Diversity and the World's Endangered Languages

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Ninety percent of the world's languages face extinction within the next century. Many social scientists attribute this to increased trade, despite a lack of empirical work exploring this relationship. This paper empirically tests whether mutual trade incentives affect language vitality for thousands of ethnolinguistic groups. We find that at the language level, groups that are more likely to trade are less likely to face extinction, in contrast to claims that trade is a threat to diversity. In fact, greater mutual trade incentives are significantly associated with more ethnolingusitic fractionalization at the country level.

Keywords: Diversity, economic incentives, language extinction.

JEL Codes: O1, Z1.

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1. Introduction

Ninety percent of the world's languages face extinction within the next century (McWhorter, 2015), and more than a third of currently active languages will not be passed on to the next generation (Simons & Lewis, 2013). Scholars of language usually attribute this looming annihilation of ethnolinguistic diversity to globalization. However, this conclusion is mostly built on case studies of threatened languages, rather than a global empirical investigation. Even among case studies, research rarely tries to identify the particular types of trade that harm diversity. Indeed, it is often taken for granted that trade will only ever quash diversity, despite a positive correlation between diversity and markets in the economics literature (Montalvo & Reynal-Querol, 2021). That said, economic research rarely considers endangered languages. These individually small groups may, collectively, shape economically important measures of ethnolinguistic heterogeneity. Accordingly, the relationship between trade and the survival of ethnolinguistic diversity remains poorly understood.

In this paper we empirically demonstrate that trade affects the vitality of thousands of languages. To do this we rely on data that measures the potential gains from local agricultural trade. This measure (from Blouin and Dyer (2022)) is based only on agricultural suitability and human nutritional needs, so it is plausibly exogenous. It captures how much each ethnolinguistic group gains from trading with each neighbouring group, and how much each of their neighbours gains from trading with them. We use this to identify which groups have large mutual gains from trade with their neighbours. In other words, the data measure where local cross-cultural trade is most likely to occur. After using this data to explore whether trade affects language endangerment, we aggregate to the level of countries, and test whether the dynamics of language vitality are substantial enough to impact the various measures of country-level diversity.

To do this requires two additional types of data, in addition to the trade data mentioned above. First, we rely on data scraped from the Ethnologue (Lewis, 2009) that codes languages according to the Expanded Graded Intergenerational Disruption Scale (EGIDS) of language vitality. Despite the Ethnologue being ubiquitous within economics, this information on the changing status of languages has infrequently been investigated. This has led to an incomplete picture of diversity and economic development, since half of groups in our data are currently undergoing either significant growth or decline. We combine this with oft-used measures of country level diversity that have been linked to important outcomes such as conflict, quality of government, and trust.

We find that language groups that are more likely to trade are less likely to face extinction, in contrast to some of the claims of the market's role in language homogenization. In such situations, trade appears to promote specialization rather than homogenization. This is consistent with work showing that a shared context leads to location-specific human capital and group formation (Michalopoulos, 2012) and that areas of greater ethnic heterogeneity are associated with more markets and economic growth (Montalvo & Reynal-Querol, 2021). However, this average effect hides considerable heterogeneity. In particular, the estimate is driven predominantly by groups who would have been categorized as 'threatened' if they were less likely to trade, and are instead classified as 'non-dominant.' We see little effect of trade on the vitality of official national or provincial languages.

Economic incentives therefore play an important role in the dynamics of language vitality, especially for endangered languages. The next natural question is whether these dynamics, in turn, impact country-level diversity. This is a potentially important issue, given the evidence that ties ethnolinguistic diversity to poor economic development at the country-level. Seminal work, for instance, shows that ethnic fractionalization is negatively related to quality of government and growth (Alesina et al., 2003). We find that greater mutual trade incentives are associated with countries being fractionalized into smaller groups. This is true whether we use the standard Ethnolinguistic Fractionalization measure (Alesina et al., 2003), an alternative measure of Fragmentation (Fearon, 2003), a Cultural Diversity measure (Desmet et al., 2009; Fearon, 2003; Greenberg, 1956),[1] or simply the number of ethnolinguistic groups in a country (Michalopoulos, 2012). Despite trade primarily impacting the vitality of small, endangered language groups, when considered together the survival of these groups significantly increases fractionalization. Understanding the factors that shape fractionalization is crucial both because of its demonstrated close relationship with economic development, and because it is important to understand when and how fractionalization is endogenous.

The same empirical relationship does not, however, hold for measures of diversity that capture polarization. The impact of mutual trade incentives is small and insignificant when we consider outcomes such as Ethnic Polarization (Esteban & Ray, 1994, 2011; Reynal-Querol, 2002). This is true regardless of whether or not we compute polarization using cultural distances (Desmet et al., 2012). The same is true for Peripheral Heterogeneity (Desmet et al., 2009), which captures the sum of differences between the largest group and all others. These measures of heterogeneity have also been shown to affect economic development through various mechanisms. Peripheral heterogeneity is associated with redistribution (Desmet et al., 2009) and polarization with conflict (Esteban et al., 2012; Esteban & Ray, 2011; Reynal-Querol, 2002). Our finding that trade impacts fractionalization but not these measures of heterogeneity is consistent with the language-level finding that trade encourages the survival of endangered languages.

All together, the contribution of this article is to show that economic trade is an important determinant of diversity because it supports the survival of endangered languages. To show this we introduce new data on language vitality, and complement this

[1] Cultural Diversity refers to fractionalization weighted by linguistic distance (Fearon, 2003).

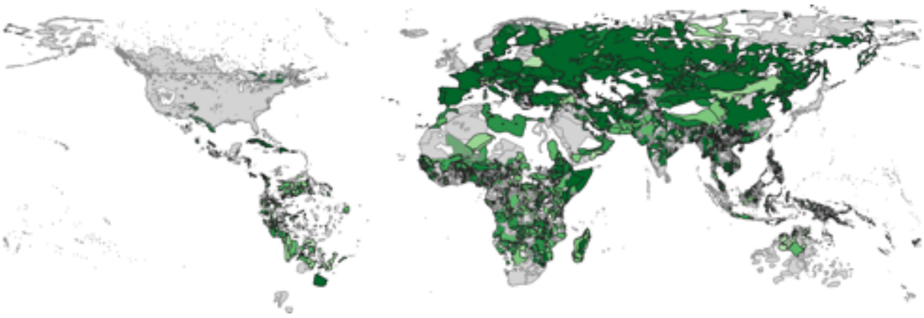
data with the main measures of diversity in the literature. Beyond those mentioned above, work by Alesina et al. (2016) shows that economic inequality determines the *impact* of diversity. They show that a measure of inequality across ethnicities dominates other population-based heterogeneity measures in explaining economic performance. We present evidence that trade incentives positively influence this measure as well, although the fact that the variable combines notions of diversity and inequality (both of which are plausibly influenced by trade) complicates the interpretation. Similarly, we also consider Ethnic Segregation (Alesina & Zhuravskaya, 2011). This measure accounts not only for the population of each group, but also their geographic dispersion. As this measure incorporates mechanisms such as integration and internal migration, interpreting the impact of trade incentives is also less clear. Nevertheless, we show that mutual trade incentives are also positively associated with this type of diversity.

While a large literature documents the economic impact of diversity, there is less work examining the endogeneity of diversity, with a few notable exceptions. The seminal work on the topic demonstrates that variation in elevation and land quality is associated with more diversity (Michalopoulos, 2012). Suggestive evidence points towards one channel being that location-specific human capital accumulation constrains the migration of members of an ethnolinguistic group. Conversely, Dickens (2022) shows that greater geographic heterogeneity between neighbouring groups leads to greater linguistic similarity. Ahlerup and Olsson (2012) show that the relationship between peripheral and core populations in a group leads to the endogenous emergence of new groups. Blouin and Dyer (2022) show that power dynamics within cross-cultural relationships shape the patterns and direction of cultural convergence. Jha (2013) shows that historical incentives for inter-group interaction lead to higher contemporary ethnic tolerance.

Finally, the investigation into language extinction contributes to a small but growing literature on cultural change, rather than culture as a fixed constraint. Giuliano and Nunn (2021) explore the role of environmental stability in the determining the strength of cultural persistence. Bisin and Verdier (2021) introduce the use of phase diagrams as a tool to explore cultural change over time.

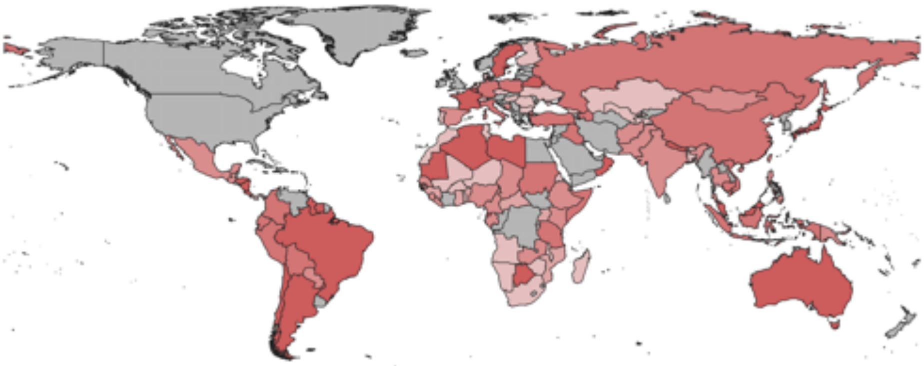
2. Data: Vitality, Diversity, and Trade Incentives

To study dynamics and economic implications of endangered language survival we need three pieces of information. First is whether groups are dwindling or thriving. To measure this, we draw upon the best-practice coding system to classify languages according to their level of intergenerational disruption. Second is how these dynamics shape country-level diversity. To measure this we collect the most common measures in the literature on ethnolinguistic heterogeneity. Third is to measure the incentive for groups to trade with each other. To this end, we use estimated trade incentives, based on plausibly exogenous

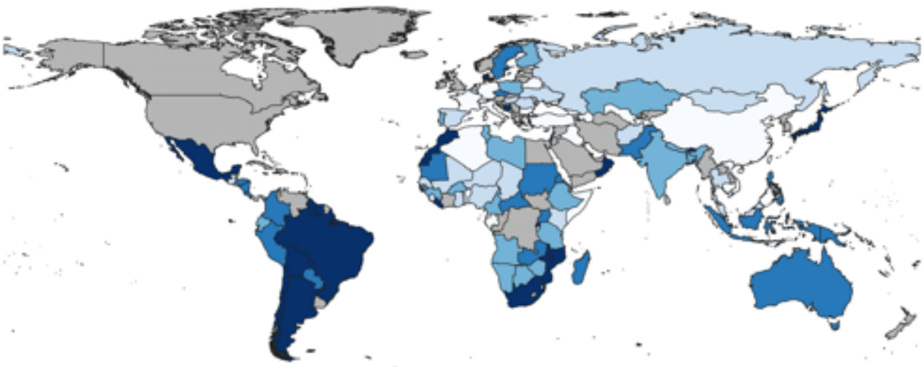


(a) Language Vitality Score

(b) Language-Level Mean Trade Incentives



(c) Country-Level Share of Languages that are Threatened



(d) Country-Level Mean Trade Incentives

Figure 1: Global Language Vitality and Mutual Trade Incentives

Description: These maps show, in panels a) and b) mean pairwise mutual trade incentives across the world, and the vitality of different language groups. In panels c) and d) we show what these measures look like when aggregated to the country level.

complementarity of geographic endowments.

Summary statistics are in table A1,[2] and the geographic distribution of both trade and ethnolinguistic diversity can be seen in figure 1. We next give a detailed discussion of each of these three types of data.

2.A. Measuring Language Vitality

There is a vast and growing literature on ethnolinguistic diversity. However, the survival of individual ethnolinguistic groups has so far received little attention from economists. We address this by compiling the meticulous work carried out by linguists to classify languages according to their vitality and disruption along a standardized scale.

The data that we introduce (to economics) in this article categorize the vitality of each language. Specifically, we extract EGIDS scores, developed by Lewis and Simons (2010), and assigned to each language in the Ethnologue database (Lewis, 2009). These EGIDS scores are assigned on a 13 point scale, ranging from languages of 'International,' 'National,' or 'Provincial' importance, through to languages that are 'Nearly Extinct,' 'Dormant,' or 'Extinct.'[3]

The process of categorizing languages into one of these groupings followed four steps. First, Lewis and Simons (2010) reviewed the academic literature covering each language, and categorized any languages where there was enough academic work to do so. Second, in cases where this information was not available, they consulted UNESCO's *Atlas of the World's Languages in Danger* (Moseley, 2010), which also provides statistics on language use that allow for categorization. From these two steps, about two thirds of languages could be categorized. For the remaining one-third, they imputed an initial categorization of 'Vigorous Oral Use,' which is the modal category across the world. Finally, they then sent this first-draft of the data to a panel of 43 regional-experts. Based on the expertise of the panel, many updates and corrections were implemented.

Conceptually, we are interested in three types of languages. First are the dominant languages that drive many measures of diversity, like ethnolinguistic polarization. Second, the stable languages whose survival is not under threat but who are not dominant at the national or regional level. Finally, the groups whose survival is under threat, and are at greatest risk of being absorbed by other groups. To this end, we group languages into three intuitive categories *dominant*, *non-dominant*, and *threatened*.[4]

The first stylized fact that should be stressed is that language groups are dynamic. We present the distribution of languages in figure B1. This histogram shows that roughly a third of languages are listed as *Threatened*, while just under a third are *Shifting*. In

[2]Balance tests are in table A2.
[3]Supplementary information on the original construction of categories is in section B2.
[4]The definition of each category in the EGIDS is in table B1, which also shows the groupings into dominant, non-dominant and threatened.

short, the majority of the world's languages are in flux. This is particularly pertinent given the tendency within the economics literature to treat the existence and distribution of languages as static (Bisin & Verdier, 2014). Further inspection of the distribution shows that, in fact, a very small share of the world's languages are dominant nationally, provincially, or regionally.

2.B. Measuring Country-level Diversity

We measure the ethnolinguistic diversity of countries using standard measures in the economics literature. These roughly fall into two categories: those that measure the degree to which a country is fragmented into many small groups (which we will call fractionalization-style measures) and those that measure to what degree a country is partitioned into competing blocks (which we will refer to as polarization-style measures).

The first type of country-level diversity measure captures the concept of fractionalization. This group of variables measures the degree to which a country is split into many different ethnolinguistic groups. We consider a number of standard fractionalization measures that are commonly used in the literature.[5] First, we use the Ethnolinguistic Fractionalization measure (henceforth ELF), first introduced in Alesina et al. (2003). Second, we explore the Fragmentation index (F), taken from Fearon (2003). F and ELF are computed in the same way - both capture the probability that if two random people from the country meet, they are from different groups. That said, they are not close to being perfectly correlated (table A5a). The difference between them is that Fearon (2003) goes to considerable lengths to base F on an underlying data set that captures how much people actually identify with a particular ethnic group, in a particular country. Conversely, ELF is based on the ethnographies of outsiders.

We also explore two other related measures. Inspired by work on cultural distance (Desmet et al., 2012; Fearon, 2003; Greenberg, 1956), we construct Cultural Diversity (CD). CD is a fractionalization measure that is weighted by cladistic language distance (i.e. the extent of overlap in the branches of a language tree).[6] Lastly, building off of Michalopoulos (2012), we also look at the logarithm of the number of ethnolinguistic groups in a country. All of these measures share the characteristic that they are largest when a country's population is split into a large number of groups.

To complement this, we consider polarization-style measures of diversity that tend to place greater weight on the distribution of the population that belongs to the larger, more dominant ethnic groups in a country.[7] If the survival of potentially threatened languages has a negligible impact on the population of large influential groups, it is possible that

[5] See supplementary details from original source in table A3.

[6] This approach is used in a number of other applications (Blouin, 2021; Desmet et al., 2009; Greenberg, 1956).

[7] See supplementary details from original source in table A4.

the impact of mutual trade incentives on fractionalization may differ markedly from the impact of trade on these other measures.

We first consider Ethnic Polarization (EP) (Esteban & Ray, 1994, 2011; Reynal-Querol, 2002). EP takes into account each group's size, and versions of it also consider the linguistic distance between them and another group. This measure, which has been associated with greater conflict (Esteban & Ray, 2011; Reynal-Querol, 2002; Reynal-Querol & Montalvo, 2005), is maximized (holding distances constant) when a country is divided into two equally large groups. Following Desmet et al. (2012) we consider variations of this measure considering group cleavages occurring at different depths of the linguistic family tree. We also examine Peripheral Heterogeneity (PHI) (Desmet et al., 2009), which takes the sum of the distance between the central (largest) group and all peripheral (other) groups, weighted by group sizes.[8]

Finally, we also consider two complex measures of diversity that are not solely population based, but incorporate other aspects of integration.[9] For this reason, the interpretation is not as straightforward as with the measures discussed above. Ethnic Inequality (EI) (Alesina et al., 2016) is a measure of fractionalization that accounts for wealth inequality. Ethnic Segregation (ES) (Alesina & Zhuravskaya, 2011) captures the degree to which the populations of different groups are segregated across sub-regions of a country. This is maximized when a country has groups living in separate sub-regions. Since both wealth and migration may also be linked to trade incentives, it is not clear that any relationship with mutual trade incentives is driven solely by the survival of threatened languages. The analysis of these outcomes, therefore, is more suggestive in nature.

2.C. Estimating Local Agricultural Trade Incentives

To measure the incentive for each language-group to trade with each other, we use pairwise language-group data on welfare gains from agricultural trade. This measure is generated based upon a combination of the methodological approach of Costinot and Donaldson (2012) and the insight that groups aim to maximize nutrients consumed, in the spirit of Galor and Özak (2016). In particular, we use the measure in Blouin and Dyer (2022), who introduce this data in greater detail and carry out a number of validation exercises. Importantly, gains from trade in this model are plausibly exogenous, as they arise from complementarity in geographic characteristics.

More specifically, Blouin and Dyer (2022) estimate the welfare gains from local agricultural trade that each group receives via trade with each other group. The data is restricted to language group pairs that are geographic neighbours, and for each of these pairs we observe the incentives for one group to trade with the other, and vice-versa. These need not be the same, and often are not. Trade incentives are structurally esti-

[8] The correlations among fractionalization and polarization measures are in table A5a and A5b.
[9] See supplementary details from original source in table A6.

mated using a rudimentary model of Ricardian trade in agricultural products, based on Costinot and Donaldson (2012). The model in Costinot and Donaldson (2012) is augmented with nutrititional data - building on Galor and Özak, 2015 - who model caloric suitability instead of simple agricultural suitability. Inspired by this insight, utility is modeled as a function of meeting the necessary nutritional requirements for survival. In short, complementarity in geographically-determined potential production of calories and sixteen essential nutrients generates the incentive to trade across ethnolinguistic groups.

The data used to estimate gains from trade are based on production suitability for forty-nine crops covering the entire world, from the Global Agro-Ecological Zones (GAEZ) data-set (IIASA/FAO, 2012).[10] These data determine the production potential of each crop for each ethnolinguistic group, and therefore allow for estimation of the supply-side of the model. Nutritional information is used to model demand for agricultural goods. This demand function generates estimates of equilibrium prices, and ultimately gains from trade. This information is based on the nutrients that are known to be essential in the diet (Chipponi et al., 1982) and the Dietary Reference Intakes (DRI) (compiled by the NAS Institute of Medicine (2006)) as the target amounts of each nutrient.

The model produces a few key pieces of information. Most importantly, it delivers the consumption utility of each group. We include this as a control throughout the analysis and also use to construct gains from trade. In particular, to compute the gains to one group (i) from trading with another (j), we take the utility of group i when they are able to trade with the entire region (U_i^{FT}), and compare this to their utility under the counterfactual when j is not in the region (U_i^{FT-j}). This captures gains from exchange between i and j, as follows:

(1)
$$\gamma_{ij} = \frac{U_i^{FT} - U_i^{FT-j}}{U_i^{FT-j}}$$
$$\iota_{ij} = \frac{U_j^{FT} - U_j^{FT-i}}{U_i^{FT-i}}$$

Because the trade incentives are not symmetric, we are able to compute the extent to which group i gains from trading with group j (γ_{ij}) as well as the extent to which group j benefits from trading with i. When both i benefits from trading j, and j benefits from trading with i, we will say that there exist mutual gains from trade. We interpret these mutual gains from trade as a measure of the likelihood of trade.

[10] Estimates are based on the potential yield for rain-fed crops using low levels of inputs, as in Galor and Özak (2016).

3. How trade impacts the survival of languages

In this section we explore the dynamics of language survival. We first describe the language-level empirical strategy, and then review the resulting empirical estimates.

3.A. Empirical Specification

For analysis at the language level we regress language vitality on trade incentives, controlling for country fixed effects and a variety of additional variables. Our main variables of interest capture the incentives for a group to trade with each of their J neighbours.

$$\gamma_i = \sum_{j}^{J} \frac{\gamma_{ij}}{J} \qquad (2)$$

$$\iota_i = \sum_{j}^{J} \frac{\iota_{ij}}{J}$$

$$\mu_i = \sum_{j}^{J} \frac{\gamma_{ij} \times \iota_{ij}}{J}$$

We interpret these variables as the group's average gain from trade (γ_i), the average gains from trade for their neighbours (ι_i), and the mutual gains from trade (μ_i). The idea behind μ_i is that it represents the likelihood that trade takes place. A trading relationship is more likely when both parties find it beneficial to trade with the other, and is unlikely if either party does not find it beneficial. The interpretation of μ_i as proportional to the likelihood of trade stems from the fact that the gains from trade variables assume frictionless trade, which does not seem realistic in reality. Because of this, the larger is interaction in the two gains from trade, the more likely it is that the benefit of trade for both parties exceeds their respective trade costs. We include all three of these variables in a regression as follows:

$$v_i = \beta_0 + \beta_1\mu_i + \beta_2\gamma_i + \beta_3\iota_i + \mathbf{X}_i'\Gamma + \alpha_c + \epsilon_i \qquad (3)$$

where $\mathbf{X}$ is a vector of controls,[11] and α_c represents country (c) fixed effects. The outcome, v_i, is the vitality of language i.[12]

[11] This includes the mean and the standard deviation of the group's area share in their neighbourhood, the share of their land that is arable, the diversity of a group's land, as well as their level of utility under trade and their mean level of neighbours' utility under trade.

[12] We estimate this as a linear regression, and semiparametrically using the Verardi and Debarsy (2012) implementation of the Robinson (1988) estimator. An overview (drawn heavily from Verardi and Debarsy (2012)) is in appendix C3.

Our primary interest is in β_1, which can be interpreted as the average effect of an increased likelihood of trade, on language vitality. Capturing the correct counterfactual is slightly tricky. In equation 3, β_1 is the estimate of trade likelihood relative to the case where neither a group nor their neighbours have any incentive to trade. However, this is not the only relevant counterfactual. Consider the four possible scenarios: (I) trade incentives are high for both, so trade is likely; two scenarios (II and III) where trade incentives are high for one party but low for the other, so trade is unlikely; and (IV) the scenario where trade incentives are low for both parties, so trade is unlikely.

β_1 captures the difference between (I) and (IV), while β_2 and β_3 capture the difference between (II) or (III) and (IV). The inclusion of γ_i and ι_i in equation 3 can make a difference to the estimate of β_1 if, in scenario (II) or (III), the group that finds trade more profitable has the option to strategically assimilate to reduce trade costs, and facilitate trade with the other groups. In this case, if we only included the variable μ_i, and not γ_i and ι_i, the estimate would reflect a comparison between (I) and all three scenarios where trade was unlikely (the combination of II-IV). However this estimate would be impossible to interpret because trade incentives would be influencing both the treatment group and the control group, but for different reasons. Accordingly, the cleanest estimate is the effect of likely trade (I) relative to the scenario where there are no trade incentive effects at all (IV). This, as we have already mentioned, is reflected by the parameter β_1 in equation 3.

That said, other comparisons may also be of interest, but they can be recovered from equation 3 as well. Most obviously, the more nuanced potential homogenizing effect of trade incentives when trade is unlikely could also be of interest. This would be captured by β_2 and β_3. Furthermore, the effect of mutual trade incentives relative to the other cases when trade is unlikely could be of interest. These effects can be recovered by examining the difference between β_1 and either of β_2 or β_3. We will consider each of these as we discuss the results that follow.

3.B. Results: Trade Incentives and Language Vitality

We turn now to the relationship between mutual trade incentives and the survival of languages. In particular, the results highlight that when mutual trade incentives are high, languages become less likely to be threatened, and more likely to be stable. This can be seen most clearly in table 1.[13] Column 1 suggests that larger mutual trade incentives are associated with a higher language vitality score, implying that trade makes languages more stable.

This overall relationship between mutual trade incentives and vitality score, however, obscures the details of what exactly happens to the languages that are under threat of

[13] The analogous semiparametric relationship is in figure A1.

Table 1: Trade Incentives and Language Vitality

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	1.916	0.055	0.284	-0.338
(μ_i, Mutual Trade Incentives)	(0.499)***	(0.041)	(0.156)*	(0.157)**
Trade is Unlikely: Neighbour Doesn't Gain	-1.040	-0.025	-0.156	0.182
(γ_i, Mean Trade Incentives)	(0.319)***	(0.027)	(0.092)*	(0.094)*
Trade is Unlikely: Only Neighbour Gains	-0.827	-0.011	-0.122	0.133
(ι_i, Partner Trade Incentives)	(0.288)***	(0.025)	(0.092)	(0.092)
Arable Land Share	✓	✓	✓	✓
Land Diversity	✓	✓	✓	✓
Utility Level under Trade	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Country Fixed Effects	✓	✓	✓	✓
Num. Observations	2530	2530	2530	2530
R^2	0.341	0.363	0.243	0.242

Note: The unit of observation is a language-group. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This table presents the impact of trade incentives on language vitality with the Vitality Scale as the first outcome, ranging from 1-12 with a higher number indicating greater vitality. We next break this scale into three intuitive categories in columns 2-4.

extinction. To see this more clearly, we present results on the likelihood of a language falling into each of our three groupings of vitality categorizations: dominant languages, non-dominant languages, and threatened languages. We find that mutual trade incentives reduce the likelihood that a language is threatened, and increase the likelihood that it is non-dominant. Meanwhile, there is no effect on dominant languages.

This result appears to be quite robust. For instance, in table A7 we show robustness to different ways of constructing mutual gains from trade. The relationship is also significant, separately, for three of the four regions that make up the bulk of the sample (table A8). It is also robust to adjusting the thresholds that define the categories of vitality (table A9). Finally, in table A10 we drop the category *Vigorous* because it was used as a default category during data construction, and doing so increases the precision of the estimates.

While our focus is on mutually beneficial trade, it is also worth noting that in table 1 the coefficient on γ_i typically follows the opposite pattern to mutual trade incentives. This suggests that, when a group has high gains from trade with their partners – but that this is not reciprocated – this group's language is more likely to be threatened. One reason for this could be that the endangered language group simply fully integrates with the group they would like to trade with. In other words, trade *incentives* in the absence of *actual* trade tend to be a force for assimilation, while mutual trade incentives (i.e. actual inter-group trade) tends to preserve diversity.

Figure 2 dis-aggregates the effect even further. The figure plots the coefficients for mutual trade incentives for each of the individual language categorizations in the EGIDS, in order from most threatened to the most vital. This is an important robustness check given the way that the EGIDS data was initially constructed by Lewis and Simons (2010). In particular the category 'Vigorous Oral Use' was initially imputed prior to being reviewed by regional experts. It may therefore reflect that there is very little information that is known about a language. Accordingly it would be a concern if estimates were primarily driven by this category, or were sensitive to how the category was treated empirically.

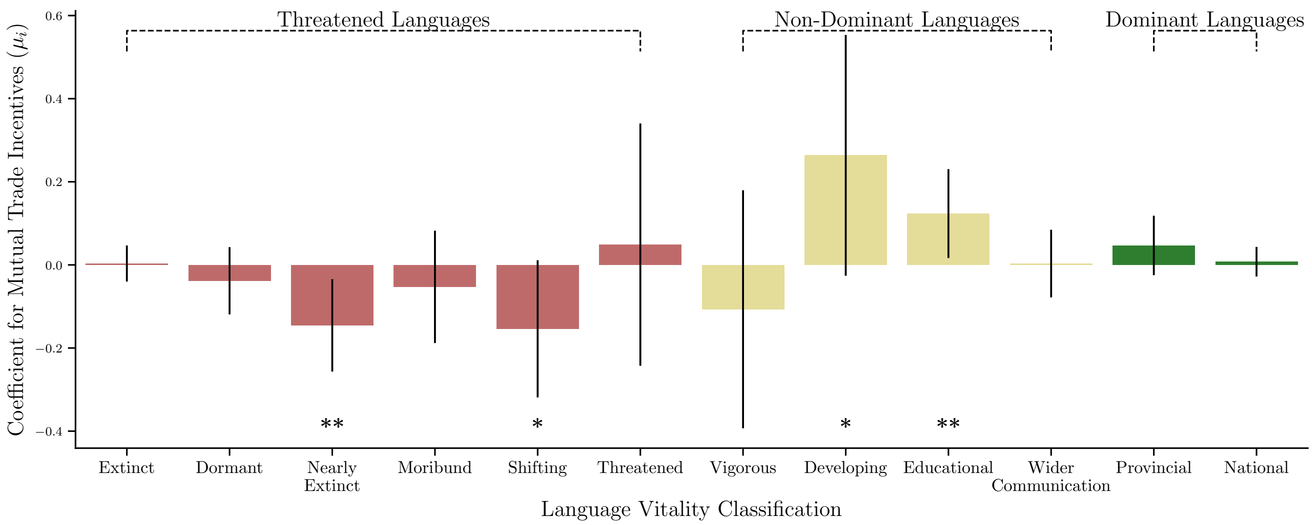


Figure 2: Regression Coefficients by Language Vitality Class

Note: Error bars represent estimates of μ_i (Mean Mutual Trade Incentives), from equation 3, where the outcome is a binary indicator variable for a language belonging to each EGIDS classification in turn. 95% confidence intervals presented. *** p<0.01, ** p<0.05, * p<0.1.

In the figure, each bar plots the value of β_1 (the coefficient on μ_i) from a regression where the outcome is an indicator variable for a language being assigned the given classification. The results reinforce the pattern in the aggregated categories. Mutual trade incentives make it less likely that a language falls into one of the threatened categories and more likely to be non-dominant. Interestingly, most of the effect seems to come from the 'Nearly Extinct' category, which is far less common when mutually beneficial trade is more prevalent. These languages instead appear to be categorized as either 'Developing' or 'Educational' when trade is mutually beneficial. Once again, we do not find much evidence that trade influences categorization into either the 'Provincial' or 'National' language categories. Importantly, results do not appear to be driven at all by the 'Vigorous Oral Use' category, which may contain a combination of legitimately vigorously used languages and missing data.

4. How trade impacts country-level diversity

The results above show that trade incentives impact the survival prospects of potentially endangered languages. We now explore whether the dynamics of trade incentives and threatened languages are large enough to impact common measures of country-level heterogeneity. As before, we begin by describing our empirical specification and how we generate the country-level data. We then review the results, first for the fractionalization-style measures, and then for the polarization-style measures.

4.A. Empirical Specification

For analysis at the country level we take the means of our key variables across groups in a country (c). The set of country-level variables are constructed as follows:

$$\bar{x_c} = \sum_{i \in c}^{I_c} \frac{x_i}{I_c} \quad \forall \ x \in \{\gamma, \iota, \mu\} \tag{4}$$

Which aggregate from the language-level (i) to the country level (c) by taking the mean over all language-groups in each country (I_c), for each of mutual trade incentives ($\bar{\mu_c}$), gains from trade ($\bar{\gamma_c}$), and trade influence ($\bar{\iota_c}$).

We then regress the diversity measures on the country-level trade variables as follows:

$$ELF_c \;=\; \beta_0 + \beta_1 \bar{\mu_c} + \beta_2 \bar{\gamma_c} + \beta_3 \bar{\iota_c} + \mathbf{X}_c' \Theta + \epsilon_c \tag{5}$$

This specification is analoguous to the language-level specification in equation 3. In this case, $ELF_{c,r}$ is the measure of diversity for country c in region r. $\mathbf{X}_c$ is a set of country level controls.[14]

4.B. Results: Fractionalization-style measures of diversity

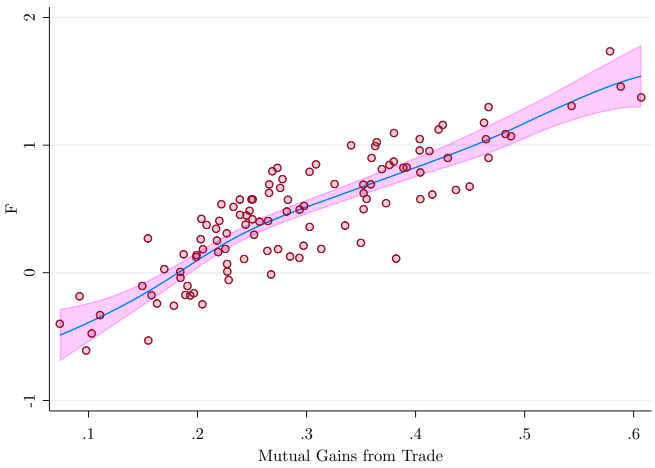
We first tackle the country-level relationship between trade and the fractionalization-style measures of ethnolinguistic heterogeneity. As already discussed, these measures are maximized in countries with a large number of small language groups. The language-level results showed that mutual trade incentives are associated with fewer endangered languages. Endangered languages tend to be small but are quite numerous. It is therefore not clear how much impact they would have on country-level measures of diversity, but if they did, we would expect fractionalization to be greater when mutually beneficial trade is more prevalent.

The results can most easily be seen in figure 3. For each of ELF (panel a), F (panel b), the number of groups (panel c), and CD (panel d) we see a strong positive association with trade incentives, which is reflected in the linear regressions as well (table A11).[15] There may be some concerns about country-level measures of fractionalization being endogenous to the impact of the size of states, artificial borders, the partitioning of ethnic groups,

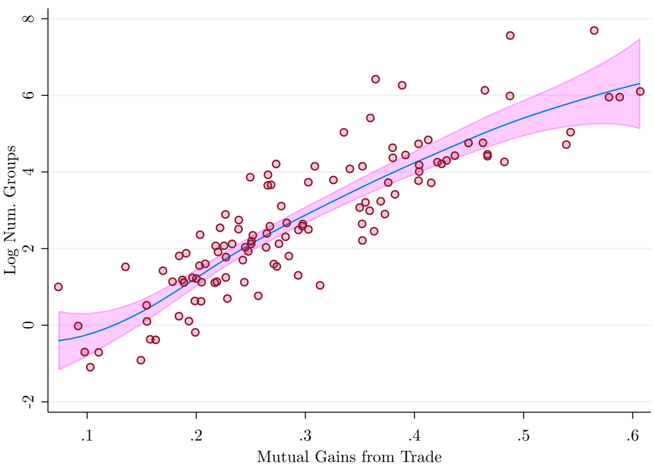
[14] These include ethnic inequality in area, the log area of the country, and the log population of the country. We also include the mean of the language-level controls and the area share controls in equation 3.

[15] A version of this table with an alternate set of additional controls is in table A12.

(a) Ethnolinguistic Fractionalization (ELF)



(b) Ethnic Fragmentation (F)



(c) Log. Number of Ethnic Groups

(d) Cultural Diversity (CD)

Figure 3: Trade Incentives and Fractionalization

These figures present the semiparametric relationship (estimated using the Verardi and Debarsy (2012) implementation of Robinson (1988)) between trade incentives and various country-level measures of diversity. Shaded area represents 95% confidence intervals. For ease of comparison these figures are truncated at the same level of automatic trimming above which data is sparse ($\mu_i = 0.65$) in the figures for distribution measures of diversity. The analogous linear regressions are presented in table A11.

or other national institutions. To address these concerns we conduct a supplementary robustness exercise in appendix D4 and show that this positive relationship is robust to using synthetically constructed countries using grid cells of various sizes, in the spirit of Montalvo and Reynal-Querol (2021).

For the four main measures of fractionalization, the pattern in the country-level data echoes the results from the language level. Mutual trade incentives impact the survival of individual languages, and the aggregate effect of this has an influence on country-level diversity. This endogeneity implies that caution is in order when interpreting estimates of the impact of fractionalization on economic outcomes as causal. In addition, simply understanding the factors that contribute to maintaining diversity is a concern for many scholars. In particular, the idea that economic trade can support linguistic diversity is certainly not the consensus, so the estimates help to improve our understanding of when linguistic diversity is truly under threat.

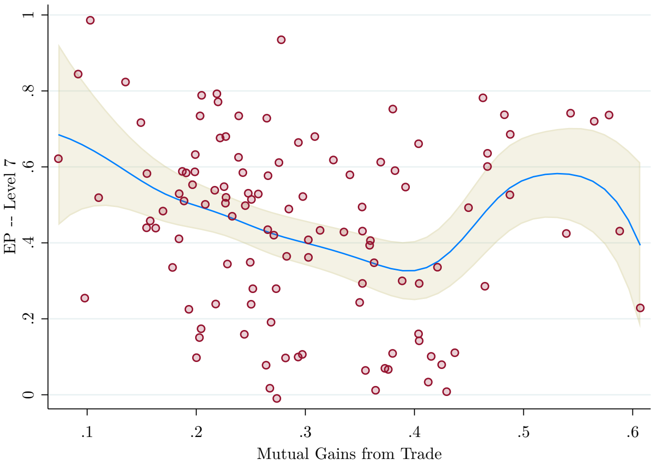
4.C. Results: Polarization-style measures of diversity

While there is evidence of a strong positive relationship between mutual trade incentives and fractionalization, in this section we argue that no similar relationship holds for the polarization-style measures that tend to place greater weight on larger, more influential ethnolinguistic groups.

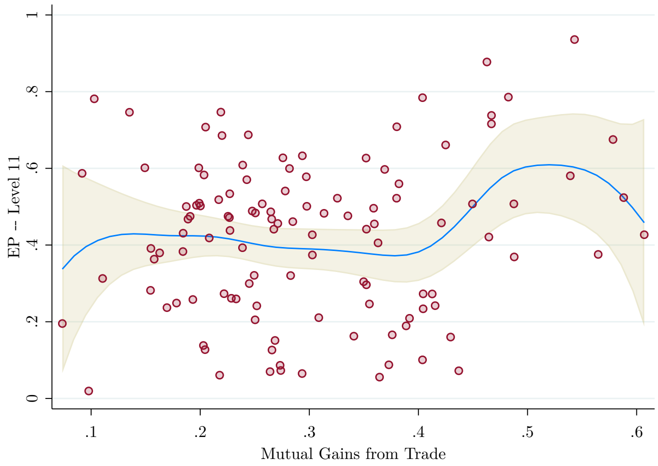
This is quite important, because for many outcomes that are crucial for economic growth, such as conflict, the evidence has shown that the most important aspect of diversity is the distribution of population across large groups. In this case it is EP that matters, which captures how close the distribution of population among ethnicities is to two equal-sized groups.

However, EP does not appear to be influenced by trade incentives. This can be visualized in figure 4a, and the analogous regression results are in table A13. We explore the effect using different cultural distance thresholds to define different groups in panels b and c, and results look similar. Table A13 presents the difference between estimates for polarization, and corresponding estimates for fractionalization (i.e. computed using the same group-defining thresholds). In each case the fractionalization estimate is significantly larger. Overall, the effect of trade incentives on group survival does not seem to correspond to how the population is distributed among the large groups. Other measures of heterogeneity - that are not necessarily maximized with a large number of small groups - look similar. For instance, consider the PHI, which captures the aggregate linguistic distance between the central group and other smaller groups. As with EP, we find no effect on this outcome (figure 4d).

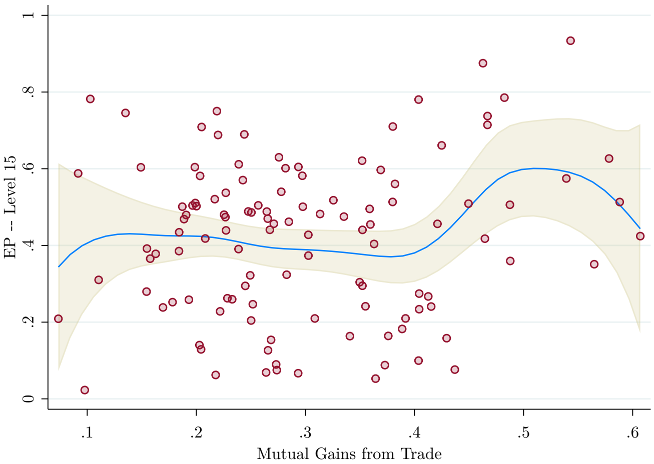
Overall, even though trade increases the vitality of potentially-threatened languages, it has no effect on measures of heterogeneity that place greater emphasis on the distribution of larger groups in society. One plausible explanation that is consistent with all three measures is that when languages die, those who would have otherwise spoken the now dead language instead speak other small, regional languages. This explanation is also consistent with the estimates from the language-level analysis, which highlighted opposite effects for the likelihood of being non-dominant and threatened, but no effect on dominant languages. This suggests some substitute-ability between non-dominant languages. Further, people who would have otherwise spoken now extinct languages do not



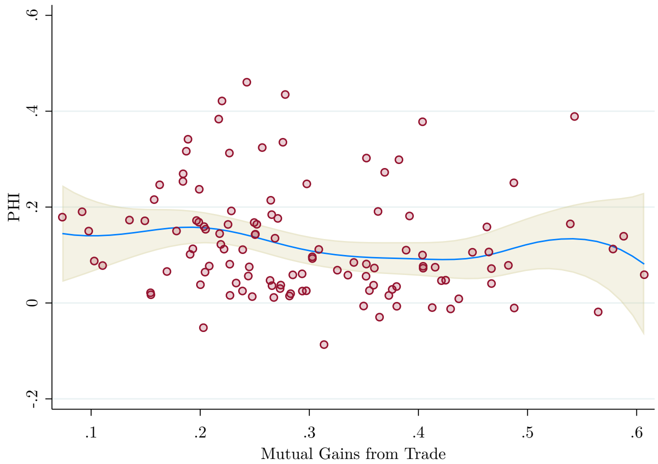
(a) Polarization, calculated using 7 levels of the language family tree



(b) Polarization, calculated using 11 levels of the language family tree



(c) Polarization, calculated using 15 levels of the language family tree



(d) Peripheral Heterogeneity Index (PHI)

Figure 4: Trade Incentives and Distribution Measures of Diversity

These figures present the semiparametric relationship (estimated using the Verardi and Debarsy (2012) implementation of Robinson (1988)) between trade incentives and various country-level polarization-style measures of diversity. Shaded area represents 95% confidence intervals. For ease of comparison these figures are truncated at the same level of automatic trimming above which data is sparse ($\mu_i = 0.65$) in the figures for distribution measures of diversity. The analogous linear regressions are in table A13.

necessarily adopt the regional *lingua franca*.[16]

[16] A country-level version of this analysis is in table A14 where the outcomes are the *share* of languages in a country falling into different categories. We find that countries with greater mutual trade incentives have a greater share of non-dominant languages. Mutual trade incentives are also associated with a lower share of dominant languages, though this may be largely mechanical, due to the greater number of threatened language groups surviving.

4.D. Results: Complex Measures of Diversity

The two measures of fractionalization that we have not yet highlighted are Ethnic Inequality (EI) and Ethnic Segregation (ES). While EI would increase with a larger number of groups, it is also weighted by wealth inequality, which is also plausibly linked to trade. Similarly, while ES would increase with a larger number of groups, it is weighted by population mixing and migration, which is also plausibly linked to trade. Accordingly any relationship between mutual trade incentives and these two outcomes may not be solely due to the improved survival of threatened languages. Nevertheless, we show the relationship between mutual trade incentives and both EI and ES in figures A2a and A2b respectively. As with the other fractionalization-style measures, there appears to be a positive and significant relationship.

5. Discussion

While economic interaction and exchange are often taken to be a homogenizing force, we argue that when neighbouring groups trade with each other, these incentives can actually sustain diversity. In fact, the effect is large enough that it has a significant effect on country level measures of fractionalization. This suggests caution when making causal assertions about the relationship between fractionalization and economic development. We do not, however, find a similar effect on polarization.

Moreover, we show that economic incentives play a significant role in shaping the survival prospects of individual language groups. In particular, where trade between two groups is mutually beneficial, this helps potentially threatened groups to survive. This encouraging insight suggests that it is essential to consider the type of incentives created by economic changes. Rather than entirely avoiding economic interaction, survival depends on shaping the right economic incentives. Since globalization seems largely impossible to avoid, this observation may offer some aid to those seeking to sustain the thousands of languages facing extinction in the near future.

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Appendix A. Supplementary Exhibits

Table A1: Summary Statistics

	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	Num. Observations
Panel A: Language Level Variables						
Share of land that is arable	.969	1	.13	.808	1	2,530
Group a estimated utility under trade	2.5	2.32	1.7	.188	5.45	2,530
Group Land Diversity	24,661	10,630	37,997	0	102,007	2,530
Distance between group a, group b centroids.	4.29	4.23	1.11	2.62	6.17	2,530
Distance between language pair families	.621	.667	.278	.114	1	2,530
Group population, 1000s	1,326	14.5	18,649	.15	2,212	2,530
Neighbourhood Area Share (1-100 pct)	11	5.49	14.4	.0614	41.5	2,530
Rank (0-1): Gain From Trade ($\gamma_i = \sum_j^J \frac{\gamma_{ij}}{J}$)	.52	.516	.222	.132	.907	2,530
Rank (0-1): Partner Gain From Trade ($\iota_i = \sum_j^J \frac{\iota_{ij}}{J}$)	.518	.497	.204	.184	.899	2,530
Mean Pairwise Minimum Gains ($\mu_i = \sum_j^J \frac{min\{\gamma_{ij},\iota_{ij}\}}{J}$)	.417	.405	.198	.0828	.777	2,530
Mean Pairwise Interacted Gains ($\mu_i = \sum_j^J \frac{\gamma_{ij}\times\iota_{ij}}{J}$)	.316	.288	.2	.026	.701	2,530
Language Vitality Score	7.1	7	1.72	4	10	2,530
Dominant Language (1/0)	.0391	.	.194	.	.	2,530
Non-dominant Language (1/0)	.633	.	.482	.	.	2,530
Threatened Language (1/0)	.328	.	.469	.	.	2,530
Panel B: Country Level Variables						
Mean Arable Land Share	0.918	0.996	0.168	0.571	1.000	119
Mean Utility Under Trade	2.756	2.560	1.612	0.374	5.334	119
Std.Dev Neighbourhood Area Share	0.069	0.051	0.071	0.000	0.218	119
Std.Dev Neighbourhood Area Share	0.090	0.058	0.100	0.002	0.257	119
Mean Land Diversity	37.146	23.250	43.063	0.447	110.608	119
Mean Utility Gain Interaction	0.313	0.276	0.145	0.135	0.578	119
Mean Utility Gain	0.530	0.509	0.141	0.307	0.785	119
Spatial Inequality	0.506	0.496	0.249	0.110	0.893	119
Ethnic Inequality in Area	0.671	0.717	0.192	0.295	0.895	119
Log Land Area	10.196	10.324	1.644	7.510	12.520	119
Log Population (2000)	16.259	16.155	1.603	13.105	18.804	119

Note: Summary statistics for language and country level variables.

Table A2: Covariate Balance

	Means			Medians		
	Trade Incentives Below Median	Trade Incentives Above Median	p	Trade Incentives Below Median	Trade Incentives Above Median	p
Panel A: Language Level Variables						
Share of group a land that is arable	0.965	0.973	0.130	1.000	1.000	0.790
Group Land Diversity	25,002	24,249	0.612	10,543	10,716	0.928
Panel B: Country Level Variables						
Spatial Inequality	0.475	0.538	0.165	0.485	0.587	0.170
Ethnic Inequality in Population	0.723	0.721	0.960	0.782	0.729	0.333
Ethnic Inequality in Area	0.691	0.650	0.236	0.757	0.660	0.011
Log Land Area	10.179	10.213	0.909	10.223	10.340	0.742
Log Population (2000)	16.448	16.067	0.196	16.215	16.145	0.260
Terrain Ruggedness Index, 100 m.	1.286	1.252	0.877	0.804	0.913	0.857
% Fertile soil	36.451	37.198	0.858	34.143	32.281	0.983
Dummy for landlocked countries	0.317	0.203	0.162	0.000	0.000	0.161
Border artificality measure	31.989	27.974	0.515	20.700	18.000	0.214
Mean Arable Land Share	0.907	0.929	0.479	0.996	0.997	0.669
Mean Utility Under Trade	2.946	2.563	0.197	2.670	2.326	0.331
Abs. Value of Latitude from Equator	28.084	20.019	0.009	30.412	15.365	0.013

Note: Covariate balance for language and country level variables.

Table A3: Fractionalization Measures of Ethnic Heterogeneity

Measure	**Acronym**	**Short Description**	**Quoted Description**
Ethnolinguistic Fractionalization	ELF	Computed as one minus Herfindahl index of population shares of ethnolinguistic groups	*"The ethnolinguistic fractionalization variable (often referred to as ELF) was computed as one minus the Herfindahl index of ethnolinguistic group shares, and reflected the probability that two randomly selected individuals from a population belonged to different groups. We use the same formula, applied to different underlying data, to compute our measures of fractionalization:* $FRACT_j = 1 - \sum_{i=1}^{N} s_{ij}^2$ *where s_{ij} is the share of group i ($i = 1, \ldots, N$) in country j."* quoted from Alesina et al. (2003)
Ethnic Fragmentation	EF	This is a version of the fractionalization measure after carefully taking into account the salience of ethnicity and the way the data is constructed and coded.	*"Implicit in the idea of an ethnic group is the idea that members and non-members recognize the distinction and anticipate that significant actions are or could be conditioned on it. So it is natural and perhaps necessary that the "right list" of ethnic groups for a country depend on what people in the country identify as the most socially relevant ethnic groupings. [...] Ideally, the standard for 'the right list' that I am seeking would be defined by a procedure like the following:* *1. Randomly sample a large number of people in the country.* *2. Ask each of them to list the major or main ethnic groups in the country.* *3. Show them or read a list of many possible formulations of the ethnic groups in the country, and ask them to say of which they consider themselves members.* *4. Repeat (3), asking them to say of which groups on the list most other people in the country would consider them to be members.* *5. Ask them to try to rank the groups they identified in (3) according to how strongly they identify with the group (e.g., which is 'most important to you,' or some such language).* *[...] Without survey data of this sort, we are forced to review existing lists and secondary sources to apply this standard"* quoted from Fearon (2003, p.198-199)
Cultural Diversity	CD	A version of the fractionalization measure but taking into account the importance of distance between groups as discussed in Desmet et al. (2012).	*"To construct a measure of "cultural fractionalization" analogous to the ethnic fractionalization measure F discussed above, consider drawing two people at random from a country and then computing their expected cultural resemblance, using rij as defined above. In a country with one language group or a set of ethnic groups that all speak highly similar languages, the expected resemblance will be close to 1. In a country with a large number of groups that speak structurally unrelated languages, the expected resemblance will be closer to zero. To get a fractionalization measure analogous to ethnic fractionalization, simply subtract expected cultural resemblance from 1. [...] Formally, cultural fractionalization is $1 - \sum_{i=1}^{n} \sum_{j=1}^{n} p_i p_j r_{ij}$, where p_i is the proportion of group i and n is the number of groups."* quoted from Fearon (2003, p.212 and p.220)

Note: This table summarizes the main measures of fractionalization used in the literature and gives an intuitive explanation of their construction and the phenomena they are intended to capture.

Table A4: Polarization Measures of Ethnic Heterogeneity

Measure	**Acronym**	**Short Description**	**Quoted Description**
Ethnic Polarization	EP	This measures polarization, which would be maximized with two groups of equal size, unlike fractionalization which is maximized with a large number of small groups.	*"We propose an index of ethnic polarization originally proposed by ReynalQuerol (2002) with the form* $$RQ = 1 - \sum_{i=1}^{N} \left(\frac{1/2 - \pi}{1/2}\right)^2 \pi_i$$ $$RQ = 4\sum_{i=1}^{N} \pi_i^2(1-\pi_i)$$ *The original purpose of this index was to capture how far the distribution of the ethnic groups is from the (1/2, 0, 0, ... 0, 1/2) distribution (bipolar), which represents the highest level of polarization."* quoted from Reynal-Querol and Montalvo (2005) and based on the measure originally proposed in Reynal-Querol (2002). Following Desmet et al. (2012) we define this measure at various levels of aggregation: *This paper seeks to measure linguistic diversity at different levels of aggregation. To do so, we use language trees. We refer to this as a phylogenetic approach (as the linguistics literature does), referring to the fact that tree diagrams capture the genealogy of languages, classified in terms of their family structure.* quoted from Desmet et al. (2012, p.324) We therefore use measures of polarization which account group divisions occurring within the first seven, eleven and fifteen branches of the language family tree.
Peripheral Heterogeneity	PH	This is a type of *social effective antagonism* index that considers the sum over all group-pairs of linguistic distance between the largest (or 'central' group) and peripheral groups (i.e all but the central group), weighted by group sizes.	*"The third [distance] matrix, denoted by T^c, assumes there is a center group c, such that $\tau_{jk} = 0$ if $j \neq c$ and $k \neq c$. This implies that only the distances between the central group and the other (peripheral) groups matter. [. . .] The A-index is* $$A(0, T^c) = 2\sum_{j=1}^{K} s_j s_c \tau_{cj}$$ *where the central group c is the largest. [. . .] It is important to point out that PH is a variant of GI, with the difference that it takes into account the alienation between the center and the peripheral groups, but not between the peripheral groups themselves."* quoted from Desmet et al. (2009)

Note: This table summarizes the main distribution-based measures of diversity used in the literature and gives an intuitive explanation of their construction and the phenomena they are intended to capture.

Table A5: Correlation between outcomes: Fractionalization and Polarization

(a) Correlation of Fractionalization Measures

	Ethnolinguistic Fractionalization (ELF)	Ethnic Fragmentation (F)	Log. Number of Ethnic Groups	Cultural Diversity (CD)
Ethnolinguistic Fractionalization (ELF)	1.000			
Ethnic Fragmentation (F)	0.743***	1.000		
Log. Number of Ethnic Groups	0.593***	0.460***	1.000	
Cultural Diversity (CD)	0.407***	0.432***	0.676***	1.000

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Ethnolinguistic Fractionalization is from Alesina et al. (2003), Ethnic Fragmentation is from Fearon (2003), Log. number of ethnicities is from Alesina et al. (2016) and Cultural Diversity is based on Fearon (2003) and the original construction in Greenberg (1956).

(b) Correlation of Polarization Measures

	Ethnic Polarization (EP)			Peripheral Heterogeneity Index (PHI)
	Level 7	Level 11	Level 15	
Ethnic Polarization (EP), Level 7	1.000			
Ethnic Polarization (EP), Level 11	0.791***	1.000		
Ethnic Polarization (EP), Level 15	0.788***	1.000***	1.000	
Peripheral Heterogeneity Index (PHI)	0.553***	0.504***	0.505***	1.000

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Ethnic Polarization measured at different levels of aggregation is from Desmet et al. (2012) and Peripheral Heterogeneity Index is from Desmet et al. (2009).

Table A6: Complex Measures of Ethnic Heterogeneity

Measure	Acronym	Short Description	Quoted Description
Ethnic Inequality	EI	Captures inequality across ethnic groups using a Gini coefficient computed using luminosity to measure mean income in an ethnic group's homeland	*"We proxy the level of economic development in ethnic homeland i with mean luminosity per capita, y_i; and we then construct an ethnic Gini coefficient for each country that reflects inequality across ethnolinguistic regions. Specifically, the Gini coefficient for a country's population consisting of n groups with values of luminosity per capita for the historical homeland of group i, y_i, where $i = 1$ to n are indexed in nondecreasing order ($\leq y_{i+1}$), is calculated as follows:* $$G = \frac{1}{n}\left[n + 1 - 2\frac{\sum_{i=1}^{n}(n+1-i)y_i}{\sum_{i=1}^{n} y_i}.\right]$$ *The ethnic Gini index captures differences in mean income—as captured by luminosity per capita at the ethnic homeland—across groups."* quoted from Alesina et al. (2003)
Ethnic Segregation	ES	This measures the degree to which groups are spatially segregated. We use the theoretically correct version which accounts for small subgroups that are counted as 'Other' in the data.	*"...we define our baseline index of segregation for country i as follows:* $$S^i = \frac{1}{M^i - 1}\sum_{m=1}^{M^i}\sum_{j=1}^{J^i}\frac{t_j^i}{T^i}\frac{\left(\pi_{jm}^i - \pi_m^i\right)^2}{\pi_m^i}$$ *where T^i is the total population of country i, t_i^j is the population of region j in country i, and J^i is the total number of regions in country i. [...] In particular, π_m^i is the fraction of group m in country i, and π_{jm}^i is the fraction of group m in region j of country i. [...] One important issue is how to handle the category "other." [...] assume that the group "others" is composed of a number of distinct and small subgroups O that data availability does not permit us to properly classify. Assume also that there is no segregation within the "other" category, i.e., the subgroups of the "other" category are uniformly distributed across all regions. Denote the number of identified groups by n. Then, under these assumptions, one can rewrite the formula for the segregation index S as follows:* $$\hat{S} = \frac{1}{N + O - 1}\left(\sum_{m=1}^{N}\sum_{j=1}^{J}\frac{t_j}{T}\frac{(\pi_{jm} - \pi_m)^2}{\pi_m} + S_O\right)$$ *where* $$S_O = \sum_{j=1} J\frac{t_j}{T}\frac{(\pi_{jO} - \pi_O)^2}{\pi_O}$$ *The fraction of "others" in the whole population is represented by π_O, and π_{jO} is the fraction of others in the region j. "* quoted from Alesina and Zhuravskaya (2011, p.1880-1881)

Note: This table summarizes two measures of diversity that are not solely based on population of different groups used in the literature and gives an intuitive explanation of their construction and the phenomena they are intended to capture.

Table A7: Trade Incentives and Language Vitality - Alternate Constructions

(a) Minimum Rank as Mutual Pairwise Incentive

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	1.155	0.022	0.236	-0.258
(μ_i, Mutual Trade Incentives)	(0.429)***	(0.036)	(0.130)*	(0.131)**
Trade is Unlikely: Neighbour Doesn't Gain	-0.683	-0.009	-0.137	0.146
(γ_i, Mean Trade Incentives)	(0.297)**	(0.026)	(0.083)*	(0.084)*
Trade is Unlikely: Only Neighbour Gains	-0.498	0.004	-0.107	0.103
(ι_i, Partner Trade Incentives)	(0.267)*	(0.024)	(0.086)	(0.086)

Note: In this version we use $\tilde{\mu}_i = \frac{1}{J}\sum_{j=1}^{J} min\{\gamma_{ij}, \iota_{ij}\}$ as our measure of mean mutual trade incentives. Definition of outcomes, number of observations and control variables are the same as in table 1.

(b) Maximum Mutual Pairwise Incentive

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	0.807	0.071	0.112	-0.182
($\tilde{\mu}_i$, Max Mutual Trade Incentives)	(0.316)**	(0.033)**	(0.096)	(0.094)*
Trade is Unlikely: Neighbour Doesn't Gain	-0.220	-0.014	-0.072	0.086
(γ_i, Max Trade Incentives)	(0.242)	(0.023)	(0.069)	(0.069)
Trade is Unlikely: Only Neighbour Gains	0.471	0.016	0.058	-0.074
(ι_i, Max Partner Trade Incentives)	(0.245)*	(0.024)	(0.073)	(0.073)

Note: In this version we use $\tilde{\mu}_i = max_{j\in J}\{\gamma_{ij} \times \iota_{ij}\}$ as our measure of mean mutual trade incentives. Definition of outcomes, number of observations and control variables are the same as in table 1.

(c) Maximum Mutual Pairwise Incentive, Mean Unilateral

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	1.794	0.117	0.182	-0.299
($\tilde{\mu}_i$, Max Mutual Trade Incentives)	(0.169)***	(0.021)***	(0.050)***	(0.048)***
Trade is Unlikely: Neighbour Doesn't Gain	-1.028	-0.059	-0.111	0.171
(γ_i, Mean Trade Incentives)	(0.193)***	(0.017)***	(0.057)**	(0.057)***
Trade is Unlikely: Only Neighbour Gains	-0.718	-0.038	-0.068	0.106
(ι_i, Mean Partner Trade Incentives)	(0.194)***	(0.019)**	(0.060)	(0.059)*

Note: In this version we use $\tilde{\mu}_i = max_{j\in J}\{\gamma_{ij} \times \iota_{ij}\}$ as our measure of mean mutual trade incentives, but use the means of the unilateral trade incentives. Definition of outcomes, number of observations and control variables are the same as in table 1.

(d) Maximum Mutual Pairwise Incentive, Mean Unilateral using Minimum Gain

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	1.877	0.121	0.191	-0.311
($\tilde{\mu}_i$, Max Mutual Trade Incentives)	(0.180)***	(0.021)***	(0.054)***	(0.052)***
Trade is Unlikely: Neighbour Doesn't Gain	-1.002	-0.057	-0.109	0.165
(γ_i, Mean Trade Incentives)	(0.193)***	(0.017)***	(0.056)*	(0.056)***
Trade is Unlikely: Only Neighbour Gains	-0.790	-0.042	-0.076	0.118
(ι_i, Mean Partner Trade Incentives)	(0.197)***	(0.020)**	(0.061)	(0.060)*

Note: In this version we use $\tilde{\mu}_i = max_{j\in J}\{min\{\gamma_{ij} \times \iota_{ij}\}\}$ as our measure of mean mutual trade incentives, but use the means of the unilateral trade incentives. Definition of outcomes, number of observations and control variables are the same as in table 1.

Table A8: Trade Incentives and Language Vitality - Region-by-Region Results

(a) Latin America & Caribbean

	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	3.501	0.124	0.094	-0.217
(μ_i, Mutual Trade Incentives)	(1.485)**	(0.109)	(0.419)	(0.408)
Trade is Unlikely: Neighbour Doesn't Gain	-2.314	-0.099	-0.032	0.131
(γ_i, Mean Trade Incentives)	(0.966)**	(0.086)	(0.268)	(0.259)
Trade is Unlikely: Only Neighbour Gains	-1.913	-0.078	-0.131	0.209
(ι_i, Partner Trade Incentives)	(0.932)**	(0.068)	(0.256)	(0.249)
Num. Observations	266	266	266	266
R^2	0.272	0.198	0.213	0.217

(b) Sub-Saharan Africa

	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	2.342	0.025	0.574	-0.599
(μ_i, Mutual Trade Incentives)	(0.988)**	(0.085)	(0.307)*	(0.300)**
Trade is Unlikely: Neighbour Doesn't Gain	-1.040	-0.018	-0.260	0.278
(γ_i, Mean Trade Incentives)	(0.606)*	(0.046)	(0.178)	(0.173)
Trade is Unlikely: Only Neighbour Gains	-0.714	0.029	-0.238	0.210
(ι_i, Partner Trade Incentives)	(0.504)	(0.046)	(0.171)	(0.167)
Num. Observations	885	885	885	885
R^2	0.289	0.281	0.156	0.163

(c) South Asia

	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	5.792	0.635	0.679	-1.314
(μ_i, Mutual Trade Incentives)	(3.124)*	(0.627)	(0.897)	(0.782)*
Trade is Unlikely: Neighbour Doesn't Gain	-3.794	-0.356	-0.647	1.002
(γ_i, Mean Trade Incentives)	(1.467)**	(0.269)	(0.482)	(0.435)**
Trade is Unlikely: Only Neighbour Gains	0.288	0.079	-0.023	-0.055
(ι_i, Partner Trade Incentives)	(1.977)	(0.399)	(0.521)	(0.460)
Num. Observations	176	176	176	176
R^2	0.204	0.178	0.224	0.288

(d) East Asia and Pacific

	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	0.468	-0.016	0.078	-0.062
(μ_i, Mutual Trade Incentives)	(0.611)	(0.021)	(0.223)	(0.225)
Trade is Unlikely: Neighbour Doesn't Gain	-0.457	-0.001	-0.050	0.051
(γ_i, Mean Trade Incentives)	(0.425)	(0.014)	(0.134)	(0.135)
Trade is Unlikely: Only Neighbour Gains	-0.081	0.031	-0.054	0.023
(ι_i, Partner Trade Incentives)	(0.356)	(0.018)*	(0.138)	(0.139)
Num. Observations	939	939	939	939
R^2	0.324	0.300	0.184	0.188

Note: In this table we show results separately for the four regions that have at least one hundred and fifty observations, and make up the largest part of our sample. Definition of outcomes and control variables are the same as in table 1.

Table A9: Language Vitality - Modified Thresholds

	First Robustness Thresholds			Second Robustness Thresholds		
	(1) Dominant	(2) Non-Dominant	(3) Threatened	(4) Dominant	(5) Non-Dominant	(6) Threatened
Trade is Likely: Mutual Benefits	0.058	0.280	-0.338	0.055	0.332	-0.387
(μ_i, Mutual Trade Incentives)	(0.057)	(0.158)*	(0.157)**	(0.041)	(0.119)***	(0.115)***
Trade is Unlikely: Neighbour Doesn't Gain	-0.017	-0.165	0.182	-0.025	-0.159	0.184
(γ_i, Mean Trade Incentives)	(0.038)	(0.094)*	(0.094)*	(0.027)	(0.074)**	(0.071)***
Trade is Unlikely: Only Neighbour Gains	-0.026	-0.108	0.133	-0.011	-0.193	0.204
(ι_i, Partner Trade Incentives)	(0.036)	(0.094)	(0.092)	(0.025)	(0.070)***	(0.067)***
Arable Land Share	✓	✓	✓	✓	✓	✓
Land Diversity	✓	✓	✓	✓	✓	✓
Utility Level under Trade	✓	✓	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓	✓	✓
Country Fixed Effects	✓	✓	✓	✓	✓	✓
Num. Observations	2530	2530	2530	2530	2530	2530
R^2	0.277	0.221	0.242	0.363	0.242	0.225

Note: The unit of observation is a language-group. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In the first set of robustness classifications, we shift the threshold for being a Dominant language by one category, including Wider Communication, Provincial, and National. In the second set of robustness classifications, we move the threshold for being Threatened down one category, including all classes with vitality less than Shifting.

Table A10: Language Vitality - No 'Vigorous' Class

		Status Groupings (1/0)		
	(1) Vitality Score	(2) Dominant Language	(3) Non-Dominant Language	(4) Threatened Language
Trade is Likely: Mutual Benefits	2.723	0.073	0.500	-0.573
(μ_i, Mutual Trade Incentives)	(0.660)***	(0.057)	(0.178)***	(0.180)***
Trade is Unlikely: Neighbour Doesn't Gain	-1.427	-0.032	-0.267	0.299
(γ_i, Mean Trade Incentives)	(0.418)***	(0.038)	(0.105)**	(0.108)***
Trade is Unlikely: Only Neighbour Gains	-1.279	-0.015	-0.259	0.274
(ι_i, Partner Trade Incentives)	(0.377)***	(0.035)	(0.105)**	(0.104)***
Arable Land Share	✓	✓	✓	✓
Land Diversity	✓	✓	✓	✓
Utility Level under Trade	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Country Fixed Effects	✓	✓	✓	✓
Num. Observations	1879	1879	1879	1879
R^2	0.384	0.394	0.284	0.299

Note: The unit of observation is a language-group. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In this table we drop all language groups assigned to the 'Vigorous' language vitality class, which was assigned as the default classification in some cases, and which therefore may have the least accurate information.

Table A11: Country-Mean Trade Incentives and Fractionalization

	Ethnolinguistic Fractionalization (1)	Ethnic Fragmentation (2)	Log Num. Ethnic Groups (3)	Cultural Diversity (4)
Trade is Likely: Mutual Benefits	2.756	2.839	11.942	1.105
($\bar{\mu}_c$, Mutual Trade Incentives)	(1.060)**	(1.024)***	(2.835)***	(0.597)*
Trade is Unlikely: Neighbour Doesn't Gain	-1.108	-1.175	-5.693	-0.682
($\bar{\gamma}_c$, Mean Trade Incentives)	(0.481)**	(0.494)**	(1.676)***	(0.305)**
Trade is Unlikely: Only Neighbour Gains	-1.604	-1.257	-6.296	-0.566
($\bar{\iota}_c$, Partner Trade Incentives)	(0.724)**	(0.617)**	(1.876)***	(0.385)
Ethnic Inequality in Area	✓	✓	✓	✓
Log Area	✓	✓	✓	✓
Log Population (in 2000)	✓	✓	✓	✓
Mean Group Arable Share	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Num. Observations	119	112	119	119
R^2	0.289	0.283	0.604	0.410

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The unit of observation is a country. The variables $\bar{\mu_c}$ (Mean Mutual Trade Incentives), $\bar{\gamma_c}$ (Mean Trade Incentives), and $\bar{\iota_c}$ (Mean Partner Trade Incentives) are constructed as in equation 5. The outcomes variables are described in detail in section 2.B and all represent fractionalization-style measures of whether a country's population is split into many small groups.

Table A12: Trade Incentives and Fractionalization - Additional Controls

	Ethnolinguistic Fractionalization					Ethnic Fragmentation					Log. Num Ethnic Groups				Cultural Diversity				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Trade is Likely: Mutual Benefits	2.504	3.095	3.483	3.264	2.323	2.711	3.280	1.418	2.070	1.528	10.932	10.471	6.869	5.725	0.982	0.929	0.705	0.741	0.148
($\bar{\mu}_c$, Mutual Trade Incentives)	(1.038)**	(0.904)***	(0.794)***	(0.848)***	(0.776)***	(0.979)***	(0.887)***	(0.988)†	(0.831)**	(0.809)*	(2.897)***	(2.794)***	(2.780)**	(2.770)**	(0.609)†	(0.613)†	(0.684)	(0.694)	(0.638)
Trade is Unlikely: Neighbour Doesn't Gain	-0.823	-1.006	-1.412	-1.317	-0.891	-0.895	-1.066	-0.408	-0.691	-0.454	-4.547	-4.404	-3.088	-2.595	-0.542	-0.525	-0.483	-0.499	-0.230
($\bar{\gamma}_c$, Mean Trade Incentives)	(0.455)*	(0.442)**	(0.446)***	(0.469)***	(0.382)**	(0.489)*	(0.457)**	(0.474)	(0.373)*	(0.356)	(1.681)***	(1.651)***	(1.413)**	(1.474)*	(0.307)*	(0.306)*	(0.323)	(0.321)	(0.277)
Trade is Unlikely: Only Neighbour Gains	-1.576	-1.939	-1.955	-1.766	-1.259	-1.370	-1.718	-0.625	-0.923	-0.626	-6.184	-5.901	-4.068	-3.086	-0.553	-0.520	-0.359	-0.390	-0.070
($\bar{\iota}_c$, Partner Trade Incentives)	(0.721)**	(0.719)***	(0.574)***	(0.613)***	(0.473)***	(0.622)**	(0.590)***	(0.607)	(0.528)*	(0.478)	(1.797)***	(1.743)***	(1.816)**	(1.867)	(0.387)	(0.387)	(0.428)	(0.437)	(0.384)
Ethnic Inequality in Area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Log Area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Log Population (in 2000)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Group Arable Share	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Region Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Abs. Value of Latitude		✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
Ethnic Inequality in Population			✓	✓	✓			✓	✓	✓			✓	✓			✓	✓	✓
Spatial Inequality				✓	✓				✓	✓				✓				✓	✓
Log Num. Ethnic Groups					✓					✓									✓
Num. Observations	119	119	119	119	119	112	112	112	112	112	119	119	119	119	119	119	119	119	119
R^2	0.342	0.389	0.591	0.603	0.740	0.352	0.397	0.456	0.599	0.685	0.645	0.646	0.738	0.754	0.434	0.435	0.480	0.481	0.587

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, † p < 0.15. The unit of observation is a country. The variables $\bar{\mu_c}$ (Mean Mutual Trade Incentives), $\bar{\gamma_c}$ (Mean Trade Incentives), and $\bar{\iota_c}$ (Mean Partner Trade Incentives) are constructed as in equation 5. The outcomes variables are described in detail in section 2.B and all represent fractionalization-style measures of whether a country's population is split into many small groups.

Table A13: Country-Mean Trade Incentives and Polarization

	Ethnic Polarization			Peripheral Heterogeneity
	Level 7	Level 11	Level 15	
	(1)	(2)	(3)	(4)
Trade is Likely: Mutual Benefits	-0.416	0.562	0.514	-0.297
($\bar{\mu}_c$, Mutual Trade Incentives)	(1.058)	(0.937)	(0.933)	(0.502)
Trade is Unlikely: Neighbour Doesn't Gain	0.242	0.126	0.144	0.068
($\bar{\gamma}_c$, Mean Trade Incentives)	(0.462)	(0.446)	(0.446)	(0.240)
Trade is Unlikely: Only Neighbour Gains	-0.494	-1.249	-1.238	-0.025
($\bar{\iota}_c$, Partner Trade Incentives)	(0.667)	(0.630)*	(0.632)*	(0.282)
pvalue H_0: $\hat{\beta}_\mu^{POL} = \hat{\beta}_\mu^{FRAC}$	0.069	0.070	0.062	0.009
Ethnic Inequality in Area	✓	✓	✓	✓
Log Area	✓	✓	✓	✓
Log Population (in 2000)	✓	✓	✓	✓
Mean Group Arable Share	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Num. Observations	119	119	119	119
R^2	0.183	0.174	0.176	0.222

Note: The unit of observation is a country. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In columns 1-3 the outcome is a measure of Ethnic Polarization from Desmet et al. (2012) at different levels of aggregation, i.e. using different depths or 'levels' of classification in the family tree of languages to aggregate groups. The higher the level, therefore, the more fine-grained classification of groups. Here $\hat{\beta}_\mu^{POL}$ refers to the coefficient on $\bar{\mu}_c$ (Mutual Trade Incentives) from the regression with the standardized z-score of the given measure of polarization as the outcome. Here $\hat{\beta}_\mu^{FRAC}$ refers to the coefficient on $\bar{\mu}_c$ from the equivalent regression with the standardized z-score of fractionalization, computed at the corresponding level of aggregation as the given polarization measure, as the outcome. We compare to the regression with the standardized z-score of the standard ELF measure in Column 1 of table A11 as the outcome in the case of Peripheral Heterogeneity. The pvalues presented for rejecting H_0 show that the impact of mutual trade incentives on polarization is different to to the impact on fractionalization.

Table A14: Language Vitality (Country-Level)

		Share of Languages in Category (0-1)		
	Vitality Score (1)	Dominant Language (2)	Non-Dominant Language (3)	Threatened Language (4)
Trade is Likely: Mutual Benefits	-9.165	-3.702	4.489	-0.787
($\bar{\mu}_c$, Mutual Trade Incentives)	(7.357)	(1.242)***	(1.234)***	(1.222)
Trade is Unlikely: Neighbour Doesn't Gain	-0.357	1.133	-2.064	0.931
($\bar{\gamma}_c$, Mean Trade Incentives)	(3.222)	(0.512)**	(0.588)***	(0.580)
Trade is Unlikely: Only Neighbour Gains	11.171	3.020	-3.011	-0.010
($\bar{\iota}_c$, Partner Trade Incentives)	(5.271)**	(0.835)***	(0.802)***	(0.868)
Ethnic Inequality in Area	✓	✓	✓	✓
Log Area	✓	✓	✓	✓
Log Population (in 2000)	✓	✓	✓	✓
Mean Group Arable Share	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Num. Observations	119	119	119	119
R^2	0.399	0.433	0.316	0.276

Note: The unit of observation is a country. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In this table the outcomes are country-level aggregates of the language-level vitality measures. The outcome in Column 1 is the average vitality score of language groups in a country. The outcomes in Columns 2-3 are the shares of language groups in that country that fall into each of the Dominant, Non-Dominant and Threatened language vitality categories.

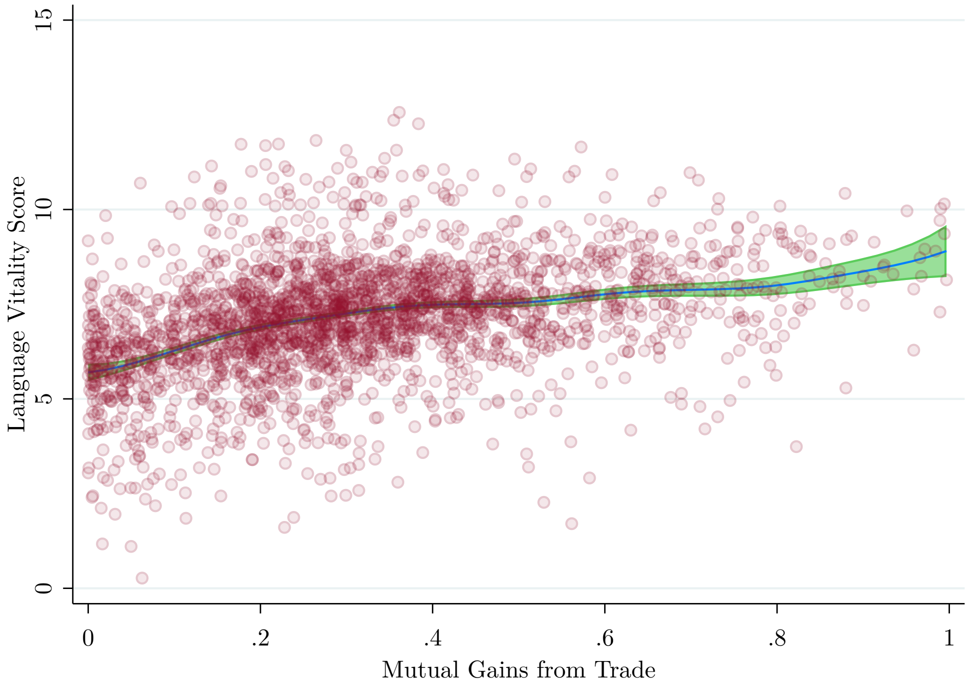
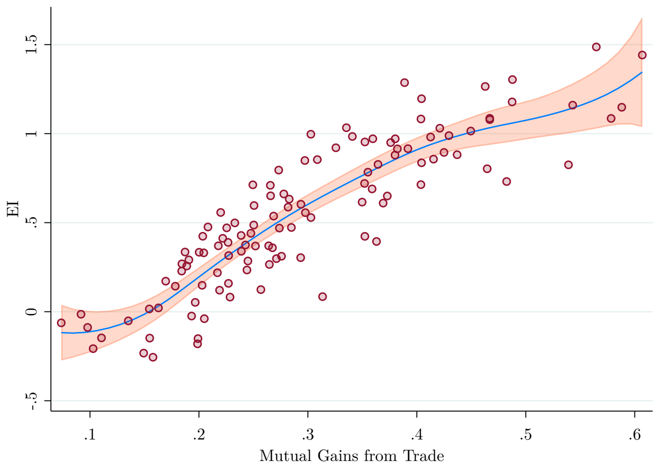
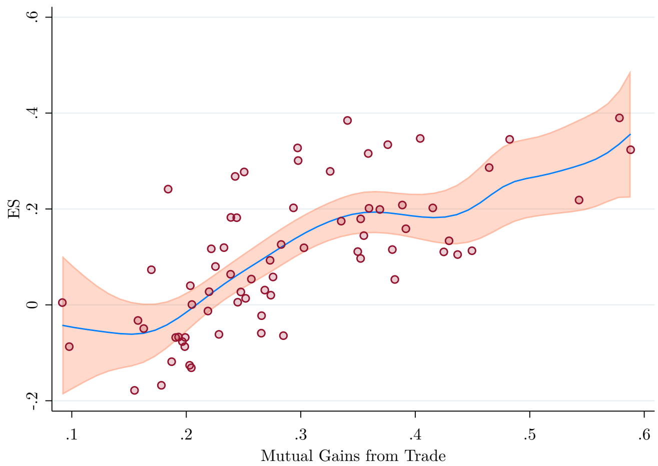


Figure A1: Trade Incentives and Language Vitality

Description: This figure shows the semiparametric relationship between trade incentives and language vitality (where a higher score means higher vitality) at the language level.



(a) Ethnic Inequality (EI)



(b) Ethnic Segregation (ES)

Figure A2: Trade Incentives and Language Vitality

Description: This figure shows the semiparametric relationship between trade incentives and two measures of ethnic diversity (Ethnic Inequality and Ethnic Segregation). These measures are not simple population identity-based measures, and include other aspects of income and where individuals live, making the conceptual relationship to trade incentives and language survival less clear. Nevertheless, there is a positive and significant relationship between mutual trade incentives and these measures of diversity.

Appendix B. Language Status Data

To measure the status of language groups, we extract scores assigned in the Ethnologue (Lewis, 2009) which follow the Expanded Graded Intergenerational Disruption Scale (EGIDS), developed by Lewis and Simons (2010), which is a more fine-grained version of the original Graded Intergenerational Disruption Scale introduced in Fishman (1991). We describe the coding of the EGIDS in table B1, taken from the Ethnologue website.[17] We scraped this information directly from the Ethnologue website using Python, by accessing the url associated with each three-letter Ethnologue code in our dataset. We then searched for a field named *Language Status* and extracted the associated text. We then checked if the associated string began with one of the categories in the table (*e.g.* *"6a (Vigorous)"*) and assigned the appropriate variable value if a match was found.[18]

Table B1: Expanded Graded Intergenerational Disruption Scale (EGIDS)

Grouping	Vitality Score	EGIDS Level	Label	Description
Dominant Language	13	0	International	The language is widely used between nations in trade, knowledge exchange, and international policy.
	12	1	National	The language is used in education, work, mass media, and government at the national level.
	11	2	Provincial	The language is used in education, work, mass media, and government within major administrative subdivisions of a nation.
	10	3	Wider Communication	The language is used in work and mass media without official status to transcend language differences across a region.
Non-Dominant Language	9	4	Educational	The language is in vigorous use, with standardization and literature being sustained through a widespread system of institutionally supported education.
	8	5	Developing	The language is in vigorous use, with literature in a standardized form being used by some though this is not yet widespread or sustainable.
	7	6a	Vigorous	The language is used for face-to-face communication by all generations and the situation is sustainable.
Dominant Language	6	6b	Threatened	The language is used for face-to-face communication within all generations, but it is losing users.
	5	7	Shifting	The child-bearing generation can use the language among themselves, but it is not being transmitted to children.
	4	8a	Moribund	The only remaining active users of the language are members of the grandparent generation and older.
	3	8b	Nearly Extinct	The only remaining users of the language are members of the grandparent generation or older who have little opportunity to use the language.
	2	9	Dormant	The language serves as a reminder of heritage identity for an ethnic community, but no one has more than symbolic proficiency.
	1	10	Extinct	The language is no longer used and no one retains a sense of ethnic identity associated with the language.

Note: This table describes how we map the EGIDS coding of language status in the Ethnologue (Lewis, 2009) into the variable we use in our analysis. The original GIDS scale was developed by Fishman (1991) and expanded into the EGIDS by Lewis and Simons (2010). Descriptions of each category taken from the Ethnologue website: https://www.ethnologue.com/about/language-status

We choose to assign each detailed category a separate variable value as the distinction between them appears to contain relevant information for our analysis. For example, the difference between *6a (Vigorous)* *"The language is used for face-to-face communication by all generations and the situation is sustainable"* and *6b (Threatened)* *"The language*

[17] https://www.ethnologue.com/about/language-status

[18] On the Ethnologue website, some coding assessments are marked as a best guess by the Ethnologue editorial team. Exact explanation: *"We use an asterisk as a modifier on the EGIDS estimate to indicate that it represents our editorial best guess. Thus 5* or 6a* indicates a language that we think is most likely to be in vigorous use by all, while 6b* indicates a language that we believe is most likely to be losing speakers."*. We accept these estimates as accurate and so in our data we consider, for example, *6b** and *6b* to be equivalent and assign them the same score.

is used for face-to-face communication within all generations, but it is losing users" is valuable information in terms of language sustainability.[19] We therefore arrive at a 13-point increasing scale for language vitality, with 13 representing the strongest languages of international significance, and 11 representing extinct languages.

After extracting data in this way, we are able to find information on the Ethnologue pages for 6,181 groups. Of these seventeen didn't include a field for *Language Status* or used a non-EGIDS classification and are dropped from the sample.[20]

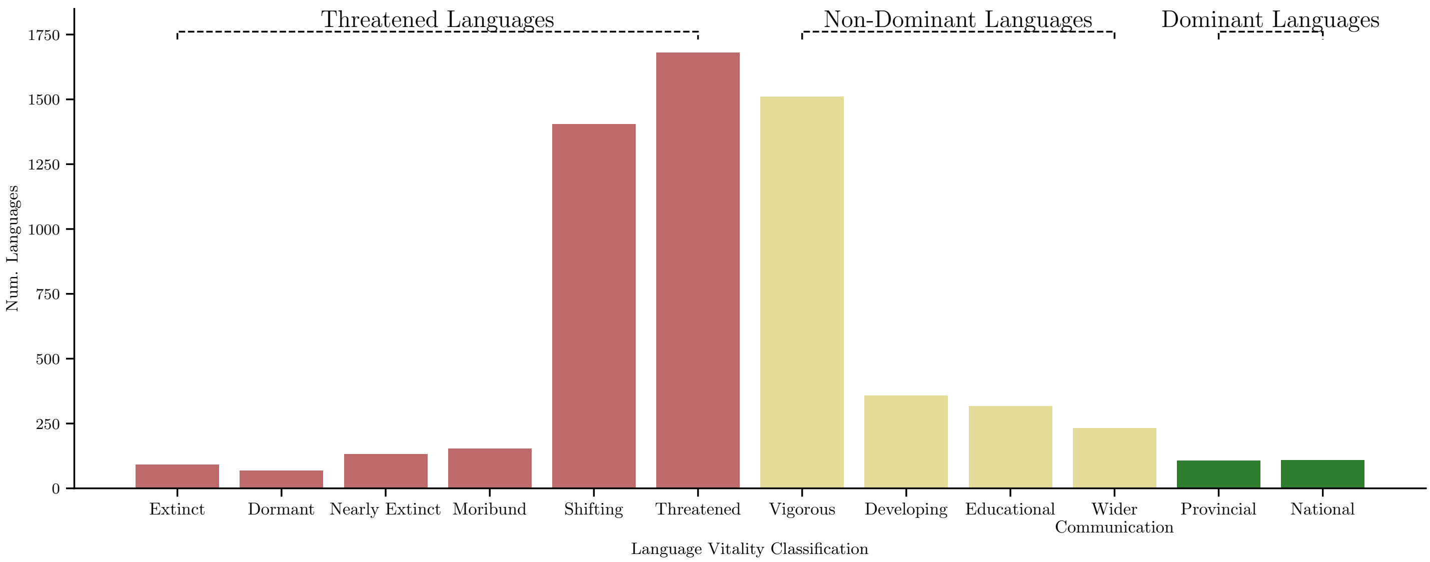


Figure B1: Distribution of Language Vitality Classes

Note: The figure shows the distribution of language vitality classifications.

[19]This importance is also recognized by the editorial board of the Ethnologue: *"From the point of view of sustaining language use, the single most significant break in the EGIDS scale is the divide between 6a and 6b. For languages that are 6a and higher, it is the norm that the language is being learned by all the children within its user community. But at level 6b and below, this is no longer the norm and intergenerational transmission is being disrupted." (quoted from https://www.ethnologue.com/about/language-info*

[20]These non-EGIDS classifications were *9 (Reawakening)* or *9 (Second language only)*.

Appendix C. Overview of Semiparametric Regression Methodology

The semiparametric estimates in this paper use the Verardi and Debarsy (2012) implementation of the Robinson (1988) estimator. In this section we provide a brief overview of the estimator, drawn heavily from Verardi and Debarsy (2012) who provide a more detailed explanation.

The double residual methodology in Robinson (1988) can be used to estimate general models of the following type:

$$y_i = \theta_0 + \mathbf{x}_i\theta + f(z_i) + \varepsilon_i \quad i = 1, \ldots, N \tag{6}$$

where y_i is the dependent variable, $\mathbf{x}_i$ is the vector of variables that enter the model parametrically, and z_i is the variable that enters the model nonparametrically. The first step is to take expectation conditional on z_i of both sides:

$$E(y_i|z_i) = \theta_0 + E(\mathbf{x}_i|z_i)\theta + f(z_i) \quad i = 1, \ldots, N \tag{7}$$

and then subtract this from the original model:

$$y_i - E(y_i|z_i) = [\mathbf{x}_i - E(\mathbf{x}_i|z_i)]\,\theta + \varepsilon_i \quad i = 1, \ldots, N \tag{8}$$

The estimated coefficients $\hat{\theta}$ are then recovered by OLS estimation of the model above after fitting conditional expectations of $\mathbf{x}_i$ conditional on z_i, denoted as $\hat{m}_{\mathbf{x}_i}$:

$$y_i - \hat{m}_y(z_i) = [\mathbf{x}_i - \hat{m}_{\mathbf{x}}(z_i)]\,\theta + \varepsilon_i \quad i = 1, \ldots, N \tag{9}$$

With the estimated coefficients $\hat{\theta}$ in hand, the nonlinear function $f(z_i)$ can be fit by nonparametric estimation of the following model:

$$y_i - \mathbf{x}_i\hat{\theta} = \theta_0 + f(z_i) + \varepsilon_i \quad i = 1, \ldots, N \tag{10}$$

In the semiparametric regressions presented in the figures in this paper, we present exactly these nonparametric fits of $f(z_i)$ where z_i is always the measure of mutual gains from trade (μ_i at the language level and $\bar{\mu}_c$ at the country level).

Appendix D. Synthetic Countries

We supplement our analysis of ethnolinguistic diversity at the country level with a robustness exercise based on the construction of synthetic countries. We show that the relationship between mutual trade incentives and ethnolinguistic fractionalization is robust to using synthetic countries of various sizes. This exercise mitigates the potential concerns raised by the endogenous construction of countries. Some of these concerns include the impact of endogenous size of countries, which has long been associated with economic performance (Easterly & Kraay, 2000; Kuznets, 1960), or the artificiality of borders (Alesina et al., 2011) and partitioning of ethnic groups (Michalopoulos & Papaioannou, 2016). Our approach to artificially constructing cells, and testing sensitivity to a given grid, follows the method outlined in Montalvo and Reynal-Querol (2021).

The first step in our procedure is to divide the area including groups in our sample into a number of cells. We then assign groups to synthetic countries according to which cell their centroid falls into.[21] We then use population figures from the ethnologue to compute a measure of ethnolinguistic fractionalization, following the standard definition of fractionalization,[22] for each of these synthetic countries. As with the fractionalization measure for real countries, this measure is maximized if the synthetic country is made up of a large number of small groups. We generate aggregate control measures from the language-level data in order to replicate our main country-level specification in equation 5 as closely as possible.

We do not take a prior stance on the appropriate size of cell to use, so we begin by dividing the range of latitudes and longitudes into equally-sized intervals. We restrict the range of our group centroids, measured in lat/lon degrees, and divide these ranges into equal intervals. We show, in figure D3 maps of the grids generated by this procedure overlaid on the world map. The most coarse grid comes from dividing the range of latitude/longitude into fourteen intervals, giving $14 \cdot 14 = 196$ cells or potential countries. The most fine grid we use divides the range of latitude/longitude into twenty intervals each for $20 \cdot 20 = 400$ cells or potential countries. Note that only the cells or potential countries that contain at least one group centroid actually end up defining synthetic countries, so the number of synthetic countries created is much lower than the total number of cells.

To ensure the results are robust to where the grid happens to be defined, we again employ a method motivated by Montalvo and Reynal-Querol (2021) and redefine grids by shifting the origin point. We do this by successively shifting the latitudes and longitudes of the grid lines by one quarter of the total interval size.[23] This gives us three alternate

[21] As we have done throughout our analysis, we use the Ethnologue (Lewis, 2009) map to define group homelands, from which we define centroids

[22] See table A3 for additional background on the various measures of fractionalization

[23] Intuitively, this procedure means we are moving the grid 'diagonally' with each variation.

grids of the same size and hence three alternate definitions of synthetic countries defined by grid-cells of the same size.

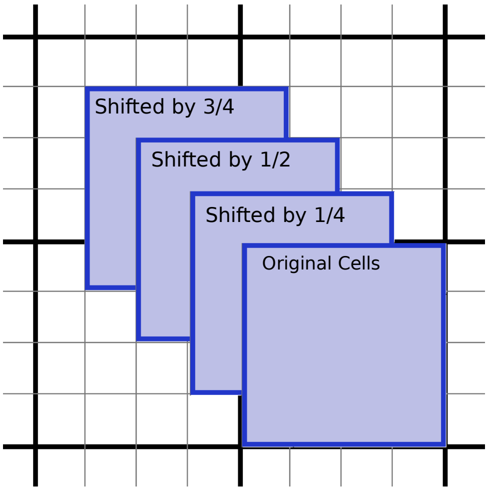
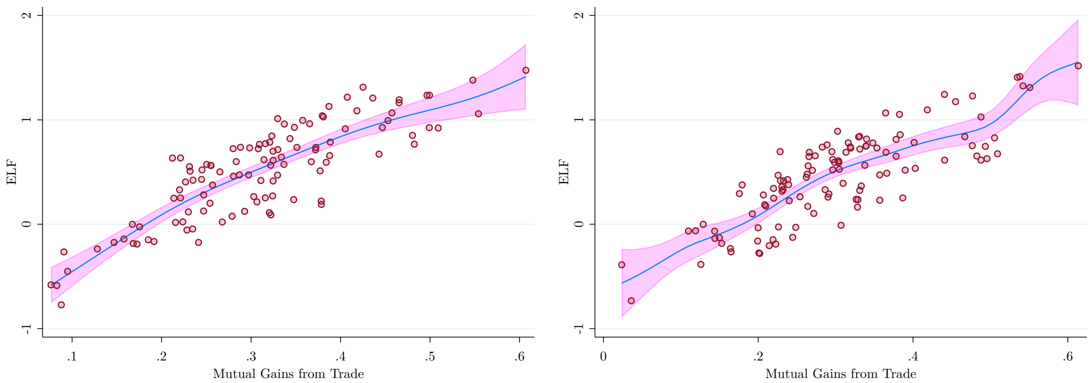


Figure D1: Cells Shifting

Note: This figure gives the intuition for the procedure we use to shift the cells used to define synthetic countries to show robustness to the positioning of cells for a given cell size.

The resolution splitting latitude/longitude ranges into seventeen intervals (resulting in $17 \cdot 17 = 289$ cells) gives us 111 synthetic countries, which is closest to the true number of observations in our cross-country analysis (119). We therefore take this resolution as our main specification, but show robustness to grids that are both larger and smaller.



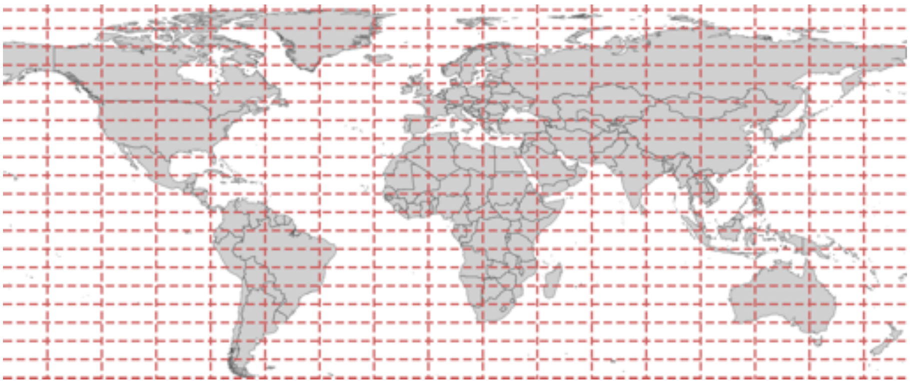
(a) Original Cells **(b)** Cells Shifted by 1/2 interval

Figure D2: Trade Incentives and Fractionalization in Synthetic Countries

Note: These figures show the semiparametric relationship between trade incentives and Ethnolinguistic Fractionalization (ELF) in synthetic countries.

The positive relationship between mutual trade incentives and national fractionalization holds when we consider these artificially constructed countries. We present the semiparametrically estimated relationship in figure D2 and present the regression estimates for all four variations of the grid in table D1. This relationship is fairly robust to adjusting the size of grid cells to generate larger and smaller numbers of synthetic countries. For four alternative numbers of cells we still find a positive and generally significant relationship (table D2).

These results show that the effect of trade incentives on the vitality of languages significantly impacts fractionalization, even after mitigating concerns related to endogenously sized countries, or colonial borders. This suggests that the impact of threatened languages is important even when we abstract from the impact of national institutions on the vitality and trajectory of language groups.

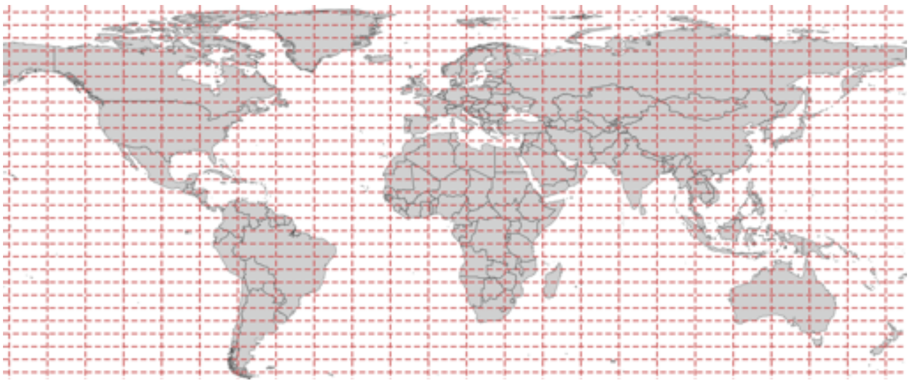


(a) 196 Cells

Note: This maps shows the lines used to split the area of the map containing the group centroids. We divide the area including group centroids into a grid of 14×14 cells for a total of 196 cells.

(b) 289 Cells

Note: This maps shows the lines used to split the area of the map containing the group centroids. We divide the area including group centroids into a grid of 17×17 cells for a total of 289 cells.



(c) 400 Cells

Note: This maps shows the lines used to split the area of the map containing the group centroids. We divide the area including group centroids into a grid of 20×20 cells for a total of 400 cells.

Figure D3: Grid-Cells Defining Synthetic Countries

Table D1: Trade Incentives and Fractionalization with Synthetic Countries

	Original Cells (1)	Cells Shifted by 1/4 (2)	Cells Shifted by 1/2 (3)	Cells Shifted by 3/4 (4)
Trade is Likely: Mutual Benefits	3.773	2.396	1.935	1.876
($\bar{\mu}_c$, Mutual Trade Incentives)	(0.781)***	(0.650)***	(0.936)**	(0.652)***
Trade is Unlikely: Neighbour Doesn't Gain	-1.765	-1.115	-1.197	-1.207
($\bar{\gamma}_c$, Mean Trade Incentives)	(0.501)***	(0.400)***	(0.478)**	(0.419)***
Trade is Unlikely: Only Neighbour Gains	-1.858	-0.984	-0.730	-0.649
($\bar{\iota}_c$, Partner Trade Incentives)	(0.449)***	(0.322)***	(0.440)*	(0.398)
Mean Group Arable Share	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓
Num. Observations	111	123	122	111
R^2	0.349	0.254	0.195	0.163

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The unit of observation is a synthetic country. In this table our main specification of synthetic countries uses the grid with 289 cells or potential countries, giving the number of synthetic countries that is closest to the number of countries in our sample. In columns 1-4 the synthetic countries are shifted as in figure D1.

Table D2: Synthetic Countries, Robustness

	196 Cells		256 Cells		324 Cells		400 Cells	
	Original (1)	Shifted by 1/2 (2)	Original (3)	Shifted by 1/2 (4)	Original (5)	Shifted by 1/2 (6)	Original (7)	Shifted by 1/2 (8)
Trade is Likely: Mutual Benefits	2.156	2.910	3.277	2.598	1.718	3.149	2.715	1.668
($\bar{\mu}_c$, Mutual Trade Incentives)	(1.364)†	(1.039)***	(0.732)***	(0.798)***	(0.779)**	(0.649)***	(0.732)***	(0.670)**
Trade is Unlikely: Neighbour Doesn't Gain	-1.754	-1.301	-1.997	-1.473	-0.827	-1.774	-1.427	-0.713
($\bar{\gamma}_c$, Mean Trade Incentives)	(0.717)**	(0.617)**	(0.542)***	(0.477)***	(0.468)*	(0.458)***	(0.410)***	(0.473)
Trade is Unlikely: Only Neighbour Gains	-0.113	-2.003	-1.131	-0.756	-0.484	-1.034	-0.919	-1.013
($\bar{\iota}_c$, Partner Trade Incentives)	(0.684)	(0.515)***	(0.313)***	(0.453)*	(0.375)	(0.428)**	(0.393)**	(0.345)***
Mean Group Arable Share	✓	✓	✓	✓	✓	✓	✓	✓
Mean Group Trade Utility	✓	✓	✓	✓	✓	✓	✓	✓
Mean Group Land Diversity	✓	✓	✓	✓	✓	✓	✓	✓
Area Share Controls	✓	✓	✓	✓	✓	✓	✓	✓
Num. Observations	91	96	109	105	124	125	142	137
R^2	0.188	0.336	0.309	0.444	0.172	0.309	0.248	0.169

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The unit of observation is a synthetic country. In this table the size of the grid-cells used to define synthetic countries is different from our main specification, with columns 1 and 2 being more coarse (fewer synthetic countries) and columns 3 and four being more fine (more synthetic countries). The definitions of synthetic countries are also shifted as in figure D1.

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