricultural investment, suggesting that it is indeed uniquely associated with the structure of the future tense.[27] In particular pre-1500 crop return is not significantly associated with the existence of either the past or the perfect tense, and it is orthogonal to non-temporal linguistic characteristics such as: (i) the existence of possessive classifications, (ii) the existence of coding for evidentiality, (iii) the number of consonants, and (iv) the number of colors.[28]

4.2 Geographical Origins: Ancestral vs. Contemporary Homelands

This subsection exploits the descent of contemporary languages from proto-languages to explore the relative contributions of the return to agricultural investment in a language's contemporary homeland vs. its ancestral homeland (Urheimat) to the existence of a periphrastic future tense in daughter languages.

This analysis is designed to mitigate concerns about (i) the role of omitted variables in the established associations between the return to agricultural investment and the existence of periphrastic future tense, (ii) sorting of individuals into geographical niches that complement their linguistic and cultural traits, (iii) the historical depth of the observed relationship between the return to agricultural investment and the existence of periphrastic future tense, and (iv) the role of the culturally-embodied geographical determinant in the Urheimat, rather than the direct effect of geography, in the evolution of periphrastic future tense.

The established associations between the return to agricultural investment and the existence of periphrastic future tense may be governed by omitted institutional, cultural, geographical and human characteristics. In order to further mitigate concerns about the importance of omitted characteristics, the analysis mirrors the epidemiological approach to cultural diffusion, and explores the geographical origins of the existence of periphrastic future tense based on variation across languages located outside the ancestral homeland of their proto-language. This approach permits the analysis to account for host region fixed-effects and thus to capture unobserved time-invariant heterogeneity at the regional level.

Moreover, the observed associations between geographical and linguistic traits may reflect the sorting of individuals into geographical niches that complement their linguistic and cultural traits. While sorting would not affect the nature of the association between these geographical and linguistic characteristics (i.e., variations in geographical characteristics across the globe would still be the origin of cross-language variation in linguistic traits), it would weaken the cultural interpretation of the underlying mechanism. Alleviating concerns about the potential sorting of individuals who use periphrastic future tense into regions with high crop return, the analysis explores whether potential crop return in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence periphrastic future tense. In addition, the analysis explores the historical

[27] This result reinforces earlier findings by Galor and Özak (2016) that pre-1500CE crop return only affects time preference and does not have a significant association with the other cultural traits.

[28] While the association between crop return and the existence of possessive classification is marginally significant in the OLS regressions, it is insignificant if Probit is used.

depth of the observed relationship between the return to agricultural investment and the existence of periphrastic future tense.

Finally, the proposed hypothesis suggests that the evolution of linguistic traits is a by product of the coevolution of cultural and linguistic traits in the course of human history, as governed by deeply rooted, culturally-embodied, common geographical roots. In order to examine this hypothesis, the empirical analysis explores whether potential crop return in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence of periphrastic future tense. Thus, the culturally-embodied geographical determinants in the Urheimat, rather than the direct effect of geography (as would have been reflected by the significance of the geographical characteristics in linguistic homeland of daughter languages), governed the evolution of linguistic traits.

Table 2: Persistent Effect of Homeland vs. Urheimat Characteristics on Periphrastic Future Tense: Languages Outside Urheimat

	Existence of Periphrastic Future Tense			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Crop Return (pre-1500CE)	0.01	0.03		-0.03
	(0.05)	(0.04)		(0.06)
Urheimat Crop Return (pre-1500CE)			0.39***	0.41***
			(0.05)	(0.07)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	-0.01	0.12	0.17	0.21
Observations	163	163	163	163
Language Families	19	19	19	19

Notes: This table explores the relative contributions of pre-1500CE crop return in the homeland vs. the Urheimat to the presence of periphrastic future tense in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests; All regressions include a constant.

Table 2 explores the relative contributions of pre-1500CE crop return in the homeland vs. the Urheimat to the presence of periphrastic future tense in daughter languages.[29] In particular, it establishes that the existence of periphrastic future tense among daughter languages located outside the Urheimat of their proto-language is significantly positively associated with crop return in the Urheimat. In particular, columns (1) and (2) establish that the crop return in the homeland of a language has no significant association with the existence of periphrastic future tense among migrant languages, while column (3) establishes a statistically and economically significant positive effect of the Urheimat's crop return on the existence of periphrastic future tense of daughter languages located outside of the Urheimat. Accounting for regional fixed effects and other geographical characteristics of the Urheimat, a one standard deviation increase in the crop return in the Urheimat is associated

[29]Given the lack of data on the location of a Urheimat for the Khosian family, the analysis in this section excludes this family.

with a 39 percentage points increase in the probability that a migrant daughter language would have a periphrastic future tense. Moreover, as established in column (4) the effect of the crop return in the Urheimat remains highly significant if crop return in the homeland of the language as well as other geographical characteristics of the homeland or Urheimat are accounted for. Thus the results suggest that omitted variables and sorting do not play a significant role in the observed association between crop return and the existence of periphrastic future tense. Moreover, they suggest that periphrastic future tense began its formation in the distant past when the speakers of the proto-language still inhabited the Urheimat of the language, reflecting the portable culturally embodied effect of crop return rather than the direct effect of geography.

The results support the proposed hypothesis that the return to agricultural investment affected the existence of periphrastic future tense. In particular, they suggest that the results are not driven by neither omitted factors nor geographical sorting, and it provides support for the deep-historical origins of the structure of the future

4.3 Mechanism

This section presents additional supportive evidence for the hypothesized geographical origins of the structure of the future tense. In view of the evidence about the effect of crop return on long-term orientation (Galor and Özak, 2016), the positive effect of crop return on the emergence of periphrastic future tense would necessitate the use of agriculture as the main source of subsistence. In particular, as illustrated in Figure 6, the proposed hypothesis would imply that: (i) higher crop return ought to be associated with a greater intensity of agriculture, and (ii) greater intensity of agriculture ought to be associated with the existence of periphrastic future tense.

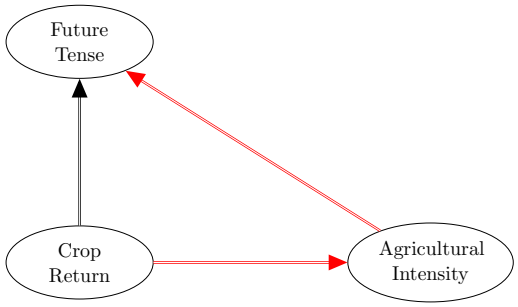

Figure 6: Crop Return, Agricultural Intensity & Future Tense

Table 3 presents supporting evidence for the proposed mechanism. In particular, it establishes the robust positive association between crop return and the level of agricultural intensity in a pre-colonial society, which in turn is positively associated with the emergence of the periphrastic future tense. Using data from the Ethnographic Atlas (Murdock and White, 1969) on the importance of patterns of subsistence – hunting, gathering, fishing, animal husbandry and crop cultivation – the analysis explores the effect of crop return on agricultural intensity (i.e., the level of dependence on agriculture) across ethnic groups, reflecting the effective crop return in the ethnic homeland. As established in Columns (1) and (2) in Table 3 societies inhabiting regions with higher crop return have higher levels

of agricultural intensity. In particular, a one-standard deviation increase in crop return is associated with a 0.24 standard deviations increase in agricultural intensity.[30] Moreover, columns (3) and (4) establish the positive association between the level of agricultural intensity in an ethnic group and the probability of existence of periphrastic future tense in the language it speaks. The results suggest that a one standard deviation increase in agricultural intensity is associated with an 8 percentage points increase in the probability of the existence of periphrastic future tense.

Table 3: Geographic Origins of Agricultural Intensity and Periphrastic Future Tense

	Mechanism			
	Agricultural Intensity		Future Tense	
	(1)	(2)	(3)	(4)
Crop Return (pre-1500CE)	0.21***	0.24***		
	(0.03)	(0.03)		
Agricultural Intensity			0.07**	0.08*
			(0.03)	(0.04)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.04	0.64	0.02	0.17
Observations	1303	1303	263	263

Notes: This table establishes, based on OLS regression, the positive statistically and economically significant effect of pre-1500 crop return on the existence of a periphrastic future tense in a language. The first two columns provide the results of the effect of crop return on agricultural intensity, and columns (3) and (4) provide evidence on the effect of agricultural intensity on the emergence of periphrastic future tense. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

4.4 Time Preference and Periphrastic Future Tense

This section explores the association between the level of long-term orientation of the community that speaks a certain language and the existence of periphrastic future tense in the language. In light of the proposed hypothesis that the periphrastic future tense is complementary to long-term oriented behavior, the prevalence of long-term orientation within a given society ought to be associated with the presence of periphrastic future tense in the language used among members of this society. Indeed, the common geographical origins (i.e., the natural return to agriculture investment) of long-term orientation as well as periphrastic future tense suggest that this positive association is likely to be observed across speech communities.

Table 4 explores the association between the prevalence of long-term orientation within a given society and the presence of periphrastic future tense in the language used among members of this society.[31] It establishes the positive significant association between the existence of the periphrastic

[30] Table A.4 establishes the robustness of this result, by constraining the analysis to the set of societies that speak languages for which data on the existence of periphrastic future tense is available.

[31] The measure of Long-Term Orientation is based on the following question in the World Values Survey (WVS): "Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially

Table 4: Long-Term Orientation and Periphrastic Future Tense

	Long-Term Orientation			
	All		Old World	
	(1)	(2)	(3)	(4)
Periphrastic Future Tense	0.12**	0.15***	0.15***	0.17***
	(0.05)	(0.04)	(0.04)	(0.05)
Crop Return (pre-1500CE)		0.29*		0.26
		(0.16)		(0.18)
Regional FE	Yes	Yes	Yes	Yes
Main Geographical Controls	No	Yes	No	Yes
Adjusted-R^2	0.16	0.24	0.18	0.26
Observations	106	106	100	100

Notes: This table establishes the statistically and economically significant positive association between periphrastic future tense and long-term orientation . The results account for the geographical origin of the periphrastic future tense and other geographical characteristics of the homeland of the language. Heteroskedasticity robust standard error estimates clustered at the language family are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

future tense and long-term orientation. This positive association is present among speakers of languages in the world as a whole (Columns (1) and (2)), as well as among speakers who reside in the Old World and speak languages originated in the Old World (Columns (3) and (4)). Moreover, as established in Columns (2) and (4), this association is highly significant and stable in magnitude if one accounts for the geographical origins (i.e., the natural return to agricultural investment) of these two traits. These findings lend credence to the proposed hypothesis that the prevalence of the trait of long-term orientation and the presence of periphrastic future tense have coevolved in the course of human history.

5 The Origins of Sex-Based Grammatical Gender Systems

The hypothesized coevolution of gender biases and sex-based grammatical gender suggests that in societies characterized by distinct gender roles and consequently by the existence of gender biases in the distant past, sex-based grammatical gender has emerged and persisted over time, reinforcing existing gender biases in society. Thus, in view of the established positive association between the suitability of land for the usage of the plow and the emergence of distinct gender roles in society (Pryor, 1985; Alesina et al., 2013), the suitability of the land for the usage of the plow is hypothesized to affect the emergence and the prevalence of sex-based grammatical gender in the course of human history.

This section analyzes the relation between the existence of sex-based grammatical gender across

important?" Individuals are considered to have Long-Term Orientation if they answered "Thrift, saving money and things".

contemporary languages and the potential suitability of the land for the usage of the plow in their geographical homelands (i.e., the indigenous regions that spoke the language in the pre-colonial as well as in the post-colonial era). Table 5 explores the association between the potential suitability of the land for the usage of the plow and the existence of sex-based grammatical gender.[32] As established in column (1), the association between the potential caloric yield of plow negative crops in the pre-1500CE period in the language's homeland (conditional on average caloric suitability that captures the likelihood of being an agricultural based society), and the existence of sex-based grammatical gender is negative and statistically significant at the 5% level, suggesting that a one standard deviation increase in the potential caloric yield of plow negative crops in the language's homeland is associated with a 13 percentage points decrease in the probability that the language is characterized by a sex-based grammatical gender. Furthermore, as established in column (2), the estimated relationship becomes more negative and becomes highly significant once the potentially confounding effects of the geographical characteristics (i.e., absolute latitude, mean elevation, terrain ruggedness, and the length of its sea coast) in the homeland of each language, are accounted for.

Table 5: Geographic Origins of Sex-Based Grammatical Gender (OLS)

	Existence of Sex-Based Grammatical Gender					
	(1)	(2)	(3)	(4)	(5)	(6)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.13**	-0.19***	-0.25***	-0.26***	-0.29***	-0.23***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
Average Caloric Yield (All Crops, pre-1500)	0.17***	0.21***	0.28***	0.29***	0.32***	0.25***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Precipitation Controls	No	No	Yes	Yes	Yes	Yes
Temperature Controls	No	No	No	Yes	Yes	Yes
Unproductive Period	No	No	No	No	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.03	0.06	0.14	0.15	0.15	0.21
Observations	217	217	217	217	217	217

Notes: This table establishes the negative, statistically, and economically significant effect of a pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a sex-based grammatical gender in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Moreover, since potential caloric yield of plow negative crops in the pre-1500CE period is estimated based on agro-climatic conditions, it might be capturing the potentially direct impact of climatic conditions on the existence of sex-based grammatical gender. In particular, variability of climatic conditions may affect the riskiness of agricultural investment, and therefore the effective caloric yield of plow negative crops, while their spatial correlation may affect the potential for spatial diversification of risk. Nevertheless, as established in columns (3) and (4), accounting for the potentially confounding

[32]Table B.1 explicitly shows all estimated coefficients in Table 5.

effects of average temperature and precipitation, as well as their standard deviations, volatility, and spatial correlation, does not alter the qualitative results.

Furthermore, the length of the period within each year in which the land is not suitable for agriculture – the unproductive period – may have conceivably affected the profitability of the usage of the plow. Nevertheless, as indicated by column (5), accounting for the length of the unproductive period, reinforces the findings and the coefficient on the caloric yield of plow negative crops becomes even more negative. Finally, as reported in column (6), accounting for regional fixed-effects, and therefore for unobserved time-invariant heterogeneity at the regional level does not alter the qualitative results. In particular, a one standard deviation increase in the pre-1500CE potential caloric yield of plow negative crops in the language's homeland is associated with a 23 percentage points decrease in the probability that the language is characterized by a sex-based grammatical gender.

5.1 Robustness

The findings in Table 5 lend credence to the hypothesis that the potential caloric yield of plow negative crops in the language's homeland, and its effect on gender biases, contributed to the emergence of sex-based grammatical gender. Nevertheless, the results conceivably might be biased due to omitted institutional, cultural, and human characteristics, precluding a causal interpretation of the estimated coefficients. While concerns about omitted variable will be directly addressed and mitigated in the next subsection, the remaining analysis in this section establishes the robustness of the results to: (i) an alternative estimation method, (ii) spatial autocorrelation, and (iii) clustering of standard errors, while demonstrating that the findings are unlikely to be driven by selection on unobservables. Moreover, the robustness to alternative aspects of grammatical gender are also considered.

5.1.1 Estimation Method, Spatial-Autocorrelation and Selection on Unobservables

Table B.2 (Panel A) establishes that the estimated average marginal effects of the Probit model are nearly identical to the estimated effects using OLS. Furthermore, Table B.2 (Panel B) establishes the robustness of the results to the clustering of the standard errors at the level of the language genus (i.e., a group of phylogenetically related languages inside a linguistic family), as well as spatial autocorrelation. In particular, the statistical significance is unaffected by the various methods used to mitigate the potential violation of the independence assumption.

Table B.2 (Panel B) further explores the potential bias that could be generated by omitted variables. In particular, using statistics on selection on observables and unobservables (Altonji et al., 2005; Nunn and Wantchekon, 2011; Oster, 2014), it establishes that the degree of omitted variable bias is low and is unlikely to explain the magnitude of the estimated effect of crop return on the existence of periphrastic future tense. In particular, omitted factors would need to be 1.3-2.3 times more strongly and negatively correlated with the caloric yield of plow negative crops, in order to account for the estimated effect of the caloric yield of plow negative crops on the emergence of sex-based grammatical gender. Thus, the estimated coefficients could be considered as the lower bound of the true effect. The bias-adjusted estimated effect of pre-1500CE caloric yield of plow negative crops is more negative than

the OLS estimate. In particular, as reported in column (6), following Oster (2014), the bias-corrected effect of caloric yield of plow negative crops, assuming that the unobservables are as strongly correlated with pre-1500CE caloric yield of plow negative crops as the set of observables that are accounted for, implies that a one standard deviation increase in caloric yield of plow negative crops in the language's homeland is associated with a 27 percentage points decrease in the probability of the existence of sex-based grammatical gender in the language.

5.1.2 Alternative Aspects of Grammatical Gender

Tables B.4, B.8 and B.13 establish qualitatively similar associations between the geographical determinants of plow-based agriculture and (i) an alternative measure of sex-based grammatical gender, (ii) the intensity of grammatical gender in a language, and (iii) the existence of gender distinctions in personal pronouns, respectively. These results suggest that various aspects of grammatical gender that have reinforced gender biases, were associated with the geographical determinants of plow-based agriculture. Moreover, Tables B.2, B.5, B.9 and B.14 establish the robustness of these alternative associations to: (i) an alternative estimation method, (ii) spatial autocorrelation, and (iii) clustering of standard errors, while demonstrating that the findings are unlikely to be driven by selection on unobservables.

5.1.3 Plow Negative Crops and Other Language Structures

The associations between the potential suitability of land for the usage of the plow and the existence of sex-based grammatical gender may reflect a broader association between plow-based agriculture and a wide range of linguistic traits, rather than its unique association with sex-based grammatical gender, weakening the proposed hypothesis. Moreover, the association between the suitability of land for the usage of the plow in the language's homeland and the existence of sex-based grammatical gender in the language may reflect a broader association between a whole range of linguistic traits and gender biases.

Table B.3 establishes, however, that alternative language structures (as reported by WALS), such as the existence of other temporal and non-temporal structures, are largely uncorrelated with the geographical determinants of plow-based agriculture. In particular the potential suitability of land for the usage of the plow is not significantly associated with the existence of the perfect tense, and it is orthogonal to non-temporal linguistic characteristics such as: (i) the existence of possessive classifications, (ii) the existence of coding for evidentiality, (iii) the number of consonants, and (iv) the number of colors.

5.2 Geographical Origins: Ancestral vs. Contemporary Homelands

This subsection exploits the descent of contemporary languages from proto-languages to explore the relative contributions of the potential suitability of land for the usage of the plow in a language's contemporary homeland vs. its ancestral homeland (Urheimat) to the existence of a sex-based grammatical gender in daughter languages.

This analysis is designed to mitigate concerns about (i) the role of omitted variables in the established associations between the potential suitability of land for the usage of the plow and the existence of sex-based grammatical gender, (ii) sorting of individuals into geographical niches that complement their linguistic and cultural traits, (iii) the historical depth of the observed relationship between the plow-based agriculture and the existence of sex-based grammatical gender, and (iv) the role of the culturally-embodied geographical determinant in the Urheimat, rather than the direct effect of geography, in the evolution of sex-based grammatical gender.

The established associations between the potential suitability of land for the usage of the plow and the existence of sex-based grammatical gender may be governed by omitted institutional, cultural, geographical and human characteristics. In order to further mitigate concerns about the importance of omitted characteristics, the analysis mirrors the epidemiological approach to cultural diffusion, and explores the geographical origins of the existence of periphrastic future tense based on variation across languages located outside the ancestral homeland of their proto-language. This approach permits the analysis to account for host region fixed-effects and thus to capture unobserved time-invariant heterogeneity at the regional level.

Moreover, the observed associations between geographical and linguistic traits may reflect the sorting of individuals into geographical niches that complement their linguistic and cultural traits. While sorting would not affect the nature of the association between these geographical and linguistic characteristics (i.e., variations in geographical characteristics across the globe would still be the origin of cross-language variation in linguistic traits), it would weaken the cultural interpretation of the underlying mechanism. Alleviating concerns about the potential sorting of individuals who use sex-based grammatical gender into regions that are suitable for the usage of the plow, the analysis explores whether the potential suitability of land for the usage of the plow in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence sex-based grammatical gender. In addition, the analysis explores the historical depth of the observed relationship between plow-based agriculture and the existence of sex-based grammatical gender.

Finally, the proposed hypothesis suggests that the evolution of linguistic traits is a by product of the coevolution of cultural and linguistic traits in the course of human history, as governed by deeply rooted, culturally-embodied, common geographical roots. In order to examine this hypothesis, the empirical analysis explores whether the potential suitability of land for the usage of the plow in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence of sex-based grammatical gender. Thus, it examines whether the culturally-embodied geographical determinants in the Urheimat, rather than the direct effect of geography (as would have been reflected by the significance of the geographical characteristics in linguistic homeland of daughter languages), governed the evolution of sex-based grammatical gender.

Table 6 explores the relative contributions of the pre-1500CE potential suitability of land for the usage of the plow in the contemporary language's homeland vs. the Urheimat to the presence of sex-based grammatical gender in daughter languages.[33] In particular, it establishes that the existence

[33]Given the lack of data on the location of a Urheimat for the Khosian family, the analysis in this section excludes this family.

Table 6: Persistent Effect of Homeland vs. Urheimat Characteristics on Gender: Languages Outside Urheimat

	Existence of Sex-Based Gender System			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.09	-0.19		0.06
	(0.12)	(0.13)		(0.07)
Homeland Average Caloric Yield (All Crops, pre-1500)	0.05	0.12		-0.02
	(0.11)	(0.10)		(0.06)
Urheimat Plow Negative Crops (Average Caloric Yield, pre-1500)			-0.23***	-0.14*
			(0.06)	(0.07)
Urheimat Average Caloric Yield (All Crops, pre-1500)			1.09***	1.00***
			(0.15)	(0.14)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	-0.01	0.21	0.70	0.72
Observations	101	101	101	101
Language Families	20	20	20	20

Notes: This table explores the relative contributions of agricultural productivity in the homeland vs. the Urheimat to the presence of sex-based grammatical gender in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

of sex-based grammatical gender among daughter languages located outside the Urheimat of their proto-language is significantly negatively associated with the caloric yield of plow negative crops in the Urheimat. In particular, columns (1) and (2) establish that the potential suitability of land for the usage of the plow in the homeland of a language has no significant association with the existence of sex-based grammatical gender among migrant languages, while column (3) establishes a statistically and economically significant negative association between the caloric yield of plow negative crops in the Urheimat and the existence of sex-based grammatical gender in daughter languages located outside of the Urheimat. Accounting for regional fixed effects and other geographical characteristics of the Urheimat, a one standard deviation increase in the potential pre-1500CE caloric yield of plow negative crops in the Urheimat is associated with a 23 percentage points decrease in the probability that a migrant daughter language would have a sex-based grammatical gender. Moreover, as established in column (4) the effect of the potential suitability of land for the usage of the plow in the Urheimat remains significant if the potential usage of the plow in the homeland of the language as well as other geographical characteristics of the homeland or Urheimat are accounted for.[34] Thus the results suggest that omitted variables and sorting do not play a significant role in the observed association between the potential suitability of land for the usage of the plow and the sex-based grammatical gender. Moreover, they suggest that sex-based grammatical gender began its formation in the distant past when the speakers of the proto-language still inhabited the Urheimat of the language, reflecting the portable, culturally-embodied, effect of the potential suitability of land for the usage of the plow

[34]The decrease in statistical significance seems to be due to the potential collinearity among the geographical characteristics of the homeland and the Urheimat.

rather than the direct effect of geography.[35]

The results support the proposed hypothesis that the potential suitability of land for the usage of the plow is associated with the existence of sex-based grammatical gender. In particular, they suggest that the results are not driven by neither omitted factors nor geographical sorting, and it provides support for the deep-historical origins of the structure of sex-based grammatical gender.

5.3 Mechanism

This section presents additional supportive evidence for the hypothesized geographical origins of the sex-based grammatical gender. In view of the evidence about the effect of plow usage on gender biases (Pryor, 1985; Alesina et al., 2013), the effect of the geographical determinants of plow-based agriculture on the emergence of sex-based grammatical gender would necessitate the adoption and use of the plow. In particular, as illustrated in Figure 7, the proposed hypothesis would imply that: (i) the geographical determinants of plow-based agriculture ought to be associated with the adoption and use of the plow, and (ii) the use of the plow ought to be associated with the existence of sex-based grammatical gender.

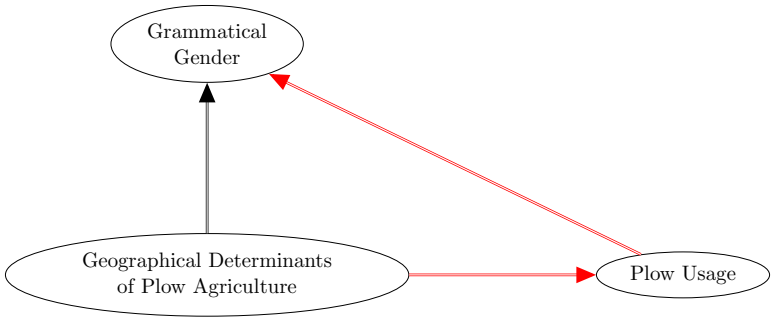

Figure 7: Geographical Determinants of Plow-based Agriculture, Plow Usage & Grammatical Gender

Table 7 presents supporting evidence for the proposed mechanism. In particular, it establishes a significant association between the geographical determinants of plow-based agriculture and the usage of the plow in pre-colonial societies, which in turn is positively associated with the emergence of sex-based grammatical gender. Using data from the Ethnographic Atlas (Murdock and White, 1969) on the presence and use of aboriginal plow, the analysis explores the effect of the geographical determinants of plow-based agriculture on a pre-colonial society's plow usage. In particular, columns (1) and (2) establish that societies the resided in regions that were less suitable for the use of the plow are less likely to use an aboriginal plow. A one-standard deviation increase in pre-1500CE caloric suitability of plow negative crops is associated with a 6 percentage points decrease in the probability of the usage of the plow. Moreover, columns (3) and (4) establish the positive association between the usage of the plow in a pre-colonial society and the probability of the existence of sex-based grammatical gender in the language it speaks. The results suggest that a one standard deviation increase in the usage of the plow is associated with a 23 percentage points increase in the probability of the existence of sex-based grammatical gender.

[35]Tables B.7, B.11 and B.16 examine the robustness of this analysis to alternative aspects of grammatical gender.

Table 7: Geographic Origins of Plow Usage and Sex-Based Grammatical Gender

	Mechanism			
	Plow Usage		Grammatical Gender	
	(1)	(2)	(3)	(4)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.26***	-0.06**		
	(0.02)	(0.02)		
Average Caloric Yield (All Crops, pre-1500)	0.26***	0.09***		
	(0.02)	(0.02)		
Plow Usage			0.38***	0.23**
			(0.08)	(0.11)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.19	0.47	0.14	0.31
Observations	1175	1175	145	145

Notes: This table establishes, based on OLS regression, the positive statistically and economically significant effect of the geographical determinants of plow usage on the existence of sex-based grammatical gender in a language. The first two columns provide the effect of the geographical determinants of plow suitability on actual usage of the plow, and columns (3) and (4) provide evidence on the effect of actual usage of the plow on the emergence of sex-based grammatical gender. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

5.4 Gender Bias and Sex-Based Grammatical Gender

This section explores the association between the existence of a gender bias in a given community and the existence of sex-based grammatical gender in the language the members of the community speak. In light of the proposed hypothesis that sex-based grammatical gender is complementary to gender biased behavior, the prevalence of gender biases within a given society is likely to be associated with the presence of sex-based grammatical gender in the language used among members of this society. Indeed, the common geographical origins (i.e., the geographical determinants of plow-based agriculture) of gender bias as well as sex-based grammatical gender suggest that this positive association is likely to be observed across various speech communities.

Table 8 explores the association between the prevalence of gender biases within a given society and the presence of sex-based grammatical gender in the language used among members of this society.[36] It establishes a positive association between the existence of sex-based grammatical gender and gender biases.[37] This positive association is present among speakers of languages in the world as a whole (Columns (1) and (2)), as well as among speakers who reside in the Old World and speak languages originated in the Old World (Columns (3) and (4)). These findings lend credence to the proposed hypothesis that the prevalence of gender biases and the presence of sex-based grammatical gender have coevolved in the course of human history.

[36]The measure of gender bias is based on the first principal component to the answer of the following questions in the World Values Survey (WVS): (i) "When jobs are scarce men should have more right to a job than women", (ii) "Men make better political leaders than women do", (iii) "Women should have the same rights as men", (iv) "A job is the best way for women to be independent", (v) "It is a problem if women have more income than husband", and (vi) "Men make better political leaders than women do".

[37]The sample of languages in the WVS for which grammatical gender data exists is small and has little regional variation. This impedes the use of regional fixed effects in the analysis and reduces the significance of the estimates.

Table 8: Gender Bias and Sex-based Grammatical Gender

	Gender Bias			
	All		Old World	
	(1)	(2)	(3)	(4)
Existence of Sex-Based Grammatical Gender	0.27	0.42**	0.18	0.18*
	(0.23)	(0.16)	(0.23)	(0.09)
Plow Negative Crops (Average Caloric Yield, pre-1500)		0.16		-0.25
		(0.43)		(0.29)
Average Caloric Yield (All Crops, pre-1500)		-0.35		0.19
		(0.49)		(0.34)
Main Geographical Controls	No	Yes	No	Yes
Adjusted-R^2	0.04	0.33	-0.00	0.38
Observations	33	33	30	30

Notes: This table establishes the statistically and economically significant association between the existence of sex-based grammatical gender and gender bias in society. The analysis accounts for the geographical origins of sex-based grammatical gender and other geographical characteristics of the homeland of the language. Heteroskedasticity robust standard error estimates clustered at the language family are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

6 The Origins of Politeness Distinctions in Pronouns

The hypothesized coevolution of hierarchical orientation (e.g., obedience, conformity and power distance) and politeness distinctions suggests that in societies characterized by higher hierarchical orientation in the distant past, politeness distinctions have emerged and persisted over time, reinforcing the existing hierarchical orientation in society. Thus, in view of the established positive association between the extent of ecological diversity and the emergence of hierarchical societies (Fenske, 2014), ecological diversity is hypothesized to affect the emergence and the prevalence of politeness distinctions in the course of human history.

This section analyzes the relation between the existence of politeness distinctions in pronouns across contemporary languages and the extent of ecological diversity in their geographical homelands (i.e., the indigenous regions that spoke the language in the pre-colonial as well as in the post-colonial era). Table 9 explores the association between the extent of ecological diversity and the existence of politeness distinctions.[38] As established in column (1), the association between the extent of ecological diversity and the existence of politeness distinctions is positive and statistically significant at the 1% level, suggesting that a one standard deviation increase in the extent of ecological diversity in the language's homeland is associated with a 15 percentage points increase in the probability that the language is characterized by the existence of politeness distinctions. Furthermore, as established in column (2), the estimated relationship remains highly significant once the potentially confounding effects of the geographical characteristics (i.e., absolute latitude, mean elevation, terrain ruggedness, and the length of its sea coast) in the homeland of each language, are accounted for. Moreover, since ecological diversity partly captures climatic conditions, it might be capturing the potentially direct

[38]Table C.1 explicitly shows all estimated coefficients in Table 9 .

impact of climatic conditions on the existence of politeness distinctions. Nevertheless, as established in columns (3) and (4), accounting for the potentially confounding effects of average temperature and precipitation, as well as their standard deviations, volatility, and spatial correlation, does not alter the results qualitatively nor quantitatively.

Table 9: Geographic Origins of Politeness Distinctions (OLS)

	Existence of Politeness Distinctions					
	(1)	(2)	(3)	(4)	(5)	(6)
Ecological Diversity	0.15***	0.10***	0.10***	0.10**	0.10**	0.10**
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Precipitation Controls	No	No	Yes	Yes	Yes	Yes
Temperature Controls	No	No	No	Yes	Yes	Yes
Unproductive Period	No	No	No	No	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.09	0.18	0.20	0.20	0.21	0.32
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity and average pre-1500 caloric yield on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Furthermore, the length of the period within each year in which the land is not suitable for agriculture – the unproductive period – may have conceivably affected the profitability of trade and therefore the effect of ecological diversity on the emergence of hierarchical society. Nevertheless, as indicated by column (5), accounting for the length of the unproductive period has little impact on the estimated association. Finally, as reported in column (6), accounting for regional fixed-effects, and therefore for unobserved time-invariant heterogeneity at the regional level does not alter the qualitative results. In particular, a one standard deviation increase in the extent of ecological diversity in the language's homeland is associated with a 10 percentage points increase in the probability that the language is characterized by politeness distinctions.

6.1 Robustness

The findings in Table 9 lend credence to the hypothesis that the extent of ecological diversity and its effect on the emergence of hierarchical societies, contributed to the emergence of politeness distinctions. Nevertheless, the results conceivably might be biased due to omitted institutional, cultural, and human characteristics, precluding a causal interpretation of the estimated coefficients. While concerns about omitted variable will be directly addressed and mitigated in the next subsection, the remaining analysis in this section establishes the robustness of the results to: (i) an alternative estimation method, (ii) spatial autocorrelation, and (iii) clustering of standard errors, while demonstrating that the findings

are unlikely to be driven by selection on unobservables. Moreover, the robustness to alternative aspects of politeness distinctions are also considered.

6.1.1 Estimation Method, Spatial-Autocorrelation and Selection on Unobservables

Table C.2 (Panel A) establishes that the estimated average marginal effects of the Probit model are nearly identical to the estimated effects using OLS. Furthermore, Table C.2 (Panel B) establishes the robustness of the results to the clustering of the standard errors at the level of the language genus (i.e., a group of phylogenetically related languages inside a linguistic family), as well as spatial autocorrelation. In particular, the statistical significance is unaffected by the various methods used to mitigate the potential violation of the independence assumption.

Table C.2 (Panel B) further explores the potential bias that could be generated by omitted variables. In particular, using statistics on selection on observables and unobservables (Altonji et al., 2005; Nunn and Wantchekon, 2011; Oster, 2014), it establishes that the degree of omitted variable bias is low and is unlikely to explain the magnitude of the estimated effect of crop return on the existence of periphrastic future tense. In particular, omitted factors would need to be 3-5 times more strongly correlated with ecological diversity, in order to account for the estimated effect of ecological diversity on the emergence of politeness distinctions. Indeed, the bias-adjusted estimated effect of ecological diversity is only slightly smaller than the value of the OLS estimate. In particular, as reported in column (6), following Oster (2014), the bias-corrected effect of ecological diversity, assuming that the unobservables are as strongly correlated with ecological diversity as the set of observables that are accounted for, implies that a one standard deviation increase in ecological diversity is associated with an 8 percentage points increase the probability of existence of politeness distinctions in pronouns.

6.1.2 Alternative Aspects of Politeness Distinctions

Tables C.4 and C.10 establish qualitatively similar associations between ecological diversity and (i) an alternative measure of politeness distinctions in pronouns, and (ii) the intensity of politeness distinctions in a language, respectively. These results suggest that various aspects of politeness distinctions that have reinforced hierarchical orientation, were associated with ecological diversity. Moreover, Tables C.5 and C.11 establish the robustness of these alternative associations to: (i) an alternative estimation method, (ii) spatial autocorrelation, and (iii) clustering of standard errors, while demonstrating that the findings are unlikely to be driven by selection on unobservables.

6.1.3 Ecological Diversity and Other Language Structures

The associations between the extent of ecological diversity and politeness distinctions may reflect a broader association between ecological diversity and a wide range of linguistic traits, rather than its unique association with politeness distinction, weakening the proposed hypothesis. Moreover, the association between the extent of ecological diversity and politeness distinctions in the language may reflect a broader association between a whole range of linguistic traits and politeness distinctions.

Table C.3 establishes, however, that alternative language structures (as reported by WALS), such as the existence of other temporal and non-temporal structures, are largely uncorrelated with the geographical determinants of hierarchical society. In particular the extent of ecological diversity is not significantly associated with the existence of the past and the perfect tense, and it is orthogonal to non-temporal linguistic characteristics such as: (i) the existence of possessive classifications, (ii) the existence of coding for evidentiality, (iii) the number of consonants, and (iv) the number of colors.

6.2 Geographical Origins: Ancestral vs. Contemporary Homelands

This subsection exploits the descent of contemporary languages from proto-languages to explore the relative contributions of ecological diversity in a language's contemporary homeland vs. its ancestral homeland (Urheimat) to the existence of a politeness distinctions.

This analysis is designed to mitigate concerns about (i) the role of omitted variables in the established associations between the extent of ecological diversity and the existence of politeness distinction, (ii) sorting of individuals into geographical niches that complement their linguistic and cultural traits, (iii) the historical depth of the observed relationship between the extent of ecological diversity and the existence of politeness distinction, and (iv) the role of the culturally-embodied geographical determinant in the Urheimat, rather than the direct effect of geography, in the evolution of politeness distinctions.

The established associations between the extent of ecological diversity and the existence of politeness distinctions may be governed by omitted institutional, cultural, geographical and human characteristics. In order to further mitigate concerns about the importance of omitted characteristics, the analysis mirrors the epidemiological approach to cultural diffusion, and explores the geographical origins of the existence of politeness distinctions based on variation across languages located outside the ancestral homeland of their proto-language. This approach permits the analysis to account for host region fixed-effects and thus to capture unobserved time-invariant heterogeneity at the regional level.

Moreover, the observed associations between geographical and linguistic traits may reflect the sorting of individuals into geographical niches that complement their linguistic and cultural traits. While sorting would not affect the nature of the association between these geographical and linguistic characteristics (i.e., variations in geographical characteristics across the globe would still be the origin of cross-language variation in linguistic traits), it would weaken the cultural interpretation of the underlying mechanism. Alleviating concerns about the potential sorting of individuals who use politeness distinctions into regions that are characterized by hierarchical orientation, the analysis explores whether the ecological diversity in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the presence of politeness distinctions. In addition, the analysis explores the historical depth of the observed relationship between the extent of ecological diversity and the existence of politeness distinctions.

Finally, the proposed hypothesis suggests that the evolution of linguistic traits is a by product of the coevolution of cultural and linguistic traits in the course of human history, as governed by deeply rooted, culturally-embodied, common geographical roots. In order to examine this hypothesis, the

empirical analysis explores whether the extent of ecological diversity in the proto-language's homeland, rather than the current geographical location of daughter languages, is associated with the existence of politeness distinctions. Thus, it examines whether the culturally-embodied geographical determinants in the Urheimat, rather than the direct effect of geography (as would have been reflected by the significance of the geographical characteristics in linguistic homeland of daughter languages), governed the evolution of politeness distinctions.

Table 10: Persistent Effect of Homeland vs. Urheimat Characteristics on Politeness: Languages Outside Urheimat

	Existence of Politeness Distinctions			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Ecological Diversity	0.14***	0.13***		0.07
	(0.03)	(0.04)		(0.05)
Urheimat Ecological Diversity			0.51*	0.35
			(0.29)	(0.28)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	0.07	0.37	0.40	0.47
Observations	116	116	116	116
Language Families	19	19	19	19

Notes: This table explores the relative contributions of ecological diversity in the homeland vs. the Urheimat to the presence of politeness distinctions in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests; All regressions include a constant.

Table 10 explores the relative contributions of the extent of ecological diversity in the contemporary language's homeland vs. its Urheimat to the presence of politeness distinctions in daughter languages. It establishes that the existence of politeness distinctions in pronouns among daughter languages located outside the Urheimat of their proto-language are mainly associated with ecological diversity in the homeland. In particular, columns (1) and (2) establish that the extent of ecological diversity in the homeland of a language has a significant positive association with the existence of politeness distinctions among migrant languages. Accounting for regional fixed effects and other geographical characteristics of the homeland, a one standard deviation increase in ecological diversity in the homeland of the language is associated with a 13 percentage points increase in the probability that a migrant daughter language would have politeness distinctions in pronouns. Furthermore, column (3) suggests that the extent of ecological diversity in the Urheimat is also associated with the existence of politeness distinctions in daughter languages located outside of the Urheimat. Finally, column (4) suggests that these associations are insignificant if ecological diversity in the homeland of the language is accounted for, reflecting the potential effect of multicollinearity among the characteristics of the homeland and the Urheimat. Similarly, Tables C.7 and C.13 establish analogous results of the effect of ecological diversity on an alternative measure of politeness distinctions in pronouns and on the intensity of politeness distinctions in pronouns.

These results suggests that politeness distinctions have emerged primarily during the demic diffusion of the language. Indeed, these results can be interpreted as an outcome of sorting of hierarchy-averse individuals into geographical locations where hierarchies are less likely to emerge. Interestingly, this would suggest that hierarchical structures and thus politeness distinctions would be more prevalent in geographical locations characterized by ecological diversity, where individuals are not freely mobile and could not flee oppression (Carneiro, 1970).

The evidence provided in this section supports the proposed hypothesis that ecological diversity affects the existence of politeness distinctions in a language, shedding light on the coevolution of language and culture. Furthermore, consistent with evidence about the greater adaptability of politeness distinctions to environmental and political changes (Wichmann and Holman, 2009; Greenhill et al., 2010; Dediu and Levinson, 2012; Dediu and Cysouw, 2013; Greenhill et al., 2017), in comparison to the structure of the future tense and sex-based grammatical gender, the findings suggest that while geographical characteristics in the ancestral homeland of the proto-language are associated with the existence of the periphrastic future tense and sex-based grammatical gender, the geographical characteristics in the homeland of the daughter languages are associated with the existence of politeness distinctions. In particular, in line with the conventional wisdom among linguists about the relative fluidity of politeness distinctions, the evidence suggests that the existence of politeness distinctions in contemporary languages are originated predominantly in cultural processes that took place after proto-languages were formed and daughter languages had started to emerge. Moreover, the evidence suggests that sorting of hierarchy-averse individuals into geographical locations that are less prone to be conducive for the emergence of hierarchical structures may have played a role in the positive association between ecological diversity in the contemporary homeland of the language and the existence of politeness distinctions.

6.3 Mechanism

This section presents additional supportive evidence for the hypothesized geographical origins of politeness distinctions. In view of the evidence about the effect of ecological diversity on the emergence of hierarchical structures (Fenske, 2014; Depetris-Chauvin and Özak, 2016), the effect of ecological diversity on the emergence of politeness distinctions would necessitate the emergence of hierarchical structures. In particular, as illustrated in Figure 8, the proposed hypothesis would imply that: (i) ecological diversity ought to be associated with more hierarchical structures, and (ii) more hierarchical structures ought to be associated with the existence of politeness distinctions.

Table 11 presents supporting evidence for the proposed mechanism. In particular, it establishes the robust positive association between ecological diversity and the level of jurisdictional hierarchy in a pre-colonial society, which in turn is positively associated with the emergence of politeness distinctions in pronouns. Using data from the Ethnographic Atlas (Murdock and White, 1969) on the level of jurisdictional hierarchy above the local level – a proxy for the size and strength of the State and hierarchical structures – the analysis explores the effect of ecological diversity on a pre-colonial society's level of jurisdictional hierarchy. In particular, columns (1) and (2) establish that societies inhabiting regions with higher ecological diversity had higher levels of jurisdictional hierarchy. The results suggest

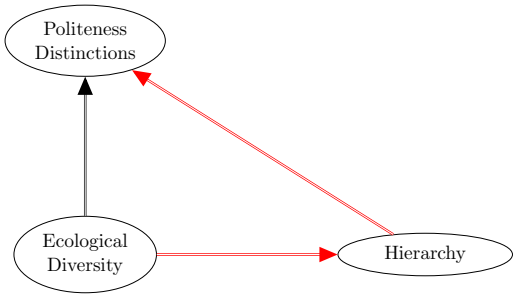

Figure 8: Ecological Diversity, Hierarchy & Politeness Distinctions

that a one-standard deviation increase in ecological diversity is associated with 0.12 standard deviations increase in jurisdictional hierarchy. Moreover, columns (3) and (4) establish the positive association between the level of jurisdictional hierarchy in a pre-colonial society and the probability of existence of politeness distinctions in the language it speaks. The results suggest that a one standard deviation increase in jurisdictional hierarchy is associated with a 16 percentage points increase in the probability of existence of politeness distinctions in pronouns.

Table 11: Geographic Origins of Politeness Distinctions and Jurisdictional Hierarchy

	Mechanism			
	Jurisdictional Hierarchy		Politeness	
	(1)	(2)	(3)	(4)
Ecological Diversity	0.23***	0.12***		
	(0.04)	(0.03)		
Jurisdictional Hierarchy			0.21***	0.16***
			(0.02)	(0.03)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.07	0.32	0.34	0.48
Observations	1154	1154	139	139

Notes: This table establishes the positive statistically and economically significant effect of the geographical determinants of statehood, as measured by jurisdictional hierarchy beyond the local level, and politeness distinctions in a language. The first two columns provide the results of the effect of ecological diversity on statehood, and columns (3) and (4) show the effect of statehood on the emergence of politeness distinctions. The table shows the estimated coefficients in an OLS regression as the dependent variable in columns (1) and (2) is not binary. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

6.4 Hierarchical Orientation and Politeness Distinctions

This section explores the association between the hierarchical orientation in a given community and the existence of politeness distinctions in the language the members of the community speak. In light of the proposed hypothesis that politeness distinctions in pronouns are complementary to hierarchical structures and cultures, the prevalence of hierarchical orientation within a given society is likely to be associated with the presence of politeness distinctions in the language used among members of this society. Indeed, the common geographical origins (i.e., ecological diversity) of hierarchical orientation

as well as politeness distinctions suggest that this positive association is likely to be observed across various speech communities.

Table 12: Hierarchy and Politeness

	Hierarchy Index			
	All		Old World	
	(1)	(2)	(3)	(4)
Politeness Distinctions	0.37**	0.23**	0.45***	0.29***
	(0.13)	(0.09)	(0.10)	(0.06)
Ecological Diversity		0.14		0.05
		(0.13)		(0.14)
Main Geographical Controls	No	Yes	No	Yes
Adjusted-R^2	0.12	0.27	0.19	0.36
Observations	53	53	50	50

Notes: This table establishes the statistically and economically positive association between of politeness distinctions and preferences for hierarchy in society. The analysis accounts for the geographical origins of politeness distinctions and other geographical characteristics of the homeland of the language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table 12 explores the association between the prevalence of hierarchical orientation within a given society and the presence of politeness distinctions in pronouns in the language used among members of this society.[39] It establishes the positive statistically and economically significant association between the existence of the politeness distinctions in pronouns and hierarchical orientation.[40] This significant positive association is present among speakers of languages in the world as a whole (Columns (1) and (2)), as well as among speakers who reside in the Old World and speak languages originated in the Old World (Columns (3) and (4)). These findings lend credence to the proposed hypothesis that the prevalence of hierarchical orientation and the presence of politeness distinctions have coevolved in the course of human history.

7 Conclusion

This research explores the geographical origins of the coevolution of cultural and linguistic traits in the course of human history, relating the geographical roots of long-term orientation to the structure of

[39]The measure of hierarchical orientation is based on the following questions in the World Values Survey (WVS): "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?" Individuals are considered to have higher hierarchical orientation if they answered "Obedience" or "Religious Faith" and lower if they answered "Independence" or "Determination, Perseverance". This measure is the opposite of the Autonomy Index introduced in Welzel (2013).

[40]The sample of languages in the WVS for which politeness distinctions data exists has little regional variation. This impedes the use of regional fixed effects in the analysis of the main measure of politeness distinctions. Reassuringly, as established in Tables C.9 and C.15, exploiting the larger regional variations present in the additional measures of politeness distinctions, permits the analysis to account for regional fixed effects, obtaining qualitatively similar results.

the future tense, the agricultural determinants of gender bias to the presence of sex-based grammatical gender, and the ecological origins of hierarchical orientation to the existence of politeness distinctions. The study advances the hypothesis and establishes empirically that: (i) variations in geographical characteristics that were conducive to higher natural return to agricultural investment contributed to the existing cross-language variations in the structure of the future tense, (ii) the agricultural determinants of gender gap in agricultural productivity fostered the existence of sex-based grammatical gender, and (iii) the ecological origins of hierarchical societies triggered the emergence of politeness distinctions.

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Appendix (Not for publication)

A The Origins of Periphrastic Future Tense

A.1 Crop Return and Periphrastic Future Tense

Table A.1: Geographical Origins of Periphrastic Future Tense (OLS)

	Existence of Future Tense					
	(1)	(2)	(3)	(4)	(5)	(6)
Crop Return (pre-1500CE)	0.06**	0.06**	0.07**	0.07**	0.09***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Absolute Latitude		-0.03	-0.03	0.03	0.05	0.15
		(0.03)	(0.04)	(0.10)	(0.10)	(0.11)
Elevation		0.04	0.03	0.05	0.05	0.03
		(0.04)	(0.04)	(0.05)	(0.04)	(0.05)
Ruggedness		-0.04	-0.03	-0.04	-0.05	-0.02
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Coast Length		0.08***	0.07***	0.06***	0.06***	0.06***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Precipitation (mm/month)			0.01	0.02	0.01	0.01
			(0.07)	(0.07)	(0.07)	(0.08)
Precipitation (mm/month) (std)			0.07**	0.01	0.01	0.04
			(0.03)	(0.05)	(0.05)	(0.05)
Precipitation Volatility			-0.04	-0.03	-0.03	-0.04
			(0.08)	(0.08)	(0.08)	(0.08)
Precipitation Spatial Correlation			0.01	0.93***	0.91***	0.95***
			(0.04)	(0.26)	(0.26)	(0.30)
Temperature (Daily Mean)				0.05	0.07	0.08
				(0.07)	(0.06)	(0.08)
Temperature (Daily Mean) (std)				0.07	0.08*	0.05
				(0.05)	(0.05)	(0.04)
Temperature Volatility				-0.01	-0.06	-0.09
				(0.08)	(0.08)	(0.09)
Temperature Spatial Correlation				-0.93***	-0.91***	-0.93***
				(0.26)	(0.26)	(0.30)
Unproductive Period (pre-1500CE)					0.08**	0.09***
					(0.03)	(0.03)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.02	0.02	0.06	0.07	0.11
Observations	275	275	275	275	275	275

Notes: This table establishes the positive, statistically, and economically significant effect of a pre-1500CE potential crop return on the existence of periphrastic future tense in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All specifications in this table are identical to the ones presented in Table 1, but here the coefficients of the controls are presented. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table A.2: Crop Return and Periphrastic Future Tense

	Existence of Periphrastic Future Tense					
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Probit					
Crop Return (pre-1500CE)	0.06**	0.06**	0.06**	0.07**	0.09***	0.12***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.01	0.03	0.04	0.08	0.10	0.14
Observations	275	275	275	275	275	275
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Crop Return (pre-1500CE)	0.06**	0.06**	0.07**	0.07**	0.09***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	([0.04])	([0.04])	([0.03])	([0.03])	([0.03])	([0.03])
	[0.04]	[0.04]	[0.03]	[0.03]	[0.03]	[0.03]
	{0.03}	{0.03}	{0.03}	{0.03}	{0.03}	{0.03}
Altonji et al						-2.09
δ						-2.84
β-Oster						0.13
R^2	0.01	0.04	0.06	0.10	0.12	0.17

Notes: This table establishes the positive, statistically, and economically significant effect of a pre-1500CE potential crop return on the existence of periphrastic future tense in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table A.3: Geographic Origins of Future and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Future	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crop Return (pre-1500CE)	0.12***	-0.06	0.05	-0.07*	0.00	0.08	0.06
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.06)	(0.34)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.11	0.08	0.14	0.15	0.20	0.31	-0.03
Observations	275	218	218	224	387	542	117

Notes: This table establishes the positive, statistically, and economically significant effect of pre-1500CE potential crop return on the existence of periphrastic future tense in a language, and not with other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table A.4: Agricultural Intensity and Crop Return

	Agricultural Intensity			
	Full Sample		Future Sample	
	(1)	(2)	(3)	(4)
Crop Return (pre-1500CE)	0.19***	0.22***	0.27***	0.30***
	(0.03)	(0.02)	(0.07)	(0.06)
Regional FE	No	Yes	No	Yes
All Geographical Controls	No	Yes	No	Yes
Adjusted-R^2	0.04	0.64	0.07	0.61
Observations	1306	1306	264	264

Notes: This table establishes the positive statistically and economically significant effect of a language's homeland's crop return on the level of agricultural intensity of a pre-colonial society that speaks that language. Standardized coefficients. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B Origins of Sex-Based Grammatical Gender

Table B.1: Geographic Origins of Sex-Based Grammatical Gender (OLS)

	Existence of Sex-Based Grammatical Gender					
	(1)	(2)	(3)	(4)	(5)	(6)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.13**	-0.19***	-0.25***	-0.26***	-0.29***	-0.23***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
Average Caloric Yield (All Crops, pre-1500)	0.17***	0.21***	0.28***	0.29***	0.32***	0.25***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
Absolute Latitude		-0.10***	-0.19***	-0.06	-0.06	-0.13
		(0.04)	(0.04)	(0.10)	(0.10)	(0.10)
Elevation		-0.01	-0.14***	-0.11**	-0.11**	-0.11**
		(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
Ruggedness		-0.02	0.08	0.08	0.08	0.06
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Coast Length		0.08***	0.09***	0.09***	0.08***	0.08***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Precipitation (mm/month)			-0.11*	-0.11	-0.12	-0.08
			(0.07)	(0.07)	(0.07)	(0.07)
Precipitation (mm/month) (std)			-0.02	0.03	0.04	0.03
			(0.03)	(0.05)	(0.05)	(0.05)
Precipitation Volatility			0.03	-0.01	0.00	0.01
			(0.07)	(0.08)	(0.08)	(0.08)
Precipitation Spatial Correlation			0.13***	0.14	0.15	0.12
			(0.03)	(0.28)	(0.29)	(0.28)
Temperature (Daily Mean)				0.08	0.07	0.04
				(0.07)	(0.07)	(0.07)
Temperature (Daily Mean) (std)				-0.07	-0.08*	-0.07
				(0.05)	(0.04)	(0.05)
Temperature Volatility				-0.08	-0.07	-0.10
				(0.09)	(0.09)	(0.09)
Temperature Spatial Correlation				-0.01	-0.02	-0.02
				(0.29)	(0.29)	(0.28)
Unproductive Period (pre-1500CE)					-0.06*	-0.02
					(0.03)	(0.03)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.03	0.06	0.14	0.15	0.15	0.21
Observations	217	217	217	217	217	217

Notes: This table establishes the negative, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 5. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.2: Geographic Origins of Sex-Based Grammatical Gender

	Existence of Sex-Based Grammatical Gender					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Probit						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.13**	-0.19***	-0.25***	-0.26***	-0.28***	-0.20**
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
Average Caloric Yield (All Crops, pre-1500)	0.16***	0.21***	0.28***	0.30***	0.32***	0.22***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.03	0.07	0.16	0.18	0.18	0.25
Observations	216	216	216	216	216	216
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.13**	-0.19***	-0.25***	-0.26***	-0.29***	-0.23***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
	([0.07])	([0.07])	([0.07])	([0.07])	([0.07])	([0.08])
	[0.06]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]
	{0.06}	{0.06}	{0.06}	{0.06}	{0.07}	{0.09}
Altonji et al						-2.26
δ						-1.29
β-Oster						-0.27
Average Caloric Yield (All Crops, pre-1500)	0.17***	0.21***	0.28***	0.29***	0.32***	0.25***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)
	([0.07])	([0.07])	([0.07])	([0.07])	([0.07])	([0.07])
	[0.06]	[0.06]	[0.06]	[0.06]	[0.06]	[0.07]
	{0.06}	{0.06}	{0.06}	{0.06}	{0.06}	{0.08}
Altonji et al						-3.02
δ						-1.56
β-Oster						0.28
R^2	0.04	0.09	0.18	0.20	0.21	0.28

Notes: This table establishes the negative, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.2. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.3: Geographical Origins of Gender and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Gender	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plow Negative Crops	-0.23***	-0.33***	-0.09	0.02	-0.05	-0.11	-0.76
(Average Caloric Yield, pre-1500)	(0.08)	(0.11)	(0.09)	(0.10)	(0.07)	(0.14)	(0.83)
Average Caloric Yield	0.23***	0.24***	0.07	-0.06	0.02	0.08	0.73
(All Crops, pre-1500)	(0.07)	(0.08)	(0.08)	(0.08)	(0.06)	(0.12)	(0.82)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.21	0.12	0.14	0.14	0.20	0.30	-0.03
Observations	217	218	218	224	387	542	117

Notes: This table establishes the statistically and economically significant effect of the geographical determinants of plow usage on the existence of sex-based grammatical gender in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B.1 Alternative Measure for Sex-Based Grammatical Gender (Extensive Measure)

Table B.4: Geographic Origins of Sex-Based Grammatical Gender (OLS)

	Existence of Sex-Based Grammatical Gender					
	(1)	(2)	(3)	(4)	(5)	(6)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.03	-0.10	-0.16**	-0.17***	-0.23***	-0.22***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.08)
Average Caloric Yield (All Crops, pre-1500)	0.09	0.14**	0.21***	0.22***	0.27***	0.26***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Absolute Latitude		-0.10***	-0.20***	-0.09	-0.10	-0.15
		(0.04)	(0.04)	(0.10)	(0.10)	(0.09)
Elevation		0.02	-0.11**	-0.09*	-0.11**	-0.13***
		(0.05)	(0.04)	(0.05)	(0.05)	(0.04)
Ruggedness		-0.05	0.04	0.04	0.05	0.05
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Coast Length		0.07***	0.08***	0.08***	0.07***	0.07***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Precipitation (mm/month)			-0.09	-0.10	-0.11	-0.06
			(0.06)	(0.07)	(0.07)	(0.07)
Precipitation (mm/month) (std)			-0.03	0.01	0.01	0.00
			(0.03)	(0.05)	(0.05)	(0.05)
Precipitation Volatility			-0.00	-0.02	-0.00	0.02
			(0.07)	(0.08)	(0.08)	(0.07)
Precipitation Spatial Correlation			0.13***	0.20	0.22	0.18
			(0.03)	(0.28)	(0.28)	(0.26)
Temperature (Daily Mean)				0.03	0.02	-0.02
				(0.07)	(0.07)	(0.07)
Temperature (Daily Mean) (std)				-0.06	-0.07	-0.06
				(0.05)	(0.04)	(0.04)
Temperature Volatility				-0.08	-0.06	-0.08
				(0.09)	(0.09)	(0.09)
Temperature Spatial Correlation				-0.07	-0.06	-0.06
				(0.29)	(0.29)	(0.26)
Unproductive Period (pre-1500CE)					-0.08***	-0.03
					(0.03)	(0.03)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.04	0.13	0.13	0.15	0.24
Observations	245	245	245	245	245	245

Notes: This table establishes the positive, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 5. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.5: Geographic Origins of Sex-Based Grammatical Gender

	Existence of Sex-Based Grammatical Gender					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Probit						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.03	-0.10*	-0.16**	-0.17***	-0.22***	-0.21***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Average Caloric Yield (All Crops, pre-1500)	0.09	0.14**	0.21***	0.22***	0.26***	0.24***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.01	0.05	0.14	0.15	0.17	0.26
Observations	245	245	245	245	245	245
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.03	-0.10	-0.16**	-0.17***	-0.23***	-0.22***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.08)
	([0.07])	([0.08])	([0.08])	([0.07])	([0.07])	([0.07])
	[0.06]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]
	{0.05}	{0.06}	{0.06}	{0.06}	{0.06}	{0.08}
Altonji et al						-1.14
δ						-0.89
β-Oster						-0.29
Average Caloric Yield (All Crops, pre-1500)	0.09	0.14**	0.21***	0.22***	0.27***	0.26***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
	([0.07])	([0.07])	([0.07])	([0.07])	([0.07])	([0.07])
	[0.06]	[0.06]	[0.06]	[0.06]	[0.06]	[0.07]
	{0.05}	{0.06}	{0.06}	{0.06}	{0.06}	{0.07}
Altonji et al						-1.51
δ						-0.89
β-Oster						0.31
R^2	0.02	0.07	0.17	0.18	0.20	0.31

Notes: This table establishes the positive, statistically, and economically significant effect of a region's pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.2. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.6: Geographical Origins of Gender and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Gender	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plow Negative Crops	-0.22***	-0.33***	-0.09	0.01	-0.05	-0.09	-0.83
(Average Caloric Yield, pre-1500)	(0.08)	(0.11)	(0.09)	(0.10)	(0.07)	(0.14)	(0.83)
Average Caloric Yield	0.25***	0.24***	0.07	-0.06	0.02	0.07	0.76
(All Crops, pre-1500)	(0.07)	(0.08)	(0.08)	(0.08)	(0.06)	(0.12)	(0.82)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.24	0.12	0.14	0.14	0.20	0.31	-0.03
Observations	245	218	218	223	386	538	116

Notes: This table establishes the statistically and economically significant effect of the geographical determinants of plow usage on the existence of sex-based grammatical gender in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.7: Persistent Effect of Homeland vs Urheimat Characteristics on Sex-Based Grammatical Gender
Languages Outside Urheimat

	Existence of Sex-Based Gender System			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Plow Negative Crops (Average Caloric Yield, pre-1500)	0.05	-0.17		0.01
	(0.13)	(0.10)		(0.08)
Homeland Average Caloric Yield (All Crops, pre-1500)	-0.04	0.14		0.03
	(0.11)	(0.08)		(0.07)
Urheimat Plow Negative Crops (Average Caloric Yield, pre-1500)			-0.15*	-0.13
			(0.07)	(0.10)
Urheimat Average Caloric Yield (All Crops, pre-1500)			0.80***	0.81***
			(0.16)	(0.19)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	-0.01	0.24	0.69	0.67
Observations	126	126	126	126
Language Families	21	21	21	21

Notes: This table explores the relative contributions of agricultural productivity in the homeland vs. the Urheimat to the presence of sex-based grammatical gender in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B.2 Alternative Measure for Sex-Based Grammatical Gender (Intensive Measure)

Table B.8: Geographic Origins of Intensity of Sex-Based Grammatical Gender System (OLS)

	Intensity of Sex-Based Grammatical Gender System					
	(1)	(2)	(3)	(4)	(5)	(6)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.25***	-0.32***	-0.40***	-0.39***	-0.47***	-0.36**
	(0.09)	(0.10)	(0.11)	(0.11)	(0.12)	(0.14)
Average Caloric Yield (All Crops, pre-1500)	0.26**	0.32***	0.41***	0.39***	0.47***	0.40***
	(0.10)	(0.11)	(0.12)	(0.12)	(0.14)	(0.14)
Absolute Latitude		-0.04	-0.21***	0.15	0.14	0.04
		(0.04)	(0.07)	(0.16)	(0.16)	(0.15)
Elevation		0.06	-0.10	-0.02	-0.03	-0.07
		(0.08)	(0.09)	(0.08)	(0.08)	(0.08)
Ruggedness		-0.14*	-0.01	-0.04	-0.03	-0.00
		(0.07)	(0.07)	(0.09)	(0.08)	(0.08)
Coast Length		0.03	0.03	0.03	0.02	0.04
		(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
Precipitation (mm/month)			-0.29**	-0.25**	-0.28**	-0.20*
			(0.11)	(0.11)	(0.11)	(0.10)
Precipitation (mm/month) (std)			0.03	-0.01	-0.00	0.01
			(0.04)	(0.08)	(0.08)	(0.08)
Precipitation Volatility			0.07	0.03	0.06	0.08
			(0.11)	(0.13)	(0.12)	(0.12)
Precipitation Spatial Correlation			0.09**	-0.09	-0.02	0.08
			(0.05)	(0.43)	(0.45)	(0.47)
Temperature (Daily Mean)				0.22*	0.20	0.08
				(0.12)	(0.14)	(0.13)
Temperature (Daily Mean) (std)				0.03	0.02	-0.02
				(0.08)	(0.08)	(0.08)
Temperature Volatility				-0.20	-0.17	-0.13
				(0.14)	(0.14)	(0.14)
Temperature Spatial Correlation				0.17	0.13	0.00
				(0.43)	(0.44)	(0.46)
Unproductive Period (pre-1500CE)					-0.14**	-0.07
					(0.07)	(0.06)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.03	0.03	0.06	0.07	0.09	0.17
Observations	181	181	181	181	181	181

Notes: This table establishes the positive, statistically, and economically significant effect of a pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 5. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.9: Geographic Origins of Intensity of Sex-Based Grammatical Gender System

	Intensity of Sex-Based Grammatical Gender System					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.25***	-0.32***	-0.40***	-0.39***	-0.47***	-0.36**
	(0.09)	(0.10)	(0.11)	(0.11)	(0.12)	(0.14)
	([0.11])	([0.12])	([0.14])	([0.13])	([0.15])	([0.14])
	[0.10]	[0.10]	[0.11]	[0.11]	[0.12]	[0.12]
	{0.10}	{0.11}	{0.12}	{0.12}	{0.12}	{0.15}
Altonji et al						-3.22
δ						-1.95
β-Oster						-0.40
Average Caloric Yield (All Crops, pre-1500)	0.26**	0.32***	0.41***	0.39***	0.47***	0.40***
	(0.10)	(0.11)	(0.12)	(0.12)	(0.14)	(0.14)
	([0.12])	([0.13])	([0.14])	([0.14])	([0.15])	([0.14])
	[0.11]	[0.11]	[0.12]	[0.11]	[0.12]	[0.12]
	{0.10}	{0.11}	{0.11}	{0.11}	{0.12}	{0.14}
Altonji et al						-2.85
δ						-1.36
β-Oster						0.45
R^2	0.04	0.06	0.12	0.14	0.16	0.26
Observations	181	181	181	181	181	181

Notes: This table establishes the positive, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.2. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.10: Geographical Origins of Gender and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Gender	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plow Negative Crops	-0.36**	-0.33***	-0.09	0.01	-0.05	-0.09	-0.83
(Average Caloric Yield, pre-1500)	(0.14)	(0.11)	(0.09)	(0.10)	(0.07)	(0.14)	(0.83)
Average Caloric Yield	0.39***	0.24***	0.07	-0.06	0.02	0.07	0.76
(All Crops, pre-1500)	(0.14)	(0.08)	(0.08)	(0.08)	(0.06)	(0.12)	(0.82)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.17	0.12	0.14	0.14	0.20	0.31	-0.03
Observations	181	218	218	223	386	538	116

Notes: This table establishes the statistically and economically significant effect of the geographical determinants of plow usage on the intensity of grammatical gender in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.11: Persistent Effect of Homeland vs Urheimat Characteristics on Intensity of Sex-Based Grammatical Gender System
Languages Outside Urheimat

	Existence of Sex-Based Gender System			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.31**	-0.42		0.02
	(0.14)	(0.29)		(0.15)
Homeland Average Caloric Yield (All Crops, pre-1500)	0.27**	0.33		-0.06
	(0.11)	(0.26)		(0.09)
Urheimat Plow Negative Crops (Average Caloric Yield, pre-1500)			-1.00***	-0.96***
			(0.13)	(0.18)
Urheimat Average Caloric Yield (All Crops, pre-1500)			1.82***	1.73***
			(0.25)	(0.27)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	0.04	0.08	0.71	0.70
Observations	88	88	88	88
Language Families	21	21	21	21

Notes: This table explores the relative contributions of agricultural productivity in the homeland vs. the Urheimat to the presence of sex-based grammatical gender in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.12: Geographic Origins of Usage of the Plow and Intensive Sex-Based Grammatical Genders

	Mechanism			
	Plow		Grammatical Gender	
	(1)	(2)	(3)	(4)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.26***	-0.06**		
	(0.02)	(0.02)		
Average Caloric Yield (All Crops, pre-1500)	0.26***	0.09***		
	(0.02)	(0.02)		
Aboriginal Plow			0.65***	0.56**
			(0.20)	(0.27)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.19	0.47	0.09	0.21
Observations	1175	1175	133	133

Notes: This table establishes, based on OLS regression, the positive statistically and economically significant effect of the geographical determinants of plow usage on the existence of sex-based grammatical gender in a language. The first two columns provide the effect of the geographical determinants of plow suitability on actual usage of the plow, and columns (3) and (4) provide evidence on the effect of actual usage of the plow on the emergence of sex-based grammatical gender. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

B.3 Origins of Gender Distinctions in Pronouns

Table B.13: Geographic Origins of Gender Distinctions in Pronouns (OLS)

	Existence of Gender Distinctions in Pronouns					
	(1)	(2)	(3)	(4)	(5)	(6)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.08*	-0.12**	-0.13***	-0.15***	-0.17***	-0.18***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Average Caloric Yield (All Crops, pre-1500)	0.10**	0.14***	0.15***	0.18***	0.19***	0.21***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Absolute Latitude		-0.04	-0.08**	0.06	0.05	0.01
		(0.03)	(0.03)	(0.07)	(0.07)	(0.08)
Elevation		0.03	-0.03	-0.01	-0.02	-0.03
		(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
Ruggedness		-0.11***	-0.05	-0.07*	-0.07*	-0.06*
		(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
Coast Length		0.07***	0.07***	0.07***	0.07***	0.08***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Precipitation (mm/month)			0.02	-0.01	-0.02	0.01
			(0.05)	(0.06)	(0.06)	(0.06)
Precipitation (mm/month) (std)			-0.00	0.02	0.02	0.01
			(0.03)	(0.04)	(0.04)	(0.04)
Precipitation Volatility			-0.09*	-0.09*	-0.09	-0.08
			(0.05)	(0.05)	(0.05)	(0.05)
Precipitation Spatial Correlation			0.04	0.24	0.26	0.34
			(0.03)	(0.23)	(0.23)	(0.25)
Temperature (Daily Mean)				0.01	0.01	-0.03
				(0.06)	(0.06)	(0.06)
Temperature (Daily Mean) (std)				-0.04	-0.04	-0.04
				(0.04)	(0.04)	(0.04)
Temperature Volatility				-0.16***	-0.16**	-0.19***
				(0.06)	(0.06)	(0.06)
Temperature Spatial Correlation				-0.19	-0.20	-0.29
				(0.23)	(0.23)	(0.25)
Unproductive Period (pre-1500CE)					-0.03	-0.02
					(0.03)	(0.03)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.06	0.08	0.10	0.10	0.13
Observations	354	354	354	354	354	354

Notes: This table establishes the negative, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of gender distinctions in independent personal pronouns in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 5. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.14: Geographic Origins of Gender Distinctions in Pronouns (Probit)

	Existence of Gender Distinctions in Pronouns					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Probit						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.06	-0.10**	-0.11**	-0.13***	-0.14***	-0.16**
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Average Caloric Yield (All Crops, pre-1500)	0.09**	0.12***	0.14***	0.16***	0.17***	0.19***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.01	0.07	0.09	0.11	0.11	0.15
Observations	350	350	350	350	350	350
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.08*	-0.12**	-0.13***	-0.15***	-0.17***	-0.18***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
	([0.05])	([0.06])	([0.05])	([0.05])	([0.05])	([0.07])
	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.06]
	{0.04}	{0.05}	{0.05}	{0.05}	{0.05}	{0.07}
Altonji et al						-1.77
δ						-1.12
β-Oster						-0.21
Average Caloric Yield (All Crops, pre-1500)	0.10**	0.14***	0.15***	0.18***	0.19***	0.21***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
	([0.05])	([0.06])	([0.05])	([0.05])	([0.05])	([0.06])
	[0.05]	[0.05]	[0.05]	[0.04]	[0.05]	[0.06]
	{0.04}	{0.05}	{0.05}	{0.05}	{0.05}	{0.06}
Altonji et al						-1.89
δ						-0.90
β-Oster						0.24
R^2	0.01	0.08	0.11	0.13	0.14	0.18

Notes: This table establishes the negative, statistically, and economically significant effect of pre-1500CE potential average plow negative crop yield on the existence of sex-based grammatical gender in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.2. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.15: Geographical Origins of Gender and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Gender	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plow Negative Crops	-0.18***	-0.33***	-0.09	0.01	-0.05	-0.09	-0.83
(Average Caloric Yield, pre-1500)	(0.07)	(0.11)	(0.09)	(0.10)	(0.07)	(0.14)	(0.83)
Average Caloric Yield	0.21***	0.24***	0.07	-0.06	0.02	0.07	0.76
(All Crops, pre-1500)	(0.06)	(0.08)	(0.08)	(0.08)	(0.06)	(0.12)	(0.82)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.13	0.12	0.14	0.14	0.20	0.31	-0.03
Observations	355	218	218	223	386	538	116

Notes: This table establishes the statistically and economically significant effect of the geographical determinants of plow usage on the existence of gender distinctions in pronouns in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.16: Persistent Effect of Homeland vs Urheimat Characteristics on Gender Distinctions in Pronouns
Languages Outside Urheimat

	Existence of Gender Distinctions in Independent Personal Pronouns			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.07	-0.20*		-0.11
	(0.08)	(0.11)		(0.09)
Homeland Average Caloric Yield (All Crops, pre-1500)	0.09	0.19		0.09
	(0.08)	(0.11)		(0.08)
Urheimat Plow Negative Crops (Average Caloric Yield, pre-1500)			-0.28***	-0.22**
			(0.08)	(0.09)
Urheimat Average Caloric Yield (All Crops, pre-1500)			0.56***	0.52***
			(0.12)	(0.11)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	0.01	0.18	0.40	0.41
Observations	175	175	175	175
Language Families	23	23	23	23

Notes: This table explores the relative contributions of agricultural productivity in the homeland vs. the Urheimat to the presence of sex-based grammatical gender in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table B.17: Geographic Origins of Usage of the Plow and Gender Distinctions in Pronouns

	Mechanism			
	Plow		Grammatical Gender	
	(1)	(2)	(3)	(4)
Plow Negative Crops (Average Caloric Yield, pre-1500)	-0.26***	-0.06**		
	(0.02)	(0.02)		
Average Caloric Yield (All Crops, pre-1500)	0.26***	0.09***		
	(0.02)	(0.02)		
Aboriginal Plow			0.24***	0.22**
			(0.08)	(0.11)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.19	0.47	0.04	0.10
Observations	1175	1175	220	220

Notes: This table establishes, based on OLS regression, the positive statistically and economically significant effect of the geographical determinants of plow usage on the existence of gender distinctions in independent personal pronouns in a language. The first two columns provide the effect of the geographical determinants of plow suitability on actual usage of the plow, and columns (3) and (4) provide evidence on the effect of actual usage of the plow on the emergence of sex-based grammatical gender. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C Origins of Politeness Distinctions

Table C.1: Geographic Origins of Politeness Distinctions (OLS)

	Existence of Politeness Distinctions					
	(1)	(2)	(3)	(4)	(5)	(6)
Ecological Diversity	0.15***	0.10***	0.10***	0.10**	0.10**	0.10**
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Average Caloric Yield (All Crops, pre-1500)		0.11***	0.10***	0.11***	0.11***	0.12***
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Absolute Latitude		0.07**	0.09**	0.23**	0.24**	0.07
		(0.03)	(0.04)	(0.11)	(0.11)	(0.11)
Elevation		0.01	0.05	0.09*	0.09*	0.10**
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Ruggedness		-0.04	-0.06*	-0.07*	-0.06*	-0.09**
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Coast Length		0.07*	0.06	0.06	0.06	0.04
		(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Precipitation (mm/month)			0.03	0.03	0.04	-0.02
			(0.06)	(0.06)	(0.06)	(0.06)
Precipitation (mm/month) (std)			0.04	0.05	0.06	0.07
			(0.04)	(0.07)	(0.07)	(0.07)
Precipitation Volatility			-0.06	-0.07	-0.08	-0.04
			(0.07)	(0.07)	(0.06)	(0.07)
Precipitation Spatial Correlation			-0.08**	0.31	0.31	0.35
			(0.04)	(0.28)	(0.29)	(0.27)
Temperature (Daily Mean)				0.07	0.07	0.04
				(0.08)	(0.08)	(0.07)
Temperature (Daily Mean) (std)				-0.01	-0.03	-0.07
				(0.07)	(0.07)	(0.06)
Temperature Volatility				-0.09	-0.07	0.03
				(0.09)	(0.08)	(0.08)
Temperature Spatial Correlation				-0.39	-0.39	-0.42
				(0.29)	(0.30)	(0.28)
Unproductive Period (pre-1500CE)					-0.06*	-0.07*
					(0.04)	(0.04)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.09	0.18	0.20	0.20	0.21	0.32
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.2: Geographic Origins of Politeness Distinctions

	Existence of Politeness Distinctions					
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Probit					
Ecological Diversity	0.14***	0.09***	0.09***	0.10***	0.10***	0.10***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.07	0.21	0.23	0.24	0.25	0.36
Observations	180	180	180	180	180	180
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Ecological Diversity	0.15***	0.10***	0.10***	0.10**	0.10**	0.10**
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
	([0.04])	([0.04])	([0.04])	([0.04])	([0.04])	([0.03])
	[0.03]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
	{0.03}	{0.03}	{0.03}	{0.03}	{0.03}	{0.03}
Altonji et al						3.10
δ						5.02
β-Oster						0.08
R^2	0.10	0.21	0.24	0.26	0.27	0.39

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.3: Geographical Origins of Politeness and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Politeness	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ecological Diversity	0.10**	0.04	0.05	-0.03	0.01	-0.10*	-0.49
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.05)	(0.37)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.32	0.07	0.14	0.14	0.20	0.31	-0.02
Observations	198	218	218	224	387	542	117

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity and average pre-1500CE crop yield on the existence of politeness distinctions in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C.1 Alternative Measure of Politeness Distinctions (Extensive Margin)

Table C.4: Geographic Origins of Politeness Distinctions (Alternative measure - OLS)

	Existence of politeness Distinctions (Alt. Measure)					
	(1)	(2)	(3)	(4)	(5)	(6)
Ecological Diversity	0.08***	0.09***	0.07**	0.09***	0.09***	0.08***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Average Caloric Yield (All Crops, pre-1500)		0.03	0.04	0.04	0.03	0.06**
		(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Absolute Latitude		-0.03	-0.04	-0.05	-0.05	-0.10
		(0.02)	(0.03)	(0.06)	(0.06)	(0.07)
Elevation		-0.06**	-0.08***	-0.07*	-0.07*	-0.06*
		(0.02)	(0.03)	(0.04)	(0.04)	(0.03)
Ruggedness		0.01	0.02	0.03	0.04	-0.00
		(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Coast Length		0.01	0.01	0.01	0.02	0.02
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Precipitation (mm/month)			-0.04	-0.05	-0.05	-0.07
			(0.03)	(0.05)	(0.04)	(0.04)
Precipitation (mm/month) (std)			0.06*	0.12**	0.12**	0.12**
			(0.03)	(0.05)	(0.06)	(0.05)
Precipitation Volatility			0.01	-0.00	-0.01	-0.01
			(0.04)	(0.04)	(0.04)	(0.04)
Precipitation Spatial Correlation			0.02	0.05	0.05	0.00
			(0.02)	(0.19)	(0.19)	(0.19)
Temperature (Daily Mean)				-0.03	-0.03	-0.06
				(0.07)	(0.06)	(0.06)
Temperature (Daily Mean) (std)				-0.08	-0.09*	-0.11**
				(0.05)	(0.05)	(0.05)
Temperature Volatility				-0.01	0.00	0.06
				(0.05)	(0.05)	(0.05)
Temperature Spatial Correlation				-0.03	-0.04	0.01
				(0.19)	(0.19)	(0.19)
Unproductive Period (pre-1500CE)					-0.03*	-0.04*
					(0.02)	(0.02)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.06	0.09	0.09	0.09	0.10	0.25
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.5: Geographic Origins of Politeness Distinctions (Alternative measure - Probit)

	Existence of Politeness Distinctions (Alternative Measure)					
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Probit			
Ecological Diversity	0.09***	0.11***	0.08***	0.08***	0.08***	0.07***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Pseudo-R^2	0.09	0.21	0.26	0.27	0.29	0.51
Observations	140	140	140	140	140	140
Panel B: OLS - Spatial-Autocorrelation, Clustering and Selection On Unobservables						
Ecological Diversity	0.08***	0.09***	0.07**	0.09***	0.09***	0.08***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	([0.04])	([0.05])	([0.04])	([0.05])	([0.05])	([0.03])
	[0.03]	[0.04]	[0.04]	[0.04]	[0.04]	[0.03]
	{0.02}	{0.02}	{0.02}	{0.02}	{0.02}	{0.02}
Altonji et al						-7.30
δ						-12.31
β-Oster						0.09
R^2	0.07	0.11	0.14	0.16	0.17	0.33
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.6: Geographical Origins of Politeness and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Politeness	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ecological Diversity	0.09***	0.04	0.05	-0.04	0.01	-0.08	-0.49
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.05)	(0.38)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.25	0.07	0.14	0.15	0.20	0.31	-0.02
Observations	198	218	218	223	386	538	116

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity and average pre-1500CE crop yield on the existence of strong politeness distinctions in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.7: Persistent Effect of Homeland vs Urheimat Characteristics on Politeness (Alternative Measure)
Languages Outside Urheimat

	Existence of Politeness Distinctions			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Ecological Diversity	0.08*	0.13**		0.12*
	(0.04)	(0.05)		(0.06)
Urheimat Ecological Diversity			-0.17	0.21
			(0.29)	(0.24)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	0.05	0.26	0.13	0.26
Observations	116	116	116	116
Language Families	19	19	19	19

Notes: This table explores the relative contributions of ecological diversity in the homeland vs. the Urheimat to the presence of politeness distinctions in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests; All regressions include a constant.

Table C.8: Geographic Origins of Jurisdictional Hierarchy and Politeness Distinctions

	Mechanism			
	Jurisdictional Hierarchy		Politeness	
	(1)	(2)	(3)	(4)
Ecological Diversity	0.23***	0.12***		
	(0.04)	(0.03)		
Average Caloric Yield (All Crops, pre-1500)	0.17***	0.23***		
	(0.03)	(0.03)		
Jurisdictional Hierarchy Beyond Local Community			0.11***	0.10***
			(0.02)	(0.02)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.07	0.32	0.18	0.41
Observations	1154	1154	139	139

Notes: This table establishes the positive statistically and economically significant effect of the geographical determinants of statehood, as measured by jurisdictional hierarchy beyond the local level, and politeness distinctions in a language. The first two columns provide the results of the effect of ecological diversity on statehood, and columns (3) and (4) show the effect of statehood on the emergence of politeness distinctions. The table shows the estimated coefficients in an OLS regression as the dependent variable in columns (1) and (2) is not binary. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.9: Hierarchy and Politeness (Alternate Measure)

	Hierarchy Index			
	All		Old World	
	(1)	(2)	(3)	(4)
Politeness Distinctions	0.31***	0.37***	0.36***	0.43***
	(0.07)	(0.11)	(0.09)	(0.12)
Ecological Diversity		0.18*		0.08
		(0.10)		(0.08)
Regional FE	Yes	Yes	Yes	Yes
Main Geographical Controls	No	Yes	No	Yes
Adjusted-R^2	0.42	0.49	0.42	0.57
Observations	53	53	50	50

Notes: This table establishes the statistically and economically positive association between of politeness distinctions and preferences for hierarchy in society. The analysis accounts for the geographical origins of politeness distinctions and other geographical characteristics of the homeland of the language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

C.2 Alternative Measure of Politeness Distinctions (Intensive Margin)

Table C.10: Geographic Origins of Politeness Distinctions (Intensive measure - OLS)

	Intensity of Politeness Distinctions					
	(1)	(2)	(3)	(4)	(5)	(6)
Ecological Diversity	0.26***	0.21***	0.20***	0.21***	0.21***	0.22***
	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)
Average Caloric Yield (All Crops, pre-1500)		0.14***	0.14***	0.14***	0.14***	0.19***
		(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Absolute Latitude		0.02	0.02	0.16	0.17	-0.01
		(0.05)	(0.06)	(0.16)	(0.15)	(0.15)
Elevation		-0.08	-0.06	-0.02	-0.01	0.01
		(0.07)	(0.07)	(0.09)	(0.08)	(0.08)
Ruggedness		-0.01	-0.02	-0.01	-0.00	-0.06
		(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Coast Length		0.12	0.11	0.12	0.12	0.10
		(0.09)	(0.09)	(0.10)	(0.10)	(0.09)
Precipitation (mm/month)			-0.01	-0.02	-0.01	-0.10
			(0.08)	(0.10)	(0.09)	(0.10)
Precipitation (mm/month) (std)			0.12	0.22	0.23	0.26**
			(0.08)	(0.14)	(0.14)	(0.13)
Precipitation Volatility			-0.06	-0.10	-0.10	-0.06
			(0.09)	(0.10)	(0.09)	(0.10)
Precipitation Spatial Correlation			-0.03	0.45	0.46	0.41
			(0.06)	(0.44)	(0.45)	(0.45)
Temperature (Daily Mean)				0.05	0.04	-0.03
				(0.14)	(0.13)	(0.13)
Temperature (Daily Mean) (std)				-0.13	-0.15	-0.23**
				(0.12)	(0.12)	(0.11)
Temperature Volatility				-0.10	-0.06	0.11
				(0.12)	(0.12)	(0.12)
Temperature Spatial Correlation				-0.51	-0.52	-0.44
				(0.45)	(0.46)	(0.46)
Unproductive Period (pre-1500CE)					-0.10**	-0.12**
					(0.05)	(0.05)
Regional FE	No	No	No	No	No	Yes
Adjusted-R^2	0.11	0.17	0.17	0.17	0.18	0.32
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on an intensive measure of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table A.1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.11: Geographical Origins of and Politeness Distinctions (Intensive Measure - OLS)
Robustness to Spatial-Autocorrelation, Clustering and Selection

	Intensity of Politeness Distinctions					
	(1)	(2)	(3)	(4)	(5)	(6)
Ecological Diversity	0.26***	0.21***	0.20***	0.21***	0.21***	0.22***
	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)
	([0.07])	([0.09])	([0.09])	([0.09])	([0.09])	([0.07])
	[0.07]	[0.09]	[0.09]	[0.09]	[0.09]	[0.08]
	{0.05}	{0.05}	{0.05}	{0.06}	{0.06}	{0.05}
Geographical Controls	No	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	No	No	Yes
Altonji et al						28.16
δ						49.64
β-Oster						0.22
R^2	0.11	0.19	0.21	0.23	0.25	0.39
Observations	198	198	198	198	198	198

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity on the existence of politeness distinctions in the language spoken in this region, accounting for regional fixed-effects and other geographical characteristics. All columns have the same specification and controls as Table 1. Geographical controls include absolute latitude, mean elevation, terrain ruggedness, and coast length, as well as other agriculture-related controls as precipitation and temperature means and standard deviations. All independent variables have been normalized by subtracting their mean and dividing by their standard deviation. Thus, all coefficients can be compared and show the effect of a one standard deviation in the independent variable on the probability of having a future tense in the language. Heteroskedasticity robust standard error estimates are reported in parentheses, clustered at the language genus in parenthesis and squared brackets, spatial auto-correlation corrected standard errors (Conley, 1999) in squared brackets and Cliff-Ord ML in curly brackets; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.12: Geographical Origins of Politeness and Language Structures

	Language Structure						
		Temporal Structures		Non-Temporal Structures			
	Politeness	Past	Perfect	Possessive	Evidentiality	Consonants	Colors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ecological Diversity	0.23***	0.04	0.05	-0.04	0.01	-0.08	-0.49
	(0.07)	(0.04)	(0.04)	(0.04)	(0.03)	(0.05)	(0.38)
All Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.32	0.07	0.14	0.15	0.20	0.31	-0.02
Observations	198	218	218	223	386	538	116

Notes: This table establishes the positive, statistically, and economically significant effect of ecological diversity and average pre-1500CE crop yield on the existence of politeness distinctions in a language, and compares their effect on other language structures. The analysis accounts for regional fixed-effects and other geographical characteristics as in previous tables. Other language structures include the existence a past tense, a perfect tense, the existence of obligatory possessive inflections, semantic distinctions of evidentiality, the number of consonants, the ratio of consonants to vowels and the number of colors. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.13: Persistent Effect of Homeland vs Urheimat Characteristics on Politeness (Intensive Measure)
Languages Outside Urheimat

	Intensity of Politeness Distinctions			
	Homeland		Urheimat	Both
	(1)	(2)	(3)	(4)
Homeland Ecological Diversity	0.26***	0.32***		0.24**
	(0.08)	(0.09)		(0.11)
Urheimat Ecological Diversity			0.11	0.39
			(0.87)	(0.67)
Regional FE	No	Yes	Yes	Yes
Homeland Geographical Characteristics	No	Yes	No	Yes
Urheimat Geographical Characteristics	No	No	Yes	Yes
Adjusted-R^2	0.09	0.41	0.36	0.48
Observations	116	116	116	116
Language Families	19	19	19	19

Notes: This table explores the relative contributions of ecological diversity in the homeland vs. the Urheimat to the presence of politeness distinctions in a daughter language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests; All regressions include a constant.

Table C.14: Geographic Origins of Juridictional Hierarchy and Politeness Distinctions (Intensive Measure)

	Mechanism			
	Jurisdictional Hierarchy		Politeness	
	(1)	(2)	(3)	(4)
Ecological Diversity	0.23***	0.12***		
	(0.04)	(0.03)		
Average Caloric Yield (All Crops, pre-1500)	0.17***	0.23***		
	(0.03)	(0.03)		
Jurisdictional Hierarchy Beyond Local Community			0.38***	0.33***
			(0.05)	(0.05)
All Geographic Controls	No	Yes	No	Yes
Regional FE	No	Yes	No	Yes
Adjusted-R^2	0.07	0.32	0.35	0.54
Observations	1154	1154	139	139

Notes: This table establishes the positive statistically and economically significant effect of the geographical determinants of statehood, as measured by jurisdictional hierarchy beyond the local level, and politeness distinctions in a language. The first two columns provide the results of the effect of ecological diversity on statehood, and columns (3) and (4) show the effect of statehood on the emergence of politeness distinctions. The table shows the estimated coefficients in an OLS regression as the dependent variable in columns (1) and (2) is not binary. Heteroskedasticity robust standard error estimates are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

Table C.15: Hierarchy and Politeness

	Hierarchy Index					
	All			Old World		
	(1)	(2)	(3)	(4)	(5)	(6)
Politeness Distinctions	0.48***	0.37**	0.37**	0.55***	0.56***	0.56***
	(0.15)	(0.14)	(0.16)	(0.16)	(0.16)	(0.10)
Ecological Diversity			0.18*			0.07
			(0.09)			(0.09)
Regional FE	No	Yes	Yes	No	Yes	Yes
Main Geographical Controls	No	No	Yes	No	No	Yes
Adjusted-R^2	0.22	0.43	0.49	0.28	0.47	0.60
Observations	53	53	53	50	50	50

Notes: This table establishes the statistically and economically positive association between of politeness distinctions and preferences for hierarchy in society. The analysis accounts for the geographical origins of politeness distinctions and other geographical characteristics of the homeland of the language. Heteroskedasticity robust standard error estimates clustered at the language family level are reported in parentheses; *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

D Variable Definitions, Sources and Summary Statistics

D.1 Variable Definition and Sources

- **Absolute latitude**: The absolute value of the latitude of a homeland's approximate geodesic centroid. Author's computations.
- **Mean Elevation**: The mean elevation of a homeland in km above sea level, calculated using geospatial elevation data taken from GLOBE Task Team and others (1999). Author's computations.
- **Terrain Ruggedness**: The mean change in elevation across cells in a homeland in km, calculated following the methodology of Riley et al. (1999), using geospatial elevation data taken from GLOBE Task Team and others (1999). Author's computations.
- **Caloric Suitability**: Pre-1500CE Caloric suitability is the potential caloric output in a region as reported in Galor and Özak (2016).
- **Coast length**: Length, in thousands of km, of a country's coastline. Author's computations.
- **Ecological Diversity**: Herfindahl index of share's of a country's area in various ecologies. Author's computations following the method of Fenske (2014) and Depetris-Chauvin and Özak (2016).
- **Volatility (temperature and precipitation)**: Volatility of temperature and precipitation constructed using v3.2 of the Climatic Research Unit (CRU) database following the method of Durante (2010).
- **Diversification (temperature and precipitation)**: Spatial Correlation of temperature and precipitation shocks constructed using v3.2 of the Climatic Research Unit (CRU) database following the method of Durante (2010).

D.2 Summary Statistics

Table D.1: Summary Statistics of the Existence of Periphrastic Future Tense by Region

Region	Observations	Mean	Std. Dev.
Sub-Saharan Africa	66	0.53	0.503
Middle East and North Africa	8	0.5	0.53
Europe and Central Asia	56	0.48	0.50
South Asia	21	0.19	0.40
East Asia and Pacific	71	0.55	0.50
North America	22	0.41	0.50
Latin America	31	0.55	0.50
Total	275	0.49	0.50

Table D.2: Summary Statistics of the Existence of Sex-Based Grammatical Gender Systems by Region

Region	Observations	Mean	Std. Dev.
Sub-Saharan Africa	27	0.63	0.49
Middle East and North Africa	7	0.71	0.49
Europe and Central Asia	40	0.48	0.51
South Asia	16	0.63	0.50
East Asia and Pacific	70	0.27	0.45
North America	25	0.08	0.28
Latin America	32	0.28	0.46
Total	227	0.37	0.48

Table D.3: Summary Statistics of the Existence of Politeness Distinctions by Region

Region	Observations	Mean	Std. Dev.
Sub-Saharan Africa	36	0.14	0.35
Middle East and North Africa	4	0.25	0.50
Europe and Central Asia	34	0.71	0.46
South Asia	19	0.63	0.50
East Asia and Pacific	59	0.32	0.47
North America	18	0.00	0.00
Latin America	28	0.18	0.39
Total	207	0.34	0.48

Table D.4: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Absolute Latitude	0.096	1.025	-1.302	2.613	275
Elevation	0.027	1.026	-0.92	4.827	275
Ruggedness	-0.014	0.979	-0.877	6.162	275
Coast Length	0.024	1.154	-0.302	11.692	275
Precipitation	-0.078	0.928	-1.3	4.4	275
Precipitation (std)	-0.02	0.911	-0.667	8.314	275
Precipitation Volatility	-0.064	0.926	-1.531	4.665	275
Precipitation Spatial Correlation	0.064	0.939	-2.133	0.810	275
Temperature (Daily Mean)	-0.054	0.977	-2.996	1.176	275
Temperature (Daily Mean) (std)	-0.017	0.929	-0.877	4.876	275
Temperature Volatility	0.079	0.991	-1.641	3.504	275
Temperature Spatial Correlation	0.068	0.939	-2.161	0.683	275

Table D.5: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Intensity of Agriculture	8.890	3.061	2	12	264

E List of Language Families, Languages and Data Sources for Urheimat

Table E.1: Language Families, Languages in the Sample and Sources for Urheimat

Language Family	Languages in the Family	Sources
Afro-Asiatic	Afar, Alagwa, Amharic, Egyptian Arabic, Gulf Speaking Arabic, Tunisian Arabic, Arbore, Awngi, Baiso, Bedawiyet, Dera, Dizi, Hausa, Hebrew, Iraqw, Kera, Kistane, Lele, Libido, Maltese, Central Marghi, Miya, Eastern Oromo, Pero, Rendill, Sebat Bet Gurage, Sidamo, Somali, Tamhaq, Tahggart, Central Atlas Tamazight, Tigre, Tigrigna, Wolaytta	Wichmann et al. (2010)
Ainu	Orok	Denoon and McCormack (2001)
Algic	Cheyanne, Cree: Plains, Montagnais, Yurok	Wichmann et al. (2010), Mithun (2001)
Altaic	South Azerbaijani, Buriat: Mongolia, Chuvash, Evenki, Karaim, Kyrgyz, Mongolian Halh, Khalaj: Turkic, Orok, Turkish, Uyghur, Uzbek: Northern, Yakut	Wichmann et al. (2010)
Arauan	Paumari	Wichmann et al. (2010)
Araucanian	Mapudungun	Adelaar (2004)
Arawakan	Apurina, Garifuna, Ashaninka	Diamond and Bellwood (2003)
Australian	Alawa, Alyawarr, Bandjalang, Dyirbal, Gooniyandi, Guguymidjir, Gunwinggu, Jaru, Kayardild, Koyata, Kuku-Yalangi, Mangarayi, Martu Wangka, Martuyhunira, Maung, Nangikurrunggur, Nunggubuyu, Pitjantjatara, Tiwi, Wajarri, Wambaya, Wangaaybuwan-Ngiyambaa, Worora, Yidinyi, Yindjibarndi	Wichmann et al. (2010)
Austro-Asiatic	Khazi, Central Khmer, Khmu, Nicobarese: Car Palaung: Ruching, Semelai, Vietnamese	Wichmann et al. (2010)

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Table E.1 – continued from previous page

Language Family	Languages in the Family	Sources
Austronesian	Batak Karo, Batak Toba, Buli, Cebuano, Chamorro, Chuukese, Fijian, Halia, Hawaiian, Iaai, Javanese, Kambera, Kilivila, Kosraean, Makian: East, Malagasy: Plateu, Malay, Maori, Mbula, Mokilese, Motu, Nakanai, Paiwan, Palauan, Pangasinan, Pohnpeian, Rapa Nui, Rukai, Sabu, Sie, Sinaigoro, Tuvaluan, Sunda, Tagalog, Tahitian, Tangga, Tawala, Tetun, Tukang Besi South, Ura, Uripiv-Wala-Rano-Atchin, Vaekau-Taumako	Bellwood (2013)
Aymaran	Aymara: Southern, Jaqaru	Diamond and Bellwood (2003)
Baining-Taulil	Qaget	Chowning (1969)
Barbacoan	Awa-Cuaiquer	Adelaar (2004)
Basque	Basque	Lewis et al. (2009)
Border	Imonda	Voorhoeve (n.d.)
Burushaski	Burushaski	Lewis et al. (2009)
Caddoan	Wichita	Wichmann et al. (2010), Mithun (2001)
Cariban	Carib, Hixkaryana	Wichmann et al. (2010)
Chapacura-Wanham	Pakaasnovos	Adelaar (2004)
Chibchan	Arhuaco, Bribri, Ngabere, Rama	Wichmann et al. (2010)
Choco	Epena	Wichmann et al. (2010)
Chukotko-Kamchatkan	Chukchi, Itelmen	Wichmann et al. (2010)
Dagan	Daga	Donohue et al. (2010)
Dravidian	Brahui, Kolami: Northwestern, Kannada, Kui, Malayalam, Tamil, Telugu	Krishnamurti (2003)
Eskimo-Aleut	Aleut, Inuktitut: Eastern Canadian, Inuktitut: Greenlandic, Yupik: Central	Abu-Manga et al. (2006), Wichmann et al. (2010)
Gapun	Taiap	Foley (2000)

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Table E.1 – continued from previous page

Language Family	Languages in the Family	Sources
Guaicuruan	Mokovi	Adelaar (2004)
Haida	Haida: Northern	Schurr et al. (2012)
Hmong-Mien	Hmong-Djua	Wichmann et al. (2010)
Hokan	Cocopa, Maricopa, Pomo: Central, Pomo: Southeastern	Wichmann et al. (2010) Mithun (2001)
Indo-European	Afrikaans, Albanian: Gheg, Armenian, Eastern Balochi, Belarusan, Bengali, Bosnian, Breton, Bulgarian, Catalan-Valencian-Balear, Croatian, Czeck, Danish, Dutch, English, Western Farsi, French, Western Frisian, Greek, Gujarati, Hindi, Icelandic, Italian, Kashmiri, Gaelic: Irish, Gaelic: Scottish Galician, Standard German, Northern Kurdish, Latvian, Lithuanian, Luxembougeois, Macedonian, Maithili, Marathi, Nepali, Norwegian, Osetin, Eastern Panjabi, Pashto: Central, Polish, Portuguese, Romanian, Romansh, Russian, Savi, Seraiki, Slovak, Slovene, Spanish, Swedish, Ukrainian, Urdu, Serbian, Sindhi, Sinhala, Vlaams, Welsh, Yazgulyam	Anthony (2010)
Iroquoian	Oneida, Seneca	Wichmann et al. (2010), Mithun (2001)
Japanese	Japanese	Wichmann et al. (2010)
Jivaroan	Shujar	Wichmann et al. (2010)
Kadugli	Krongo	Wichmann et al. (2010)
Karok	Karok	Mithun (2001)
Kartvelian	Georgian	Wichmann et al. (2010)
Keresan	Western Keres	Mithun (2001)
Khosian	Juhoan, Nama	Lewis et al. (2009)
Kiowa-Tanoan	Kiowa	Mithun (2001)
Korean	Korean	Lewis et al. (2009)
Kutenai	Kutenai	Mithun (2001)
Lower Sepik-Ramu	Yimas	Wichmann et al. (2010)

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Table E.1 – continued from previous page

Language Family	Languages in the Family	Sources
Macro-Ge	Canela	Brown et al. (2013)
Marind	Marind	Wichmann et al. (2010)
Matacoan	Wichi Lhaments Guisnay	Wichmann et al. (2010)
Mayan	Eastern Jakalteko, Maya: Yucatan, Tojolabal	Wichmann et al. (2010)
Mixe-Zoque	Zoque: Copainala	Wichmann et al. (2010)
Mosetenan	Tsimane	Manning (2006)
Mura	Piraha	Adelaar (2004)
Muskogean	Koasati	Mithun (2001)
Na-Dene	Slavey: North, Tlingit	Wichmann et al. (2010), Mithun (2001)
Nakh-Daghestanian	Archi, Dido, Ghodoberi, Hunzib, Ingush, Lak, Lezgi	Wichmann et al. (2010)
Niger-Congo	Akan, Bamanakan, Baoule, Bemba, Dagbani, Defaka, Engenni, Ewe, Ganda, Gikuyu, Southern Grebo, Igbo, Isekiri, Jola-Fonyi, Western Karaboro, Koongo, Koromfe, Lelemi, Lozi, Luvale, Mann, Kissi: Northern, Moore, Mwera, Noon, Nyanja, Pular, Rwanda, Senufo: Supiyre, Northern Sotho, Southern Sotho, Swahili, Swati, Tem, Themne, Tooro, Tsonga, Tswana, Venda, Vengo, Wolof, Xhosa, Yoruvba, Zanda, Zulu	Wichmann et al. (2010)
Nilo-Saharan	Avokaya, Bagirmi, Bari, Didinga, Fur, Kenuzi-Dongola, Central Ksnuri, Kunama, Lango, Masalit, Murle, Ngambay, Ngiti, Songhay: Koyraboro Senni	Wichmann et al. (2010)
Nimboran	Nimboran	Foley (2000)
Nivkh	Gilyak	Chaussonnet (1995)
Northwest Caucasian	Abkhaz	Wichmann et al. (2010)
Oregon Coast	Coos	Wichmann et al. (2010)
Oto-Manguean	Chinantec: Palantla, Mixtec: San Miguel el grande, Otomi: Mezquital	Wichmann et al. (2010)

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Table E.1 – continued from previous page

Language Family	Languages in the Family	Sources
Panoan	Chacobo, Shipibo-Conibo	Wichmann et al. (2010)
Peba-Yaguan	Yagua	Pena (2009)
Penutian	Maidu: Northeast, Nez-Perce, Tsimshian, Umatilla	Wichmann et al. (2010), Mithun (2001)
Quechuan	Quechuan: South Bolivian, Quichuca: Imbabura Highland	Wichmann et al. (2010)
Salishan	Shuswap, Thompson	Wichmann et al. (2010), Mithun (2001)
Sentani	Sentani	Wichmann et al. (2010)
Sepik	Alamblak, Yessan-Mayo	Foley (2000)
Sino-Tibetan	Burmese, Chepang, Chin: Bawm, Chin: Hakk, Chinese: Hakka, Chinese: Mandarine, Chinese: Yue, Dumi, Garo, Kayah: Eastern, Ladakhi, Lahu, Lepcha, Limbu, Meiti, Rawang, Tibetan: Central, Wayu	Wichmann et al. (2010)
Siouan	Lakota	Wichmann et al. (2010), Mithun (2001)
Solomons-East Papuan	Lavukaleve	Bellwood (1991)
Tacanan	Araona	Wichmann et al. (2010)
Tai-Kadai Tol	Dong: Northern, Lao, Thai Tol	Wichmann et al. (2010)
Torricelli	Bukiyip	Wichmann et al. (2010)
Totonacan	Totonac: Yecuatla	Wichmann et al. (2010)
Trans-New Guinea	Amele, Bongu, Citak: Tamnim, Dani: Lower Grand Valley, Kewa: West, Kobo, Kombai, Ono, Suena, Una, Usan, Yagaria	Wichmann et al. (2010)
Tucanoan	Barasana-Eduria, Tanimuca: Retuara, Tucano	Adelaar (2004)
Tupian	Cocama-Cocamilla, Siriono, Udmurt	Wichmann et al. (2010)
Uralic	Erzya, Finnish, Hungarian, Kaapor, Mansi Nenets,	Wichmann et al. (2010)

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Table E.1 – continued from previous page

Language Family	Languages in the Family	Sources
Uto-Aztecan	Cahuilla, Comanche, Nahuatl: Eastern Huasteca, Nahuatl: Northern Puebla, Nahuatl: Telelcingo, Pipil, Timbisha, Tohono-Oodham, Yaqui	Mithun (2001), Wichmann et al. (2010)
Wakashan	Nootka	Wichmann et al. (2010), Mithun (2001)
Warao	Warao	Durbin (1985)
West Papuan	Abun, Hatam, Mai Brat, Tidore	Wichmann et al. (2010)
Yanomam	Sanuma	Durbin (1985)
Yele	Yele	Trudgill (2004)
Yeniseian	Ket	Wichmann et al. (2010)
Yukaghir	Southern Yukaghir	Uhlenbeck (1940)
Zuni	Zuni	Mithun (2001)
Other	Angolar, Aukan, Bunaba, Hawaiian Creole English, Tayo	