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New Approaches to the Dynamics, Measurement and Economic Implications of Ethnic Diversity

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Editor's Preface

In his dissertation, Philipp Kolo examines the measurement and econometric effects of ethnic diversity. This issue is of great relevance to research and policy and is currently being discussed a great deal in the literature. In particular, a sizable literature has suggested that ethnic diversity constitutes a significant barrier to economic development. The precise measurement and interpretation of these results are a matter of substantial controversy. This book makes significant contributions to these debates. First, the dynamics of ethnic diversity are being empirically analyzed for the first time. Second, it develops and applies a new measure of ethnic diversity which takes the distance between groups into account, thus focusing on diversity rather than mere fragmentation. Mr. Kolo convincingly confronts theoretical considerations with (new) data and thereby provides a good mix of theory and empirics and valuable input to this field. These two aspects are new to this extremely diverse area of literature and Mr. Kolo shows that he is well-aware of recent developments in the field and is able to significantly contribute to it.

Chapter 1 provides the theoretical basis for the following empirical chapter 2, presenting the first substantial analysis. Here the development of ethnic diversity over time is explained within a model framework. Above all, the influences of education, development, trade and immigration are theoretically examined, illustrating how these factors can have an influence on the development of ethnic diversity.

In the second chapter, the level of ethnic diversity and its trends is empirically analyzed. Initially, the factors influencing ethnic diversity are derived from the literature and regressions are then run. The results show that there is a 'base level' of heterogeneity, determined by geography and evolutionary factors. Additionally, it is found that the nature of colonization has a particularly strong influence, while urbanization, education and immigration are the most influential factors regarding changes in ethnic fractionalization over time. Showing the dynamics of ethnic fractionalization empirically is a major contribution of this dissertation. The results here are based on the data on diversity that Mr. Kolo has discovered over the last two years and these will certainly be received with great interest.

In the third chapter, a new measure of ethnic diversity is then generated, which, as mentioned, takes the distance between groups into account. The so-called distance adjusted ethno-linguistic fractionalization index (DELF) builds on an impressive amount

of new data to address this issue. Mr. Kolo calculates three indices of religious, ethnoracial, and linguistic diversity, and an overall index based on these three components. The main analysis weights the three components equally. However, the appendix reports a substantial amount of detail on different possible weighting schemes, showing the results to be robust. Again, this is very well derived and almost solely based on new data. In turn, yet another important desideratum is tackled in the literature.

Finally, in the last chapter, this measure is employed in order to replicate a number of different analyses from the literature. In particular, the influence of ethnic diversity on conflict, growth, trust, trade and the mutual opinions of different populations towards their counterparts are applied. In these cases, it is shown that this measure portrays just as well, and sometimes even better effects. A genuine contribution to the literature is also achieved here, and it is impressive to see how many studies are replicated and further enriched through this new measure.

Altogether this thesis provides a highly interesting and sophisticated theoretical as well as empirical evaluation of the measurement, determinants, and consequences of ethnic fragmentation and diversity. The fact that all four pieces break new ground in terms of methodical and empirical analysis is particularly commendable, and with this, Philipp Kolo has succeeded in providing several important contributions to the literature.

Prof. Stephan Klasen (Ph.D.)
Göttingen, April 2012

Acknowledgements

Bringing this dissertation to a successful end is hardly possible without the help and support of many people, colleagues, and friends. My deepest thanks go to my supervisors, first and foremost Prof. Stephan Klasen. Coming back to the university after several years working in a business environment, I am indebted to him for giving me the opportunity to work on this dissertation, researching in a particular fascinating field. I am especially grateful for his continuous support and all the inspiring inputs I received. There was not a single point when I didn't have the impression he had advice or a new idea ready before I even finished my question. This agility and his diversity of knowledge was always intriguing. The trust in giving me the freedom to work from long distance during most of my research topped off his diligent supervision. I would also like to thank Prof. Axel Dreher for his willingness to supervise my dissertation although he left Göttingen for Heidelberg. I benefited enormously from his inspiring comments and his responsiveness easily compensated for the distance between us. Finally, my thanks go to Prof. Walter Zucchini, who accepted the supervision, taking up his free time after retiring from active teaching, actively engaging in further improving this dissertation.

Although I was not continuously in Göttingen, I benefited a lot from all my colleagues at the Chair of Development Economics, and all other chairs that filled our staff seminar with life and stimulating contributions. Even more importantly, colleagues turned into friends, supporting me with advice and encouraging words, especially during the final stretch. Additionally, I gained new insights from seminar participants' helpful suggestions and valuable comments at the DIW (Berlin) and the University of Hannover, who had different perspectives on my research. The exchange and discussions with Joan Esteban, Olaf de Groot and Laura Mayoral helped to excel my results. I am especially thankful to Christian Bjørnskov, Anne-Célia Disdier, Eliana La Ferrara and Gabriel Felbermayr for sharing their data and making some of my empirical analysis possible.

Finally, sincere thanks go to my family and my friends, who always trusted and encouraged me along this journey. Without their persistent support, successfully finishing this project would have been much, much harder!

Philipp Kolo
Munich, April 2012

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List of Abbreviations

A.D.	Anno Domini
ANM	Atlas Narodov Mira
BODI	Balance of diversity index
CEEC	Central and Eastern European countries
CI	Confidence intervall
CIA	Central Intelligence Agency
Comp.	Single components of principal component analysis
CoW	Correlates of War
DELF	Distance adjusted ethno-linguistic fractionalization index
$DELF_E$	Ethno-racial $DELF$
$DELF_{Geo}$	$DELF$ with geometric averaged similarity values
$DELF_L$	Language $DELF$
$DELF_{Pc}$	$DELF$ with partly compensated similarity values
$DELF_{PCA}$	$DELF$ with principal component analysis averaged similarity values
$DELF_R$	Religion $DELF$
E. Europe	Eastern Europe
EC	European Community
ELA	Ethno-linguistic affinity index
ELF	Ethno-linguistic fractionalization index
ESC	Eurovision Song Contest
EU	European Union
EU15	Group of the 15 European Union member countries until 2004
FE	Fixed effects
FTA	Free trade area
GDP	Gross domestic product
GDP/cap.	GDP per capita
GELF	Generalized ethno-linguistic fractionalization index
HDI	Human Development Index
L. America	Latin America
Ln	Natural logarithm
Logit	Logistic estimator

Max.	Maximum value
MENA	Middle East and North Africa
Min.	Minimum value
Obs.	Observations
OLS	Ordinary least squares
Opin.	Bilateral opinion
PCA	Principal component analysis
POL	Polarization index
Pop.	Population
PRIO	Peace Research Institute of Oslo
RE	Random effects
SIGI	Social Institutions and Gender Index
SUR	Seemingly unrelated regressions
SSA	Sub-Saharan Africa
Std. Dev.	Standard deviation
UN	United Nations
UNDP	United Nations Development Program
US	United States of America
W. Count.	Western countries
WCE	World Christian Ecyclopedia
WVS	World Values Survey

Chapter 0

Introduction and Overview

> *Sed Angelus est melior quam lapis. Ergo duo Angeli sunt aliquid melius quam Angelus et lapis. (...) Quod quamvis Angelus absolute sit melior quam lapis, tamen utraque natura est melior quam altera tantum: et ideo melius est universum in quo sunt Angeli et aliae res, quam ubi essent Angeli tantum.*
>
> Thomas D'Aquinas - *Scriptum super Sententiarum*[1]

The valuation of two different things and assigning a personal hierarchy to them is often feasible. The valuation of a combination of these things is, however, more complicated. Not only the values of the single objects are important; the specific combination of these (dis)similar elements is also essential and the reason why any valuation cannot be a simple addition of its elements. This fundamental concept is well illustrated by the opening citation by Thomas D'Aquinas some 750 years ago, and must have been the essential considerations of Noah when he boarded his ark. The quantity of any single species was of less importance than having the highest possible diversity. In 1992, more than 150 countries ratified the Rio Convention, aiming towards the "conservation of biological diversity".[2] Furthermore, at the end of 2010 the United Nations General Assembly declared the decade 2011–2020 would be the 'United Nations Decade on Biodiversity'. Despite all efforts towards, and challenges of safeguarding biodiversity there is at least a common understanding that this diversity is something exceptional and deserves to be protected and conserved.[3]

When writing his essay, Thomas D'Aquinas certainly did not exclusively refer to the diversity of animals and plants, but to the different natures of human kind. So, what is it

[1] "Since an angel is better than a stone, therefore two angels are better than one angel and a stone. (...) Although an angel, considered absolutely, is better than a stone, nevertheless two natures are better than one only; and therefore a universe containing angles and other things is better than one containing angels only." - Thomas d'Aquinas, *Scriptum super Sententiarum*, lib. 1 d. 44 q. 1 a. 2, 6 and lib. 1 d. 44 q. 1 a. 2, ad 6 (D'Aquinas, 1873, Vol. VII, p.527–528). Translation taken from (Lovejoy, 1957, p.77).

[2] Article 1 of the *Convention on Biological Diversity* (http://www.cbd.int/convention/text/).

[3] Besides biodiversity's instrumental value, one ascribes a high intrinsic value to it. Its instrumental value, for example, arises from its potential agricultural or pharmaceutical applications. In contrast, the intrinsic value of biodiversity originates from its mere existence.

about their (ethnic) diversity? Is the agglomeration of different cultural, religious or language groups just as unequivocally seen as something exceptional, deserving of protection and conservation? Dalby (2003) believes that 2,500 languages are likely to be lost over this century. With less than 7,000 living languages in the world listed by the *Ethnologue* project (Lewis, 2009), this heavily impacts the diversity of global languages. However, to assess the values of any of these lost languages is equally hard to assess as the loss of any species to biodiversity.[4] So, is ethnic diversity as threatened as biodiversity?[5]

Until the 20th century, the ethnic composition of countries was more associated with established nation states. In this regard, ethnicity was more a unifying factor than one that posed any threat of conflict. Over the course of history, however, the concepts of nation states and ethnic diversity became diametrical ones. Since then, there have been many negative, despotic, nationalistic eras in history, but also constant positive examples of coexistence. These alleged opposing extremes culminated when Huntington (1993) proclaimed the 'clashes of civilizations'. In his view of a post Cold War era, the ideology driven conflict of that time is replaced by cultural and religious clashes between global civilizations. The rather random division of the world into eight civilizations on whose borders conflicts are supposed to arise, has drawn a lot of criticism.[6]

Having eight civilizations is indeed a very superficial classification that fails to take the ethnic setup and internal dynamics within these civilizations into account. What's more, not only are these civilizations diverse, but also the countries within them, which all differ in their levels of diversity. Increased mobility, economically and socially, has fueled ethnic diversity, for example, in Europe. If these dynamics stretch the European

[4] Admittedly, the extinction of languages, even major ones, is anything but new. Latin, the language of the Roman Empire, is one of the most prominent examples. On the contrary, the evolution of languages also created new ones. The Romance languages that evolved from the common Latin origin and various Creole languages, through mixing with the languages of colonizers, are such examples. If one does not assign, for example, language diversity any intrinsic value, the disappearance of a language is just the result of its instrumental value dropping insofar as it no longer fulfills its speaker's socioeconomic needs (Mufwene, 2005).

[5] For an approach to reconcile biodiversity and cultural diversity, see Loh and Harmon (2005). They construct a combined biocultural diversity index. Equally, Evers et al. (2010) apply methods of biodiversity research on analyses of Malaysia's multicultural society.

[6] The eight civilizations are meant to be the "Western, Confucian, Japanese, Islamic, Hindu, Slavic-Orthodox, Latin American and possibly African civilization" (Huntington, 1993, p. 25). Although the strong differences between civilizations are the key motivation for his claim, it lacks a consistent logic explaining the reason behind selecting exactly these eight civilizations. The fact that the number of distinct civilizations is not even clearly defined is covered well in the versed critique of Tipson (1997). Additionally, there are several other lines of critique. Whereas Huntington (1993) gives the idea that democracy was, and still is a unique Western value, Sen (1999) refers to the significantly different democratic traditions between Western countries and democratic traditions found in other regions of the world historically. The categorization of roots of conflicts is another line of critique. Huntington (1993) claims that before the French Revolution, conflicts were between princes and emperors over influence and territory. The period following this is exemplified by the fight between people and nations, until the root of confrontation was replaced by ideology after both World Wars. This simplification fails to cover earlier cultural or ideological conflicts during the Reformation, the Thirty Years War, or the period of Enlightenment. A final line of critique is that ethnic grouping may also arise only due to ideological mobilization by elites contending for political influence and unfulfilled socioeconomic needs, especially within countries. This will be briefly discussed in **Chapter 1**.

community too far, or if they are even the base for Europe's future success, remains debatable. This dissertation will go about improving the understanding of ethnicity and its potential implications. However, to not lose oneself in equally arbitrary or vague characterizations, a clear as possible definition of the main concepts, ethnicity and diversity, as well as the extent of the economic implications on whose backdrop both will be examined, seems necessary.

Ethnicity Economists mostly fail to give a more thorough definition of ethnicity, and there is wide agreement that it is a "rather vague and amorphous concept" (Alesina et al., 2003, p. 160). Although a clear cut definition is indeed difficult, at least a common understanding is crucial. The *Encyclopædia Britannica* defines an ethnic group as "a social group or category of the population that (...) is set apart and bound together by common ties of race, language, nationality, or culture." (Encyclopædia Britannica, 2007, Vol. IV, p. 582). Thus, these groups need to be distinguishable from each other along a defined characteristic. According to the above definition, these are mainly:[7]

- *Language*
  Language is a fundamental mechanism through which people create social life and the means for any interaction. Anyone who has ever learnt another language is conscious of their differences. For an Italian, it is in generally easier to learn Spanish than Japanese, for example. Thus, language is probably the clearest characteristic and their differences rather well defined.
- *Race*
  The racial part of the definition inherits some biological classification. It may be described as a population with a common ancestry and shared habits that represent a common genetic pool (Barrett et al., 2001, Vol. II). These physical characteristics need to be understood in light of evolutionary processes as an adaptation to different environments and should not be confused with any racist categorization.[8]
- *Culture*
  The aspect of culture is probably the least clear due to the ambiguous nature of its roots and the fact that it is mutually influenced by the previous aspects. Culture is supposed to consist of "languages, ideas, beliefs, customs, taboos, codes, institutions, tools, techniques, works of art, rituals, ceremonies and other related components" (Encyclopædia Britannica, 2007, Vol. III, p. 784). Beliefs and all forms of religion influence many components of this definition. Thus, it seems obvious to include religion as an important pillar of one's culture.[9] As there is also strong interplay

[7] Many sources use very comparable sets of characteristics. See, for example, Barrett et al. (2001), Alesina et al. (2003), Okediji (2005) or de Groot (2009).

[8] In this regard, skin pigmentation is a good example. For the above characterization, it is seen as reflecting an adaptation to geographic particularities, i.e., in reaction to different intensities of UV light.

[9] This not only includes the main 'institutionalized' religions, but all animist- and ethno-religions that existed long before the religions we know of today.

between languages and cultural behavior, ethnolinguists have termed groups defined along this double identification as ethno-linguistic groups.[10]

- *Nationality*
  Nationality originates from the historic unity idea of a national state. This characteristic is less important for describing modern, ethnically diverse countries and is probably the one which is the easiest to change. One does not necessarily need to learn a new language or adapt to a new culture to obtain a passport.

These aspects defining an ethnic group, according to the *Encyclopædia Britannica*, are obviously not clear cut concepts, often overlapping and depending especially on the self assignment of its individuals.[11] It is important, however, for any social or economic interpretation, that these aspects may be observed by individuals, and are used to determine any form of 'otherness' between two individuals or groups. Only if this (socially) constructed 'otherness' has an impact on social interactions does it subsequently affect economic outcomes.[12] Predominantly aligned with most of the economic literature, for the remainder of this dissertation, diversity will focus on the three 'clearer' aspects of language, race and religion.[13]

Diversity Although one generally speaks of an ethnically heterogeneous country, there are two very distinct concepts used in the economic literature for its measurement, these being ethnic fragmentation and ethnic diversity. The fragmentation or fractionalization of countries assesses the multitude of different groups. This is the most widely used index in the economic literature and was introduced by Taylor and Hudson (1972) as the ethnolinguistic fractionalization index (ELF).[14] It is based solely on the relative group sizes of groups defined along any of the above characteristics.[15]

Diversity, in contrast, is a more elaborate measure of ethnicity as it takes the dissimilarities between groups into account. To assess a country's fragmentation, it is sufficient to know that there exists, say, two angels and one stone. To assess the diversity of this small country, one needs to assess distances between both groups that are "such an absolutely fundamental concept in the measurement of dissimilarity that it must play an essential

[10] A classic example is the multitude of words the Inuit culture has for snow, underlining the close relationship of both concepts (Encyclopædia Britannica, 2007, Vol. IV).

[11] Besides the definition of what ethnicity comprises, why ethnic groups emerge and change are equally important questions. This will be addressed in more detail in **Chapter 1** and **2**. A related problem is the situational or contextual identification with one or the other group. For a distinction between ethnic structure (descent based attributes) and ethnic practice (activation of these attributes), see Chandra and Wilkinson (2008). This distinction is, however, not in the scope of this dissertation.

[12] With this important point, a difference between ethnic diversity and biodiversity becomes obvious.

[13] A more detailed definition of these three pillars as they are defined for the purpose of this dissertation, is found in **Chapter 3**.

[14] The data source Taylor and Hudson (1972) based their first ELF on, the *Atlas Narodov Mira* (Bruk, 1964), is mainly defined along ethno-linguistic criteria, which explains the name. However, the ELF is now also calculated based entirely on linguistic, ethnic or religious groups.

[15] The mathematical attributes of all of the index calculations will be discussed in the respective chapters.

role in any meaningful theory of diversity or classification" (Weitzman, 1992, p. 365). To arrive at these distances, one needs to know more about the characteristics of both groups, which makes the clear definition of groups based on any of the above concepts even more important. The introduction of an index covering ethnicity's diversity in contrast to its mere fragmentation is the main focus of **Chapter 3**.[16] As countries can be heterogeneous in both ways, i.e., being fragmented or being diverse, heterogeneity is used as the general term for both.

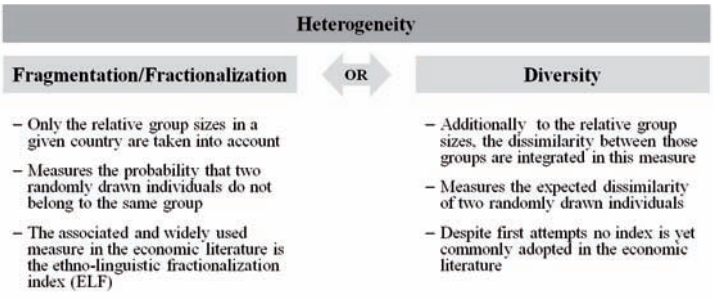


Figure 0.1: Difference of fragmentation and diversity measure

Economic implications Economists only started to engage in discussions surrounding the 'Noah's Ark Problem' (Weitzman, 1992, 1998) in the 1990s. Today, a wide range of socioeconomic problems are supposed to be linked to a country's ethnic heterogeneity.[17] Mauro (1995) is considered to be the first to assess the role of ethnicity on economic outcomes empirically. He linked a higher level of ethnic fragmentation to higher levels of corruption. Soon after, Easterly and Levine (1997) believed the apparent higher ethnic fractionalization of Africa to be responsible for its 'growth tragedy'. The focus on GDP per capita levels became subsequently one of the major strands of the literature.[18] Departing from the outcome, mirrored in higher income levels (GDP per capita), the focus moved to various socioeconomic factors that are supposed to affect different income levels.

Alesina et al. (1999) showed that public goods provision is lower in ethnically more heterogeneous communities, with communal participation equally being reduced (Alesina and La Ferrara, 2000). La Porta et al. (1999) and Alesina and Zhuravskaya (2011) document the negative impact ethnic heterogeneity has on the general quality of government. Thus, in general, higher ethnic diversity is associated with poorer institutions and governance. Bjørnskov (2007, 2008) searches for a correlation between ethnically more fragmented

[16] Despite these two major concepts, which will be the focus of this dissertation, an index of polarization has drawn more attention. This measure will be discussed in the essays whenever deemed necessary to offer a broader picture, or when it is of equal importance for specific questions.

[17] These analyses rely almost entirely on the measure of ethno-linguistic fractionalization (ELF).

[18] See, for example, Collier (1998), La Porta et al. (1999), Alesina et al. (2003), Alesina and La Ferrara (2005) or Garcia-Montalvo and Reynal-Querol (2005a).

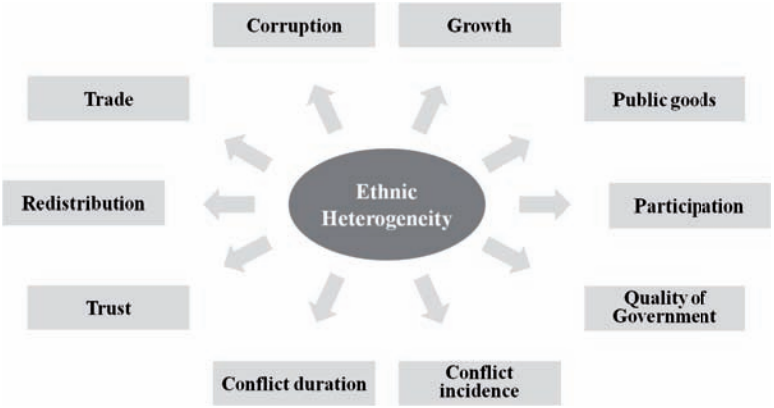


Figure 0.2: Overview of ethnicity's role in the economic context

countries and its impact on the general level of trust.[19] Equally, the level of redistribution is supposed to be lower for more heterogeneous countries (Desmet et al., 2009). Finally, Felbermayr and Toubal (2010) show a trade increasing effect for countries that are ethnically closer.[20] Collier and Hoeffler (2002) initiated the second most prominent strand of literature by exploring the role ethnicity plays in the incidence, onset or duration of conflicts, which was subsequently extended by Collier and Hoeffler (2004), Collier et al. (2009), and Garcia-Montalvo and Reynal-Querol (2002, 2005b, 2008, 2010). Additional conflict leads to even lower institutional quality. This is often compensated for by higher ethnic identification, making any interaction possible in the absence of codified laws and proper governance structures, starting a vicious cycle.[21] A more salient ethnic identification leads, in line with the above literature, to worse economic performance und suboptimal institutional structures.[22]

Surprisingly, most results hint to a negative effect and thus document the societal costs of ethnic diversity. Only a few articles question this biased analysis of ethnic heterogeneity. Alesina and La Ferrara (2005), for example, posit that its impact may well be positive

[19]This is inspired by earlier work of Zak and Knack (2001).

[20]This result, which is confirmed in **Chapter 4**, does not, however, mean that two countries need to be more homogeneous. The contrary may be the case. When sizeable diasporas are present in countries they may be internally more diverse. These groups, in turn, exhibit closer (ethnic) ties to their home countries, being one reason for an increased trade volume between these two countries. Thus, expelling an ethnic group may make a country internally more homogeneous but would reduce the ethnic ties to the expelled groups' home country, limiting the trade volume.

[21]See, for example, Greif (1993) for historic examples of where kinship ties replaced codified laws and institutions, or Akerlof and Kranton (2000) on how identity associated with different (social) categories influences economic outcomes.

[22]Based on these results, one would assume that every country would strive for higher homogenization or assimilation. This is not a necessary result, as demonstrated in **Chapter 1** and **2**.

but depends on the level of development in a country.[23] Thus, does ethnic diversity only have positive effects for countries that can afford it? There might indeed be high societal costs in order to achieve proper communication, education, and higher quality of society's institutions in general, and thus to overcome all the documented evils of a more heterogeneous community.

A better understanding of the roots of ethnicity, what drives its changes and a different method of measurement might help to bridge the gap between the very different perceptions of biodiversity and cultural diversity.

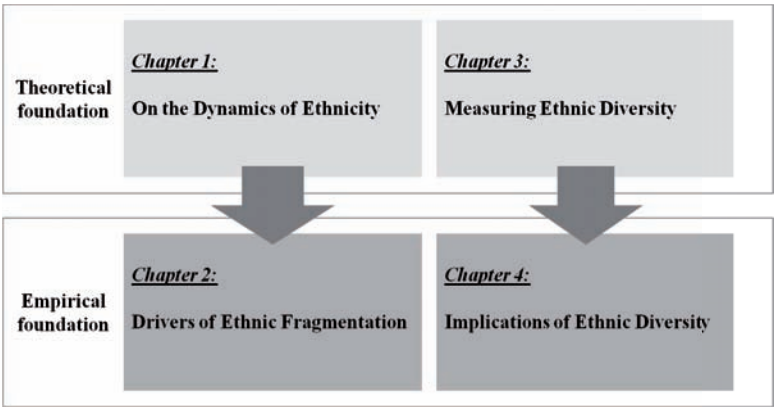


Figure 0.3: Structure of the dissertation

Structure of the dissertation This dissertation consists of four distinct essays, each covered in a chapter of their own. Two essays mutually complement each other, thus forming two main parts. Both parts are based on a strong theoretical foundation and are subsequently empirically tested. The first strand adds new insights into a more profound understanding of ethnic fragmentation. It is extended by modeling its dynamics and a subsequent empirical analysis of the drivers for any change in a country's ethnic fragmentation. The second part offers a new index measuring the important aspect of ethnic diversity in contrast with the standard indices. Due to this additional aspect of

[23] Schüler and Weisbrod (2010) show that the effect for countries whose ethnic fragmentation is mainly due to high immigration (e.g., Australia) is less detrimental. Similarly, with well established institutions the negative effect can equally be mitigated (Alesina and La Ferrara, 2005; Easterly, 2001). Contrary to the above literature based on cross-country analyses, there are some articles focused on (metropolitan) regions and companies that document positive effects of diversity. This is mainly attributed to the impact of ethnic diversity on the degree of innovation and consequent increase in productivity. Ottaviano and Peri (2005), Ozgen et al. (2011a,b) and Sparber (2010) confirm productivity increases at the regional level and for selected countries. Regarding companies, Prat (2002) shows, in a game theoretical analysis, that the positive impact of a heterogeneous versus a homogeneous team depends on the complementary nature of their tasks. A comparable result is also found in Hong and Page (1998).

ethnic diversity covered in the new index, it performs differently in explaining a range of the aforementioned economic implications.

Dynamics and drivers of ethnic fragmentation

Chapter 1 Contrary to biodiversity, where the dissimilarities between its elements are crucial, most of the economic literature uses the measure of ethno-linguistic fractionalization (ELF). Starting out with this concept, the first chapter summarizes the theoretical discussions on the dynamics of ethnicity. Obviously, ethnicity is not a static concept as ethnic identification and its translation into ethnic groups is subject to change. This is transferred into a theoretical model that provides a close connection to the index of ethno-linguistic fractionalization (ELF). It shows that countries are generally not faced with a continuous trend to become more homogeneous, instead illustrating that they may well retain their level of ethnic fragmentation or even become more heterogeneous.

The main contribution of this chapter is twofold. The present literature almost completely excludes the dynamics of ethnicity from analysis, treating it as exogenously given. Introducing a clear motivation within this framework of the dynamic nature of a country's ethnic setup challenges this basic assumption. The model is constructed in a way that simulates the adaptation of the ELF index. This offers a better understanding of the applicability and possible interpretation of the ELF index, especially regarding endogeneity problems. Secondly, it outlines specific drivers responsible for these adaptations. Beginning with a specific group constellation, economic development and education drive homogenization. In contrast, migration and a more profound integration into the international economy through trade at least retains, or increases the given level of heterogeneity.

Chapter 2 Building on the theoretical foundation of the previous chapter, the second chapter proofs the drivers of ethnic fragmentation empirically. It is in line with recent contributions outlining initial ideas as to why different levels of ethnic fragmentation have evolved. These are mainly based on biodiversity and evolutionary theories and show again the close connection between both kinds of diversity. It confirms the results that a 'base-level' of fragmentation evolved due to geographical and evolutionary factors.

A new contribution is the closer examination of the role colonization plays in influencing the levels of fragmentation, especially regarding how a country was colonized. Countries where colonial powers did not have any incentive to settle and build good institutions, instead exploiting the country's resources, show a significantly higher level of ethnic fragmentation.

The most important contribution of this chapter is to highlight the changes in the ethnic setup over a rather short time frame. Although migration is the most obvious factor, urbanization and education in particular play an even more important role in influencing a country's ethnic setup.

Measuring ethnic diversity and assessment of its implications

Because the ELF index is the most widely used measure, it was used for a closer analysis of the dynamics of ethnicity and directly applies to the broad range of papers building on it. Its selection is driven additionally by data availability, as consistent data for two points in time was uniquely available for ethnic fractionalization. However, the dynamics of ethnic fractionalization can be easily transferred to the case of ethnic diversity. The identification with a specific group, affecting the relative group sizes and thus the level of fragmentation is also a key building block of any diversity measure. Refraining now from the more limited concept of ethnic fractionalization presented in the first two chapters, the second part of the dissertation is dedicated to ethnic diversity.

Chapter 3 For any diversity index the introduction of distances between groups is essential. For an appropriate diversity index, a combination of different characteristics measured in a consistent way is used. Language, ethno-racial and religious characteristics are combined for a composite similarity value. The resulting distance adjusted ethno-linguistic fractionalization index ($DELF$) is based on an extensive amount of group data, covering a wide range of countries. Whereas ethnic fragmentation (ELF) only contained meaningful information for single countries, the $DELF$ index can also assess differences between countries, where it fills an even bigger gap.

The new diversity index, $DELF$, contributes in various ways. It uses a very detailed data source, containing more than 12,000 groups defined along all three characteristics. Finally it offers, by applying the equivalent approach as that of the diversity measure for single countries, an assessment of cultural differences between countries. As the new index measures a country's ethnic diversity, it is a good starting point to review some of the existing approaches linking ethnicity to economic outcomes.

Chapter 4 Developing a new index without testing its applicability is of limited merit. That is why this last chapter offers a range of applications for the $DELF$ index. For many economic problems, it is not the pure quantity of (relative) groups which is of interest, but the difficulty of coordination or instrumentalization between these various groups. This is crucially dependent on the differences between those groups and not only on their mere existence.

By replicating some established analyses, the $DELF$ shows good applicability for conflict incidence compared to the often used index of polarization (POL). For growth, it confirms the commonly found detrimental effect. In an extension of the analysis of Alesina and La Ferrara (2005), a positive effect of the $DELF$, dependent on a country's general level of development, is found – which is not the case for the ethno-linguistic fractionalization (ELF) index. Therefore, it is not about being able to 'afford' diversity in money terms; a broader level of development with higher education and health levels

seems to be a prerequisite to harvest the positive implications of diversity and to break away from the vicious cycle most of the previous literature alluded to.

Furthermore, the $DELF$ is tested on its applicability as a measure of cultural distance between countries. It can be shown that higher ethnic diversity between countries reduces the positive relationship between them. The general trust within countries, however, is not affected by a higher ethnic diversity. Finally, the $DELF$ is a valuable measure for cultural affinity between countries, which affects trade flows positively. Overall, it substitutes a broad range of affinity proxies very well and its broad global coverage asks for a wider adoption.

Outlook The results of the first two chapters on the roots and dynamics of ethnicity, have two implications for further research. It is a strong basis to refute the common assumption of its static nature. This raises the problem of ethnicity's endogeneity, at least for studies spanning several decades. In general, this does not question their results but adds a caveat for their interpretation. Secondly, it offers a deeper understanding of the nature of ethnic heterogeneity – a variable that has rightly become more and more important in economic analyses. Understanding the roots and driving factors of the dynamics of ethnicity is crucial for any meaningful further research

The second part of this dissertation has an even stronger implication. The introduction of the $DELF$ index allows one to assess ethnic diversity based on multiple characteristics within, and between countries covering nearly the entire globe. The mere quantity of cultural backgrounds is of less importance than their diversity, and thus higher complementarity to fuel innovations and productivity.

The call for a rising awareness of ethnic diversity does not originate from a romanticized view of the world which is disconnected from further development and globalization. There will be a further loss of languages and traditions, reducing ethnic diversity – just like the extinction of a species reduces biodiversity. Evolution will bring about new languages and traditions – as new species develop adapting to a changing environment. Equally, societal costs in preserving a higher level of diversity will always accrue – as they do for biodiversity. This, however, does not call for more assimilation in order to avoid these costs, but for the strengthening of institutions and improvement of prerequisites encouraging the reduction of the costs of diversity, and capitalizing earlier on the positive returns it can bring.

Having a better understanding of ethnicity's impacts and a better set of tools for its analysis is an important step for putting the claim of a clash of civilizations into perspective. This is even more important during the current times of economic downturn, with nationalistic parties on the rise globally. They refer to and exploit the potential societal costs of cultural diversity without balancing it out with its prospective benefits.

Endowed with a deeper understanding of the dynamics of ethnicity and a crucial new measure of ethnic diversity, I encourage more research in this field to gain more insight into its implications on economics and the broader development of countries, thus offering

better coverage of its full impact. Ethnic diversity, as is the case with biodiversity, is not a necessary evil constraining the development of countries by burdening them with high societal costs, but something worth preserving, with its benefits eventually outweighing its costs.

Chapter 1

The Dynamics of Ethnicity

1.1 Introduction

In the empirical literature, the role of culture and ethnicity in the economic context is attracting more and more attention.[24] This literature, however, almost completely excludes the dynamics of ethnicity from the analysis, instead treating it as exogenously given. This is largely due to data constraints that impede tracking the dynamics of ethnicity. Still, as ethnicity is increasingly becoming a key variable for many current research strands, a better understanding of its dynamics is fundamental for the interpretation of the results.

Despite the understandable limitations of the empirical literature, there are also only limited efforts by economists to approach these dynamics on theoretical grounds. A few exceptions offer some motivation for the dynamics of changing ethnic boundaries.[25] Although these models try to offer a better understanding of decision processes to migrate, to offer differentiated public goods or to fully assimilate, they lack a clear link to the growing empirical literature. In particular, there is no link to the applicability of the dynamics found in the models to the empirical operationalization of ethnicity. However, for empirical analyses and the interpretation of their results, it is crucial to have a clear understanding of if, and why ethnicity should be subject to changes, and what its potential drivers are. Based on an extension of the model by Lazear (1999), this essay shall provide this link, as well as providing a starting point to test these dynamics empirically. The model shows

[24] For a more detailed overview, see, for example, Alesina and La Ferrara (2005) and Garcia-Montalvo and Reynal-Querol (2003). For a broader discussion on the different concepts of ethnicity and its operationalization, see Brown and Langer (2010).

[25] Constant and Zimmermann (2007) discuss in a simple framework the main assimilation strategies of immigrants. Bodenhorn and Ruebeck (2003) model and analyze the emergence of mixed ethnic groups in the United States in order to improve their economic position. Darity et al. (2006) use an evolutionary game theory model to show different 'acculturation' outcomes and Caselli and Coleman (2008) analyze the decision to change group membership within a model of ethnic conflict. Ahlerup and Olsson (2007) build their model on kinship-based social organization providing public goods. Finally, Lazear (1999) models assimilation processes of language groups to sustain or ameliorate trade. Subsequently, Kónya (2005) discusses the implication of multiculturalism versus a melting pot.

that the group constellation, the costs of learning another language, economic growth, and immigration rates all significantly influence a country's heterogeneity.

The remainder of this chapter is organized as follows. In section 1.2, a general discussion of the definition of ethnicity is carried out, as well as describing the key aspects of the main theoretical models. Section 1.3 extends the language assimilation model of Lazear (1999) and describes the individual strategies in a state of autarky. In section 1.4, individual behavior is aggregated to the overall society, and the resulting dynamics towards possible equilibria are analyzed. Here, the link to the broadly used ethno-linguistic fractionalization index (ELF) is discussed. Section 1.5 outlines some basic further extensions of the model predictions in relation to globalization and international trade. Finally, section 1.6 summarizes the key findings, concludes and gives an outlook for further research.

1.2 General attributes of ethnicity and key models

For interaction to occur between different individuals, a common factor, like origin or language, is assumed to be necessary to signal and establish a certain level of common ground (Leeson, 2005). This is less important in countries, where institutions and codified laws replace this signaling. In discussing these common markers, the economic literature mainly focuses on three characteristics: ethnicity, language and religion. They offer rather clear (observable) definitions that involve certain costs in order to be changed or adapted.[26] This, however, does not answer the question about what has shaped or constantly shapes ethnic identities and groups. Three main approaches are discussed in the literature to explain these dynamics: the primordial, the instrumentalist and the constructivist.[27]

Primordialism views ethnic identities, and thus their group structure, as rather fixed, showing a long historical continuity. Smith (1986) summarizes the primordialist view by maintaining that "ethnic communities are the natural and integral elements of the human experience," and he regards "language, religion, race, ethnicity and territory as the basic organizing principles and bonds of human association throughout history" (Smith, 1986, p. 12). Similarly, Young (1998) describes the primordial dimension of ethnicity as an "internal gyroscope, [a] cognitive map and dialogic library through which the social world is perceived" (Young, 1998, p. 6). Likewise, van den Berghe (1981) sees ethnic groups as nothing but an extension of the concept of kinship. The nepotistic behavior can be observed in all mammal species and is the result of an evolutionary survival strategy. Living in an environment with only limited resources, sticking with your kin leads to "greater reproductive success and tend[s] to dominate all populations" (Ahlerup and Olsson, 2007,

[26] See, for example, Bruk (1964), Alesina et al. (2003), and Fearon (2003), who build their measures on the combined taxonomy of ethno-linguistic groups combined with other characteristics such as language, ethno-racial belonging or religion.

[27] For an extensive overview of these three analytical approaches, see Brown and Langer (2010) and Le Vine (1997) for a more critical review.

p. 6). As these kinship groups grew, they developed common (cultural) traits or markers to sustain the structure for a more extended group.

Instrumentalists basically build on the primordial structures but emphasize that several of these aspects might be differently and selectively activated in different situations. Ethnic groupings thus emerge around an identity causing characteristic, which then increases collective interest. This holds true for social and political interactions especially. Consequently, the idea of social stratification and the emergence of political elites that leverage ethnic identifications to mobilize supporters at a rather low cost are closely linked (Bates, 2006).[28] Young (1998) concludes that ethnicity is shaped "in everyday political and social interaction, ethnicity often appears in instrumental guise, as a group weapon in the pursuit of material advantage" (Young, 1998, p. 6).

On the other hand, more recent factors and the emergence of nations have also left their traces on the development of ethnic groups. According to this constructivist view, major changes in the structure of human interaction arose through the development of modern nation states. Subsequently, the formation of nations and modern states shaped and changed group construction and identification drastically.[29] Finally, Young (1998) summarizes that ethnic "identities are socially constructed, a collective product of the human imagination" (Young, 1998, p. 6) and are constantly reshaped in the mutual exchange between the various groups and identities within a globalized world. Thus, constructivists believe external forces and the interaction with other groups to be responsible for the definition and attribution of one's ethnic group, which finally becomes a social construct of a society itself.[30]

Fenton (2010) combines all three aspects excellent, thus painting a more accurate picture of the complex nature of ethnicity.[31] In his view ethnicities are "grounded as well as constructed. Ethnic identities take shape around real, shared material experience, shared social space, commonalties of socialization and communities of language and culture. Simultaneously, these identities have a public presence; they are socially defined in a series of presentations (...) by ethnic group members and non-members alike" (Fenton, 2010, p. 201). Thus, ethnicity as such contains some irrevocable core characteristics that represent the most essential characteristics of a group, whereas other parts of the ethnic identity might be subject to change. Having combined the different views of ethnic emergence, according to Fenton its activation is due to "the degree of collective self-consciousness and thus in the extent to which individual and collective action is calculated or instrumental in the pursuit of ethnic ends" (Fenton, 2010, p. 201). So not every ethnic identity is activated

[28] For some African case studies and an empirical investigation of how political competition affects ethnic identification, see Eifert et al. (2007).

[29] Miguel (2004) shows, using an African example, how nation building changed the affiliation to tribes.

[30] For an effort to predict the social construction of ethnic identities, see Chai (2005).

[31] A comparable approach is taken by Wimmer (2008), who develops a framework to explain which of these theories are activated and, to a lesser extent, to explain the superiority of a single one.

in the political or societal arena, and this might differ due to a wide range of (contextual) reasons.

Despite these discussions on what brings humans to identify along ethnic structures mostly led by non-economists, some theoretical discussions in economic models have recently emerged. The major models shall be briefly discussed here to give an overview of the current status of this strand of research, and also to make the differences compared to the model outlined in this chapter more clear.

Bodenhorn and Ruebeck (2003) model and empirically test the changing assimilation of blacks with lighter complexion into mixed ethnic groups in the mid-nineteenth century in the US. They balance the improved economic opportunities emerging from a higher degree of acceptance by the economically dominant white group with the (implicit) costs of adopting and maintaining white culture. Additionally, the lighter complexed blacks often faced punishment by abandoning one's former group. To differentiate themselves and to exclusively retain the monetary gains, they formed a comparable parochial group of 'mulattos'.[32]

Darity et al. (2006) and Caselli and Coleman (2008) build their models on the excludability of individuals from a group based on phenotypical attributes. Darity et al. (2006) use an evolutionary game theory model. The decision to follow either an racialist or an individualist strategy form different 'acculturation' outcomes.[33] Finally, they argue that the construction of rigid racial identities and the cumulative effects of racial exclusion lead to a wealth differential between different ethnic groups (mainly between blacks and whites in the US). Whereas Darity et al. (2006) try to explain the general adoption and austerity of cultural traits, Caselli and Coleman (2008) analyze the decision of individuals to change group membership. If several groups quarrel over some expropriable resources of a country, the identification of group membership plays a crucial role in the incidence and severity of conflicts. The decision to start a conflict or war is for a considerable part based on the possibility to exclude the adversary group from future gains, e.g., a country's natural resources setup.[34] This not only introduces potential group change as a strategic thought but as a direct possible incentive for an individual to pursue such a change.

Ahlerup and Olsson (2007) outline a model of endogenous group formation. They build a model on kinship-based social organizations providing public goods. Differences between the main types of living in ancient times (hunter-gatherers versus sedentary agriculture), the role of statehood, and differences between core and periphery influence secession and fractionalization tendencies are all analyzed. In contrast to the other models, the key

[32]For an additional model on restrictive cultures strongly regulating members' behavior and specifically limiting social deference, see Carvalho (2010).

[33]According to the notion of Darity et al. (2006), an individualist is a person who does not identify and comply with the expected behavior of one's ethnic group.

[34]In their empirical analysis, Collier and Hoeffler (2004) and Collier et al. (2009) follow the model predictions of Caselli and Coleman (2008), according to which greed and thus opportunity is responsible for the incidence of ethnic conflict rather than grievance.

contribution here is that it covers the emergence of new groups, instead of the changes between existing groups and assimilation looked at in most of the other models.

Lazear (1999) uses a single stage trade model to analyze language assimilation between minority groups and the majority group. The more a country is split into one clear majority and one or several small minorities, the faster one observes the assimilation process, because their value from assimilation is higher.[35] The model outlined in this essay is based on this basic trade model.

Kónya (2005) builds on Lazear (1999) and offers two interesting extensions. In his model, a social planner is introduced to answer the question of whether multiculturalism or a melting pot was the best solution. Additionally, Kónya (2005) introduces the role of different population growth rates, internally or externally through migration. Differences in these rates can lead to stabilization in the assimilation of the (immigrant) minority group, and even to the displacement of the host's majority group. Both aspects will also be treated by the model outlined here.

1.3 Basic model

The following model captures when and why language assimilation takes place within a country. It consists of two stages instead of only a single one, as is the case in the original model of Lazear (1999).[36] For interpretation and discussion, Lazear's interpretation of 'language assimilation', i.e., learning of an additional language, is consistently used. Although the model considers linguistic groups, a broader applicability of the model to ethnic or cultural groups is obvious.[37]

First of all, the focus is on the decision of an individual in a single country, who speaks only one language. In the first stage, every individual can decide either to search for a trading partner or to invest his time into learning another language. Trade will only take place if two individuals meet who speak the same language. Learning a new language does not result in any trade in the first period, but increases the possibility of meeting a trading partner in the second period, because the individual now speaks an additional language.

The respective relative population shares of the k language groups within this country are given by p_g with $g \in \{1, ..., k\}$, $p_g \in [0; 1]$ and $\sum_{i=1}^{k} p_g = 1$. Any trade is assumed to yield the same value for all individuals and is normalized to a value of one. If individuals decide to engage in trade, the random matching process of monolingual individuals leads

[35] The same dynamics were modeled by Church and King (1993) and Selten and Pool (1991) on game theoretic grounds. Whereas the first is more similar to the approach followed here, the second opens up the possibility of bilingualism but remains more general in its conclusions.

[36] This extended approach is drawn exemplarily from Galor and Zeira (1993). In their model, an individual has the choice to pursue unskilled work in both periods or to invest in education in the first period and to pursue skilled labor in the second stage. The resemblance to my model is obvious.

[37] For a discussion on the congruency of language and culture, see Chong et al. (2010). Falck et al. (2010) also conclude that "language differences are probably the best measurable indicator of cultural differences" (Falck et al., 2010, p. 30). In the following, it becomes clear that the processes and dynamics found for language can easily be transferred to other characteristics of ethnicity.

to a probability of trade equal to p_g – the expected probability to meet another individual of its own group.[38] The expected revenue (R_g) of all individuals of group g is then:

$$E[R_g] = p_g \cdot 1 = p_g \quad \text{for all } i \in \{1, ..., k\} \tag{1.1}$$

Consider the groups g and h, where $p_g \leq p_h$. It follows that $E[R_g] \leq E[R_h]$. Individuals of smaller groups thus have a general incentive to assimilate into bigger groups in order to increase the probability of trade.[39]

The effort an individual needs to make in order to learn another language is defined as a function of learning costs $b(\theta, a_i)$. The costs depend on a general costs parameter θ and on the ability level a_i of each individual i.[40]

θ defines the general cost function for each group member to learn another language, depending on the differences between one's own language and the one to be learnt.[41] The more similar two languages are, the more straightforward it is to learn them. This is reflected in a lower θ, and $\partial b_g(\theta, a_i)/\partial\theta > 0$ applies. Lazear (1999) describes the costs $b(\theta, a_i)$ as the efficiency to learn another language.[42] This can easily be linked to the education level of each group. With no education, it is much harder to learn another language than with a certain level of education already attained. More specifically, θ_{gh} affects the cost function of all individuals of group g who learn the language of group h, given by $b_g(\theta_{gh}, a_i)$.

Finally, each group consists of individuals with different levels of ability a_i. From $\partial b(\theta, a_i)/\partial a_i < 0$ follows that higher individual ability lowers the costs of learning. This implies that it is not equally wise for all individuals to learn a new language.[43] However, the ones with the highest ability would decide in favor. The distribution function of a_i within the respective group g is given by $P_g(a_i)$. Consequently, the proportion of group g that learns the language of group h is then given through P_h^*.

[38] A more general characterization of 'communication benefits' is used by Selten and Pool (1991). They are directly influenced by the size of the language community.

[39] This can also be interpreted as access to the bigger market and to higher possible revenues. A comparable result is found by Christofides and Swidinsky (2010). They show for Canada that the wage premium for learning an additional official language is much higher for the minority French-speaking group than for the majority English-speaking group. Chiswick and Miller (2007, Ch. 3) discuss the decision of immigrants in multi-language country surroundings which language to acquire, proving a general preference for the majority language. A broader overview of studies that assess wage premiums of additional languages up to 20% is found in Ginsburgh and Weber (2011, Ch. 5).

[40] The same split into these two factors influencing an individual's cost function is applied by Selten and Pool (1991).

[41] Chiswick and Miller (2007, Ch. 20) assess the distance between two languages for a broad set of languages in accordance with the difficulty to learn English. For a broader overview of different methods to assess the distance between languages, see Ginsburgh and Weber (2011, Ch. 3).

[42] If θ_{gh} covers only the differences between languages, the symmetry assumption $\theta_{gh} = \theta_{hg}$ is reasonable to use. If it represents the overall efficiency or ease to learn another language, it is obvious that it might be easier for group g to learn h than the other way round and $\theta_{gh} \neq \theta_{hg}$, for example, due to differences in the educational level between both groups.

[43] Based on these insights Ginsburgh et al. (2007) subsequently construct demand functions for languages within the European Union based on individual second-language learning costs (Gabszewicz et al., 2008).

Table 1.1 summarizes the potential pay-off in the first round for an individual of group g depending on the choice whether or not to learn the new language of group h with $p_g < p_h$.

	No new language	New language
First stage	p_g	$-b_g(\theta_{gh}, a_i)$
	$\Downarrow$	$\Downarrow$
Second stage	$p_g + P_g^*$	$\left(p_g + P_g^*\right) + (p_h + P_h^*)$

Table 1.1: First round pay-offs per stage and depending on the decision taken

In the first stage, not learning a new language and deciding to trade leads to an expected pay-off of $E[R_g] = p_g$. Learning the language of group h for an individual i of group g, accrues costs of $b_g(\theta_{gh}, a_i)$. In the second stage, some adaptations in the group composition arise due to the decisions in the first stage. P_g^* is the proportion of individuals of all other groups that assimilated into group g. Therefore, the potential for trade for an individual of group g might increase by the amount P_g^*.[44] The individual of group g who learnt the language of group h can now communicate in the second stage with individuals from group h. The share of all other individuals that learnt either the language of group g or group h, indicated by P_g^* and P_h^*, additionally applies. The choice to learn another language is always an individual one, i.e., collusive action within a group is not possible in this model.[45] An individual i of group g will decide to assimilate into another group h with $p_g < p_h$ if:

$$(p_g + P_g^*) + (p_h + P_h^*) - b_g(\theta_{gh}, a_i) \geq p_g + (p_g + P_g^*) \tag{1.2}$$

$$\Leftrightarrow \quad (p_h + P_h^*) - b_g(\theta_{gh}, a_i) \geq p_g$$

$$\Leftrightarrow \quad f(p_g, p_h, b) := (p_h - p_g + P_h^*) - b_g(\theta_{gh}, a_i) \geq 0 \tag{1.3}$$

Without making any additional assumptions, this already leads to some insights. For a given and equal level of a_i and θ across all groups, individuals in the smallest group have the highest incentive for assimilation. The bigger a minority group gets, the lower the probability of assimilation of its members becomes. When the first wave of migrant workers arrived in Europe, they represented a very small minority and had high incentives to assimilate in the respective new country's main group. As these groups grew over the years, the need and incentive to do this decreases.[46] Upon approaching close to an even split of the two groups, it is highly unlikely that any assimilation will take place, but the

[44] However, with the definition $p_g < p_h$ this is rather a theoretical possibility.

[45] Additionally, to already include the outcome of the second stage in the considerations of the first, one normally needs to discount the second stage. Since it will not change the general outcome, it is abstained from doing this for the sake of simplicity.

[46] Danzer and Yaman (2010) find a negative effect of the size of the immigrants groups on the host country's language proficiency in Germany. Additionally, immigrants with high learning costs prefer to move to enclaves of their own descent.

status quo will persist. On the other hand, the higher the share p_h of the bigger group is, the more individuals from minority groups will assimilate. This tendency is intensified even more if other individuals learn the language of group h, P_h^*. The harder it is to learn the other language, $b_g(\theta_{gh}, a_i)$, the lower the potential for assimilation. These dynamics can easily be seen by differentiating *(1.3)*:

$$\begin{aligned} \partial f/\partial p_g &< 0 \\ \partial f/\partial p_h &> 0 \\ \partial f/\partial P_h^* &> 0 \\ \partial f/\partial b_g &< 0 \end{aligned}$$

In highly fragmented countries, the revenue differential $(p_h - p_g)$ between two groups might be too small for any group to assimilate, and no changes would take place. Thus, there is no general trend to more homogeneity, with very fragmented countries possibly persisting as well.

For any country, its development level and economic growth is highly important. That is why the parameter $s(y) \geq 1$ is introduced. It covers more generally the country-specific specialization or level of development.[47] Depending on its stage of economic development y, a higher $s(y)$ describes a more developed country. If only a few goods are traded in a country and all groups rely on subsistence farming, there is no need to conduct trade amongst each other, let alone with other groups. With an increasing trade volume, it is more interesting to participate, as more is at stake. A higher $s(y)$ thus describes the overall trade volume that is available in each round. We may therefore expect $\partial s(y)/\partial y > 0$. Introducing $s(y)$ in *Equation (1.2)*, leads to:[48]

$$\begin{aligned} & s(y) \cdot \Big[(p_g + P_g^*) + (p_h + P_h^*)\Big] - b_g(\theta_{gh}, a_i) \geq s(y) \cdot \Big[p_g + (p_g + P_g^*)\Big] \\ \Leftrightarrow \quad & s(y) \cdot (p_h - p_g + P_h^*) - b_g(\theta, a_i) \geq 0 \end{aligned} \tag{1.4}$$

Comparing *(1.3)* and *(1.4)*, one can clearly see that with a rising level of development, the return split would increase, and assimilation into the majority becomes more likely. Starting with a very fragmented country (small p_g and p_h), potentially no group has an incentive to assimilate, as the return split is still too low. With an increasing level of development, assimilation would become more likely, and countries should tend to homogenize in this process. Very fragmented countries, paired with lower levels of development,

[47] Lazear (1999) points out that it is not entirely random for individuals to meet in a country, but one can normally observe a grouping of peers or a segregation of groups. Lazear (1999) describes this as specialization. A very remote tribe living in autarky, would produce all that it needs and one would not find any specialization between groups. In less developed countries the contact between various groups is often additionally constrained due to poorer infrastructure, which fortifies the remoteness of these groups or tribes. For more developed countries, specialization and thus trade possibilities increase in importance.

[48] Additionally, it is assumed that the costs $b_g(\theta, a_i)$ are independent of a country's specialization level $s(y)$.

would, however, be expected to remain in a very fragmented equilibrium. With rising development, a continuous process of assimilation into the majority group is expected to take place.

1.4 Country equilibria

Having discussed the decisions of individuals regarding assimilation into a new language group, we can proceed to analyze the country equilibria. This is necessary to answer the main question as to whether, and how a country's heterogeneity is changing. Before we can draw these conclusions, some additional assumptions need to be discussed and be further specified.

1.4.1 Theoretical considerations and base scenario

The processes outlined in the previous section will be repeated for several rounds. After the first two stages, the group sizes change, and therefore decisions in a new round face changed revenue and cost considerations. After each round, i.e., the two stages, each individual has to decide which of the two languages he will use in the next round, so that at the beginning of each round only monolingual groups exist. Although that is a strong limitation, it has some obvious arguments to follow. The ethno-linguistic fractionalization index (ELF) commonly used in the econometric literature does not allow for bilingualism, with an individual only able to belong to one specific group. The ELF index is calculated like a Herfindahl-Hirschman concentration index, with:

$$ELF = 1 - \sum_{g=1}^{k} p_g^2 \tag{1.5}$$

Its value moves between zero and one and represents the probability that two randomly selected individuals from a population come from different groups. A higher value thus indicates a more fragmented country. As this essay aims to provide a model interpretation of the expected dynamics of the ELF index, it seems fair to adopt the above assumption. An even more plausible interpretation seems to be that parents need to decide in which culture or language they want to raise their children, because learning a language and settling in a new group takes time and effort.[49] As every round represents a new generation, this correlates with a certain inertia towards assimilation processes in this regard. In the model, as well as in reality, adaption processes to change one's culture or language are

[49] In an extension of his model, Lazear (1999) also discusses the decision of parents of which language or culture will be passed on to their children. For a more detailed discussion on the vertical transmission of culture and language, and an explicit model of these decisions, see Bisin and Verdier (2001) and Ashraf and Galor (2007). Additionally, Aspachs-Bracons et al. (2007b) show in a case study for Catalonia that irrespective of the parents' origin school children identify with the Catalonian identity the more intense they were taught in Catalan. This is carried forward in their political behavior (Aspachs-Bracons et al., 2007a).

not subject to instantaneous changes.[50] This assumption therefore has an additional implication. By deciding what language to activate in the next round, each individual would decide to follow the bigger group.[51]

Since we are now in the dynamic process, all individuals that learnt another language and decided to no longer be in the original group need to be accounted for. These are indicated by $P_g^{'}$, which is the net change of individuals speaking language g. Thus, $P_g^{'}$ can be positive or negative. With $g < h$, $P_g^{'}$ is assumed to be negative as one expects that more individuals of group g decide to assimilate into group h than vice versa. Covering the discussion above, the adapted pay-offs for all subsequent rounds are outlined in *Table 1.2*:

	No new language	New language
First stage	$p_g + P_g^{'}$	$-b_g(\theta_{gh}, a_i)$
	$\Downarrow$	$\Downarrow$
Second stage	$p_g + P_g^{'} + P_g^{*}$	$\left(p_g + P_g^{'} + P_g^{*}\right) + \left(p_h + P_h^{'} + P_h^{*}\right)$

Table 1.2: Individual pay-offs for all subsequent rounds

In order to keep the modeling as simple as possible, a small restriction is taken into account, i.e., only assimilation into the majority group m is further discussed and $p_m = p_h = max\{p_g\}$. This is, however, not too restrictive. Learning a new language incurs costs of $b_m(\theta, a_i) \geq 0$ for a member of the majority group m. However, the major additional pay-off in the second stage does not present a big increase in p_m but only in the smaller group p_g. Thus, it would not be reasonable for a member of p_m to assimilate into a smaller group, as costs accrue and the additional revenue p_g is by definition lower than p_m as $p_m = max\{p_g\}$. Thus, majority members do not learn a new language and receive a potential pay-off of $2 \cdot (p_m + P_m^{'}) + P_*^m$, benefiting from all other individuals that assimilated into the majority group.[52]

The distribution functions $G_g(a_i)$ of a_i within the respective group g might be similar across all groups but they can also be different. The distribution function for the model is given by a Beta distribution. The advantage of this distribution is that it offers a continuous probability distribution over the ability interval $a_i \in [0, ..., 1]$.

[50] Belloc and Bowles (2009) explicitly model this inertia in their game theoretic analysis of the impact of cultural conventions on the production and trade of products, where complete contracts are not feasible. Guiso et al. (2007) offer some examples as to how historical events and institutions due to this inertia affect trust between countries.

[51] This directly follows from *Equation (1.1)* and the discussions in the previous section.

[52] Although the majority group p_m would by definition lead to the highest possible revenue, individuals of group g might decide to assimilate into another group h with $p_m > p_h > p_g$. Despite the lower additional revenue $p_m > p_h$, θ_{gh} might be sufficiently lower than θ_{gm}, and some individuals of g might decide to assimilate into h instead of m. In the base analysis below, θ is assumed to be equal for all groups, thus this option will not apply.

Additionally, some further specifications regarding the costs function $b_g(\theta, a_i)$ are taken. In the following, the cost function for an individual of group g who wants to learn the language of group h is given through:

$$b_g(\theta_{gh}, a_i) = \log_{\theta_{gh}}(a_i) \tag{1.6}$$

This cost function is defined over the whole range of ability levels and fulfills all major assumptions.[53] For higher ability levels, the costs are decreasing ($\partial b/\partial a_i < 0$). Additionally, it holds that $\partial b/\partial \theta_{gh} > 0$. The more different two languages are, the higher the costs are to learn another language for all ability levels.[54]

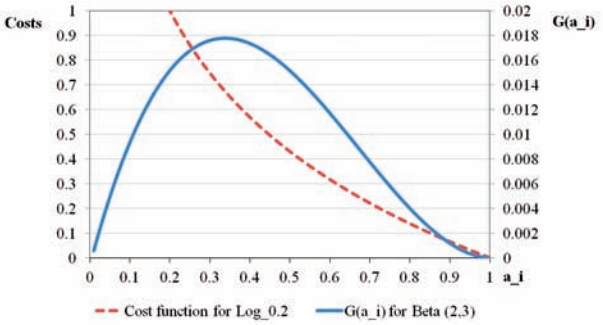


Figure 1.1: Density function for selected B(2,3) distribution and cost function with $\theta = 0.2$

The modeling is exemplarily based on three groups with $p_A = 0.20$, $p_B = 0.30$ and $p_C = 0.50$, corresponding to an ELF value of 0.62. The ability levels are distributed in all groups with a Beta (2,3) distribution. For simplicity, θ is similarly assumed to be equal for all groups, with $\theta = 0.20$. The density function of ability levels and the corresponding cost function are depicted in *Figure 1.1.*

In every round, the individuals of each group make the decision whether or not to learn a new language as outlined in *Table 1.2.* At the start of every new round, the ELF value of the new constellation is calculated.

The relative group sizes and the ELF value are shown for 15 rounds (or generations) in *Figure 1.2.* Both smaller groups assimilate more and more into the majority group, raising the majority's share as a result. The revenue split $(p_m - p_g)$ is constantly increasing. Thus it will become more and more reasonable for lower ability levels a_i to cover the individually increasing costs of learning. After 15 rounds, the group split levels out for $p_A = 0.08$,

[53] To be precise, it must hold that $a_i \in]0, ..., 1]$ and $\theta_{gh} \in]0, ..., 1[$ for the cost function to be defined. As the definition boundaries would lead to either no costs at all or infinite costs regardless of the ability levels, excluding these two values does not constrain the model.

[54] Mathematical details and some graphical examples of the cost function are given in *Appendix A.1* and *A.2.*

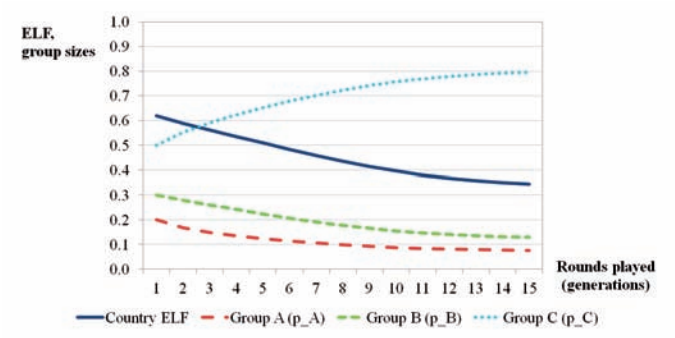


Figure 1.2: Results of dynamic modeling per round

$p_B = 0.13$ and $p_C = 0.80$ as for some individuals costs always exceed the revenues of an additional language.[55] This leads to a significantly lower ELF value of 0.34. On the path to the equilibrium, the smaller group A shows a faster assimilation process, due to the higher revenue differential $(p_C - p_A)$, than the medium sized group B.

1.4.2 Implications of group constellations and cost assumptions

The previous section made it clear that the respective group constellation is relevant to the achieved equilibrium. From the construction of the ELF, it is obvious that different group constellations can lead to the same ELF value.[56] *Figure 1.3* shows the equilibrium path for three different group constellations with equal ELF levels at the beginning.

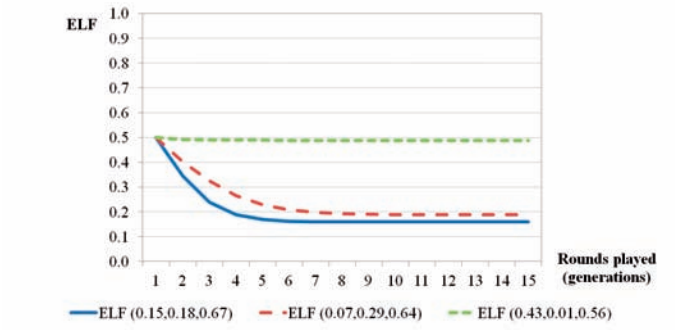


Figure 1.3: ELF values for different group constellations

[55] The relative group sizes do not add up to 1 due to rounding.

[56] This is also one of the main criticisms of the ELF, as its value does not entirely reflect the distribution of the groups. For more details, see *Appendix A.1.2.*

All trajectories start with an ELF of 0.5. In the first case, with two groups of the same size and one majority group ($p_A = 0.15$, $p_B = 0.18$, $p_C = 0.67$), individuals from both smaller groups have an equal incentive to assimilate. After a fast assimilation process, an ELF of 0.16 is approached. In the second case ($p_A = 0.07$, $p_B = 0.29$, $p_C = 0.64$), most of the individuals from the smallest group assimilate. The medium-sized group is already quite large, so fewer individuals decide in favor of assimilating into the majority group. Only after an increase of p_C, due to the assimilation of p_A, do more individuals of p_B assimilate. This leads to a slower assimilation process. The ELF value reached after 15 rounds is 0.19. In the final case, where a high polarization of two big groups is found ($p_A = 0.43$, $p_B = 0.01$, $p_C = 0.56$), there is not much movement between the groups, leading only to an marginally decreased ELF of 0.49.

Turning back to the initial group constellation with $p_A = 0.20$, $p_B = 0.30$ and $p_C = 0.50$, the influence of a changing θ is shown in *Figure 1.4*.

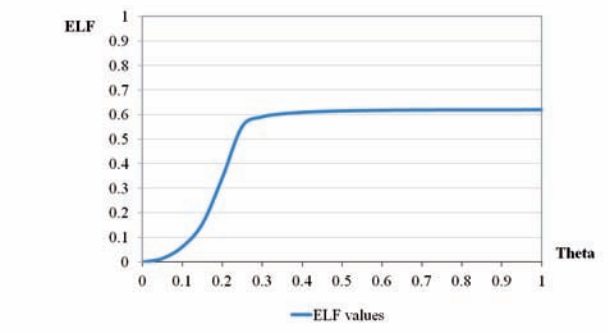


Figure 1.4: ELF values after 15 rounds depending on θ values

Obviously, with θ tending to zero there are literally no costs at all in learning another language, and all individuals, irrespective of their ability level, would assimilate into the majority. The ELF value thus becomes zero, indicating a completely homogeneous country. With a rising θ, the costs increase rather quickly.[57] For higher values of θ, the final ELF value tends to the start value – in the example, tending to an ELF value of 0.62. In this case, it is not feasible for any individual to change groups, as the costs are always too high.

1.4.3 Implications of economic growth and immigration

So far, the role of a growing economy, as covered in the $s(y)$, was neglected. In the following, it constant economic growth is assumed, i.e., a continuous increase in overall economic activity. This scenario is depicted in *Figure 1.5*.

[57] For the mathematical details of $\partial b/\partial\theta$, see *Appendix A.1.1.*

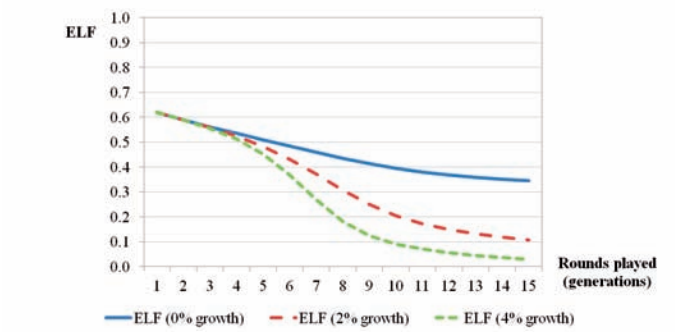


Figure 1.5: ELF values for different growth rates

Growth clearly increases the speed and scale of the assimilation process. In the employed example, the first case is the same as that above without growth. The equilibrium ELF value approaches 0.34 after 15 rounds. For the growth cases, the final ELF value significantly drops to 0.11 and 0.03, respectively. Combined with the previously found results, one can see that growth can make the homogenization process possible although there might be rather high costs, e.g., due to a low level of education or poor infrastructure.

Finally, one would expect immigration to be a major driver of a country's diversity. A very rough extension of the model above captures these dynamics. To account for this, a fourth group – the immigrant group – is introduced. Their relative population share at the beginning is zero. After that, the country experiences a steady immigration inflow of 2% into this group.[58] This leads to the effect that, even without covering the assimilation processes initially, one will find changes in the group setup. By introducing the immigrants group, the other relative group sizes decrease. All other dynamics discussed above remain comparable.[59] As immigrants incur higher costs in learning the language of the host country, it is assumed that immigrants have a higher cost function, with $\theta = 0.40$. For all

[58]The immigration rate is a net rate, i.e., it is designed as the immigration rate exceeding the country's residents population growth rate.

[59]There is one additional assumption to ensure that the dynamics remain constant. The reduction of the resident group proportion due to an increasing share of immigrants can, in some constellations, lead to a decreasing revenue split $(p_m - p_g)$ for the smaller resident groups. This means for some individuals who already assimilated, the decision would no longer be viable in retrospect. In this case, no re-assimilation into one's old group is assumed.

other groups, the previous assumption of $\theta = 0.20$ still applies.[60] The differences from the base example of *Figure 1.2* are shown in *Figure 1.6*.

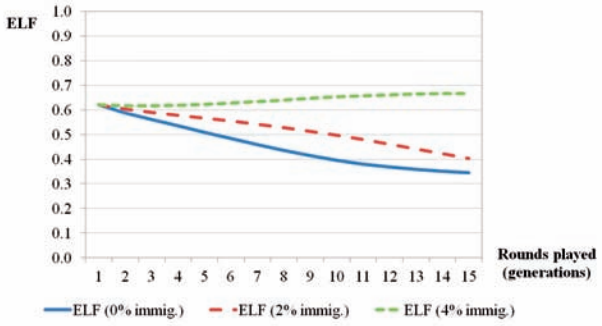


Figure 1.6: Overall country ELF values for different immigration rates

Besides the case without migration, two additional cases include a 2% and a 4% immigration inflow. In the 2% case, the ELF values still decrease, showing a constant homogenization of the country, but the scale is significantly lower, and the ELF value eventually tends to 0.40. With a high immigration rate, however, the fragmentation is increasing, resulting in a more heterogeneous country with an ELF value of 0.67.[61]

The dynamic part of the model shows, in a simple manner, how the group constellation, the costs of assimilation, economic growth, and immigration affect a country's language heterogeneity. The important result to note is that there is no uniform dynamics evident leading to more homogeneous countries, but the initial heterogeneity might well persist, or even increase due to immigration.

1.5 Extensions with international trade

In a globalized world, considering a country in autarky will not tell the whole story. In this section, the additional dynamics through an extension of the model covering international trade is outlined, and a second country is included. This extension shall only roughly sketch the additional implications and does not take all the dynamics of the previous

[60] Higher social and cultural cohesion within the country's resident groups make it more costly for immigrants to assimilate. See, for example, Carvalho (2010). For empirical evidence of quite lethargic processes of assimilation by immigrants into their host country's culture, see Fernandez and Fogli (2005) and Fernandez (2010). Additionally, if the immigrant groups are easily excludable and the host country groups develop a racialist strategy, the costs of integration will further increase. These points are theoretically discussed in the models of Caselli and Coleman (2008) and Darity et al. (2006). On the contrary, a rising share of immigrants may reduce the costs of migration and it becomes feasible for more people to take this step, reducing the marginal needed ability level. Beine et al. (2011) confirms this empirically, showing that the average educational level is significantly negatively correlated with the size of existing diasporas.

[61] Besides immigration, differences in fertility rates across residents groups may equally lead to more heterogeneous countries.

section into account. However, the main implications are easily visible. The two countries A and B are of equal size, and within the countries the pay-off incentives are similar. The incentive constraints now only carry a country indicator. In line with *Equation (1.4)*, they are now given through:

$$s(y^A) \cdot (p_m^A - p_g^A) - b_g^A(\theta, a_i) \geq 0$$
$$s(y^B) \cdot (p_m^B - p_g^B) - b_g^B(\theta, a_i) \geq 0$$

Now, all individuals can also engage in trade with the other country. Again, to facilitate trade, the individual would need to learn the language of the group he wants to trade with. Learning the language of another country bears the cost of $c_g^A(\theta, a_i)$, and it is assumed that pointwise $c_g^A \geq b_g^A$ holds and thus:[62]

$$c_g^A(\theta, a_i) = g \cdot b_g^A(\theta, a_i) \qquad \text{, with} \qquad g \geq 1 \tag{1.7}$$

This is indeed plausible, as learning a foreign language makes it likely that the two languages are more distant than within a country. Additional costs might arise, because learning possibilities are more limited due to geographical distance. In order to trade with another country, trading costs of τ, with $(0 \leq \tau \leq 1)$ accrue. For an individual of country A to engage in trade with country B, the following equation needs to hold:

$$\begin{aligned} & \left[(1-\tau) \cdot s(y^B) \cdot p_m^B + s(y^A) \cdot p_g^A\right] - c_g^A(\theta, a_i) \geq 2 \cdot s(y^A) \cdot p_g^A \\ \Leftrightarrow \quad & \left[(1-\tau) \cdot s(y^B) \cdot p_m^B - s(y^A) \cdot p_g^A\right] - c_g^A(\theta, a_i) \geq 0 \end{aligned} \tag{1.8}$$

Comparing now (1.4) and (1.8), one can see that if the countries' structures are comparable, international trade is not pursued. If both countries have a comparable development structure $(s(y^A) \approx s(y^B))$ and the majority groups are the same size $(p_m^A \approx p_m^B)$, it is rather unlikely to see international trade emerge, as higher costs $(c_g^A \geq b_g^A)$ and trade costs τ apply. If the structures are different, international trade might emerge.

Individuals of a certain group i in country A have three possibilities: remain in autarky, assimilate into the majority group of their own country, or engage in international trade with the other country. The sum of pay-offs over both stages in autarky is easily given by:

$$2 \cdot s(y^A) \cdot p_g^A \tag{1.9}$$

The two other options involve some learning costs but also the possibility of higher revenue. For these choices, the following constraints need to be satisfied:

[62] For $c_g^A(\theta, a_i)$, $\partial c_g^A(\theta, a_i)/\partial a_i < 0$ and $\partial c_g^A(\theta, a_i)/\partial \theta > 0$ also applies.

Assimilation (national trade):

$$\begin{aligned} & s(y^A)\cdot(p_m^A+p_g^A)-b_g^A(\theta,a_i)\geq 2\cdot s(y^A)\cdot p_g^A \\ \Leftrightarrow \quad & s(y^A)\cdot(p_m^A-p_g^A)-b_g^A(\theta,a_i)\geq 0 \end{aligned} \tag{1.10}$$

International trade:

$$\begin{aligned} & \Big[(1-\tau)\cdot s(y^B)\cdot p_m^B+s(y^A)\cdot p_g^A\Big]-c_g^A(\theta,a_i)\geq 2\cdot s(y^A)\cdot p_g^A \\ \Leftrightarrow \quad & \Big[(1-\tau)\cdot s(y^B)\cdot p_m^B-s(y^A)\cdot p_g^A\Big]-c_g^A(\theta,a_i)\geq 0 \end{aligned} \tag{1.11}$$

As a prerequisite for an alternative decision to autarky, the *Equations (1.10)* or *(1.11)* need to hold in order to be chosen by any individual of a minority group in country A. In addition, to make a decision in favor of international trade, *Equation (1.11)* needs to deliver a higher pay-off than (1.10) and thus:

$$\begin{aligned} & (1-\tau)\cdot s(y^B)\cdot p_m^B-s(y^A)\cdot p_g^A-c_g^A(\theta,a_i)\geq \\ & \qquad s(y^A)\cdot(p_m^A-p_g^A)-b_g^A(\theta,a_i) \\ \Leftrightarrow \quad & \Big[(1-\tau)\cdot s(y^B)\cdot p_m^B-s(y^A)\cdot p_m^A\Big]-\Big[c_g^A(\theta,a_i)-b_g^A(\theta,a_i)\Big]\geq 0 \\ \Leftrightarrow \quad & \Big[(1-\tau)\cdot s(y^B)\cdot p_m^B-s(y^A)\cdot p_m^A\Big]-\Big[(g-1)\cdot b_g^A(\theta,a_i)\Big]\geq 0 \end{aligned} \tag{1.12}$$

For high costs, the autarky option delivers the highest expected revenue. Furthermore, the dynamics of the previous sections still apply. Lowering the costs $b_g^A(\theta,a_i)$ or increasing $s(y)$ makes assimilation more probable as a result. Decreasing transportation costs τ (or closer integration in the international trade) increases the value of the international trade option and would thus also make it more probable. With further increased education and better integration into the global economy, the international trade option offers the highest pay-off. Having more opportunities to engage in international trade, a single group would have a greater possibility of finding an international trading pair that minimizes its assimilation costs. With more developed and integrated international trade, there are many incentives not to assimilate into the majority group of their own country, but to pursue international trade.

This dynamic might even increase if the assumption of two countries of equal size is abandoned, and the second country is interpreted as the access to global trade. If this were the case, relatively smaller groups would still be big enough to be interesting for a small group in country A from an absolute size perspective. In the single country case, the assimilation decision was only relevant for all $p_g \leq p_m$. However, the international trade decision might even be relevant for a majority group, as long as p_m^B is sufficiently larger than p_m^A. This is certainly the case in the global trade interpretation. Introducing the

second country thus clearly opens up the possibility for heterogenization dynamics that were not possible in the single country case.

In terms of regional trade integration, it is even more relevant. One often finds the same ethnic or language group in two neighboring countries. In the case that this group is a majority in the one country but a minority in the other, the costs of assimilation tend to zero and only the transportation costs τ apply. In such a setting, the minority would not assimilate into the majority group of its country but would pursue further trade integration with the brother group in the neighboring country.[63]

1.6 Conclusion

Following the basic outline of Lazear (1999), his trade model is extended to better understand the dynamics of changes in a country's heterogeneity. The basic model shows that depending on the group split, the assimilation costs, and economic growth, complete assimilation is not a necessary equilibrium and a certain level of heterogeneity could well exist. The highest incentive lies with the minority group(s) to assimilate into the majority group. The larger the difference between the minority and majority group, the faster assimilation will take place. A country that is fragmented into rather equally sized groups, however, will not experience major changes in its group setup, retaining its level of heterogeneity.

In analyzing the changes in dynamics over some generations, the core dynamics of the basic model are confirmed. However, a close link to the changes in ELF values is also evident. Due to these analyses, one can see that countries with different group setups, but with the same level of ELF, might experience quite different changes, leading to different equilibrium ELF values. This clearly questions the general applicability of the ELF index. Although it measures fragmentation to some extent, it might not be the adequate measure of ethnicity in all analytical setups. With high costs of learning another language, for example due to a generally lower level of education in a country, or because of the fundamental differences between two languages, the heterogeneity of a country is retained. Thus, raising a country's level of education and reducing the assimilation costs for all ability levels should go hand in hand with a steady process of homogenization. This process is strengthened by higher economic growth. Thus, over its economic development path, one should find many more homogeneous countries. Besides the main drivers already looked at, migration can, as expected, retard the process of homogenization and, above

[63]This additional option is probably the reason for the persistence of a high heterogeneity in Sub-Saharan Africa. In the nation building process, as part of the colonization of Africa, the colonial powers seldom drew borders along group lines, often bisecting the territory of ethnic groups with a border between two new countries. See Alesina et al. (2011) for an assessment of 'artificial' states and a new measure of how borders split ethnic territories between neighboring countries. Michalopoulos and Papaioannou (2011) analyze the effects of dividing these ethnic groups on their contemporary economic performance. For African case studies on how different relative group sizes affect the political salience of conflict between these groups, see Posner (2004b), and for resulting differences in public goods provision, see Miguel (2004).

a certain threshold, even lead to more heterogeneous countries. The important result to note is that there is no uniform dynamic in more homogeneous countries, but that the initial level of heterogeneity might well persist, or even increase due to immigration.

A rough extension covering two countries, i.e., providing for the possibility of international trade, gives some insights as to how changes in the dynamics of ethnic group splits might be altered. In this case, one might expect more languages and thus a more heterogeneous country. This is especially clear in the case where ethnic groups were split up, having to live in different countries and represent different shares of their respective country's populations. The incentive of assimilation for the minority group fades here as it can pursue trade with their neighboring relatives with higher trading costs, but without the high costs of assimilation.

The extended model outlined in this essay gives a better understanding of ethnicity's dynamics and its endogenous formation. Furthermore, the results call for an empirical verification and for more profound analyses of specific case studies to better understand the dynamics of ethnicity, as it can hardly be assumed to be static anymore. This is especially important for the growing strand of empirical literature on the role of ethnicity. Using the ELF index for these analyses, one should be cautious in the interpretation of its role and discuss the results in the light of the dynamics found in this essay.

Chapter 2

Drivers of Ethnic Fragmentation

2.1 Introduction

"Every valley is still a little world that differs from neighboring world as Mercury does from Uranus" (Weber, 1976, p. 47). In this quote, Weber is not referring to a developing country in the heart of the African continent where ethnic heterogeneity is claimed to be at the roots of its growth problems.[64] Instead, it is a citation of an economist describing France in the second half of the 19th century. Only 36 out of 89 *départments* were fully French-speaking, and "French was a foreign language for a substantial number of Frenchmen, including almost half the children who would reach adulthood in the last quarter of the century" (Weber, 1976, p. 67). In addition to the language's heterogeneity, Weber describes in great detail how diversity was persistent in every part of life, from cultural traits, measurement systems, currencies, and various beliefs which were in contrast to the officially proclaimed Christianity. Several decades later, in the middle of the 20th century, demographic estimates already showed the more common picture of France being the homogeneous '*grande nation*'.[65]

This paves the way to investigate the dynamics of a country's ethnic heterogeneity and to question the static nature in which most of the economic literature bases its analyses on the role of ethnic heterogeneity.[66] Although most authors admit that there is some endogeneity involved, they do not pursue this fact further and proclaim that fragmentation, at least, is not changing over a short period of time.[67] However, in a time where conflicts,

[64] See the influential paper of Easterly and Levine (1997) about 'Africa's growth tragedy'.

[65] Héran et al. (2002) assess that less than 10% of parents did not speak French with their children in 1950.

[66] For a more detailed overview of the ways in which ethnic fragmentation is affecting the economic outcome of a country, via its influence on institutional and policy drivers of growth, see, for example, Alesina and La Ferrara (2005). For a good overview of ethnic fragmentation's influence on conflict incidence, type and duration, see additionally Garcia-Montalvo and Reynal-Querol (2003).

[67] A rare exception is Fedderke et al. (2008), with a case study on South Africa. They employ changing values of racial fragmentation for each decade in their analysis on its role in economic growth. Evers et al. (2010) offer a rough overview of a newly developed index for Malaysia, intended to better analyze Malaysia's ethnically heterogeneous society and to track its changes.

migration and globalized trade are shaping countries and their populations, shouldn't one be able to observe shifts in a country's ethnic setup over several decades?

In contrast to this literature, some recent publications try to shed some more light on what roots ethnic heterogeneity might have and why it developed so differently across the globe. In contrast to the previous essay, where the dynamics of ethnic fragmentation were modeled theoretically, the focus of this essay is to empirically test what drives these dynamics. Ahlerup and Olsson (2007) analyze the influence of human settlement, finding that the duration of uninterrupted settlement leaves more time to diverge into different groups, leading to an increased fragmentation. The existence of modern states and their institutions lowered a country's fractionalization.[68] Additionally, policies might directly or indirectly promote 'assimilation'.

Michalopoulos (2011) bases his article on Darwin's theory of evolution. He argues that various geographical conditions are "the ultimate cause of the emergence and persistence of ethnic diversity" (Michalopoulos, 2011, p. 2). These different settings in turn lead to the emergence of different species, adapted to their specific niche, which is also true of the modern human being.

Whereas both Michalopoulos (2011) and Ahlerup and Olsson (2007) explore rather long-term historical and geographical determinants of ethnic fragmentation, Campos and Kuzeyev (2007) analyze changes in heterogeneity in the former Soviet republics after the fall of the Iron Curtain. Their approach thus comes closest to the intention of this essay. They show that over the decade that followed 1989, ethnic fractionalization decreased in most countries, language heterogeneity did not change significantly, and religious heterogeneity demonstrated a slight increase.[69] Unfortunately, Campos and Kuzeyev (2007) conclude with these findings and stop short of empirically analyzing the reasons for the adaptations.[70]

Using data for the 1960's and 1980's, this essay supports the above findings that a 'base-level' of ethnic fragmentation evolved due to a set of geographical and historical variables. Furthermore, it offers a new interpretation of colonization's impact on shaping a country's ethnic fragmentation. The approach the colonial powers followed in their pursuit plays an important role. The main finding of this essay is that ethnic heterogeneity is changing over a rather short period of twenty years. Migration is the most obvious factor in a more integrated and globalized world, which is confirmed by this study. However, it also shows

[68] See also Ranis (2011), who argues that kinship relationships are a mere compensation for nom existent official social security networks.

[69] For a discussion of the interrelations between various forms of fractionalization and various social, political and institutional dimensions in a case study of South Africa, see Fedderke and Luiz (2007).

[70] In an independent, but simultaneous contribution, Green (2011) follows an approach comparable to the one followed here. He uses the same data set, but follows a different empirical strategy and does not differentiate between drivers for a 'base-level' of fragmentation and more short term influential factors. The main driver for a country's homogenization in Green (2011), urbanization, is found to be equally influential here. However, the results of this essay show that it is not only one driver, but additional important ones that have an influence, which are either not identified or deemed less influential by Green (2011).

that urbanization and education in particular play a significant, and even more important role.

The remainder of this chapter is organized as follows. In section 2.2, ethnicity is briefly framed and the key views on its dynamics are introduced. Section 2.3 structures and discusses the various drivers that might be responsible for changes in a country's ethnic setup. Section 2.4 outlines the empirical strategy and discusses the data sources used, their coverage, limitations and first insights into the descriptive statistics. Section 2.5 then discusses the empirical significance of the drivers for a wide range of countries. Finally, section 2.6 summarizes the key findings, concludes and gives an outlook for further research.

2.2 Framing ethnicity

Ethnicity is sometimes described as a "rather vague and amorphous concept" (Alesina et al., 2003, p. 160). Despite the lack of a clear cut definition, economic literature focuses mainly on three characteristics when discussing a country's cultural fragmentation: its ethnic, language and religious fragmentation. The combination of ethnic and language characteristics leads to the widely used taxonomy of ethno-linguistic groups.[71] Based on relative group sizes defined along these characteristics, Taylor and Hudson (1972) built the ethno-linguistic fractionalization index (ELF) as a measure of a country's ethnic setup. Although other forms of operationalization have recently emerged to go about answering specific questions, the ELF is still the most commonly used measure whenever ethnicity is included in economic analyses.[72] The ELF is calculated based on a Herfindahl-Hirschman concentration index:

$$ELF = 1 - \sum_{i=1}^{K} p_i^2, \qquad i = 1, ...K \tag{2.1}$$

where p_i are the relative group sizes of the K groups in a given country. The measure ranges between zero (only one group and thus complete homogeneity) and one (complete heterogeneity). It reflects the probability that two randomly selected individuals from a population come from different groups and generally increases with the number of groups.

However, to define ethnic heterogeneity and its measurement does not yet explain what led to the emergence of ethnic groups and what shaped, or constantly shapes ethnic identities and their group identification. Three schools of thought have emerged to provide

[71] See, for example, Alesina et al. (2003), and Fearon (2003), who build their measures based on this combined taxonomy. For more details on language groups and the mutual differences, see Lewis (2009) and Fearon (2003). For some specific analysis on the role of religion, see, for example, Guiso et al. (2009) or Barro and McCleary (2003) and Garcia-Montalvo and Reynal-Querol (2003) for the role of religious polarization.

[72] The seminal articles of Mauro (1995), Easterly and Levine (1997), Collier (1998, 2001), Alesina et al. (2003) and Alesina and La Ferrara (2005) all rely on the ELF index. For details on other measures, see Garcia-Montalvo and Reynal-Querol (2003, 2005a, 2008) for an index of polarization, Posner (2004a) on his restricted index of politically relevant ethnic groups, and Fearon (2003) for the idea of ethnic distance that is further explored in Chapter 3.

an answer to these questions. The primordial, the instrumentalist and the constructivist approach differ in their interpretation of origin, persistence and shaping forces of ethnic groups. Fenton (2010) combines the three concepts and aspects very well, offering a comprehensible argumentation for the main argument of this essay, i.e., ethnic boundaries are indeed subject to change. In his view ethnicities are "grounded as well as constructed. Ethnic identities take shape around real, shared material experience, shared social space, commonalties of socialization and communities of language and culture. Simultaneously, these identities have a public presence; they are socially defined in a series of presentations (...) by ethnic group members and non-members alike" (Fenton, 2010, p. 201). Ethnicity, as such, therefore contains some irrevocable core characteristics that represent the most essential characteristics of a group, whereas other parts of the ethnic identity might be subject to change. Thus, identification of ethnic groups can either be driven by self identification of its members around a common marker, or at least partly driven and shaped by the political or societal arena in which their identities are activated, and in which the ethnic group identification is formed. In analyzing drivers of changes in a country's ethnic setup, all three approaches subsequently deliver potential explanations and influential factors.

Some theoretical frameworks and mathematical models offer additional motivation for the dynamics of changing ethnic boundaries. Constant and Zimmermann (2007) discuss, in a simple framework, the main strategies of immigrants with respect to their ethnic heritage, following either an assimilation, integration, marginalization or separation strategy. Depending on the strategy chosen, different effects on the ethnic composition in the destination country would emerge. Bodenhorn and Ruebeck (2003) model and analyze the emergence of mixed ethnic group in the United States in order to improve their economic position. Darity et al. (2006) use an evolutionary game theory model to show different 'acculturation' outcomes, and Caselli and Coleman (2008) analyze the decision to change group membership within a model of ethnic conflict. Ahlerup and Olsson (2007) build their model on kinship-based social organizations providing public goods.[73] Finally, Lazear (1999) models the assimilation processes of language groups in order to sustain or ameliorate trade. Chapter 1 extended this approach and covered the main dynamics this essay tries to prove empirically. It balances the gains of increased trade possibilities from learning a new language with the costs of doing so. The costs are strongly influenced by the proximity of the two languages and the infrastructure available, both for learning as well as trading. Trading gains in turn are defined by the size of trade partners, i.e., the size of the respective language groups. The extended model shows that with rising development, a continuous process of assimilation into the majority group is expected. Increasing education lowers the costs of learning and more individuals would decide in favor of assimilation. Higher transportation costs (or less integration or infrastructure) decrease the value of the trade option and would thus make assimilation less probable.

[73]The aforementioned models were already described in more detail in Chapter 1.

Migration can impede the homogenizing path of a developing country and might even increase a country's heterogeneity in some cases. Thus, the model of Chapter 1 gives some initial points of reference for the subsequent discussion of potential drivers for a changing ethnic setup.

2.3 Potential drivers of ethnic fragmentation changes

Ethnic boundaries that are based on tradition, ancestry and conveyed habits, are certainly not subject to instant changes. However, the environment in which a generation is are raised, be it economically, socially or educationally, should leave its mark, thus leading to a changed ethnic identification; especially in an increasingly globalized world. A key difference between the prospective drivers of change might be their time dimension. The geographic properties of a country are, for all intents and purposes, fixed.[74] Other factors can change rather quickly and are susceptible to political influence. Depending on the ease of change, the variables can be categorized into two groups: evolutionary and historical factors, and socioeconomic and policy factors.

2.3.1 Evolutionary and historical factors

Location and geographical conditions One of the most basic location characteristics of a country is its latitude. Michalopoulos (2011) points to the fact that biodiversity decreases with an increasing distance from the equator. The high amount of biodiversity around the equatorial region is rooted to its tropical climate, the associated habitat heterogeneity, and its higher pathogen load (Cashdan, 2001). The lack of climatic variability in tropical areas leads to specialization in a very specific environment or niche. Areas with high climatic variability (e.g., hot summer, cold winter) require a more generalized approach to manage this variability, subsequently leading to a lower species variation. Additionally, a country that has a large proportion of mountainous areas offers more niches and at the same time makes an exchange between these areas much more difficult. For both reasons, one would expect more mountainous countries to be more diverse. Large countries that cover a huge area should encompass more bio-geographic niches and should thus demonstrate greater heterogeneity.[75]

Human development The historical duration of uninterrupted human settlement for millennia has allowed more time for humans to diverge into different groups. Ahlerup and Olsson (2007) rebuild the way in which the modern human migrated from its birthplace in East Africa to all other parts of the world. In doing so, the development follows a

[74] The access to remote areas can be alleviated, but this is a policy decision regarding infrastructure, rather than a change in geographical conditions per se.

[75] Ashraf and Galor (2007) model explicitly how geography affects cultural assimilation and cultural diffusion. They conclude that these two modes of influence are responsible for different timing and speed of industrialization, which affects the economic performance of nations today.

constant process of genetic fractionalization. Geographical conditions are an important driver in the emergence of different human groups. Whereas the vast amount of time since the emergence of the modern human has already led to diversification solely based on genetic mutations, geographical conditions help to shape and maintain heterogeneity in various locations.[76] Ahlerup and Olsson (2007) direct attention to Papua New Guinea as an example of how both aspects jointly affect ethnic heterogeneity. Its special geography spans a wide array of bio-geographic niches, and with humans known to have lived there since 65,000 years ago, this has led to many isolated and distinct ethnic and language groups. Some 860 indigenous languages, spoken within a total population of only around four million, are still reported today.[77]

State history and colonization Institutions can play a decisive role in homogenizing countries. Well functioning institutions that include codified laws, security and military protection have rendered ethnic and cultural forms of interaction less important and this should have led to an assimilation process into the major group.[78] For Olsson and Hibbs (2005), the transformation from a hunter-gatherer economy to sedentary agricultural production was one of the most important events in shaping societies.[79] This transition led to a very basic set of institutions. A subsequent increase in productivity promoted the development of a non-producing class. Freeing this class from production obligations left room for the development and organization of knowledge, leading to the expansion of science, technology, and state formation. The time since the agricultural transition is therefore assumed to be a factor influencing civilizations and their respective heterogeneity.[80]

In many developing countries, the arrival of colonizers had a lasting influence on existing structures and was a significant factor in creating and shaping countries and societies. Colonizers tried to introduce their legal and political systems, as well as often forcing their own language on occupied countries. From a language point of view, Latin America displays a strong homogeneity as Spanish was widely adopted. The same is true of many French-speaking countries in Africa. The identity of the colonizer and the time span of colonization might be crucial factors for changes in ethnic boundaries. Depending on the interest of the colonial power, they either pursued the 'divide-and-rule' approach and just exploited the country without any long term interest (mainly in Africa), or actually established institutions to sustain a long term development and settlements (e.g., Canada or Australia). Acemoglu et al. (2001) attribute these two contrasting approaches to the

[76] For an additional discussion of the similarity between biocultural heterogeneity and ethnic fragmentation, see Loh and Harmon (2005) and Evers et al. (2010).

[77] The 860 languages represent over one tenth of the world's total (Lewis, 2009).

[78] See, for example, Greif (1993) on an example of ancient trade relationships in the Maghreb region. For a broader overview, see Rauch (2001).

[79] In their argumentation, Olsson and Hibbs (2005) follow Diamond (1997) who roots the Neolithic Revolution in different biogeographical endowments, leading to differences in resource surpluses.

[80] Ahlerup and Olsson (2007) explore how experiences with a modern state over the last hundred years significantly reduced fragmentation. Yet they admit that causality in this aspect is not clear, and more homogeneous countries might have developed a modern state more easily and thus earlier in history.

differences in living conditions the colonizer came across at that time. They measure these conditions as the mortality rate amongst the Europeans arriving in their respective colonies. In countries with higher mortality rates, the colonizers did not want to create lasting structures and institutions intended for long term settlements. A more extractionary approach specifically exploited differences between groups, deepened them and turned the groups against each other. This was pursued by the Belgians in Rwanda with the Hutu-Tutsi split, which was still salient in the twentieth century.[81] In countries with higher mortality rates, which were subsequently exploited and experienced lower levels of institutional development, one might find a higher degree of ethnic fragmentation.

2.3.2 Socioeconomic and policy factors

Demographic factors The global international migrant stock rose from 72 million to 213 million people between 1960 and 2010 (World Bank, 2011). Immigration is seen as the primary reason responsible for increasing heterogeneity with respect to ancestry, ethnic origins, and religions, bringing long-term changes to the population make-up (Coleman, 2009).

Schüler and Weisbrod (2010) analyze whether the effect of ethnic heterogeneity on economic performance changes for countries with a higher stock of immigrants. They conclude that migrants increase trade as they import information about their home country, thereby reducing transaction costs and simultaneously increasing trade due to their preferences for home country products. However, they do not analyze what impact immigration has on the level of heterogeneity in a country.[82]

Fertility rates and population growth are affected by a wide range of factors. Ultimately, not only a woman's personal experience but also her heritage plays a decisive role.[83] Different preferences in fertility rates between a country's historic population and immigrant groups might be important. Most host countries (mainly developed countries) experienced their fertility transition earlier than most less developed countries (where many immigrants originate from), significantly lowering the number of births per woman. This should have a significant impact on destination countries.[84]

A rising population density will mainly affect very small countries. The growth of metropolitan regions is more susceptible to changes in a broader set of countries. The population density in urban areas might even increase when the country density remains constant due to high rural-urban migration flows. In her work on biodiversity, Cashdan (2001) showed that an increased density of species leads to a higher degree of specialization

[81] For a broader discussion of a 'divide-and-rule' strategy as a principle of mere exploitation, see Ahlerup and Olsson (2007). For the Rwandan case, see also Caselli and Coleman (2008), who discuss their theoretical model in light of this conflict.

[82] Especially their heterogeneity measure does not change even for high immigration countries.

[83] Fernandez and Fogli (2009) find that heritage-induced fertility is a significant and persistent factor within second generation immigrant mothers in the United States.

[84] Hispanic and Asian 'minority' groups in the United States are projected to account for around 36% of the total population by 2050 (Coleman, 2009).

in a smaller area and thus eventually to a higher level of heterogeneity. Urban areas are an agglomeration of people all struggling over limited resources. Thus, coordination along ethnic ties to better sustain economic or social development can be expected. However, as the newly arrived population needs to interact with the existing masses, an integration into this mainstream is also expectable. One can maintain the argument that urbanization erodes cultural foundations and replaces ethnic ties with more interest-based liaisons (Bates, 2006). This could have an effect on the ethnic differences between groups. Ethnic borders become less pronounced, leading to a more homogeneous civilization. The impact of urbanization is thus, a priori, not clear.

Conflicts A wide set of literature tries to link an increased incidence of conflict with higher ethnic fragmentation.[85] The reverse causal chain has yet to be addressed in empirical papers, but some theoretical models capture this dynamic.[86] What remains unquestioned is that the various forms of conflict have a significant impact on a country's population. Presumably, death from prosecution or combat has a direct impact on the population, whereas indirectly it is affected by refugee-induced migration. This is true in both the country where the conflict is rooted and neighboring countries. The violent construction of ethnic identities, ethnic cleansing and genocides are the most brutal form of this. In line with the constructivist view, additionally, the question arises, whether ethnic identities arise or are shaped upon the onset of ethnic conflicts. Elites might agitate their peers and strategically use potentially salient ethnic divisions for their ambitions. Fearon and Laitin (2000) analyze a wide range of case studies concluding that elites systematically construct ethnic identities in order to strengthen. maintain or seek power.[87]

Economic factors and trade There is a growing literature on factors benefiting the economic growth of a country, including various measures of institutions, financial indicators, trade, education or infrastructure.[88] Thus, it would be obvious to include GDP figures in the regressions. However, it is hard to see why the economic development level, per se should have altering effects on the ethnic heterogeneity of a country, if this is not the case with various variables highly linked to it. Thus, to better elaborate upon which of these variables affect heterogeneity, a set of variables highly linked to GDP per capita measures is included.

[85] The first to analyze the effect of ethnic fragmentation on conflicts were Collier and Hoeffler (1998). Fearon and Laitin (1999) then analyzed the question with a focus on minority groups, Collier (1998) with a focus on democratic institutions, and Fearon (2003) with a more general approach.

[86] See, for example, Caselli and Coleman (2008) or Darity et al. (2006) and more generally Ahlerup and Olsson (2007).

[87] Fearon and Laitin (2000) also give a general overview of the theory on social construction of ethnic identities.

[88] An exemplary selection of papers analyzing economic growth factors that also deal with ethnic fragmentation include Easterly and Levine (1997), Mauro (1995), Alesina and La Ferrara (2005), Bellini et al. (2009), Collier (2000) and Sachs (2001).

Olsson and Hibbs (2005) discuss the structural changes within an economy over its development path. A different economic structure could be more susceptible to different values regarding ethnic heterogeneity. Gellner (1983) reasons that the industrial revolution and the accompanying higher division of stages in production led to a need for higher homogenization. To face the new division of labor and to efficiently work together, there was a need for a certain level of assimilation or homogeneity.

Assimilation does not necessarily take place within one economy only, but can also have the effect of a mutual rapprochement between two different countries. For Janeba (2004), imported Western products are responsible for crowding out locally manufactured goods and might even marginalize local culture. In general, trade makes a higher variety of (foreign) products available and normally also reduces the price of these goods. The increased access and lower relative price decrease the overall cost of non-conformity with the individual's own culture and paves the way for a more globalized, or generalized, culture.[89] In some constellations of his model, this might even outweigh the gain of trade.

Institutions and policy factors Institutions in general and their underlying ideology might play an important role. The development of state structures, codified law, governing institutions and common military protection have changed the way we live together. Ethnic identity might always be a point of tension in a nation state promoting cultural similarity and integration. The relationship between ethnic fragmentation, the emergence of institutions and vice versa is not a priori clear. Institutions can grant equality, human rights and freedom to pursue cultural expressions. They can also be used as an excessive form of nationalism, excluding culturally deviant citizens with various forms of pressure, or even brutality.[90] This kind of uniforming policy can be present in all forms of state activities, always with the intention of considerably altering the ethnic composition into a more nationalistic, homogeneous country. In forming a French identity, as outlined in the introduction, the modus operandi was rather peaceful. In the last century, however, some cases exhibited unimaginable brutality.

Linked to institutions is the inevitable question of the role of democracy. Both Alesina and La Ferrara (2005), and Collier (1998) show that more democratic regimes moderate the potentially detrimental effect of ethnic fractionalization on economic development. This could indicate a more tolerant environment in democratic countries in which more diverse views are accepted. Campos and Kuzeyev (2007) hold the more tolerant environment of democratization after the fall of the Iron Curtain in the former Soviet republics responsible for an increased religious heterogeneity. However, this might have been a special case, as religious activity was especially disregarded under the communist regime. More autocratic or dictatorial regimes that are built around a very nationalistic ideology might display

[89] Dreher (2006), for example, proxies social globalization inter alia with the number of McDonald's restaurants.

[90] For a discussion of the blurred transition between ethnicity and nationalism, see Eriksen (1991).

significantly lower heterogeneity. Again, the role of democratic regimes and the direction of causality is not clear.[91] However, there is some indication that this kind of political regime at least leaves more room for cultural activity, which might be represented in a more diverse religious or ethnic identification.

Education plays a key role in the development of a country (Barro, 1999; Knack and Keefer, 1997) and its democratization (Akdede, 2010; Barro, 1999). Bolt and Bezemer (2009) describe well the different effects education might have. In a general interpretation, education increases one's human capital. Being endowed with higher human capital, one's social and economic vulnerability declines. Less vulnerable groups are less reliant on ethnic differentiation or identification to pursue their (economic) activities. It also increases tolerance and leads to more rational decisions. Both effects back up the argument that ethnic identification becomes less important with an increasing level of education. Transporting a common history and culture can lead to a better mutual understanding but can also be used as a form of exerting an influence over young citizens. In the context of this Chapter, education is also interpreted as a strong expression of state power with the "purpose of cultural repression" (Bolt and Bezemer, 2009, p. 28). For minorities, education often includes language education, as they might have been raised in their native language.[92] It seems that early education has the most significant effects, as it is the first time in many countries that a young citizen is confronted with the influence of state institutions. Thus, the shift from no schooling to primary schooling is thus probably the most important one. A country with a higher primary enrollment rate or educational coverage might be more homogeneous as a result. The impact and role of higher (secondary or tertiary) education is, however, less obvious.[93]

Despite geographical hurdles, modern forms of infrastructure and communication make an exchange between remote areas possible. Roads, on which goods and services may travel, are crucial to starting business with the periphery. Infrastructure can counterbalance geographical disadvantages by enabling participation in national or international trade.[94] Accordingly, Cashdan (2001) shows that ethnic fragmentation is indeed lower where land and water transportation are more efficient.[95]

[91] Collier (1998), for example, discusses, how more democratic regimes might only emerge (or at least more easily) in countries where ethnic differences are less problematic.

[92] Turkey, for example, still partly prohibits the native Kurdish language and promotes an education system exclusively in Turkish. Aimed at marginalizing this culture and to repress its minorities, it still uses discriminatory language in school books (European Commission, 2006). Aspachs-Bracons et al. (2007b) show in a case study for Catalonia that the identification with the Catalonian identity significantly increased after the introduction of Catalan as the compulsory educational language in schools. This effect was found irrespective of the parents' origin (Spanish versus Catalan).

[93] Barro (1999) also finds differences in terms of explanatory power of the various education levels on democratization. Whereas average years of attainment and the gender gap at the primary level have high explanatory power, secondary and higher levels of education do not.

[94] For a detailed survey of infrastructure and their impact on trade flows, see Limao and Venables (2001).

[95] For recent studies on how the 'modernization' theory of nationalism (economic, infrastructural and political development) affects ethnic identification in Africa, see Eifert et al. (2007) and Robinson (2009).

2.4 Empirical strategy and data

In order to relate to the existing literature, some of the key results of Ahlerup and Olsson (2007) and Michalopoulos (2011) regarding a 'base-level' of ethnic heterogeneity are replicated. This analysis takes on the effects of the evolutionary and historical factors discussed in section 2.3, which will stay constant or not change over long periods of time. The corresponding ordinary least square (OLS) regressions are for:

$$ELF_i = \beta_0 + \beta_i \cdot Z_i + \epsilon_i \tag{2.2}$$

where ELF_i is the ELF level in country i. Z_i is a vector of the various independent variables, and ϵ_i is a random error term. The model uses heteroskedasticity robust estimators.

Having analyzed the static variables influencing ELF levels, some new insights in to how fragmentation is changing over a rather short period is the focus of the second step. An adjusted growth model, taking into account level data that do not change over the period, and the relevant variables that should be responsible for the change of ELF levels is used here. The linear regression model is specified as follows:

$$\Delta ELF_i = \beta_0 + \beta_i \cdot Z_i + \gamma_i \cdot \Delta X_i + \epsilon_i \tag{2.3}$$

where ΔELF_i is the change of the ELF value of country i between the two points in time. Vector Z_i contains level data that are static (e.g., country size). These factors are controlled for, as the timing or magnitude of changes could be influenced by their presence. In a very mountainous country, ethnic fragmentation might be much more stable than in a small country that does not have any geographical barriers. ΔX_i instead contains the relevant changes in the socioeconomic and policy variables over the period covered. ϵ_i is a random error term, and again, the model uses heteroskedasticity robust estimators.

The key question for the empirical operationalization is which source should be applied for the ELF values. Defining ethnic groups is very much liable to the subjective decision of the respective authors. Combining two sources over different points in time is highly difficult. A distinction between differences in definitions and real changes in a country's ethnic setup is all but impossible. The only data source that offers ethnic heterogeneity data on two points in time is the *Atlas Narodov Mira* (*ANM*), compiled by Russian ethnographers (Bruk, 1964; Bruk and Pučkov, 1986). Although only the first edition of the Atlas Narodov Mira (Bruk, 1964) is widely used in the literature, there is a second edition from the mid-1980s (Bruk and Pučkov, 1986).[96] Some later critique centered around the *ANM*'s bias towards a higher linguistic than ethnic split of groups. This underestimates

[96] As both are only published in Russian, this essay relies on Roeder (2001), who calculated and published ELF values based on these two editions. Roeder (2001) also calculates ELF values in three different ways, depending on the aggregation levels of sub-groups reported in the original data. Following the approach of Alesina et al. (2003), this analysis is based on the most disaggregated values that use all sub-groups reported.

the fractionalization in regions like Latin America, where Spanish is widely spoken by minority populations. More important for this essay is that the definition of the groups follows the same lines in both points in time and less whether the chosen group characterization is the correct one.[97] Despite the critique on the *ANM* data, when comparing them with the two main alternatives, Alesina et al. (2003) and Fearon (2003) yield high correlations, as displayed in *Table 2.1*.[98]

	ANM '61	ANM '85	Alesina	Fearon
ANM '61	1			
ANM '85	0.949	1		
Alesina	0.843	0.786	1	
Fearon	0.814	0.839	0.858	1

Table 2.1: Spearman rank correlations of main ELF indices

Additionally, one might argue that the data have been assembled under the auspices of the Soviet Union, with a significant bias between Eastern and Western countries. Taylor and Hudson (1972) tested for this potential problem but did not find anything to support this argument.[99] Finally, Weidmann et al. (2010) conclude that the *ANM* data "is complete and carefully researched, it relies on a uniform group list that is valid across state borders" (Weidmann et al., 2010, p. 5). The last point is probably the most important for this essay.

Based on the sources used to calculate the ELF values, Roeder (2001) reports the data to be for the years 1961 and 1985. As yearly data on most of the covariates used to explain ethnic heterogeneity and its trends is scarcely available, average values for 1960–65 (the first point in time) and for 1975–80 (the second) are used.[100] An important reason for taking the average of several years, instead of single ones, is to avoid, or at least reduce, the impact of cyclical deviations. For the later time span, one could alternatively use 1980–85 instead of 1975–80. The period from 1975–80 is preferable for two reasons. First, if ethnic fragmentation adjusts in reaction to policy changes, as is argued in this essay, it needs time to adapt and will not change immediately. Taking a lag of five years gives some room for these adjustments to occur.[101] Second, with time having elapsed between changes in policy variables and the ELF adaptations, this limits the suspicions of reverse causality that ELF changes are responsible for policy adjustments.

[97] For more information on the data offered in the *Atlas Narodov Mira* and a high level comparison to other sources, see Weidmann et al. (2010).

[98] For their ELF indices both combine different sources, mainly the *CIA Factbook* (CIA, 2011) and the Encyclopædia Britannica (2007). Whereas Alesina et al. (2003) intend to always select the most granular source, Fearon (2003) limits the data on groups that at least constitute 1% of a country's population.

[99] The same conclusion is drawn by Ginsburgh and Weber (2011) in comparing the *ANM* data with other sources of this time, namely Roberts (1962) and Muller (1964). The data of both sources were also found in Roeder (2001).

[100] In the early 1960s, data were often only available in five-year spans. Taking six-year averages increases the data availability for many countries for the first point in time.

[101] Analyzing the adjustment times between policy changes and ELF value changes, which might differ considerably between variables, exhibits an interesting area for future research.

	ANM 1961			ANM 1985			Delta ('85-'61)		
Region	Obs.	Mean	Std.Dev.	Obs.	Mean	Std.Dev.	Obs.	Mean	Std.Dev.
World	138	0.463	0.278	168	0.461	0.272	138	0.006	0.086
Asia	22	0.483	0.295	27	0.467	0.306	22	-0.035	0.053
E. Europe	5	0.138	0.094	26	0.371	0.207	5	-0.029	0.038
L. America	25	0.446	0.194	26	0.443	0.213	25	0.012	0.061
MENA	19	0.318	0.165	20	0.342	0.222	19	0.040	0.177
SSA	45	0.674	0.226	46	0.663	0.235	45	-0.011	0.037
W. Count.	22	0.231	0.210	23	0.273	0.227	22	0.050	0.076

Table 2.2: Summary statistics of Atlas Narodov Mira data for 1961, 1985 and its change between 1961 and 1985

Roeder (2001) reports data for 138 countries at both points in time based on the respective edition of the Atlas Narodov Mira.[102] *Table 2.2* displays the distribution of ELF values across regions for both years. The highest median level is found, as expected, in Sub-Saharan Africa (SSA) and the lowest in Western countries.[103] This picture is consistent in both years. The same is true of the intermediate ELF values for Asia, Latin America and the Middle East and North Africa (MENA). The huge change in ELF values in Eastern Europe between the 1961 values and those of 1985 comes entirely from an increase in the number of countries under observation, from five in 1961 to 26 in 1985.[104]

Regions that became more homogeneous (a decreasing ELF value) display negative values, whereas regions that became more heterogeneous (an increasing ELF value) show positive values. Although the median country per region did not change much, all bar 33 countries report a change in their respective ELF value.[105] The biggest changes were experienced in the MENA region, where countries moved significantly in both directions. Nevertheless, some tendencies of regional drift can be noted. Whereas Asia experienced a homogenization, Latin America and the Western countries displayed some heterogenization. On average, Sub-Saharan Africa did not experience much variation over the 20 years in question.

[102] In total, data are reported for 151 countries for the two points in time. However, some (former) countries where no additional data were available and countries that changed considerably over the time due to secession (e.g., Pakistan/Bangladesh) or union (e.g., Vietnam) were excluded.

[103] Besides the European Countries, this includes developed nations like Australia, Canada, Japan, New Zealand and the United States. Categorization is taken from Fearon (2003).

[104] The countries for which values are available for both points in time are Albania, Bulgaria, Hungary, Poland and Romania. Their mean ANM value for 1985 is 0.109.

[105] This includes countries that only exhibited a marginal change of ± 0.01 or less.

2.5 Results

2.5.1 Influential factors on a 'base-level' of ethnic fragmentation

The regressions from *Table 2.3* are based on *Equation (2.2)* and include the major geographical variables already discussed. *Latitude* reflects the distance from the equator, *Altitude* measures the altitude variation that is found within a country, and *Area* is its surface area[106]. The further away a country is located from the equator, the more one would expect decreasing biodiversity and, in turn, lower ethnic fragmentation. *Latitude* has the expected negative sign and is highly significant (at the 1% level). The location of Sweden compared to Uganda would explain nearly half of their ELF difference for example.[107] Larger and more mountainous countries have a higher probability of encompassing different habitats. This allows for more solitary areas that facilitate the development of different species and ethnic groups, also acting as a barrier which ensures their sustainability. *Altitude* does not have a significant impact at conventional levels in the first regression but *Area* again exhibits a highly significant, positive impact on a country's heterogeneity at the 1% level.

The fourth variable included in the first regression is *Agritime*. It captures the time elapsed since the transition from a hunter-gatherer economy to agricultural production, covering the historical development of institutions. The earliest countries transitioned around 8500 B.C. and the latest only around 1600 A.D.[108] Countries that made the transition earlier in time should then exhibit a lower level of fragmentation as they had more time to develop into more advanced civilizations. Indeed, *Agritime* displays a negative sign that is significant at the 10% level. The different transition times between the first and the last countries (approx. 10,000 years) lead to 0.15 lower ELF values.

In regression (2), another variable used by Ahlerup and Olsson (2007) is included. The experience of a modern state captures how many years a country had power over its territory in the time between 1800 and 1950. It has a comparable interpretation to *Agritime*, but captures to some extent the final result, or how well early civilizations developed into modern civilizations. Therefore, it comes as no surprise that both variables point in the same direction.[109]

Regression (3) controls for more specific geographical characteristics, including a *Tropics* variable and regional dummies. The *Tropics* variable measures the percentage of a country's total area classified as being exposed to a tropical climate. As expected, one finds a positive and significant (10%) correlation between tropical climate and fragmenta-

[106] For a detailed description of the variables and their sources, see *Table B.1* of *Appendix B.1*

[107] *Latitude* additionally functions as a proxy for migration distance or genetic fission. As the birthplace of the modern human is supposed to be near today's Ethiopia, the distance from the equator also partly covers the idea of human origin (Ahlerup and Olsson, 2007).

[108] The first were Israel, Jordan, Lebanon and the Syrian Arab Republic, whereas Mauritius and Australia were the last.

[109] Both variables show a rather low correlation of 0.11.

	(1) ANM '85	(2) ANM '85	(3) ANM '85	(4) ANM '85
Latitude	-0.611***	-0.460***	-0.378	-0.696***
	(-5.65)	(-4.12)	(-1.44)	(-4.96)
Altitude	0.066	0.143**	0.137***	0.191**
	(1.30)	(2.35)	(2.68)	(2.42)
Ln (Area)	0.024***	0.041***	0.023*	0.034*
	(2.66)	(4.16)	(1.92)	(1.82)
Agritime	-0.015*	-0.021**	-0.006	-0.009
	(-1.76)	(-2.56)	(-0.49)	(-0.73)
Modern		-0.027***		-0.017*
		(-4.93)		(-1.69)
Tropics			0.174*	
			(1.87)	
Asia			-0.051	
			(-0.51)	
E. Europe			0.099	
			(1.58)	
L. America			-0.114	
			(-1.16)	
MENA			-0.001	
			(-0.01)	
SSA			0.133	
			(1.30)	
Democratic trad.				0.009**
				(2.39)
Constant	0.575***	0.715***	0.356*	0.606***
	(8.93)	(10.62)	(1.79)	(3.14)
Observations	158	142	151	66
Adjusted R^2	0.279	0.384	0.349	0.357
F-Test	17.779	20.983	12.200	10.320

Heteroscedasticity robust standard errors used;
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.3: Influence of geographic and historical variables on Atlas Narodov Mira ELF scores.

tion. None of the regional dummies are significant at conventional levels. *Latitude*, which was highly significant in all previous regressions, loses its significant explanatory power when the regional dummies are included. This is not too surprising as the regional division partly reflects the distance from the equator. Additionally, *Tropics* seem to better capture the idea of a different habitat around the equator. Nevertheless, the major geographical variables, *Altitude* and *Area*, actually maintain their significance at the 10% and 1%level. Thus, latitude, per se, is not the driver of a different level of heterogeneity but the different geographical and climatic conditions found along the latitudinal stretch.

More democratic regimes are considered to give their citizens more freedom of personal expression and therefore might also exhibit a higher level of heterogeneity. Democratic

tradition is measured by the average Polity score after World War II (1945–1960)[110] developed by Marshall and Jaggers (2008), ranging between -10 and 10. *Democratic Tradition* displays the expected positive sign at the 5% level.[111]

As the covariates did not change between the first and the second *ANM* data, there should be no different result in using the latter. As expected, there is no qualitative difference between the two data sets and the results remain very much comparable.[112] All results so far are in line with the results of Ahlerup and Olsson (2007) and Michalopoulos (2011). As these authors do not test their hypotheses using the *ANM* data, but on the ELF indices from Alesina et al. (2003) and Fearon (2003), regressions (1) and (2) from *Table 2.3* are replicated for both alternative sources. The results are reported in *Table 2.4* and generally support all findings discussed so far. These results give additional credibility to the *ANM* data.[113]

	(1)	(2)	(3)	(4)	(5)	(6)
	ANM '85	ANM'85	Alesina	Alesina	Fearon	Fearon
Latitude	-0.611***	-0.460***	-0.691***	-0.566***	-0.739***	-0.548***
	(-5.65)	(-4.12)	(-6.72)	(-5.56)	(-7.07)	(-5.37)
Altitude	0.066	0.143**	0.037	0.099	0.068	0.163***
	(1.30)	(2.35)	(0.68)	(1.51)	(1.46)	(2.86)
Ln (Area)	0.024***	0.041***	0.025***	0.041***	0.018*	0.032***
	(2.66)	(4.16)	(2.87)	(4.62)	(1.82)	(3.15)
Agritime	-0.015*	-0.021**	-0.005	-0.009	0.003	-0.009
	(-1.76)	(-2.56)	(-0.55)	(-1.00)	(0.37)	(-0.98)
Modern		-0.027***		-0.025***		-0.029***
		(-4.93)		(-4.26)		(-5.65)
Constant	0.575***	0.715***	0.550***	0.670***	0.569***	0.746***
	(8.93)	(10.62)	(9.62)	(10.23)	(7.63)	(9.87)
Observations	158	142	160	143	150	139
Adjusted R^2	0.279	0.384	0.305	0.407	0.282	0.410
F-Test	17.779	20.983	21.762	21.484	18.554	24.314

Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.4: Comparison between various ELF measures – influence of geographic and historical variables

Exceeding the scope of the studies by Ahlerup and Olsson (2007) and Michalopoulos (2011), this essay investigates more deeply on the grounds of colonization. *Table 2.5* shows the main results. Regression (1) is the aforementioned setup for the full set of

[110] Alesina and Zhuravskaya (2011) use a comparable time frame to assess a democratic tradition variable. If the time frame for the *Democratic Tradition* variable is extended to 1900–1960, the results do not change, but the observations are further reduced.

[111] A caveat is that the inclusion of the *Democratic Tradition* variable nearly halves the number of observations. Using alternative data sources (e.g., Vanhanen (2000)) have the same limitations. That is also why these variables are not included in coming regressions, unless if explicitly controlling for the role of democracy.

[112] Results are reported in *Table B.4* of *Appendix B.2*.

[113] If not otherwise stated, the data of 1985 is subsequently used for the regressions as it contains more observations than the data from 1961.

countries. In regression (2), a *Colony* dummy is included to control for the possibility of former colonies generally exhibiting differences in their ethnic fragmentation from non colonial countries. Former colonies are attributed with an approximately 17% lower level of heterogeneity, whereas the regional dummies for Sub-Saharan Africa and Latin America are not significant. This result could be driven by the linguistic bias of the heterogeneity data. Especially in Latin America, the colonial regime left a common language. Regression (3) tries to prove this by entering interaction terms for the colony and the regional dummies for Latin America and Sub Saharan Africa.[114] Although they have the expected sign, Latin America negative and Sub-Saharan Africa positive, both are not significant at conventional levels. The result of the *Colony* variable is not altered greatly.[115] The longer the colonial powers stayed the more settlers might have domiciliated in the new countries permanently. Aligned with earlier findings of Ahlerup and Olsson (2007), the colonial duration (*Duration*) has a positive, but barely significant, impact on fragmentation as displayed in regression (4). Controlling for the colonizer's homeland in regression (5), one finds no significant correlation for Spanish and British colonizers, and a barely significant one for former French colonies.

In regressions (6) and (7), the idea of Acemoglu et al. (2001) is picked up upon, exploring the implication of how, rather than by whom, countries were colonized. The 'divide-and-rule' approach simply exploited the country without any long term interest. In other countries, however, colonizers established institutions to sustain a long term development and settlements. Acemoglu et al. (2001) attribute differences in these two approaches to the differences in living conditions the colonizer came upon at that time, i.e., the mortality rate amongst the Europeans arriving in their respective colonies. In countries with higher mortality rates, the colonizers did not want to create lasting structures and institutions intended for long term settlements. In the absence of good institutions, ethnic identification is more important to sustain group cohesion and economic activities. A more extractionary colonization approach, additionally, exploited differences between groups, deepening them and turning the groups against each other, leading to a higher or deepened heterogeneity. Higher mortality rates, leading to worse institutions and more ethnically motivated turmoil, should be attributed with more heterogeneous countries. Indeed, *Mortality* displays a significant positive correlation with the level of fragmentation. Including the *Mortality* estimate also affects the colonizer homeland dummies, rendering the British dummy significant at the 5% level.[116]

[114] The dummy for Latin America drops out due to perfect collinearity with the *Colony* dummy.

[115] An additional caveat is that it is hard to distinguish whether the effect reflects a reverse causality, and colonial powers just chose more homogeneous countries for their colonization efforts.

[116] Including the mortality variable increases the explanatory power of the model, increasing the adjusted R^2 from 0.39 to 0.52 between regressions (1) and (5). However, the number of observations decreases again significantly. Alternatively using the extended data on early disease environment compiled by Auer (2009) increases the number of observations slightly but does not yield significant results for this variable and again reduces the level of the adjusted R^2.

	(1) Full sample	(2) Full sample	(3) Full sample	(4) Colonies	(5) Colonies	(6) Colonies	(7) Colonies
Latitude	-0.460***	-0.639***	-0.668***	-0.839***	-0.868***	-0.769***	-0.923***
	(-4.12)	(-3.84)	(-3.60)	(-4.12)	(-3.69)	(-3.82)	(-4.46)
Altitude	0.143**	0.158***	0.160**	0.147*	0.184*	0.201**	0.317***
	(2.35)	(2.69)	(2.30)	(1.69)	(1.83)	(2.23)	(2.91)
Ln(Area)	0.041***	0.045***	0.046***	0.068***	0.063***	0.063***	0.049***
	(4.16)	(4.65)	(4.04)	(6.08)	(5.13)	(4.62)	(3.65)
Agritime	-0.021**	-0.032***	-0.033***	-0.045**	-0.053***	-0.042**	-0.053**
	(-2.56)	(-2.67)	(-2.64)	(-2.64)	(-2.91)	(-2.05)	(-2.44)
Modern	-0.027***	-0.026***	-0.025***	-0.037***	-0.032***	-0.038***	-0.007
	(-4.93)	(-4.03)	(-3.80)	(-5.36)	(-3.43)	(-4.30)	(-0.73)
L. America		-0.009					
		(-0.15)					
SSA		0.088	-0.039				
		(1.48)	(-0.17)				
Colony		-0.171**	-0.187**				
		(-2.11)	(-2.27)				
Colony*LA			-0.009				
			(-0.13)				
Colony*SSA			0.129				
			(0.57)				
Duration				0.003			0.000
				(1.65)			(0.14)
Spanish colony					0.069		-0.119
					(0.92)		(-1.47)
French colony					0.100*		0.069
					(1.87)		(0.90)
British colony					0.062		0.155**
					(0.95)		(2.19)
Ln(Mortality)						0.034*	0.052***
						(1.99)	(3.34)
Constant	0.715***	0.855***	0.870***	0.733***	0.722***	0.658***	0.327*
	(10.62)	(6.43)	(5.78)	(9.11)	(7.09)	(4.42)	(1.95)
Observations	142	142	142	86	85	59	58
Adjusted R^2	0.384	0.417	0.414	0.415	0.381	0.515	0.545
F	20.983	15.811	12.088	15.825	10.368	11.656	8.661

Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5: Influence of various colonization characteristics on Atlas Narodov Mira ELF scores

Analyzing the influence of evolutionary and historical factors, two important insights become clear. First, earlier findings with different data sets, showing that geographical attributes (especially *Altitude, Area* and *Latitude*) are highly responsible for the 'base level' of heterogeneity, are confirmed. Second, attention is drawn to the role of colonization. This essay argues that the homeland of the colonizers is less important for a former colony's heterogeneity than how the colonial powers actually pursued their endeavors.

2.5.2 Drivers of fragmentation level changes over a short period

Table 2.6 reports the first results of the regressions based on *Equation (2.3)*. It contains all variables that display a change over the period covered, i.e., variables of the vector ΔX_i. *Latitude, Altitude, Area, Agritime* and the *ANM* values in 1961 are included as static variables of vector Z_i. Although the variables of vector Z_i do not show any changes over time, they might have a mediating role for any adaptations. This is why they are controlled for in all regressions in this table. However, almost none of the variables are significant at conventional levels.[117]

As discussed earlier, data availability in the early 1960's poses a major limitation to the regressions. This essay tries to make the best possible trade-off between including additional variables and thereby reducing the risk of omitted variables by not downsizing the number of observations available too much.

Regression (1) controls for the most important changes in developing countries regarding their settlement and population patterns. Metropolitan areas attract people from the countryside with the prospect of a better economic future. Many old traditions are left behind, and one tries to merge into the more mainstream culture of major cities. The change in *Urbanization*, measured as the percentage of the population living in urban areas does indeed have a significant negative impact on the level of heterogeneity.[118] As expected, the most obvious effect of *Immigration* on heterogeneity is positive. Both are significant at the 5% level. Comparing both effects, immigration plays a bigger role. An increase of one standard deviation in the change in immigration increases the change in heterogeneity by 0.44 standard deviations, whereas the same change in urbanization leads to a decrease of -0.19 standard deviations. Population growth (*Population*) shows no significant impact at conventional levels in this initial regression.

In regression (2), primary schooling rates (*Primary Schooling*) are included.[119] This variable not only covers educational attainment, and, to a large extent, the overall level of education in a country, but can also be understood as a proxy for state influence on an increasing part of the population. It shows a significant negative impact and lowers the size and significance level of both *Urbanization* and *Immigration*. *Primary Schooling* and *Immigration* display the highest impact with beta-coefficients of -0.26 and 0.41, respectively.[120]

Controlling for various other variables in regressions (3)–(6), the significant influence of *Urbanization*, *Immigration* and *Primary Schooling* persists, at least at the 5% level. Nei-

[117] Results are reported in *Table B.5* of *Appendix B.2*.

[118] A recent survey on Africa also found that a higher degree of urbanization alters ethnic identification in favor of national identification (Robinson, 2009).

[119] *Primary Schooling* is measured as the average years of primary school attainment, provided by Barro and Lee (2010).

[120] Green (2011) does not apply level variables and use different time frames with comparable time frames allowing adaptation in the ethnic fragmentation. He finds an equally important influence of urbanization. However, migration is in his analysis only relevant in highly urbanized countries. In contrast to the findings here, education is no focus in Green (2011).

	(1) ANM change	(2) ANM change	(3) ANM change	(4) ANM change	(5) ANM change	(6) ANM change	(7) ANM change	(8) ANM change
Ln (Urbanization)	-0.060**	-0.048*	-0.104***	-0.048**	-0.098***	-0.080***	-0.062**	-0.060*
	(-2.53)	(-1.98)	(-3.21)	(-2.01)	(-4.19)	(-3.27)	(-2.43)	(-1.82)
Immigration	0.006**	0.005*	0.012***	0.005*	0.011***	0.012***	0.005	0.005*
	(2.00)	(1.85)	(3.60)	(1.82)	(3.35)	(3.82)	(1.26)	(1.78)
Ln (Population)	-0.029	-0.006	0.124*	-0.006	0.188***	0.077	-0.017	-0.010
	(-0.41)	(-0.09)	(1.92)	(-0.08)	(2.86)	(1.27)	(-0.29)	(-0.14)
Primary Schooling		-0.056**	-0.042**	-0.056**	-0.056***	-0.041**	-0.031*	-0.053**
		(-2.36)	(-2.15)	(-2.34)	(-2.77)	(-2.18)	(-1.77)	(-2.30)
Polity IV			-0.000					
			(-0.43)					
Conflict				-0.000				
				(-0.08)				
Ln (Trade)					-0.004			
					(-0.17)			
Ln (Telephones)						0.013		
						(0.93)		
Ln (GDP/cap.)							-0.020	
							(-0.94)	
SSA								0.017
								(0.44)
L. America								0.014
								(0.45)
Asia								-0.034
								(-1.23)
Constant	0.014	0.069**	0.042	0.069**	0.043	0.030	0.066**	0.054
	(0.47)	(2.10)	(1.09)	(2.08)	(0.97)	(0.73)	(2.16)	(1.12)
Level var. included	yes	yes	yes	yes	yes	yes	yes	yes
Observations	130	116	101	94	86	89	91	116
Adjusted R^2	0.207	0.254	0.468	0.550	0.562	0.590	0.160	0.263
F-Test	2.947	2.753	3.127	2.383	9.871	4.403	3.162	2.365

Included level variables (Z_i): *Latitude, Altitude, Area, Agritime* and the *ANM* values in 1961
Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6: Influence of socioeconomic and policy factors – dependent variable, change in Atlas Narodov Mira ELF scores

ther a change in the level of democracy (*Polity IV*), the number of conflict years (*Conflicts*) nor *Trade* and Infrastructure (*Telephones*) show any significant impact.[121] Countries with higher population growth rates demonstrate a significant positive impact in two regressions (3)/(5). By including changes in logged GDP per capita levels (*GDP/capita*) in regression (7), this makes all variables, except for *Primary Schooling* and *Urbanization*, insignificant. Although the variable carries the expected negative sign, it is also insignificant at conventional levels. Most of the socioeconomic policy variables are very strongly associated with higher wealth levels of a country, reflected in growing GDP per capita levels. The fact that *Primary Schooling* and *Urbanization* remain significant, although the GDP per capita increase is included, confirms that they are no transmission channel leading to a higher GDP. Regression (7) is also the only one where *Immigration* loses its significance. As immigrants are attracted to prosperous countries, i.e., countries with high GDP per capita growth rates, a high correlation with immigration is inevitable. Controlling for regions in regression (8), does not alter the results, although the significance levels are lower. In addition, because none of the regional dummies are significant at conventional levels, the results are not driven by regional differences.

As has already been pointed out in the discussion of the economic and policy factors, it is hard to see why GDP per capita levels should have a direct impact on heterogeneity. The regressions in *Table 2.6* already showed some influential factors that all are highly linked to GDP per capita its rate of growth. However, as the overall economic development of a country plays a crucial role, it is also controlled for here. This is done more so as an additional robustness check, rather than to generate new insights than. Taking selected regressions from *Table 2.6*, in *Table 2.7* various measures of (economic) development are included. Regressions (1) and (2) are those already known. In regressions (3) and (4), the GDP per capita level in 1960, based on the Penn World Tables (Heston et al., 2009), is added to the otherwise unchanged setup.[122] *Urbanization* and *Immigration*, which show the highest correlation with the GDP per capita level become insignificant. Instead, the GDP per capita level at the beginning of the period is positive in all regressions, at least at the 10% level. *Primary Schooling* shows lower, but still significant values if the GDP per capita level is included. If GDP growth (change in GDP per capita levels) is included, the significance fades. This has two important interpretations. First, the results for *Primary Schooling* are robust. Although the GDP per capita level variable absorbs some of its influence, its significance does not change considerably. Countries that are richer already have much higher primary schooling figures, so changes would be expected to be smaller. Still, the influence persists. Second, countries that already have a higher level

[121] That conflicts have no impact on the ethnic heterogeneity is rather surprising. However, if one uses different conflict data sources (PRIO data (Gleditsch et al., 2002), Genocides and Political Instability Task Force (PITF) data (Marshall et al., 2010)) the non-significant result is confirmed.

[122] The results displayed are based on the Laspeyres index of the Penn World Tables. The regressions with the Chain index yield the same results.

of development seem to move in the other direction, thus becoming more heterogeneous. Most of the highly developed countries are classic immigration countries, like the US, Australia and Canada. This hints to a curvilinear relationship of ethnic identification and development or 'modernization', discussed in Bannon et al. (2004). Ethnic fragmentation is not necessarily a sign of backwardness.

	(1) ANM ch.	(2) ANM ch.	(3) ANM ch.	(4) ANM ch.	(5) ANM ch.	(6) ANM ch.
Ln (Urbanization)	-0.048*	-0.062**	-0.030	-0.022	0.022	0.027
	(-1.98)	(-2.43)	(-1.02)	(-0.74)	(0.63)	(0.75)
Immigration	0.005*	0.005	0.004	0.004	0.002	0.001
	(1.85)	(1.26)	(1.16)	(1.17)	(1.19)	(1.13)
Ln (Population)	-0.006	-0.017	0.002	-0.016	-0.024	-0.023
	(-0.09)	(-0.29)	(0.03)	(-0.27)	(-0.64)	(-0.64)
Primary Schooling	-0.056**	-0.031*	-0.031*	-0.025	-0.036**	-0.025
	(-2.36)	(-1.77)	(-1.94)	(-1.57)	(-2.12)	(-1.53)
Ln (GDP/cap.) '61			0.020*	0.022**		
			(1.85)	(1.99)		
Ln (GDP/cap.)		-0.020		-0.028		
		(-0.94)		(-1.37)		
HDI level					0.142***	0.155***
					(3.40)	(3.66)
HDI						-0.366**
						(-2.43)
Constant	0.069**	0.066**	-0.113	-0.115	-0.021	-0.004
	(2.10)	(2.16)	(-1.24)	(-1.27)	(-0.55)	(-0.11)
Level var. included	yes	yes	yes	yes	yes	yes
Observations	116	91	91	91	98	98
Adjusted R^2	0.254	0.160	0.194	0.196	0.180	0.219
F-Test	2.753	3.162	2.904	3.024	3.258	3.191

Included level variables (Z_i): *Latitude, Altitude, Area, Agritime* and the *ANM* values in 1961
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.7: Influence of various economic and human development levels at the beginning of the period (average 1960-65) – dependent variable, change in Atlas Narodov Mira ELF scores

Regressions (5) and (6) use Human Development Indicator (HDI) levels (UNDP - United Nations Development Programme, 1994). This is a broader indicator of development, not only taking into account GDP per capita levels, but also health and education figures. In general, the results are very much comparable to the results discussed above. The broader construction of the HDI, especially the inclusion of education variables, explains why the HDI variable is the only one where the change variable also has a significant and negative impact, taking over the influence of the *Primary Schooling* variable.

As further robustness checks, the key regressions of *Table 2.6* are run again with different model specifications. Both fixed-effect (FE) and random-effect (RE) models are tested. The results are reported in *Table B.6* of *Appendix B.2*. Using the FE model, a correlation between the entity specific error term and the explanatory variables is allowed.

Furthermore, all level variables that are time-invariant are removed from the regressions. The RE model, in contrast, assumes independence between the entity error term and the explanatory variables. From the discussion above, the superior suitability of the FE model is clear.[123] Although the values of the coefficients vary, the significant positive or negative effects of the main variables, *Urbanization, Immigration* and *Primary Schooling*, are clearly confirmed.

Because *Primary Schooling* seems to play a crucial role, *Table 2.8* depicts the influence of different measures of education, as well as various education levels, to test for the robustness of the finding.[124] Regression (1) corresponds to the second regression in *Table 2.6*. *Immigration* and *Primary Schooling* are both significant. In regression (2), *Secondary Schooling* and *Tertiary Schooling* are included in addition. The coefficient of *Primary Schooling* remains significant and increases in size. Looking at the role of higher education, reveals another interesting insight. *Secondary Schooling* enters the regression with a significant and positive sign. Higher education apparently has a different effect on fragmentation than primary education.[125] While the effect of primary education is uniformly negative, secondary education is mostly positive.

Regressions (3)–(7) confirm the findings with different measures of education, offered by Barro and Lee (2010). The total sum of all years of schooling (*Schooling total*) does not show any significant impact. This is not surprising. As primary and higher educational levels enter the regression with opposite signs, they seem to cancel each other out. All other regressions confirm the homogenizing impact of primary education. In most cases, the positive impact of higher education is also confirmed. However, the coefficients are no longer significant. These robustness checks confirm the apparent importance of primary schooling for a country's homogenization and do not depend on the definition or measure of primary education.

In section 2.4, the time frame chosen was discussed. For endogeneity reasons, as well as the time needed for potential adjustments in heterogeneity, the time frame 1960/65–1975/80 was chosen. Nevertheless, the results should not entirely depend on the choice of the time frame. As an additional robustness check, the time frame for all policy variables was changed from 1960/65–1975/80 to 1960/65–1980/85. The results are reported in *Table B.7* of *Appendix B.2*. Although the coefficient sizes vary slightly, the significance levels of all variables discussed only change marginally.

[123]However, the Hausman test supports the FE model in only half of the regression pairs. This is the case for the regression pairs (2/6) and (3/7). Results of the Hausman test are not reported here.

[124]Indeed, Bossuroy (2011) also identifies lower educational levels to have the most robust and sizeable positive impact on one's ethnic identification. The higher the level of educational attainment, the more individuals from surveys in West Africa identified with the nation instead of one's ethnic group. This consequently lead to lower ELF levels.

[125]In their analysis of education's role on trust, Knack and Keefer (1997) find a comparable differentiated result for primary and secondary education. Additionally, in an analysis of ethnic identification for a small set of African states, Bannon et al. (2004) find that students identify themselves more along ethnic lines than farmers.

	(1) ANM change	(2) ANM change	(3) ANM change	(4) ANM change	(5) ANM change	(6) ANM change	(7) ANM change
Ln (Urbanization)	-0.048*	-0.023	-0.056**	-0.038	-0.036	-0.026	-0.025
	(-1.98)	(-0.90)	(-2.20)	(-1.57)	(-1.45)	(-0.97)	(-0.96)
Immigration	0.005*	0.005*	0.006*	0.006**	0.006*	0.005*	0.005*
	(1.85)	(1.81)	(1.90)	(2.04)	(1.97)	(1.77)	(1.74)
Ln (Population)	-0.006	0.003	-0.023	-0.033	-0.030	0.002	0.018
	(-0.09)	(0.04)	(-0.32)	(-0.48)	(-0.43)	(0.03)	(0.24)
Primary Schooling	-0.056**	-0.070***					
	(-2.36)	(-2.64)					
Secondary Schooling		0.054**					
		(2.22)					
Tertiary Schooling		0.057					
		(0.73)					
Schooling Total			-0.006				
			(-0.49)				
Primary Completion				-0.003***	-0.003**		
				(-2.96)	(-2.58)		
Secondary Completion					0.000		
					(0.02)		
Tertiary Completion					0.003		
					(0.51)		
Primary Enrollment						-0.003**	-0.004**
						(-2.24)	(-2.05)
Secondary Enrollment							-0.002
							(-1.35)
Tertiary Enrollment							0.001
							(0.19)
Constant	0.069**	0.048	0.028	0.042	0.038	0.014	0.031
	(2.10)	(1.48)	(0.78)	(1.49)	(1.19)	(0.50)	(1.03)
Level var. included	yes	yes	yes	yes	yes	yes	yes
Observations	116	116	116	116	116	116	116
Adjusted R^2	0.254	0.298	0.195	0.253	0.240	0.268	0.279
F-Test	2.753	4.341	2.153	2.940	2.647	2.863	4.711

Included level variables (Z_i): *Latitude, Altitude, Area, Agritime* and the *ANM* values in 1961
Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.8: Differences in various education measures – dependent variable, change in Atlas Narodov Mira ELF scores

2.6 Conclusion

In line with the recent publications of Ahlerup and Olsson (2007) and Michalopoulos (2011) on the roots of ethnically diverse countries, the major results are confirmed. Although different data and data sources were used, the results remain robust. Geographical characteristics, like a country's surface and altitude variation, and evolutionary factors, like the transition from sedentary farming, are major drivers of a 'base-level' of ethnic fragmentation. A more detailed view on colonization is also added to the analysis of geographical and historical factors. Whereas the homeland of the colonizer seems to play no major role, the way a country was colonized does show a significant impact. Countries, where colonial powers did not have any incentive to settle and build good institutions, instead exploiting the country's resources, show a significantly higher level of ethnic fragmentation. The manipulation of ethnic boundaries seemed to be an easy way to play one group off against the other. Mistrust and rifts between ethnic groups seem to persist after independence – mirrored in higher fragmentation levels.

What this chapter mainly wants to add to the recent discussion is that ethnic fragmentation cannot be treated as being exogenous, or only being rooted in geographic and historical factors. Especially since the beginning of the 20th century, various policy and economic factors significantly changed the dynamics between ethnic groups, their interchange and assimilation, as well as migration patterns. Migration proves to be the most important factor in changing a country's fragmentation. Gulf countries, relying heavily on immigrants, show this trend most clearly. Doubtlessly, migration plays an even bigger role in the globalized world after the 1960–1985 period analyzed in this essay. Its impact might therefore be even more pronounced today. The same is true for the other variables shown to have a significant impact on a country's ethnic fragmentation. More policy-induced variables, like urbanization and especially primary education, leave their marks on a country's heterogeneity. Urbanization and the growth of metropolitan areas, attracting huge parts of the population, lead to an erosion of old habits and to an assimilation into, or the emergence of a 'mainstream' culture. Education is, according to the findings of this chapter, not only a measure of a higher educational level attained. Because primary education is, in general, the first point of contact with the state authorities, it is also a good proxy for the government's influence. By expanding the government's reach for more remote areas, more and more people are exposed to its influence. In line with recent findings of other authors, education does not influence heterogeneity uniformly. The empirical results suggest that higher educational levels lead to a more heterogeneous society.

Nevertheless, this essay also faces some limitations. The range of possible variables to be tested in this analysis is rather confined due to data limitation in the early 1960s. Only data on ethno-linguistic fragmentation, and not on other concepts regarding language or religion, were available. In line with Campos and Kuzeyev (2007), the distinction

between ethnic, linguistic and religious fragmentation could be an interesting field for future research. Not only could these different characteristics be driven by different factors, the time span in which changes occur and their direction might also be different. Both Campos and Kuzeyev (2007) and Fedderke and Luiz (2007) find more significant changes in the ethnic and racial setup than for the linguistic and religious characteristics. As the *ANM* data is mainly defined along linguistic characteristics, limited changes in its data may mask some results.

Admitting that a country's ethnic setup changes and can be influenced, turns one back to the growing literature on the effects of ethnic fragmentation. Having seen that ethnic composition is changing with variables that are highly linked to the development level of a country, using a fixed measure of ethnicity for economic growth analysis seems rather unreasonable. This would attach greater importance to older measures of the ex-ante ethno-linguistic composition of a country in the analysis of economic outcomes, because the ethnic setup may have been endogenously determined by the factors under investigation. This is exactly what Campos and Kuzeyev (2007) find for their data set on former Soviet republics. Whereas the effect of an exogenous heterogeneity measure on growth is limited, the dynamic measure illustrates a significantly negative effect.

Despite its limitations, the set of variables and data used for this essay show clear and very robust results. They are a very good basis to refute the assumption of static ethnic heterogeneity. More than a caveat, this essay offers a first attempt to venture into the dynamics of ethnic heterogeneity and gives a better understanding in to how policy, intentionally or unwittingly, can shape a country's ethnic setup.

Chapter 3

Measuring Ethnic Diversity

3.1 Introduction

There is a fast growing literature on ethnicity and its role in the economic development of a country or the incidence of conflicts.[126] To advance the research in this area, current approaches try to improve data sources, to increase its coverage, and to construct indices to better measure its complexity. Because ethnicity is not a clear cut concept it contains various aspects. Therefore, better indices in this regard do not mean more accurate indices but rather those that reflect the different aspects more adequately. Starting with the ethno-linguistic fractionalization index (ELF) by Taylor and Hudson (1972), an index on polarization (Garcia-Montalvo and Reynal-Querol, 2002), the reduction to politically relevant groups (Posner, 2004a) or the role of regional segregation of ethnicity (Alesina and Zhuravskaya, 2011) have been studied more intensively.[127]

All these indices, however, are based on pre-defined groups within a country or principal region. This gives rise to an important problem. All calculations rely on a rather arbitrary definition of groups that do not necessarily share a comparable line of differentiation.[128] Fearon (2003) summarizes the absence of a clear-cut definition of ethnic groups and states, maintaining "that in many cases there is no single right answer to the question 'What are the ethnic groups in this country?'."(Fearon, 2003, p. 197). To be less arbitrary, a common differentiator, be it on the grounds of ethnicity, language, religion, or any other characteristic need to exist. So, an assessment of distances between groups "is such an

[126]Ethnic fractionalization is supposed to negatively affect corruption (Mauro, 1995), economic growth (Alesina et al., 2003; Easterly and Levine, 1997), public goods provision (Alesina et al., 1999), communal participation (Alesina and La Ferrara, 2000), general quality of government (Alesina and Zhuravskaya, 2011; La Porta et al., 1999) and democracy (Akdede, 2010). Collier (1998) initiated a new, and now broad strand of literature exploring ethnicity's impacts on the incidence, onset or severity of conflicts that was furthered by the introduction of an index of polarization (Garcia-Montalvo and Reynal-Querol, 2003, 2005a, 2008).

[127]For a broad overview of the literature on conflict, see Blattman and Miguel (2010). A good description of concepts and measures of ethnicity is found in Brown and Langer (2010). A new approach to better study ethnic distribution at the micro-economic level is to geo-reference ethnic groups (Weidmann et al., 2010).

[128]For a similar line of critique, see Lind (2007).

absolutely fundamental concept in the measurement of dissimilarity that it must play an essential role in any meaningful theory of diversity or classification" (Weitzman, 1992, p. 365).[129] This, however, requires more detailed information on the groups so that they show a comparable level of distinction in any of the characteristics. Nearly all authors treat these attributes equally irrespective of the differences between the groups, i.e., how big the distance is. This is mainly because data on the different similarity levels are either hardly available, or quite complex. Thereby, it is obvious that two groups whose respective members speak two completely different languages, follow different religions and have different physiognomic attributes, are more distant than two groups that share similarities in their languages, follow the same religion and have a similar appearance. This underlines the key difference between the diversity concept and the fragmentation and polarization indices. For many economic problems, it is not the pure number of groups that is of interest, but rather how difficult coordination or instrumentalization between the various groups is. In more diverse countries, agreement on public goods (e.g., infrastructure or social security systems) is more difficult (Alesina et al., 1999), the level of generalized trust lower (Bjørnskov, 2008) and the incidence of conflicts higher (Collier and Hoeffler, 2002).[130] The main aim of this essay is to fill this gap and to offer an index taking these aspects into account. The global data set offers the possibility to construct an index covering the degree of diversity between groups within countries, as well as the cultural or ethnic (dis)similarity between countries. A measure of cultural affinity which extends the rather crude measure of genetic distance should affect international trade flows. Assessing this new multi-faceted index is thus the base to further expand current research on the implication of ethnicity with a new aspect of cultural distance, i.e., its diversity.

The remainder of this chapter is structured as follows. Section 3.2 briefly summarizes the current discussion surrounding the conceptual und measurement problems. In section 3.3, the theoretical background of the new similarity parameters is outlined. Section 3.4 introduces the data sources used. Section 3.5 discusses the operationalization of the new distance adjusted ethno-linguistic fractionalization index ($DELF$), and compares it with existing measures. Section 3.6 outlines the resulting new diversity values for a range of countries. In a second step, a (dis)similarity measure between countries, based on comparable premises, is set up and discussed. Finally, section 3.7 summarizes the key findings, concludes and gives an outlook for further research.

[129] For a good, yet methodological-technical discussion of the prerequisites to measure diversity, see Bossert et al. (2003) and Nehring and Puppe (2002). Both rely on the earlier concept developed by Weitzman (1992).

[130] To be precise, ethnic fragmentation or diversity per se is not the cause of the various (negative) socio-economic outcomes. However, both settings offer more possibilities to exploit these distinctions.

3.2 Different aspects of ethnicity and its measurement

Alesina et al. (2003) describe ethnicity as a "rather vague and amorphous concept" (Alesina et al., 2003, p. 160) that makes any measurement hard to grasp.[131] To better operationalize ethnicity, this essay follows Chandra and Wilkinson (2008). According to them, ethnic structure comprises a set of ethnic identities that includes all phenotypical attributes (skin pigmentation or body figure), as well as religion, language and the traditions one was raised in. This is very much in line with Barrett et al. (2001), whose data is used later on in this chapter.[132] Following these authors, ethnicity is defined in this chapter along language, ethno-racial (ethnic origin, skin pigmentation and race) and religious aspects.

Defining the characteristics of ethnicity in detail, which is already more diligent than most papers in this field, is not sufficient for what this essay strives for. Within each of the defining criteria a (dis)similarity level between two distinct groups must be assignable. Information on the degree of (dis)similarity is the crucial starting point in any assessment of diversity (Bossert et al., 2003). Despite the reluctance of many authors to define the characteristics of ethnicity, a more thorough examination of similarity differences has not been discussed at all. Distance between groups neither influenced the decision of how to draw the line between groups, nor the interpretation of the fractionalization found. Taking language groups as an example, one could divide groups based on mere dialects, different languages or even different language families. Depending on the level of similarity between groups, different group setups would then emerge.[133] In this case, the amount of common vocabulary would define their distance.

Based on the defined number of ethnic groups, the question of its mathematical operationalization arises.[134] The most common measure for ethnicity is its fractionalization, known as the ethno-linguistic fractionalization index (ELF). It is calculated as an Herfindahl-Hirschman concentration index:

$$ELF = 1 - \sum_{i=1}^{K} p_i^2, \qquad i = 1, ...K \tag{3.1}$$

where K is the number of groups i and p_i their relative group sizes. Its value moves between zero and one and represents the probability that two randomly selected individuals from a population come from different groups. A higher value thus indicates a more fragmented country, i.e., a country with a higher number of distinct ethnic groups. A value close to

[131] Brown and Langer (2010) offer a broad summary of the recent discussion surrounding the definitions of ethnicity as well as its measurement problems.

[132] They include language, ethnic origin, skin pigmentation, race, culture or religion, and nationality as characteristics to describe ethnicity.

[133] For a discussion on how different levels of aggregation of linguistic fragmentation affect the outcomes in the analysis of ethnic conflicts, see Desmet et al. (2012).

[134] Ginsburgh and Weber (2011, Ch. 6) offer a good overview of the different classes of indices used, their historical development and recent applications. Desmet et al. (2009) compare the effect of most of these different indices on the level of redistribution.

one indicates high fragmentation within countries. After the introduction of the ELF by Taylor and Hudson (1972), based on the data of the Atlas Narodov Mira (Bruk, 1964), several additional indices were developed. The second most prominent of these is the measure of polarization introduced by Garcia-Montalvo and Reynal-Querol (2002).[135] It shows a completely different aspect of a country's ethnic setup, and underlines that for each economic problem under analysis, the adequate index needs to be applied. Assessing the variation away from an even 50/50 split of two groups, Garcia-Montalvo and Reynal-Querol (2002) find that this index is a much better predictor of conflict incidence than the ELF measure. It apparently better measures the ethnic constellations responsible for an uprising. The polarization index (POL) is defined as:

$$POL = 1 - \sum_{i=1}^{K} \left(\frac{0.5 - p_i}{0.5} \right)^2 \cdot p_i, \qquad i = 1, ...K \tag{3.2}$$

p_i are again the relative group sizes of groups i. The POL index is also tending towards zero for very homogeneous countries, i.e., with only one group. However, with increasing group numbers, ELF and POL show clearly different courses. *Figure 3.1* shows these differences based on equally sized groups. While ELF is an increasing function of the number of groups, POL reaches its maximum with two equally sized groups and decreases afterwards. This clearly underlines that the indices do in fact measure two different things although they are based on the same data.

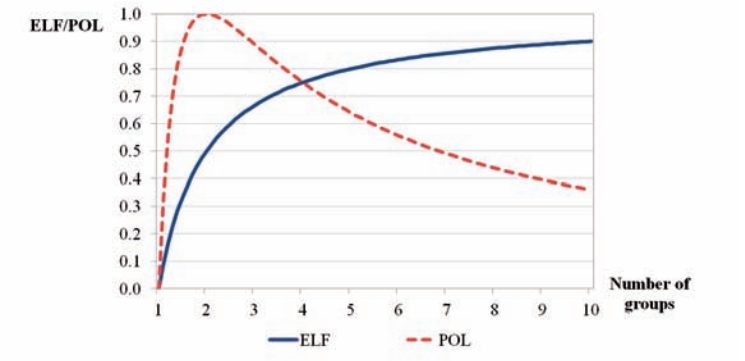


Figure 3.1: ELF and POL values depending on the number of equally sized groups

Bossert et al. (2011) introduce a more flexible version of the ELF, the generalized ethnolinguistic fractionalization index (GELF). The technical side of the index brings two important improvements. Firstly, it does not rely on pre-defined groups but takes the individual

[135] Their approach goes back to earlier work of Esteban and Ray (1994).

and its specific characteristics as a starting point.[136] Based on the specific characteristics, a mutual similarity matrix between individuals takes the distance between them into account. Hereby the groups emerge 'endogenously' from the matrix. The similarity value between two individuals i and j for all $i, j \in \{1, ..., N\}$ is given through s_{ij}, with:

$$1 \geq \quad s_{ij} \quad \geq 0 \tag{3.3}$$

$$s_{ii} \quad = \quad 1 \tag{3.4}$$

$$s_{ij} \quad = \quad s_{ji} \tag{3.5}$$

A similarity value of one indicates perfect similarity, whereas a value of zero would indicate two individuals that do not share any characteristics. For a society with N individuals, all $\{s_{ij}\}$ are contained in a $N \times N$ matrix, labeled similarity matrix S_N, which is the main building block of the GELF. Based on this matrix, the corresponding GELF value for a country with N individuals is given through:

$$G(S_N) = 1 - \frac{1}{N^2} \sum_{i=1}^{N} \sum_{j=1}^{N} s_{ij} \tag{3.6}$$

GELF is then the expected dissimilarity between two randomly drawn individuals. As data on individuals are seldom available, the transfer to group-specific data on the smallest aggregation level is needed. The adaptations are, however, rather small. In a society with N individuals, K groups exist with respective populations of m_k individuals for all $k \in \{1, ..., K\}$. It holds that $\sum_{k=1}^{K} m_k = N$ and $p_k = m_k/N$ is the respective relative group size. The individuals in each group are all perfectly similar, i.e., their mutual individual similarity values would be one. By grouping all individuals together that share similarity values of one, groups emerge 'endogenously'. The similarity between two groups, k and l, is denoted as $\hat{s}_{kl}$ and is equivalent to the individual similarity value s_{ij} for any $i \in m_k$ and $j \in m_l$. In rearranging *Equation (3.6)*, it follows that:

$$\begin{aligned} G(S_n) &= 1 - \frac{1}{N^2} \sum_{k=1}^{K} \sum_{l=1}^{K} m_k \; m_l \; \hat{s}_{kl} \\ &= 1 - \sum_{k=1}^{K} \sum_{l=1}^{K} \frac{m_k}{N} \; \frac{m_l}{N} \; \hat{s}_{kl} \\ &= 1 - \sum_{k=1}^{K} \sum_{l=1}^{K} p_k \; p_l \; \hat{s}_{kl} = DELF \end{aligned} \tag{3.7}$$

The relation between the $DELF$ and the ELF index is quite obvious. The ELF is based on groups that either have a similarity value of one, given both belong to the identical group, and zero otherwise. Thus, the products are always zero if two different groups

[136] This, however, is the main drawback of its operationalization, as reliable data on individuals are seldom available, especially in developing countries.

are matched. A value of one is only assigned if the groups are matched with themselves, leading to a value of $(p_k \cdot p_k \cdot 1) = p_k^2$ and $(p_k \cdot p_l \cdot 0) = 0$, respectively. The sum over all K groups then directly leads to *Equation (3.1)*, where the ELF is specified.[137] The important improvement in this approach is that it does not rely on pre-defined groups, thus avoiding to treat groups as equal that actually have very large distances between them.[138]

Finally, de Groot (2009) assessed the ethnic affinity between African nations.[139] In doing so, he also draws on the articles of Fearon (2003) and an earlier version of Bossert et al. (2011), and is closest to the approach of this essay. De Groot (2009), however, only offers data on ethnic affinity between countries and limits his assessment to Africa. This essay consequently extends the work of all three studies.

3.3 Calculation of the distance values

For the calculation of the distance values, this essay draws on Fearon (2003). His approach is adapted for three ethnicity characteristics: language, ethno-racial and religious identification. Taking a broader set of characteristics and similarity measures into account offers a more multifaceted picture.[140]

3.3.1 Language classification

Language is probably the most researched and operationalized characteristic.[141] As is the case with a family tree, languages can be ordered in accordance with their mutual relatedness. The distance between the branches gives a measure of their degree of (dis)similarity. This is well analyzed and operationalized by the *Ethnologue* project (Lewis, 2009). To uniquely identify each language, it assigns each one with a three letter code. The de-

[137] Note that due to the construction of *Equation (3.7)*, $DELF$ values take into account mutual similarity values between groups that are not fully identical and will therefore always be lower than the ELF values. The $DELF$ delivers the same result as a monolingual weighted index proposed by Greenberg (1956) and used by Fearon (2003) in his calculation of 'cultural fractionalization'. Further attributes of the new index and its relation to the other indices (ELF and POL) are discussed in Garcia-Montalvo and Reynal-Querol (2005a, 2008) and Esteban and Ray (2011). In the latter, the index is labeled as the 'Greenberg-Gini' index.

[138] The superior theoretical explanatory power of such an index is also discussed in Ginsburgh and Weber (2011).

[139] The ethnic linguistic affinity (ELA) of de Groot (2009) measures, in contrast to the ELF, the amount of characteristics shared between two countries and thus follows an inverse logic. Because it is the most widely propagated, this essay follows the logic of the ELF, where higher values denote more fragmented countries.

[140] Ginsburgh (2005) and Ginsburgh and Weber (2011, Ch. 3) offer an introduction into alternative methods to assess the distances between groups, especially genetic and cultural distances. Genetic distance can be traced back to Cavalli-Sforza and Feldmann (1981). In contrast, Hofstede (2000) assesses differences between cultures and nations along four dimensions: power distance, individualism, masculinity and uncertainty avoidance. Comparable, but slightly different approaches, use answers from the *World Value Survey* (Desmet et al., 2011) or the voting behavior in the Eurovision Song Contest (Felbermayr and Toubal, 2010) to construct cultural differences between nations.

[141] Ginsburgh and Weber (2011, Ch. 3) offer a good overview of the different approaches to assess the distances between languages.

cision and categorization as a separate language (instead of a dialect) not only follows pure linguistic and lexical similarities, but also considers how a mutual understanding in communication is possible.

This essay relies on a very closely related approach used in the *World Christian Encyclopedia* (Barrett et al., 2001). A wide congruency of both sources exists, as the *World Christian Encyclopedia* (henceforth *WCE*) is one of the sources for the *Ethnologue* data. Here, a seven character code is assigned to each distinct language. A distinct language is defined as "the mother tongue of a distinct, uniform speech community with its own identity" (Barrett et al., 2001, V.II, p. 245). It comprises all dialects that share at least 85% of their vocabulary and grammar to ensure adequate communication.[142] In total, 6,656 distinct languages are contained in the data analyzed. Two persons speaking one language are treated as completely similar ($s_{ij} = 1$).[143] The more characters of the assigned code two languages share, the more similar they are. The structure is depicted in *Table 3.1.*

Glossocode	Description	Minimal similarity level	Number of distinct groups	$\bar{s}^L_{kl}$
0	Macrozone	0%	10	0.01
01	Glosso-zone	5%	100	0.06
01-A	Glosso-set	30%	594	0.35
01-AA	Glosso-chain	50%	1,213	0.59
01-AAA	Glosso-net	70%	2,388	0.82
01-AAAA	Glosso-cluster	80%	4,241	0.94
01-AAAA-a	Language	85%	6,656	1.00

Table 3.1: Language similarity classification according to Barrett et al. (2001)

The Afghan Persian (58-AACC-b) and Southern Pathan (58-ABDA-b) group share the first three digits and thus belong to one Glosso-set, sharing between 30% and 50% of their vocabulary and grammar. Subsequently, both groups are assigned a similarity value $\bar{s}^L_{kl}$. The assigned values are normalized on a scale between zero and one, and are matched to demonstrate the same decreasing slope as the lexical similarity levels. Belonging to one language group and thus sharing 85% lexical similarity corresponds to the highest $\bar{s}^L_{kl}$ with $\bar{s}^L_{kl} = 1$.[144] In the case of the example $\bar{s}^L_{kl}$ takes a value of 0.35.

3.3.2 Ethno-racial distance

Fragmentation that is derived from a biological taxonomy of species is mainly based on genealogical relatedness between different people in modern humanity. The long evolu-

[142]The same threshold is used by the *Ethnologue* project (Lewis, 2009), which is one of the main sources for the assignment of language similarity levels. The second source is Dalby and Williams (1999). The data and classification can also be found online under: http://www.linguasphere.info.

[143]For a different way taking language differences into account, see Desmet et al. (2012). Depending on the similarity level defined (e.g., dialects vs. languages), different numbers of groups and thus different levels of fragmentation, eventually emerge. This follows on from the discussion in the introduction that the (arbitrary) group definition significantly impacts ELF levels.

[144]For a discussion on alternative similarity values, see *Appendix C.1.2.*

tionary process is described by Ahlerup and Olsson (2007) as 'genetic drift'. This means that the human species developed quite differently in various parts of the world, with one being able to map a genealogical tree based on the genetic congruence of the resulting races. Cavalli-Sforza and Feldmann (1981) created these phylographic trees by mapping the differences in special sections of the human DNA. Cavalli-Sforza et al. (1993) assessed dyadic distances between 42 world populations computed from 120 alleles in the human genome.[145]

This was certainly a pioneering piece of work but also demonstrates some limitations. The first one is the small number of groups (42) for the global classification. For Europe, Spolaore and Wacziarg (2009) only refer to four different genetic groups in their analysis of innovation and development diffusion across countries.[146] It is quite obvious that this might not be sufficient to describe the diversity of Europe. The second caveat is brought forward by Giuliano et al. (2006), who discuss in detail the use of genetic distance data and conclude that it is a proxy for geographical distances, rather than a proxy for cultural distances.[147] The genes used to assess the genetic distance in Cavalli-Sforza et al. (1993) are only in a very limited way responsible for the phenotypical or anthropometric differences. The part of the DNA used is located on neutral points only subject to random drift, and less to evolutionary selection.[148] However, to assess the distance between two human beings, with respect to their ease or willingness to cooperate, phenotypical or anthropometric markers should be relevant.[149]

In order to combine these views and caveats, this essay follows an ethno-racial taxonomy outlined by Barrett et al. (2001). Each unique group is assigned a six character code based on differences of race, skin pigmentation and ethnic origin.[150] Although those characteristics are closely linked in their development, their role for mutual understanding differs and is treated as cumulative in the subsequent analysis.[151]

[145]Due to the special location of the DNA compared, differences are caused only by a constant random drift. This allows one to calculate when two populations split up genetically during the course of the peopling of the world.

[146]For Europe, a more precise split of genetically different groups is available, but it is not possible to combine this with the global structures, because these data are based on a different set of genes. Ashraf and Galor (2011) use an extended version of genetic distance data covering 53 ethnic groups and their mutual heterozygosity based on Ramachandran et al. (2005).

[147]Ramachandran et al. (2005) confirm this hypothesis in an analysis of their extended set of 53 populations. They show that correlation values between different measures of genetic distance and the geographical distance from Ethiopia is at least 0.76.

[148]However, evolutionary selection is strongly driven by the appearance of species (e.g., mating) or their better adaptability to the surroundings; that is mainly due to differences in their physical shape.

[149]Caselli and Coleman (2008), for example, attribute the emergence of the conflict in Rwanda to the possible distinction between Hutus and Tutsis according to their body sizes.

[150]This also includes some major similarities between languages to define distinct cultural groups, which is due to the very closely linked development of genetical and language evolution (Cavalli-Sforza et al., 1988).

[151]This approach is also followed by de Groot (2009).

Analogous to the pure language case, the different levels of ethno-racial classification are summarized in *Table 3.2*.[152] The broadest classification is along racial lines, with five different races existing. The next level adds a geographical marker (e.g., African or European) to the race distinction. The major culture area adds an additional physiological characteristic, mainly driven by skin pigmentation. The first three characters of the code are thus driven by phenotypical differences. Local races are characterized as a "culture area, local breeding population/reproductive isolate and genetically distinct population" (Barrett et al., 2001, V.II, p. 19). To differentiate between larger ethno-racial families and to characterize distinct ethnic groups or 'microraces', a final character is assigned as an identifier. On the global scale, the data contains 393 such ethno-racial families.[153]

E-L-Code	Description	Similarity level	Number of distinct groups	$\bar{s}^E_{kl}$
A	Race	1	5	0.01
AU	Geographical race	2	13	0.21
AUG	Major culture area	3	18	0.59
AUG-03	Local race	4	72	0.88
AUG-03-b	Ethno-racial family	5	393	1.00

Table 3.2: Ethno-racial group and similarity classification according to Barrett et al. (2001)

For the ethno-racial classification, Barrett et al. (2001) do not clearly develop a similarity measure, instead measuring the distance on integer values. The different similarity levels ($\bar{s}^E_{kl}$) are calculated with the same decrease in slope of the similarity values being found as that of the language characteristic.[154]

Taking the same two groups in Afghanistan and comparing their ethno-racial classification, allows one to derive their similarity value of this characteristic. Accordingly, the Persians (CNT-24-f) and Southern Pathans (CNT-24-a) belong to one ethno-racial family and are eventually assigned a mutual similarity value $\bar{s}^E_{kl}$ of 0.88.

3.3.3 Religious classification

Religion is undoubtedly a major factor in shaping cultural habits and practices. The existence of different religions is often seen as an important reason for conflicts or general misunderstandings between different groups.[155] Religious identification is in a certain way, an especially potent, but easily implemented instrument to expand ones political

[152] Whenever it is not the unique contribution of Barrett et al. (2001), the ethno-racial classification closely follows the *Encyclopædia Britannica*.

[153] Barrett et al. (2001) caution that these racial classification only act as a mere indicator as there "exist almost imperceptible gradations of genetic character from one group of people to the next" (Barrett et al., 2001, V.II, p. 15). In general, this allows for mixtures between the outlined races.

[154] Therefore the values of $\bar{s}^E_{kl}$ clearly differ, because only five levels are assigned for the ethno-racial classification, instead of seven, as is the case for language.

[155] See, for example, Garcia-Montalvo and Reynal-Querol (2003) for the increased incidence of conflicts and de Groot (2009) for its spillover effects between neighboring states. For a more general discussion on the effect of religious beliefs on economic growth, see Barro and McCleary (2003).

power through mobilizing one's followers. Religious inspiration may then be used to trade loyal following in this life, for rewards in an afterlife. The commonalty of religion, however, can also be a major driver of trust, enhancing trade between nations with the same denomination (Guiso et al., 2009). This underlines the importance of this specific characteristic in assessing the differences between groups.

The major problem with religion is the assessment of their differences. How to treat the differences between different denominations, i.e., between Catholics and Protestants, or between Shias and Sunnis, is quite hard to answer. One could try to pursue the same method as that of language and race to assess mutual commonalties. For religion, one could rely on shared festivities, common holy books, common saints/prophets, traditions or values (e.g., mercy). However, there is no known source offering a discussion of this, let alone a structured assessment of the religions of the world. The *WCE* lists 14 major religions in the data: Agnostics, Buddhists, Chinese folk-religionists, Christians, Confucianists, Daoists, Ethnoreligionists, Hindus, Jews, Muslims, New religionists, Sikhs, Spiritists and Zoroastrians. This essay follows the approach that Bossert et al. (2011) applied in their study. For their partition along ethnic lines, they apply a purely categorical assessment, i.e., the mutual similarity values are either one or zero.[156] This approach should be adjusted as better data become available.

3.3.4 Other socioeconomic aspects

An interesting idea championed by Bossert et al. (2011) is that for the distance people feel between each other, not only does their ethnicity play a role, but also their similarities in other dimensions. Bossert et al. (2011) use educational and income similarities in addition to ethnic diversity, arguing that these variables are relevant for a 'felt' distance between individuals or groups.[157] Bossert et al. (2011) conclude that in states where one finds economic homogeneity, ethnic diversity might be less important than in economically more heterogeneous states, where both show comparable levels of ELF.

As for this essay, one faces two problems. Most socioeconomic variables are not available to the same level of granularity as the data used here, and data might not be matched to the ethnic groups. The more serious problem is that most economic literature finds a significant impact of ethnicity on various socioeconomic variables. Additionally, in many countries, the wealth or education stratification is closely linked to ethnic descent. Thus, with a high certainty there exists endogeneity of these socioeconomic variables with regard to ethnicity.[158] As this cannot be ruled out – and there is no adequate data to match the level of detail for ethnicity employed hereafter – further analysis into this aspect is not pursued.

[156] Guiso et al. (2009) use the same approach but with a slightly smaller amount of denominations.

[157] In this regard, Bjørnskov (2008) points toward social trust and income inequalities. Another interesting approach for the US is that of Lind (2007). He tries to assess the inter-group distance through measuring differences in stated preferences on policy questions.

[158] The same might be true for religion and languages, or even dialects.

3.4 Data description and comparison with other sources

There are various sources for religious, ethnic and language data that are widely used in the literature. Besides the wide range of ethno-linguistic groups in the *Atlas Narodov Mira* (Bruk, 1964), Alesina et al. (2003) mainly use data from the *Encyclopædia Britannica* (Encyclopædia Britannica, 2007) and from the *CIA World Fact Book* (CIA, 2011) for their data on ethnicity. For languages, the *Ethnologue* project (Lewis, 2009) offers very detailed data of nearly 7,000 languages. Finally, *L'Etat des Religions dans le Monde* (Clévenot, 1987) offers very exhaustive data on religious affiliation for a wide range of countries.[159] All these sources have their advantages and are certainly applicable for the intention of the respective authors. They, however, lack an important aspect, which is relevant for the analysis here. To build the similarity matrix based on all three traits (language, ethno-racial, religion), each group needs to be defined in accordance with all three of them. This is not possible with the above sources as the groups found in the sources vary depending on the defining criteria.

The source offering the required data is the *World Christian Encyclopaedia* (Barrett et al., 2001).[160] It contains data for over 12,000 groups in 210 countries, classified according to language, ethno-racial group and religion.[161] The data are based on various sources including official reports, national censuses, statistical questionnaires, field surveys and interviews. as well as several other published and unpublished sources. The level of detail and the vast coverage of countries is a strong advantage of this source. The data on languages and ethno-racial affiliation are widely used.[162] Due to the Christian background of the publishing institutions, one could argue (at least for the data on religion), that the numbers might be biased. Their very detailed assessment of Christian denomination, however, is an indication of a real interest to survey Christianity, drawing an unbiased picture of their faith.[163] The high granularity of data might still raise some questions

[159] Akdede (2010) gives a good overview of the data sources used in a broad set of influential articles and discusses their differences.

[160] For all calculations the online version, *The World Christian Database* (Johnson, 2010), is used. It reflects the data in the printed version of Barrett et al. (2001) but includes significant updates and refers to the 2005 – 2010 time period.

[161] In total, over 13,500 groups for 239 countries are included in the data. Groups that differ only through dialects or, in some cases, geographical specifics, like, for example, the Bedouin tribes in Algeria, were excluded. Additionally, very small islands and constituencies with an unclear legal status (e.g., Western Sahara) were excluded.

[162] See, for example, Annett (2001), Barro (1999), Barro and McCleary (2003), Collier and Hoeffler (2002, 2004), Collier et al. (2004), Garcia-Montalvo and Reynal-Querol (2005a, 2008, 2010), Loh and Harmon (2005), or Okediji (2005).

[163] Additionally, Barrett et al. (2001) explicitly mention the United Nations' Universal Declaration of Human Rights in their preface, which grants the freedom to choose one's religion, including not having a religion at all. De Groot (2009) uses a similar, unorthodox evangelical source, the Joshua Project (2007). He also concludes that the "religious fervency with which this organization collects data works in our advantage" (de Groot, 2009, p. 14). Collier and Hoeffler (2002, 2004) and Collier et al. (2004) used it for their index on religious fractionalization. However, Garcia-Montalvo and Reynal-Querol (2005a) discuss some bias towards Christianity at the expense of Animist cults in Latin American countries. Although there is no evidence of a general bias in religious affiliation, it can't be ruled out completely.

Table 3.3: Descriptive statistics of ethnic groups by geographical area

	World	**Western Countries**[a]	**MENA**	**Latin America**[b]	**Asia**[c]	**Eastern Europe**	**SSA**
Number of countries[d]	**210**	33	21	38	40	29	49
Fraction of total		*16%*	*10%*	*18%*	*19%*	*14%*	*23%*
Number of groups	**12,432**	1,716	625	1,405	4,143	1,019	3,524
Fraction of total		*14%*	*5%*	*11%*	*33%*	*8%*	*28%*
Average groups per country	**59**	52	30	37	104	35	72
Max. number of groups	**884**	300	71	255	884	156	513
Min. number of groups	**3**	3	14	6	3	8	6
Average pop. share of largest group	**57%**	68%	60%	64%	52%	75%	39%
Number of countries with a group ≥50%	**123**	25	14	27	19	26	12
Fraction of all countries	**59%**	*76%*	*67%*	*71%*	*48%*	*90%*	*24%*

[a]Western Europe and Australia, Canada, Greenland, Japan, New Zealand and United States.
[b]Includes the Caribbean.
[c]Includes the Pacific islands.
[d]In total data for 239 countries and constituencies are provided. Data on small islands and legally unclear constituencies were excluded: Anguilla, Bougainville, British Indian Ocean, British Virgin Islands, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Falkland Islands, French Guiana, Gibraltar, Guadeloupe, Holy See, Martinique, Montserrat, Niue, Norfolk Island, Northern Cyprus, Pitcairn Islands, Reunion, Western Sahara, Saint Helena, Saint Pierre & Miquelon, Somaliland, Spanish North Africa, Svalbard & Jan Mayen, Taiwan, Tokelau Islands, Turks & Caicos Islands, Wallis & Futuna Islands.

about its accuracy. To test the robustness of the base data, two additional data sets with some noise based on a normal randomization are created. Additionally, the consistency of the data was tested if very small groups in the data were excluded. For both robustness checks, no significant deviation from the results employing the base data set occur.[164]

Below, the most granular group data is used to offer the best possibility of endogenous group formation. Although data at the individual level is not available, this very granular data is very close to the desired approach outlined earlier. *Table 3.3* gives an overview of the data, which is structured according to Alesina et al. (2003) and Fearon (2003).

The *WCE* data clearly show much more groups. Alesina et al. (2003) have, on average, less than six groups per country. While 59 groups are counted in the present data set, on average. Besides the higher number of groups in general, the pattern of fractionalization across the regions is quite similar, with one exception. In contrast to the previous sources, this data show that most groups are located in Asia.[165] This is nearly exclusively driven by three countries that contribute half of all groups in this region: Papua New Guinea with 884 groups, Indonesia 762 and India 428.[166] Excluding these three countries, Sub-Saharan Africa is again the region with the most fragmented countries.[167] This becomes even clearer when one compares the other figures in *Table 3.3*. The average population share of the largest group is only 39% of the population's total in Sub-Saharan Africa, whereas it is at least 50% in all other regions. Also, the number of countries that have a majority group of 50% is significantly lower.

Source		Obs.	Mean	Std. Dev.	Min.	Max.
ELF	ANM	169	0.458	0.273	0.000	0.984
	Alesina	186	0.440	0.257	0.000	0.930
	Annett	144	0.479	0.275	0.010	0.950
	Fearon	153	0.471	0.270	0.002	0.953
	WCE	210	0.563	0.270	0.019	0.982

Table 3.4: Main statistical characteristics of ELF values for different sources

The higher amount of small groups also has an effect on the ELF values based on the *WCE* data, reflected in a noticeably higher mean value. A higher number of groups will increase the ELF index by design.[168] *Table 3.4* confirms this by showing the summary statistics of the ELF values for the various sources described earlier.

[164] For more details on these robustness checks, see *Appendix C.1.1.*

[165] The Asian region includes the Pacific countries and islands.

[166] Although this number seems to be high, it is very much in line with other very detailed sources. Lewis (2009) lists 860 languages for Papua New Guinea, over 10% of the world's total in his data set.

[167] Excluding these three countries, the average number of groups per country in Asia would only amount to 56.

[168] The theoretical attributes of the ELF and POL are nicely met by the *WCE* data. *Figure C.6* of *Appendix C.1.3* shows the increasing ELF values in conjunction with a rising number of groups within a country.

3.5 DELF operationalization

For the construction of the new composite distance adjusted ethno-linguistic fractionalization index ($DELF$), two major, partly interconnected, questions arise. The first is, whether the single components are redundant when compared to each other. The second is the assignment of weights and the way of combining the single characteristics.

Based on theoretical considerations, no single characteristic out of the three is deemed to be superior or more sound than the others, with all of them seeming to be of equal relevance.[169] For the same reason, Okediji (2005) proposes including ethnic differentiation alongside racial and religious characteristics.[170] Finally, one can argue that the distance between the groups increases, if more differences are in place, which would be in line with the cumulative statement of de Groot (2009).[171]

The most common approach when incorporating different characteristics into a combined index is to assign equal weights to all of its components.[172] Following this approach, the $DELF$ is calculated according to *Equation (3.7)* as:

$$DELF = 1 - \sum_{k=1}^{K} \sum_{l=1}^{K} p_k \; p_l \; \hat{s}_{kl} \tag{3.8}$$

where the combined $\hat{s}_{kl}$ is the equally weighted average of the similarity values of each ethnicity characteristic.

$$\hat{s}_{kl} = \frac{1}{3} \left[\; \bar{s}^L_{kl} \; + \; \bar{s}^E_{kl} \; + \; \bar{s}^R_{kl} \; \right] \tag{3.9}$$

where $\bar{s}^L_{kl}$, $\bar{s}^E_{kl}$ and $\bar{s}^R_{kl}$ are the respective similarity values for the language, ethno-racial and religious classification.[173] The single characteristic $DELF$s are equally calculated

[169] See, for example, Chandra and Wilkinson (2008) and Barrett et al. (2001). Hofstede (2000) concludes similarly that "the world population has diversified in three ways: in genes, in languages, and in cultures" (Hofstede, 2000, p. 3)

[170] Okediji (2005) constructs his social diversity index based on the complementary nature of the three characteristics and also uses *WCE* data. However, he does not take into account the mutual (dis)similarities between the groups.

[171] One could argue that by design, the language and ethno-racial classification is not without overlaps. This is why one should weight their sum less. On the other hand, the religious classification is less accurate and would, in contrast, argue for a lower weighting of this characteristic. If there is no strong reason for deviating from the equal weighting, Haq (2006) argues strongly for this principle.

[172] The most well-known index calculated utilizing this approach is the UNDP's Human Development Index (HDI). More recent examples are the SIGI index on gender equality (Branisa et al., 2009) or the 3P index on trafficking policies (Cho et al., 2011). For an analysis of different operationalization strategies for a broad set of composite development indicators, see Booysen (2002).

[173] The main focus of this essay is to assess the diversity of a country, which is well reflected by the $DELF$. However, from the discussion above, one can easily apply the similarity values $\hat{s}_{kl}$ to an adapted version of the polarization index found in *Equation (3.2)*. This would then transform to a distance adjusted POL index with: D-POL $= \sum_{k=1}^{K} \sum_{l=1}^{K} p_k^2 \cdot p_l \cdot \hat{s}_{kl}$ (Esteban and Ray, 1994). For further theoretical discussions on this kind of index, see Esteban and Ray (2008) and Esteban and Ray (2011). For rare examples of an empirical application of this index, see Desmet et al. (2009), Esteban et al. (2010), Esteban and Ray (2011) and Esteban and Mayoral (2011). The data for the D-POL index based on the *WCE* data can be obtained from the author upon request.

using *Equation (3.9)*. Instead of the composite similarity measure ($\hat{s}_{kl}$) the characteristics specific similarity values ($\bar{s}^L_{kl}$, $\bar{s}^E_{kl}$, $\bar{s}^R_{kl}$) are used. To decide on the redundancy of the composite index and its components, McGillivray and White (1993) propose two thresholds of correlation values between the components: 0.90 and 0.70.[174] The Spearman's rank correlations of the $DELF$ values based on the components (labeled with a respective subscript for (L)anguage, (E)thno-culture and (R)eligion) and the composite $DELF$ index are shown in *Table 3.5*.[175]

	$DELF$	$DELF_L$	$DELF_E$	$DELF_R$
$DELF$	1			
$DELF_L$	0.904	1		
$DELF_E$	0.714	0.537	1	
$DELF_R$	0.665	0.529	0.195	1

Table 3.5: Rank correlation for the composite $DELF$ and its components

The correlations between the single components are no higher than 0.54, falling clearly below both thresholds. Thus, any form of double counting by using collinear indicators can be neglected. As the composite index is partly matched to its components, the resulting correlations are naturally higher. By correlating the components with reduced forms of the $DELF$ (by excluding the respective component), most correlations again fall below both thresholds (McGillivray and White, 1993; Ogwang and Abdou, 2003).[176] In addition to the overall correlations, Noorbakhsh (1998) proposes to split the total observations into different groups. A high correlation overall might hide differences within groups, e.g., split into quintiles. *Table 3.6* shows the correlations seen in *Table 3.5*, split between equally sized quintiles.

		Quintiles				
	All obs.	**1**	**2**	**3**	**4**	**5**
	$DELF$	$DELF$	$DELF$	$DELF$	$DELF$	$DELF$
$DELF_L$	0.904*	0.282	0.483*	0.401*	0.556*	0.814*
$DELF_E$	0.714*	0.056	0.156	0.050	0.141	0.815*
$DELF_R$	0.665*	0.569*	0.142	0.004	0.276	0.372*

* indicate rank correlations that are significant at the 5% level

Table 3.6: Rank correlation for equally sized quintiles (according to their $DELF$ values)

Indeed this shows that the higher correlations between the components and the composite $DELF$ vanish completely, or are at least far below both thresholds, except for the

[174] Cahill (2005), McGillivray and Noorbakhsh (2004), Branisa et al. (2009) and Cho et al. (2011) subsequently used this decision rule.

[175] Because all conditions are fulfilled, Pearson's correlation coefficients can also be used. The results are comparable throughout, but slightly lower. As, in the following, the focus is mainly on ranking comparison, Spearman's rank correlations are consequently used.

[176] The correlation between $DELF_L$ and the reduced $DELF$ by excluding $DELF_L$ shows a value of 0.69. The respective values for excluding $DELF_E$ and $DELF_R$ are 0.48 and 0.43, all falling below both thresholds.

fifth quintile. In light of the above discussion, it is reasonable to assume that all components are individually relevant, they indeed measure different characteristics, and the combination of all three is a valid way to cover the complexities of ethnic diversity.

To come up with the composite $DELF$, an equal weighting scheme has been applied to date. Following an extensive critique on the rather simplistic equal weighting of composite indices (Cahill, 2005; McGillivray and White, 1993), the call for a more elaborate weighting scheme, or at least a better foundation, is understandable.[177] One approach widely discussed is the principal component analysis (PCA).[178] Principal components are calculated as linear combinations of the original variables (the single characteristic $DELF$ values in this case) in a way of explaining the largest part of its variation. The first principal component explains most of the variance, followed by the second and third principal component. In doing so, principal component analysis transforms correlated variables into uncorrelated ones and all principal components are orthogonal. The assigned loading factors can then be used to weight the sub-indices.[179]

The very high correlation of 0.999 between the $DELF$ and the index based on PCA calculations ($DELF_{PCA}$) is seen in the upper part of *Table 3.7*. This suggests that one can resign from using the more complex weighting schemes and it underlines that none of the components dominates the other components in a problematic way.[180]

		$DELF$	$DELF_{PCA}$	$DELF_{Geo}$	$DELF_{Pc}$	ANM	Alesina	Annett
$DELF$	$DELF$	1						
	$DELF_{PCA}$	0.999	1					
	$DELF_{Geo}$	0.963	0.963	1				
	$DELF_{Pc}$	0.994	0.994	0.959	1			
ELF	ANM	0.698	0.697	0.707	0.736	1		
	Alesina	0.628	0.630	0.632	0.662	0.800	1	
	Annett	0.630	0.630	0.651	0.671	0.874	0.883	1
	Fearon	0.607	0.606	0.626	0.621	0.748	0.817	0.795

Table 3.7: Rank correlation matrix for differently weighted $DELF$ values and the most common ELF indices

Having discussed the possible redundancy of the components and ways to assign their weights, there are two ways to aggregate the components; using the arithmetic, or the

[177] Chowdhury and Squire (2006) show that the vast majority of scholars still opt for the equally weighted average regarding aggregated development indices, despite ongoing discussions. For the HDI, Nguefack-Tsague et al. (2011) also provide a statistical reinforcement of the equal weighting scheme. An additional problem often raised is the implicit weighting due to different scales of the sub-indices (McGillivray and Noorbakhsh, 2004; Noorbakhsh, 1998). Through construction of the sub-indices, this problem does not apply to the $DELF$.

[178] For a discussion and its application, mainly to the HDI, see Jolliffe (1973), Ram (1982), Ogwang (1994), Noorbakhsh (1998) or Ogwang and Abdou (2003).

[179] For the results of the PCA and further details, see *Appendix C.2*.

[180] Additionally, the variances of the sub-indices are rather similar. So, none of the sub-indices would significantly bias the equally weighted index. For details on key statistical attributes of the single sub-indices, see *Table 3.8*.

geometric mean.[181] Using a geometric mean does 'penalize' high dissimilarity in one of the components, however. This is often used in composite indices on various inequality measures, e.g., poverty, where the direct compensation of one component through another is not desired.[182] Two individuals from the same ethno-racial and language backgrounds, who adhere to different religions, would be completely different in the case of a geometric mean because the religious component would be zero.[183] That a certain similarity still prevails between both individuals/groups is obvious. Thus, for the application here, a form of compensation between components seems reasonable. In connection with the discussion above, the interpretation of the cumulative nature of the characteristics is more perspicuous and, additionally, argues in favor of an arithmetic mean. Due to these very different attributes, it is not surprising that the $DELF_{Geo}$ has a lower, yet still very high correlation to all the other $DELF$ values.

As an alternative, the introduction of a certain non-linearity of compensation between characteristics might be reasonable. This is, for example, promoted by Branisa et al. (2009). To allow for a certain compensation, one squares the components before the calculation of the arithmetic mean. This leads to an adjusted value of $DELF_{Pc}$. In line with Nardo et al. (2005), in this approach the weights are interpreted as trade-offs and not as importance coefficients.[184]

Finally, the $DELF$ index should contain different information than other indices that try to measure ethnic fragmentation or diversity. Thus, the redundancy considerations regarding the components can be applied as a comparison to existing ELF indices. The results are found in the lower part of *Table 3.7*. All rank correlations between the most common ELF indices and the new $DELF$ fall below both redundancy thresholds.[185] Although already alluded to the theoretical discussion, where it was apparent that both indices measure different things (fragmentation versus diversity), the statistical results provide additional confirmation.

[181] An additional aggregation for the $DELF_{PCA}$ index is not necessary because, by construction, the distance vector of the first principal components contains the weights and aggregation implicitly.

[182] The HDI just recently switched from an arithmetic mean to a geometric one. To advance a country's development it now needs to advance much more equally across the sub-indices than before, where one could compensate for one index with another. A geometric mean for an index would also imply a clear assignment of both a bad and good state for the values of zero and one. This is possible for poverty and development indices but not for the $DELF$, which describes a state between two extremes without valuation.

[183] Collier and Hoeffler (2002), Collier and Hoeffler (2004) and Collier et al. (2004) use a multiplicative combination of the ethnic and religious fractionalization measure to assess 'social fractionalization'. To avoid the dominance of one characteristic, where two groups are completely different, they add the index which is the greater to the product of both indices.

[184] Thus, an individual can reduce the distance between another individual that does not adhere to the same religion by learning his language. For further theoretical discussions on weighting and differences between compensatory and non-compensatory approaches, see Munda and Nardo (2005). Branisa et al. (2009) offer a functional operationalization.

[185] Note that the number of observations varies across the correlation values with the ELF indices due to their more limited observations.

The arithmetical average between the single characteristics is therefore the easiest way to operationalize the composite $DELF$ index. Furthermore, it has the compensatory attributes between the characteristics that reflects their complementarity. This is not given by using the geometric mean, for example. By using the part compensation method and principal components, comparably adequate results are found to those of the simple arithmetic mean. As their correlation is rather high, the method used here follows the principle of keeping it as simple as possible.[186]

3.6 Results

For each country, a similarity matrix is calculated, containing all $\hat{s}_{kl}$ for the weighting of mutual group similarities. *Tables C.2* and *C.3* of *Appendix C.2* detail the general similarity matrix calculation. The group similarity calculations are comparable to the ones within a country and for the difference between countries.

3.6.1 Diversity measure within countries

The size of the respective $K \times K$ matrices for each country is defined by the number of groups found in it, ranging from 3 to 884.

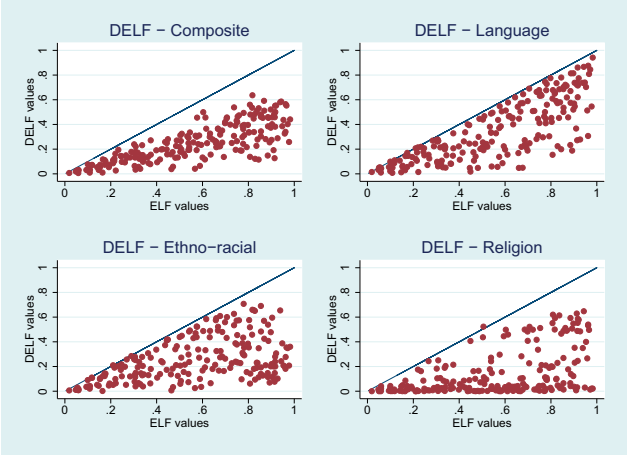


Figure 3.2: Combined and single characteristic $DELF$ values against ELF values.

[186] For further details on all weighting schemes, see *Appendix C.2*. A detailed discussion of the superiority of the equal weighting scheme is found in McGillivray and Noorbakhsh (2004), who conclude that more elaborate weighting schemes "produce values which are generally indistinguishable from values of the equally weights index" (McGillivray and Noorbakhsh, 2004, p. 15). Comparably, de Groot (2009) uses the same approach in his ethno-linguistic affinity index.

To make the differences between the ELF and $DELF$ values clear, *Figure 3.2* shows the influence of the various characteristics.[187] By adjusting for the language differences only, reduces the values by less than when all three characteristics are considered. The most influential changes emerge if religion is taken into account, since in many countries a majority religion is present, which acts as a unifying characteristic. The combined $DELF$, weighting all three characteristics, yields more consistent values, which is confirmed in *Table 3.8*. The standard deviation of the composite $DELF$ is considerably lower than those of the decomposed indices.

Religious and language homogeneity, in particular, are spread differently across regions. This is why the adjustments also vary significantly between regions. In Latin-America,[188] Spanish is the dominant language, although there are different ethno-racial and/or religious groups. The language similarities add to a higher affinity between the groups and, in turn, lower the $DELF$ values. *Table 3.9* summarizes the mean values for different ELF and $DELF$ specifications across regions. Additionally, it compares the average ranks of the countries in the respective groups. A rank of one is assigned to the most heterogeneous countries, i.e., the countries with the highest ELF or $DELF$ values. Comparing both ranks gives a good indication of how large the adjustments in the $DELF$ calculation are compared to the standard ELF values.

Index	Observations	Mean	Std. Dev.	Min.	Max.
ELF	210	0.563	0.270	0.019	0.982
$DELF$	210	0.252	0.157	0.006	0.636
$DELF_L$	210	0.353	0.243	0.008	0.942
$DELF_E$	210	0.255	0.176	0.002	0.708
$DELF_R$	210	0.148	0.188	0.000	0.648

Table 3.8: Main statistical characteristics of $DELF$ values, decomposed for all ethnicity characteristics

Sub-Saharan Africa (SSA) demonstrates a much higher value when measured by the ELF compared to the $DELF$, resulting in a negative rank delta. As seen earlier, this region includes countries with the highest number of groups, mirrored by high ELF values. However, if one takes the similarity between the groups into account, the ranks decrease. Eastern Europe, in contrast, shows much more diversity when considering the DELF value rather than the ELF value.

More interesting is the decomposition of the $DELF$ into its single characteristics. For the language characteristic, Latin America hosts the most homogeneous countries, whereas Sub-Saharan Africa again shows the most heterogeneous ones. Taking into account only the ethno-racial aspect, Latin America shows the highest diversity. This might come from the interbreeding of the native Indian population with the high number of descendants from the Western colonial powers and the resulting Mestizo progeny. The region with

[187] Both indices are based on *WCE* data.
[188] Includes the Caribbean.

the most homogeneous countries in this regard is Eastern Europe, a region where outside powers have interfered less. The religious characteristic again demonstrates the expected distribution. Sub-Saharan Africa has the most religiously heterogeneous countries and Western and Latin American countries, with high numbers of Christians, host the most homogeneous ones. Not surprisingly, the Middle East and Northern African (MENA) countries also show values indicating rather homogeneous religious characteristics, which is not surprising considering the high proportion of Muslims in these areas. Most countries that have a majority religion, i.e., more than 60% of the population either adhere to Christianity (133 countries) or to Islam (43 countries), exhibit rather low religious $DELF$ values. For all other countries, where there is either no majority religion or it is made up of another denomination, show significantly higher religious $DELF$ values. Also, their average overall $DELF$ rank is substantially higher than when only taking the number of groups in the ELF value into account.

	Obs.	Mean values							
		ELF	$DELF$	$DELF_L$	$DELF_E$	$DELF_R$	Rank ELF	Rank $DELF$	Delta Rank
Asia	40	0.608	0.290	0.435	0.240	0.194	93.3	90.8	2.5
E. Europe	29	0.389	0.197	0.261	0.204	0.126	145.9	125.0	20.8
L. America	38	0.509	0.227	0.220	0.386	0.075	121.3	114.5	6.8
MENA	21	0.558	0.249	0.358	0.275	0.114	108.1	107.0	1.2
SSA	49	0.741	0.319	0.490	0.219	0.248	62.6	81.2	-18.6
W. Count.	33	0.465	0.184	0.279	0.206	0.066	128.7	130.9	-2.2
World	210	0.563	0.252	0.353	0.255	0.148	–	–	–
Muslim	43	0.571	0.262	0.389	0.271	0.127	105.6	100.7	4.9
Christian	133	0.519	0.208	0.299	0.251	0.076	115.7	121.2	-5.7
Other	34	0.729	0.407	0.519	0.249	0.454	65.6	50.1	15.5

Table 3.9: Mean ELF and $DELF$ values and ranks for all regions and countries with main majority religions

The single country perspective shows even more considerable adjustments. The ELF and $DELF$ values of each country are listed in *Table C.7* of *Appendix C.3*. The countries are ordered according to their ELF values in descending order, from the most heterogeneous country to the most homogeneous country. The third column depicts their corresponding $DELF$ values and $DELF$ ranks. The difference between the ELF and $DELF$ ranks is shown in column four. The next column outlines the $DELF$ values, decomposed for each characteristic, which helps to better illustrate the adjustments.[189] An adjustment of over 40 places is seen by half of the 10 most diverse countries. Looking at the lower end, one sees only marginal adjustments, as expected. The 15 most homogeneous countries are, with three exceptions, the same for both indices. For the other countries, however, significant adjustments are found. For example, Zambia, the Republic of Congo, Zimbabwe, Angola

[189]From *Figure C.7* of *Appendix C.1.3*, one can see that the adjustments will tend to be more significant for higher values of ELF than for lower ones, where both indices are much closer. This is clearly visible for the higher ELF values at the top of *Table C.7*.

and Italy, which are treated as much more homogeneous by the $DELF$ compared to the ELF, show difference in ranking of more than 100 places are. Nevertheless, one also finds adjustments in the opposite direction, i.e., countries that have a higher diversity rank based on $DELF$ values. The countries with the most significant adjustments in this regard – all more than sixty places – are Kazakhstan, Bahrain, Macedonia, Lebanon, Sudan and the Russian Federation. These upward changes are mainly driven by relatively high language diversity.

3.6.2 Similarity measure between countries

To date, most authors have focused on the assessment of ethnicity within a country, as has this essay. This has also been the case in analyzing a country's growth or conflict incidence. De Groot (2009) expands upon this and proposes his index of ethno-linguistic affinity (ELA) to measure the similarities between two neighboring countries. He shows that conflict spillovers are more likely between contiguous countries sharing stronger ethnic similarities. The extended calculation for the $DELF$ between countries is nearly identical to *Equation 3.7*, and is defined through:

$$DELF_{ij} = 1 - \sum_{k=1}^{K} \sum_{m=1}^{M} p_{ik}\ p_{jm}\ \hat{s}_{km} \tag{3.10}$$

where country i hosts groups $k = 1, ..., K$, and country j groups $m = 1, ..., M$, respectively. The distance between the two groups k and m is given through $\hat{s}_{km}$. The result is the expected dissimilarity between two individuals randomly drawn from each country.

The 210 countries analyzed here give a matrix containing over 150 million similarity values and nearly 44,000 dyadic relations between countries.[190] Due to the amount of country-pairs, only a discussion of averages and some tuples with the highest discrepancy is offered here.[191] Naturally, all $DELF$ values are much higher than those for individual countries. *Table C.8* of *Appendix C.3* lists the mutually most similar and dissimilar countries at the single country level.[192] Many of the mutually most similar countries come from the MENA region. The religious homogeneity of this region plays an important role in their overall similarity level. It is not surprising that the most dissimilar pairs are matches between Asian and African countries. Except for some minority migrant groups, one does

[190] This significantly exceeds the 2,809 dyadic relations offered by de Groot (2009) for the 53 African countries.

[191] The complete data set can be received upon request.

[192] In general the interpretation of the $DELF$ value between countries ranging between zero and one is comparable to the case of $DELF$ values within countries. Two countries that consist of groups that share not a single characteristic show a mutual $DELF$ value of one, being completly different. Lower values of $DELF$ correctly indicate countries that share more characteristics and thus are more 'similar'. However, the theoretical country setup maximizing the similarity between two countries (minimizing the $DELF$ value) deviates in its limit from the generally understood meaning of the word 'similar'. This is discussed in more detail in *Appendix C.2.6*. I would like to thank Walter Zucchini for this important comment.

not find many shared ethnic characteristics between these countries and all their values are close to one.

A regional aggregation also offers come interesting insights. For the calculation of the regional averages, the $DELF$ values between countries are adjusted for the different population sizes of the respective country pairs.[193] *Table 3.10* summarizes the regional and global averages.

	Regional $DELF$	Country pairs
Asia	0.719	1,600
Eastern Europe	0.479	841
Latin America	0.340	1,444
North Africa & Middle East	0.430	441
Sub-Saharan Africa	0.643	2,401
Western Countries	0.572	1,089
World	0.841	44,100

Table 3.10: $DELF$ average by main geographical regions

The global cultural diversity measured by the $DELF$ displays an average of 0.84. Asia exhibits the highest diversity level compared to all other regions. Thus, from a regional perspective, Asia seems to be the most diverse region, and not SSA.[194] Latin America, in contrast, displays the least interregional diversity.

The regional level of diversity plays an important role in the European Union (EU). The success of European integration is often questioned by the high level of cultural diversity. This was debated before the last enlargement in particular, when the EU grew from 15 to 25 and shortly after to 27 member states. It will eventually lead to even more controversial debates regarding future enlargement plans. With the above approach, the developments in the level of diversity through language, ethno-racial, and religious characteristics, can easily be traced.

Figure 3.3 shows the diversity level of the EU for each wave of enlargement.[195] The predecessor of today's EU was initiated in 1952, including Belgium, France, Germany, Italy, Luxembourg and the Netherlands. This 'core Europe', which it is often referred to, displayed a regional $DELF$ value of 0.37. The next two enlargement waves added nearly 25% to the total population. However, these countries were not overly different from the existing group and were internally rather homogeneous. Hence, the $DELF$ only slightly increased. The addition of Portugal and Spain in 1986, two populous and very homogeneous countries, slightly decreased the overall level of European diversity, whereas

[193] For the weighting, population data averages for 2005–2010 from the *World Development Indicators* World Bank (2011) were used. For more details on how regional averages are calculated and the differences in the calculation of $DELF$ values between countries, see *Appendix C.2.7*.

[194] Note that from the single country perspective, SSA still has the countries with the highest internal heterogeneity. This is an indication that the drawing up of borders in Asia proceeded more 'endogenously' than the method used in SSA by the colonial powers.

[195] For more details on the different waves of enlargement in the EU, and the respective diversity levels, see *Table C.9* of *Appendix C.3*.

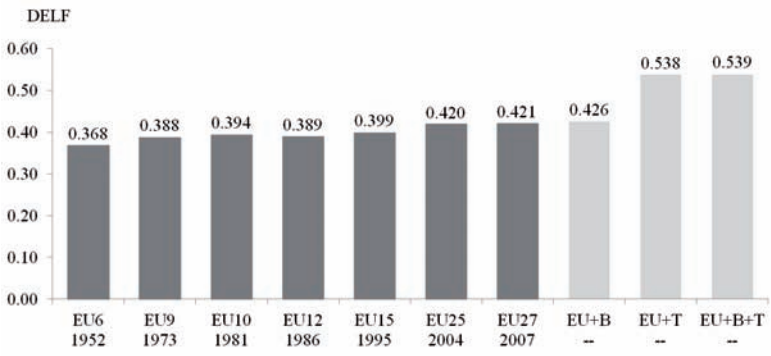


Figure 3.3: Average $DELF$ values of the EU per enlargement wave

the huge enlargement of 10 countries in 2004, and of two more in 2007, again increased the $DELF$ level significantly.[196] Looking at potential future enlargements, the admission of mainly Balkan states, as well as Iceland (EU+B), would not change the status quo greatly. The highest increase in diversity within the EU would result from admitting Turkey (EU+T). The increased cultural diversity Turkey would bring to the EU can't be judged as good or bad, per se – however, it offers an easy target for exploitation of these differences and political agitation. This was already the case during earlier waves of enlargement which only displayed marginal increases in the EU's diversity. The increase Turkey would bring, as stated, would be far greater, thus the potential for exploitation and political agitation could be far greater.

Finally, the $DELF$ values between countries are compared with the most widely used measure of cultural distance between countries, its genetic distance. By matching these with the detailed data on genetic diversity compiled by Spolaore and Wacziarg (2009), yields only a very limited correlation (*Table 3.11*).[197] The rank correlation of genetic distance and the composite $DELF$ is only 0.25, and thus fail to meet both of the redundancy thresholds discussed above.[198] This comparison underlines that the genetic distance data is hardly a good proxy for the 'cultural' differences between countries.

[196] One important caveat applies for this. As essay 2 outlined, cultural heterogeneity levels are subject to change. As the underlying data for the $DELF$ calculation is dated for the years 2005–2010, using it for time frames of over 50 years ago will lead to distorted values. Thus, the $DELF$ values for the EU enlargement for the earlier years can only be taken as an indication. The changing $DELF$ values are only attributable to compositional changes of the European Union and not to expectable changes over time.

[197] Spolaore and Wacziarg (2009) construct two measures of genetic relatedness between countries. One is based only on the genetic distances between the plurality ethnic groups of each country. The second is a measure of weighted genetic distance of all groups. The latter construction is more comparable to the one employed in this essay.

[198] As expected from the characteristic definition, the highest correlation of the genetic data is with the ethno-racial $DELF$ values at 0.7. Both are correlated but still seem to measure different things.

	$DELF$	$DELF_L$	$DELF_E$	$DELF_R$
$DELF$	1			
	43890			
$DELF_L$	0.566	1		
	43890	*43890*		
$DELF_E$	0.489	0.636	1	
	43890	*43890*	*43890*	
$DELF_R$	0.899	0.363	0.193	1
	43890	*43890*	*43890*	*43890*
Genetic Distance	0.245	0.484	0.697	0.018
	30800	*30800*	*30800*	*30800*

Table 3.11: Rank correlations between $DELF$, its sub-indices and genetic distance data (observations in italics)

3.7 Conclusion

Taking the mutual (dis)similarities between ethnic groups into account, the new $DELF$ index covers a new and very important aspect of ethnicity: its diversity. This additional aspect was ignored by the most commonly used measures of ethnicity. The $DELF$ index for 210 countries shows considerable differences between countries and regions. The differences suggest that it indeed measures different aspects of ethnicity, which might have a contrasting effect on the socio-economic problems under investigation.

Many current papers analyzing the role of ethnicity based on the ELF index can profit from taking the mutual (dis)similarities between individual groups into account. In countries, where ethnic groups show higher differences, it might be even more difficult to agree on public goods (e.g., infrastructure or social security systems), as has already been shown by Alesina et al. (1999). Caselli and Coleman (2008) discuss the importance of barriers between groups to prevent assimilation between them on the incidence of wars. This is exactly what Collier and Hoeffler (1998, 2004), Collier et al. (2009) and Fearon and Laitin (2003) try to find in their analyses. i.e., whether ethnic fragmentation increases the incidence of wars. Their results do not find a robust influence of ELF on conflict incidence. It might still be the case that there is a strong influence of ethnic diversity on conflicts, but the applied ELF index does not measure the appropriate aspect of ethnicity in order to prove this. Additionally, the possibility to analyze the single characteristic $DELF$ for very specific questions offers new room for application. Akdede (2010), for example, shows the different implications of ethnic and religious fractionalization on democratic institutions.

Research that leveraged genetic distances to assess the dissimilarity between countries should equally profit from employing the $DELF$ between countries. It offers a much more comprehensive data set of 'cultural' affinity between nations. As de Groot (2009) concludes, it is not necessarily the geographical distance, often used in spatial economics, which is being applied to assess the influences one country might have on others. Nor does genetic distance really offer a satisfying alternative. The $DELF$ values between countries

offer an excellent and valid extension of the analysis into spillover effects between countries. De Groot (2009) shows the role cultural affinity between neighboring countries plays in the spillover of conflicts.

Trust is associated closely with more homogeneous and similar country setups. Genetic distance only covers trust in a very limited way. Trust is seldom hidden in the genetic code, evolving out of the interaction between individuals whose cultural backgrounds play an important role.[199] Leveraging genetic distance is even more problematic in Spolaore and Wacziarg's (2009) analysis on the spillover effect of innovations and development between countries. Imitation and adaptation costs of innovations rely significantly more on the 'cultural' barriers (different language, ethno-racial background and beliefs) than on the biological ones (genes).

Nevertheless, there are some caveats that one cannot overlook. As the data source used is somewhat unique in its combination of all characteristics, only limited robustness checks with other sources on the combination of the characteristics are possible. Secondly, the weighting of the three sub-indices is debatable, as is the case for most composite index calculations. Here, the most general approach is used. For specific questions, different emphasis might be given to specific characteristics. The clear discussion and overview of the single sub-indices should encourage every researcher to do so. Finally, there might be country or region-specific characteristics influencing cultural diversity not covered in the (globally comparable) three characteristics treated in this essay. The caste system in India would be one example. Thus, for a country or region-specific analysis, the diversity data offered might have restricted relevance. Nevertheless, the approach discussed here can still be applied.

In the above cases the $DELF$ index should be more appropriate than the ELF index as it incorporates the fundamental concept of diversity. The extension to measure cultural dissimilarities between nations offers a good alternative to the applied genetic distance data. The broad foundation and the detailed new data set should be a call to critically review the usage of the ELF index and the genetic distance data. Additionally, it provides a starting point for new research on the specific role of the diversity of countries.

[199] For an indication of how a common language increases trust and common identification in a case study for the US, see Chong et al. (2010). Falck et al. (2010) show that German cross-regional migration and economic exchange can be attributed to dialect similarities from the 19th century that remain today.

Chapter 4

The Implications of Ethnic Diversity

4.1 Introduction

Recent literature on the role of ethnicity in socioeconomic contexts has strived to find different ways of measuring its various aspects. Most papers rely on an index covering the fragmentation (ELF) or the polarization (POL) of a country's ethnic groups.[200] In general, the ELF is an increasing function of the number of groups. A country with more, and thus smaller relative groups, is more fragmented. On the contrary, the POL measures the deviation from a situation of two equally sized groups. For such a setup, the POL reaches its maximum value and decreases afterwards. Already from their construction one can see that both measures cover different ethnic setups and are therefore supposed to explain different problems. The distance adjusted ethno-linguistic fractionalization index $DELF$ now adds a third aspect, a country's ethnic diversity.

For many economic problems, it is not the pure quantity of (relative) groups which is of interest, but the difficulty of coordination or instrumentalization between them. This is crucially dependent on the differences between these groups and not only on their mere existence. Thus, one expects the $DELF$ to exhibit a different performance on a range of economic questions compared to the ELF and POL. This chapter shows the applicability of the $DELF$ index in different fields, selected as to cover a broad range of economic problems.[201]

The mere quantity of groups might demonstrate more divisions through which conflicts may ignite, arguing for the ELF index. To the contrary, in very heterogeneous countries,

[200] See, for example, Mauro (1995), Easterly and Levine (1997), Collier (2001), Alesina et al. (2003) and Alesina and La Ferrara (2005) for different applications of the ELF concept and Duclos et al. (2004), Garcia-Montalvo and Reynal-Querol (2002, 2005b, 2010) and Ranis (2011) for the application of the POL index.

[201] Additionally, limited access to the underlying data of some relevant articles in the respective fields hindered a broader testing of the applicability of the index, therefore affecting the selection of the replications. Again, a sincere thank you to all authors who generously shared their data for this study.

with many small groups, coalition building to create a strong enough power base becomes more difficult. This is why others argue that it is the specific quantitative constellation of groups, i.e., their polarization (POL), that impacts the incidence of conflicts (Garcia-Montalvo and Reynal-Querol, 2005b). Caselli and Coleman (2008) point to obvious barriers between groups that are important regarding the decision to enter conflicts. If a group can easily exclude another (potentially the defeated group) from the resources gained (due to an obvious ethnic identifier existing between both groups), it raises the incentives to start a conflict. This would argue for an important role of the diversity measure $DELF$. Thus, it is difficult to decide a priori which ethnicity index better explains conflicts.

A high ethnic fragmentation is associated with lower growth rates, mainly through its effect on other socioeconomic variables (e.g., corruption or public goods provision).[202] The more groups that exist, the more visions regarding the realization of education, location and forms of infrastructure, or the design and extent of institutions, differ. Because every groups wants at least some of its wishes to be met, the government's difficulty in achieving a consensus, and the distribution of its available funds might indeed depend on the mere quantity of groups, reflected in a higher fragmentation (ELF). In contrast, the different backgrounds and experiences of a country's working population may be an asset to sustain more complementary production procedures and drive innovation. For this, not only the mere quantity of groups, but also their differences seem to be relevant. This potential might, however, only unfold in more developed countries.[203] Whether, and how the ELF or the $DELF$ may impact on economic growth is, again, not completely clear.

Trust is an important precondition for nearly any transaction. Different groups should equally influence the general trust level in a country. Bjørnskov (2008), however, finds no significant impact of fractionalization (ELF) on trust. This might be true due to the fact that the quantity of groups in a country are less relevant to the emergence of trust, than the differences between them (which only the $DELF$ takes into account). Unfortunately this can't be confirmed by the following analyses.

The $DELF$ has an additional huge advantage, in that it can be used to assess the cultural differences between countries. For both the ELF and POL, this is not possible. Thus far, bilateral differences between cultures were assessed by data based on quite limited differences (e.g., genetic distance) or a broad set of proxy variables that are often regionally bounded (e.g., mutual voting behavior at regional song contests). The global $DELF$ data shall offer some escape from these limitations. Again, taking the level of trust as an important prerequisite for any economic activity, cultural diversity affects the level of positive opinions between countries (Disdier and Mayer, 2007). More specifically, the

[202] The most prominent are Easterly and Levine (1997), Alesina et al. (2003) and Alesina and La Ferrara (2005).

[203] One can, however, also argue that with a rising difference between the groups a consensus becomes even more difficult and thus a high diversity should also have a negative impact on growth. For these potentially different effects, the development level of a country seems to be especially crucial and will be further discussed in section 4.4.

$DELF$ shows a significant impact on trade volumes in two analyses with an European focus. It substitutes a list of various cultural affinity proxies very well, thus paving the way to expand these trade analyses on to a global scale.

The remainder of this chapter is organized as follows. Section 4.2 gives a short overview of the main indices commonly used and outlines the clear distinction between them and the $DELF$ index. In section 4.3, the $DELF$ is tested based on its implications for conflict incidence. The differing impact of ethnic diversity on economic growth is analyzed in section 4.4. Section 4.5 discusses the potential improvements of the diversity measure against the fractionalization measure for the level of trust within and between countries. Section 4.6 again uses $DELF$ values between countries to identify its role on bilateral trade. Finally, section 4.7 summarizes the key findings, concludes, and gives an outlook for further research.

4.2 Overview of relevant indices

The most commonly used index to cover ethnicity in the economic context is the ethnolinguistic fractionalization index (ELF). It was first published for a broad range of countries by Taylor and Hudson (1972).[204] The ELF is calculated as an Herfindahl-Hirschman concentration index:

$$ELF = 1 - \sum_{i=1}^{K} p_i^2, \qquad \text{for all} \quad i \in \{1, ..., K\} \tag{4.1}$$

where K is the number of groups i, and p_i represents their relative group sizes. Its value moves between zero and one and represents the probability that two randomly selected individuals from a population come from different groups. A higher value indicates a more fragmented country, i.e., a country with a higher number of distinct ethnic groups.

The second prominent measure is an index of polarization, introduced by Garcia-Montalvo and Reynal-Querol (2002).[205] Assessing the variation outside of an even 50/50 split of two groups, Garcia-Montalvo and Reynal-Querol (2002) find that this index is a much better predictor for conflict incidence than the ELF measure. The polarization index (POL) is defined as:

$$POL = 1 - \sum_{i=1}^{K} \left(\frac{0.5 - p_i}{0.5} \right)^2 \cdot p_i, \qquad \text{for all} \quad i \in \{1, ..., K\} \tag{4.2}$$

The POL index also tends towards zero for very homogeneous countries, i.e., with only one group. However, with increasing group numbers, ELF and POL show clearly different

[204] Ginsburgh and Weber (2011, Ch. 6) offer a good overview of the different classes of indices used, their historical development and recent applications. For a broad overview on general concepts and measures of ethnicity, see Brown and Langer (2010).

[205] Their work is considerably based on Esteban and Ray (1994).

courses. While ELF is an increasing function of the number of groups, POL reaches its maximum with two equally sized groups and decreases afterwards.

The $DELF$ now takes the distance between these groups into account. The idea dates back to Greenberg (1956), and later Fearon (2003), who both proposed using linguistic similarities between language groups to cover the distance aspect. In addition to the language characteristic, the DELF includes information on the ethno-racial and religious characteristics of all groups.[206] The three characteristics are weighted to arrive at the composite $DELF$ values.[207] Aligned with the ELF index, the $DELF$ index is calculated as:

$$DELF = 1 - \sum_{k=1}^{K} \sum_{l=1}^{K} p_k \; p_l \; \hat{s}_{kl}, \qquad \text{for all} \quad k,l \in \{1,...,K\} \tag{4.3}$$

where the combined $\hat{s}_{kl}$ is the equally weighted average of the similarity values of each ethnicity characteristic between all groups $k,l \in \{1,...,K\}$. This new global data set is based on data from the *World Christian Encyclopedia* (Barrett et al., 2001) and offers ethnic diversity data for 210 countries. By construction, a close relationship to the ELF measure is evident. Both are influenced by the number of groups, which in a way determine the relative groups sizes – a key building block for both. Based on this additional aspect, accounting for the differences between groups, the $DELF$ leads to significant differences between a country's ELF and its $DELF$ values. *Figure 4.1* shows the ranks of all countries depending on its ELF and $DELF$ values, where the highest values correspond with the rank of one.[208] Changes in the heterogeneity ranking of more than 30 places (indicated by the dotted lines) are quite common. Countries such as Zambia, the Republic of Congo, and Zimbabwe seem to be more homogeneous when using the $DELF$ compared to their ELF values. Contrarily, Kazakhstan, Bahrain or the Sudan turn out to be more diverse than fragmented.

In addition to the diversity data of single countries, the index offers information on nearly 44,000 dyadic relations between countries and their respective cultural distance. This is a key advantage of the $DELF$ as the ELF and POL do not allow for any assessment of ethnic differences between countries. For this reason, an index of genetic distance was often used, although one may raise some reasonable objection to its applicability.[209] It is based on a rather limited number of 42 distinct world populations for its calculation and

[206] Two other recent approaches consider a set of characteristics to assess the differences between groups. Bossert et al. (2011) combine ethnic and various socioeconomic differences between citizens to construct ELF values comprising of diversity for US counties. De Groot (2009) measures a broad set of cultural characteristics (e.g., language, religion) to assess the ethno-linguistic affinity between countries in Africa.

[207] For more details on the distance calculations for each characteristic and the different weighting possibilities, see the *Appendix C.2*.

[208] More details on the ELF and $DELF$ values are found in *Table C.7* of *Appendix C.3*.

[209] The assessment of genetic distance can be traced back to the pioneering work of Cavalli-Sforza and Feldmann (1981), who created phylographic trees by mapping the differences in special sections of the human DNA.

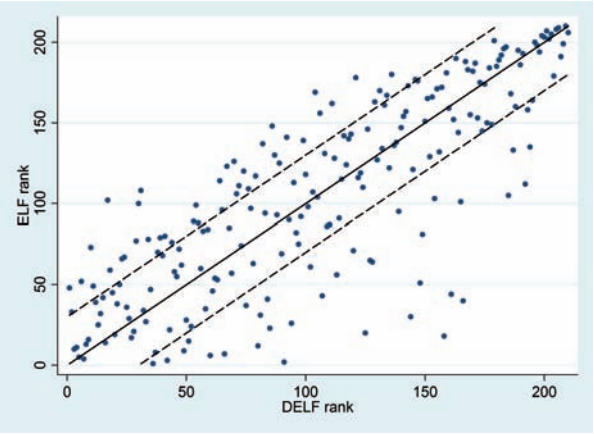


Figure 4.1: Scatter plot of ELF and $DELF$ rank values

turns out to be a predictor for geographic distance from a common place within Africa (Giuliano et al., 2006; Ramachandran et al., 2005). The global $DELF$ values between countries offer a good option to escape from these limitations.

4.3 Implications of ethnic diversity on conflict

The relationship between ethnic division and conflict is probably the most researched field regarding a possible impact of ethnicity. Due to this, different aspects of conflict have been highlighted. The analyses of its roots and influencing factors differ for the incidence, onset and duration of conflicts. While incidence measures if any form of conflict is currently occurring in a given country, its onset measures whether a specific conflict starts at a given time. For example, a country that experiences a two year conflict, exhibits a conflict incidence for both years, but conflict onset only in the first year. Finally, the duration measures the overall length of a given conflict. In the aforementioned example, this would be two years.[210]

For conflicts in general, greed, rather than grievance is held responsible (Collier and Hoeffler, 2004). More opportunities to hide in mountainous regions, the possibility of gaining higher amounts of natural resources, and lower opportunity costs for an impoverished population are brought forward as arguments. However, the more ethnic groups that are oppressed by the ruling regime raises the probability of revolts. Not only oppression, but marginalization and the intentional underdevelopment of groups not belonging to the ruling clan may raise tensions, which may develop into conflicts. In line with the greed and opportunity theories, a broad strand of literature relying on the ELF index has not found

[210]For more details on the different conflict measures, see Bleaney and Dimico (2009).

strong empirical evidence for a relationship between ethnic fragmentation and any of the conflict measures (Fearon and Laitin, 2003).[211] Apparently the mere number of groups is not that relevant for conflict.[212]

These arguments led Garcia-Montalvo and Reynal-Querol (2002) to develop a polarization index (POL) as a more relevant measure of relationship between ethnic division and conflict.[213] They argue that deviation from the situation of two equally strong groups, that might both seize power over the whole country, is more relevant for the incidence of conflicts than the fractionalization of a country. In general, polarization is indeed more robustly associated with the conflict measures.

In a theoretical contribution, Caselli and Coleman (2008) stress the importance of potential excludability of the defeated party from economic or political gains. The possibility to exclude another group based on obvious barriers (physiognomic, language, ethnic) between them, raises the incentives to start a conflict. The distance between groups, mirrored in the $DELF$ index, should be a relevant factor for the consideration of whether or not to start a war.

Garcia-Montalvo and Reynal-Querol (2005b) test the applicability of ethnic and religious polarization against the respective fractionalization indices in the incidence of wars. They use data from the Peace Research Institute of Oslo (PRIO), which include intermediate and high-intensity armed conflicts. A range of standard control variables (*GDP/capita, Population, Primary exports, Mountains, Contingency*, and *Democracy*) are included in all regressions. The regressions in *Table 4.1* are replications from the ones in the original article and use a logit model for the incidence of civil wars based on five-year periods. The ethnic polarization variable (*Ethnic pol.*) clearly outperforms the fractionalization variable (*Ethnic frac.*) in regards to the level of significance.[214] All control variables carry the expected sign.

The regressions in *Table 4.2* now rebuild the approach of Garcia-Montalvo and Reynal-Querol (2005b). However, the fractionalization indices are replaced by the composite $DELF$ and the $DELF_R$.[215] The higher significance of the polarization measure (*Ethnic pol.*) fades and gives way to the composite $DELF$. The coefficients for the control variables and their significances remain more or less unchanged. It is apparent that the $DELF$, covering the differences between groups, contains important information regarding

[211] See also Collier and Hoeffler (2004) and Collier et al. (2009).

[212] Furthermore, the quantity of groups, demonstrating more divisions through which conflicts may arise, may make coalition building in order to create a strong enough power base more difficult. This may additionally impede a linear relationship of ELF and conflicts.

[213] This is based on earlier work of Esteban and Ray (1994). Garcia-Montalvo and Reynal-Querol (2005b, 2010) further develop the polarization index and its application. See Blattman and Miguel (2010) for a broad literature overview.

[214] The ethnic variables are also based on data from the *World Christian Encyclopedia* (Barrett et al., 2001), whereas the religious measures are mainly built based on data from the *L' Etat des Religions dans le Monde* (Clévenot, 1987).

[215] To be consistent, the fractionalization indices were also taken from the same data source as the $DELF$ is calculated, i.e., the *WCE*.

	(1) Conf.	(2) Conf.	(3) Conf.	(4) Conf.	(5) Conf.
Ethnic frac.	**1.19***		**0.18**		**0.05**
	(1.89)		(0.19)		(0.05)
Ethnic pol.		**2.38*****	**2.29****		**2.09****
		(2.97)	(2.23)		(2.03)
Rel. frac.				-4.97*	-4.45
				(-1.65)	(-1.39)
Rel. pol.				3.90**	3.29
				(1.97)	(1.59)
Ln (GDP/capita)	-0.29	-0.44**	-0.42*	-0.33	-0.38
	(-1.27)	(-1.99)	(-1.79)	(-1.13)	(-1.33)
Ln (Population)	0.35**	0.41**	0.40**	0.44***	0.44***
	(2.18)	(2.40)	(2.21)	(3.01)	(2.72)
Primary exp.	-0.91	-1.01	-1.07	-0.35	-0.90
	(-0.52)	(-0.54)	(-0.57)	(-0.21)	(-0.48)
Mountains	0.00	-0.00	-0.00	0.00	-0.00
	(0.49)	(-0.25)	(-0.19)	(0.29)	(-0.16)
Non contiguous	0.08	0.30	0.29	0.31	0.48
	(0.13)	(0.49)	(0.48)	(0.49)	(0.79)
Democracy	0.08	0.03	0.03	0.02	-0.03
	(0.21)	(0.09)	(0.09)	(0.05)	(-0.09)
Constant	-5.82**	-6.23*	-6.30**	-6.90**	-7.47**
	(-2.06)	(-1.93)	(-2.01)	(-2.26)	(-2.32)
Observations	846	846	846	846	846
Pseudo R^2	0.101	0.122	0.122	0.110	0.134

Cluster robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.1: Original logit regression for the incidence of civil wars as found in Garcia-Montalvo and Reynal-Querol (2005b)

the incidence of conflicts. In line with the contribution of Caselli and Coleman (2008), obvious barriers should play a role in this decision. That the composite $DELF$, covering all characteristics, has a significant impact compared to the $DELF$ solely based on religion, confirms their theoretical arguments. In most cases, religious identification may not be an obvious enough characteristic to rule out future assimilation.

Having found a significant impact of $DELF$ on the incidence of conflicts does not, however, allow one to infer its applicability onto other conflict measures, namely its onset and duration. Further research deems necessary to fully understand the dynamics as to how the different aspects of a country's ethnic composition affects the different phases of conflict.

4.4 Implications of ethnic diversity on growth

The second most prominent question of ethnicity's role is whether, and how it affects economic growth. This was the starting point for the seminal paper of Easterly and

	(1) Conf.	(2) Conf.	(3) Conf.	(4) Conf.	(5) Conf.
DELF	**2.40***		**2.55****		**4.25****
	(1.87)		(2.05)		(2.31)
Ethnic pol. (WCE)		**0.45**	**0.74**		**0.28**
		(0.39)	(0.64)		(0.22)
$DELF_R$				-9.59	-12.48
				(-1.38)	(-1.53)
Rel. pol. (WCE)				5.98	6.43
				(1.35)	(1.30)
Ln (GDP/capita)	-0.35	-0.47*	-0.40	-0.42*	-0.47
	(-1.48)	(-1.87)	(-1.50)	(-1.75)	(-1.64)
Ln (Population)	0.39***	0.40**	0.39**	0.42***	0.45***
	(2.59)	(2.56)	(2.54)	(2.75)	(3.37)
Primary exp.	-0.96	-0.27	-1.00	0.07	-0.46
	(-0.48)	(-0.16)	(-0.50)	(0.04)	(-0.26)
Mountains	0.00	0.00	0.00	0.00	0.00
	(0.54)	(0.30)	(0.41)	(0.34)	(0.17)
Non contiguous	0.10	0.12	0.21	0.05	0.13
	(0.16)	(0.18)	(0.31)	(0.08)	(0.18)
Democracy	0.03	0.08	0.02	0.06	-0.02
	(0.09)	(0.22)	(0.05)	(0.16)	(-0.07)
Constant	-6.17**	-4.94*	-6.10**	-5.58*	-6.52**
	(-2.15)	(-1.70)	(-2.09)	(-1.92)	(-2.35)
Observations	833	833	833	833	833
Pseudo R^2	0.108	0.092	0.110	0.101	0.128

Cluster robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.2: Logit regression for the incidence of civil wars, based on Garcia-Montalvo and Reynal-Querol (2005b)

Levine (1997), who concluded that Africa's lower growth rate can be explained to a large extent by its higher ethnic fragmentation. Their approach was extended and updated with new ELF data by Alesina et al. (2003). Subsequently, Schüler and Weisbrod (2010) added an additional decade of observation and thus based their analysis on a broader foundation.[216] They all very much confirm the negative effect of the ELF on a country's growth rate. For more developed countries with better education and infrastructure, this effect is found to be less detrimental (Alesina and La Ferrara, 2005). Ethnic diversity might even be a driver of innovation for these countries and should thus affect growth in a positive way. Nevertheless, cooperation is apparently more difficult in more heterogeneous countries so it is natural to question the $DELF$'s role in economic growth. As the data compiled by Schüler and Weisbrod (2010) offers the most observations, it seems obvious to replicate their analyses.

[216]Whereas Alesina et al. (2003) covered the period from 1960 to 1989, Schüler and Weisbrod (2010) expand the data to cover the period 1960 to 1999.

	(1) Growth	(2) Growth	(3) Growth	(4) Growth
Africa	-0.009**	-0.014***	-0.012***	-0.016***
	(-2.66)	(-3.47)	(-3.67)	(-4.27)
La. America	-0.016***	-0.014***	-0.018***	-0.016***
	(-5.93)	(-4.63)	(-6.60)	(-5.08)
Ln (GDP/cap.)	0.041***	0.027	0.045***	0.030
	(2.71)	(1.46)	(2.89)	(1.59)
(Ln (GDP/cap.))^2	-0.003***	-0.003**	-0.003***	-0.003***
	(-2.99)	(-2.47)	(-3.08)	(-2.61)
Ln (Schooling)	0.011***	0.003	0.011***	0.003
	(3.40)	(0.66)	(3.36)	(0.66)
Assassinations		-21.103**		-19.766**
		(-3.48)		(-2.18)
Financial depth		0.009**		0.010**
		(2.14)		(2.00)
Black market premium		-0.021***		-0.021***
		(-5.34)		(-5.31)
Fiscal surplus/GDP		-0.000**		-0.000*
		(-1.81)		(-1.91)
Ln (Telephones/worker)		0.016***		0.017***
		(3.15)		(3.34)
ELF (Alesina)	**-0.019*** **	**-0.012** **		
	(-3.86)	(-2.20)		
DELF			**-0.017** **	**-0.005**
			(-2.34)	(-0.58)
Observations	82/88/ 94/92	38/67/ 74/80	81/87/ 93/91	38/67/ 74/79
R^2	0.24/0.24/ 0.36/0.16	0.46/0.45/ 0.49/0.30	0.21/0.20/ 0.35/0.12	0.46/0.44/ 0.48/0.27

Robust t statistics in parentheses; observation and R^2 values are decade specific
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Growth is measured as annual growth rate of per capita GDP

Table 4.3: Influence of ethnic diversity on economic growth, based on Schüler and Weisbrod (2010)

Table 4.3 shows, in regressions (1) and (2), replications of the original growth regressions of Schüler and Weisbrod (2010).[217] Regression (1) contains only limited control variables that are supposed to influence the economic development of countries. Both regional dummies, for *Africa* and *Latin America*, are negative and significant at the 5% and 1% levels. The income level (*GDP/cap.*) at the beginning of each decade shows a catch-up effect, at a slightly diminishing rate as its squared term is negative but with a very small coefficient. As one expects, *Schooling* has a significant effect on increasing

[217]The regressions here are run, in line with Schüler and Weisbrod (2010), using seemingly unrelated regressions (SUR). SUR is used to allow for country random effects to be correlated across decades, in order to increase the efficiency of the estimators. However, comparing the results to a model run with robust OLS regressions and decade dummies displays nearly no differences. Thus, the decade correlations seem to be very limited.

growth.[218] Finally, ethnic fractionalization (ELF), based on the data compiled by Alesina et al. (2003), reveals a detrimental growth effect. A completely homogeneous country would expect an almost 2% higher rate of annual growth compared to a completely fractionalized country. The different level of ethnic fractionalization between Korea and Côte d'Ivoire is thus responsible for roughly 1.6% of their growth rate differential.[219] Regression (2) mow includes a broad set of variables affecting growth. The number of *Assassinations*, the *Black market premium* and the *Fiscal surplus* all negatively affect growth at highly significant levels of 1%. Financial depth and the number of *Telephones per worker* are used as proxies for the level of infrastructure in a country, with both showing a growth enhancing potential and being highly significant. As ethnic fractionalization per se can hardly impact upon growth, all of these variables are meant to be channels through which ethnic fragmentation affects growth. This is supported by a high correlation between the ELF and those variables. Indeed, Easterly and Levine (1997) and Alesina et al. (2003) find a vanishing effect of the ELF as the number of covariates included in the regressions increases, until it becomes equally insignificant. By including data from the 1990s, Schüler and Weisbrod (2010) find a robust, albeit smaller, negative effect of the ELF on growth, controlling for all other variables. This, therefore, still confirms that the ELF potentially works through affecting these variables.[220]

Regression (3) now exchanges the ELF values with $DELF$ values. Nearly all of the coefficients and significance levels remain relatively unchanged and, interestingly, the $DELF$ displays nearly the same coefficient as the ELF. However, it loses its significant impact when all controls are included in regression (4), as in the articles of Easterly and Levine (1997) and Alesina et al. (2003). Although the coefficients look similar their economic impact differs. Whereas an increase of one standard deviation in the ELF reduces growth by 0.56 percentage points, the same increase in the $DELF$ would only lead to a reduction in growth of 0.29 percentage points.[221] Again comparing Korea and Côte d'Ivoire, the difference in their respective $DELF$ levels is responsible for slightly less than one percentage point of their growth rate differential.[222] Thus, ethnic diversity seems to be less detrimental to economic growth than the ELF. As both affect growth through different variables (channels), a more detailed analysis on ELF and $DELF$ effects is deemed necessary here.

[218] Measured as the average years of total school attainment at the start of the decade.

[219] In the data of Alesina et al. (2003) Korea has an ELF of 0.002, whereas Côte d'Ivoire has an ELF of 0.82.

[220] If one uses the ELF index based on the same data as the $DELF$ (WCE data), its effect remains highly significant in regression (1) but fades again in regression (2).

[221] The standard deviation of ELF is 0.27, whereas it is only 0.16 for the $DELF$. For the annual growth rate the standard deviation is 0.027.

[222] Korea has a $DELF$ of 0.032, whereas Côte d'Ivoire has a $DELF$ of 0.586.

However, for these basic regressions, the sheer number of groups are more robust than taking their differences additionally into account.[223]

Despite the finding that heterogeneity negatively affects economic growth, one can question if this relation changes in different country settings. The reasoning for this is promoted mainly by articles analyzing metropolitan regions and companies.[224] They often find that ethnic heterogeneity has a positive effect on innovation and productivity. With very comparable data to that above, Alesina and La Ferrara (2005) try to prove this positive effect in a large scale cross country analysis. They show that the detrimental effect of ethnic heterogeneity does indeed fade for more economically developed countries. The original paper, however, relies on the limited dataset from 1960–1989.

Table 4.4 replicates the analysis of Alesina and La Ferrara (2005) with the extended data of Schüler and Weisbrod (2010).[225] Following the argumentation of Alesina and La Ferrara (2005) that richer countries are less prone to the ELF's detrimental effect, the heterogeneity measures (ELF and $DELF$) are both interacted with the countries' income levels (*GDP/cap.*). The negative effects for ELF and $DELF$ remain in regressions (1) and (2), although they are no longer or only marginally significant at conventional levels. The same is true for the interaction terms of the heterogeneity measures (ELF/$DELF$) and the level of initial income (*GDP/cap.*). Thus, the finding of Alesina and La Ferrara (2005) cannot be confirmed for the extended time period. However, it is questionable whether a mere higher income level is the basis for diversity to deliver benefits to a country. Countries need instead to establish a common base that allows the different groups to interact in a productive way.[226] An indicator reflecting a broader perspective of development is the Human Development Indicator (HDI). Regression (3) and (4) include the HDI level and an interaction term with the heterogeneity indices, replacing the income level used before.[227] The ELF and $DELF$ again enter the regression with the familiar significant negative effect, although the $DELF$ is slightly less significant. More interestingly, the interaction

[223]The static nature of both the ELF and the $DELF$ calls for an important caveat. Chapter 2 showed that the level of ethnic heterogeneity in a country is changing and makes inter alia education responsible for this. Although the ethnic setup of a country does not change quickly, an analysis covering four decades, with a single static ethnic measure, requires some caution.

[224]Ottaviano and Peri (2005) show that native US citizens receive higher wages in metropolitan areas where ethnic heterogeneity is increasing. Again for the US, Sparber (2010) confirms a productivity increasing effect of racial diversity for cities, but less so at the state level. Florida (2004) argues that a more diverse agglomeration of creative capital increases innovations and ultimately economic growth. Equally, Niebuhr (2010) finds that cultural diversity raises innovative activity, positively affecting the performance of regional research and development (R&D) sectors in Germany. Ozgen et al. (2011a) show a comparable result for European regions. Watson et al. (1993) show empirically that more diverse teams need longer to establish a common understanding, but if that is reached they outperform more homogeneous groups. Similarly, Prat (2002) shows, in a game theoretical analysis, that the positive impact of a heterogeneous versus a homogeneous team depends on the complementarity of their tasks. A comparable result is also found in Hong and Page (1998).

[225]The regressions are again run with robust OLS and decade dummies that are not explicitly reported.

[226]This is comparable to multicultural companies that need to enforce a common understanding between its diverse employees to profit from their different backgrounds.

[227]Besides purely economic measures, the HDI includes differences in its educational and health levels. The data is taken from UNDP - United Nations Development Programme (1994).

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth
Africa	-0.012***	-0.016***	-0.010**	-0.015***	-0.012***
	(-2.66)	(-4.02)	(-2.32)	(-3.83)	(-2.66)
La. America	-0.017***	-0.018***	-0.017***	-0.018***	-0.016***
	(-5.25)	(-5.78)	(-5.32)	(-5.79)	(-4.80)
Ln (GDP/cap.)	0.017	0.026	0.023	0.033*	0.031
	(0.79)	(1.37)	(1.19)	(1.73)	(1.58)
(Ln (GDP/cap.))^2	-0.002**	-0.003***	-0.003**	-0.003***	-0.003***
	(-1.99)	(-2.73)	(-2.27)	(-2.89)	(-2.68)
Ln (Schooling)	0.002	0.002	-0.000	-0.002	-0.003
	(0.32)	(0.35)	(-0.03)	(-0.43)	(-0.55)
Assassinations	-18.945**	-17.614*	-19.129**	-17.434*	-20.922**
	(-1.99)	(-1.83)	(-2.02)	(-1.82)	(-2.19)
Financial depth	0.008*	0.007*	0.008	0.007	0.008*
	(1.65)	(1.52)	(1.65)	(1.55)	(1.80)
Black market premium	-0.020***	-0.020***	-0.021***	-0.020***	-0.020***
	(-5.02)	(-4.90)	(-5.08)	(-4.99)	(-4.98)
Fiscal surplus/GDP	-0.000*	-0.000*	-0.000*	-0.000*	-0.000*
	(-1.85)	(-1.93)	(-1.93)	(-1.95)	(-1.74)
Ln (Telephones per worker)	0.014**	0.014***	0.014***	0.014***	0.013***
	(2.44)	(2.41)	(2.50)	(2.48)	(2.25)
HDI	0.025	0.033	0.009	0.015	0.011
	(1.19)	(1.55)	(0.38)	(0.69)	(0.51)
ELF (Alesina)	**-0.066**		**-0.034****		**-0.011**
	(-1.56)		(-2.70)		(-0.61)
ELF * Ln (GDP/cap.)	**0.006**				
	(1.31)				
ELF * HDI			**0.038****		**-0.016**
			(1.74)		(-0.52)
DELF		**-0.125***		**-0.042****	**-0.044**
		(-1.84)		(-2.01)	(-1.64)
DELF * Ln (GDP/cap.)		**0.015***			
		(1.82)			
DELF * HDI				**0.070****	**0.109****
				(2.10)	(2.22)
Observations	38/65/ 71/76	38/65/ 71/75	38/65/ 71/76	38/65/ 71/75	38/65/ 71/75
R^2	0.44/0.43/ 0.51/0.34	0.46/0.41/ 0.49/0.34	0.43/0.43/ 0.51/0.34	0.44/0.41/ 0.50/0.35	0.44/0.42/ 0.50/0.40

Robust t statistics in parentheses; observation and R^2 values are decade specific
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Growth is measured as annual growth rate of per capita GDP

Table 4.4: Influence of ethnic diversity on economic growth depending on economic and human development levels, based on Alesina and La Ferrara (2005)

terms reveal a new result. Both the ethnic fractionalization and ethnic diversity indices show a positive impact for more developed countries. Regression (5) includes both the ELF and the $DELF$ indices, as well as their interaction terms. Whereas most ethnicity

variables are now insignificant, the interaction term of $DELF$ with the HDI level remains positive and significant, albeit at a reduced level of 10%. *Figure D.1* of *Appendix D.1* shows the average marginal effect of the $DELF$ dependent on the HDI level for both last regressions. In the case of regression (4) the $DELF$ exhibits a positive impact for a HDI level of 0.6 and above. This corresponds with countries like Indonesia or the Philippines.[228] for regression (5) the threshold for a positive implication is already at 0.4. A positive and significant effect (at the 5% level) is found for HDI level of 0.7 and above. For example, Paraguay, Tunisia, and Turkey exhibited such a level of development for the 1990s. This result confirms the expectation that ethnic diversity, in contrast to its mere heterogeneity, has a positive impact on the economic growth of a country.

Using the broader data from Schüler and Weisbrod (2010), Alesina and La Ferrara's (2005) result of a positive impact of ethnic heterogeneity depending on a country's income level, cannot be confirmed. However, a new insight is generated by using a broader approach related to a country's level of development. Countries that rank higher in the HDI may well harvest the positive effects of ethnic diversity. This is an important finding as it is a good basis for challenging the common understanding that ethnic diversity, in the economic context, has negative consequences. If the right conditions are in place, it seems that it can support a country's economic success. However, the potential innovative power of ethnic diversity only unfolds in countries that can cope with its adversary effects.

4.5 Implications of ethnic diversity on trust

Trust between citizens or between countries can be an influential factor in various economic fields. It can be the root of the difficulty to agree on public goods (Alesina et al., 1999; Desmet et al., 2009), or be responsible for conflicts between countries (de Groot, 2009). As trust, shared values or opinions are generally hard to measure, and data are seldom readily available, a growing literature is devoted to discovering the roots of these factors. Alesina and La Ferrara (2002) look for factors associated with trust between citizens in the US, and Bjørnskov (2007, 2008) does this for a large set of countries.[229] Both articles find that economic and political opportunities play an important role, as well as cultural aspects. For a set of 100 countries, Bjørnskov (2008) finds that countries with a predominantly Catholic or Muslim population are less trusting, while ethnic fractionalization does not affect trust.[230] Comparable to the discussion on conflict, employing the appropriate measure of ethnicity or culture also seems to be crucial in identifying an effect in this strand of the literature. Diversity in this respect, again, offers an interesting new facet.

[228] These HDI values correspond to the latest decade in the data, starting with 1990.

[229] For a related, yet somewhat different, approach to assessing differences between countries (instead of within countries), see Desmet et al. (2011). They use a broad range of responses on cultural values from the *World Value Survey*, for countries in the European Union, to construct a measure of cultural distance.

[230] Equally, La Porta et al. (1999) associate countries with mainly Catholic and Muslim populations with inferior government performance.

That one does not find an influence of ethnic diversity on trust is arguably due to the fact that the fractionalization measure (ELF) does not measure diversity correctly, as it neglects the group differences.[231] The varying distances between groups should be more relevant for the level of trust than the mere number of groups. Hence, regressions (1)–(3) in *Table 4.5* replicate the major regressions of Bjørnskov (2008).[232] The regressions are performed using simple OLS with robust standard errors, with a ten year average since 2000 being employed for most of the variables. Social trust within countries is based mainly on the results of the *World Value Survey* (Inglehart et al., 2004).[233] Having a higher level of *Income inequality*, as well as being a *Post communist* country, reduces trust, whereas Monarchies (*Monarchy*) and *Nordic countries* are, in general, more trusting.[234] High political diversity is associated with a significantly lower level of trust. Political competition, however, does not seem to play a major role.[235] The dummies for countries that have a dominant religion, exhibit a negative impact for *Catholic* and *Muslim* countries, albeit slightly less for the latter. Regressions (4)–(6) now re-run the first three, this time replacing the fractionalization measure (ELF) with the diversity measure ($DELF$). Contrary to expectations, the $DELF$ regressions remain equally insignificant. The impact on all other variables is also very limited.

One must consider that ethnic fractions may be salient under one condition, and less so under another. In addition, these conditions might not been included in the original regressions. Bjørnskov (2008) reasons on the same grounds, arguing that changes in citizens' sensitivity towards ethnic diversity changes over the course of development in a country. Better institutions and social systems improve trust between groups, whereas rising income inequality causes more frictions. Another explanation might be differences in the segregation of ethnic communities. The trust one has in fellow citizens depends on the people that individual is surrounded by. In the case of highly segregated communities within a country, the group an individual trusts in is very homogeneous. Thus, a high amount of trust in ones fellow (homogeneous) community can coexist with high diversity in a country as long as the different ethnic groups are segregated. As it stands, the role of ethnicity cannot be answered on the grounds of the above findings.

In a comparable approach, Disdier and Mayer (2007) try to analyze the roots of bilateral opinions. Although trust and opinions are not exactly the same, they are often used

[231] Bjørnskov (2008) applies the ELF measure compiled by Alesina et al. (2003). If one uses the ELF based on *WCE* data, the results remain relatively unchanged

[232] The coefficients and significance levels slightly differ from the original paper as the data used for the replication are based on an updated version covering additional countries. The outcomes are, however, not affected.

[233] Trust is measured on a scale between zero and 100, and reflects the percentage of the population answering positive to the question: 'In general, do you think that most people can be trusted?'. For some countries, the social trust value is derived from the *Afrobarometer* and the *Latinobarometro* surveys with a comparable question.

[234] These include Denmark, Finland, Iceland, Norway and Sweden.

[235] Political diversity is defined as the variance of political self-placement based on *WVS* data. Political competition is the Herfindahl-Hirschman index of legislature based on the Database of Political Institutions from the World Bank.

	(1) Trust	(2) Trust	(3) Trust	(4) Trust	(5) Trust	(6) Trust
Income inequality	-0.47***	-0.30***	-0.51***	-0.51***	-0.34***	-0.52***
	(-5.33)	(-3.23)	(-5.50)	(-5.92)	(-3.67)	(-5.48)
Post communist	-6.16**	-6.00**	-8.09***	-7.11***	-6.95***	-7.98**
	(-2.43)	(-2.63)	(-2.77)	(-2.66)	(-2.82)	(-2.31)
Monarchy	8.33***	7.38**	8.71***	8.66***	7.13**	9.01***
	(3.33)	(2.61)	(3.27)	(3.19)	(2.33)	(3.23)
Nordic country	16.01***	15.59**	16.59***	16.77***	15.96**	17.65***
	(2.96)	(2.54)	(2.72)	(3.20)	(2.57)	(2.90)
Political diversity		-2.02***			-1.99***	
		(-3.87)			(-3.76)	
Political comp. ('80-'05)			3.58			2.87
			(0.51)			(0.36)
Protestant	0.08	0.08	0.07	0.08	0.07	0.07
	(1.33)	(1.15)	(1.15)	(1.22)	(1.07)	(1.05)
Muslim	-0.06	-0.07**	-0.07*	-0.06	-0.07**	-0.06
	(-1.60)	(-2.17)	(-1.86)	(-1.61)	(-2.14)	(-1.65)
Catholic	-0.06**	-0.08***	-0.06*	-0.06*	-0.08**	-0.05*
	(-2.28)	(-2.82)	(-1.94)	(-1.97)	(-2.43)	(-1.71)
Eastern	-0.02	0.01	-0.03	-0.03	0.02	-0.03
	(-0.38)	(0.24)	(-0.50)	(-0.40)	(0.40)	(-0.45)
ELF (Alesina)	**-2.97**	**-2.00**	**-3.49**			
	(-0.77)	(-0.49)	(-0.90)			
DELF				**-1.30**	**-0.94**	**-1.37**
				(-0.18)	(-0.11)	(-0.20)
Constant	47.41***	51.56***	47.46***	47.94***	52.70***	46.89***
	(9.62)	(10.27)	(8.49)	(9.02)	(9.40)	(8.41)
Observations	113	89	110	109	85	107
Adjusted R^2	0.565	0.675	0.571	0.572	0.675	0.567
F-Test	30.65	31.86	28.68	31.22	30.19	28.66

Robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.5: Determinants of social trust, based on Bjørnskov (2008)

in an equivalent manner. Disdier and Mayer (2007) use the opinions of EU member countries (EU15) towards the Central and Eastern European Countries (CEEC) before their admission to the EU in 2004.[236] A link between opinions and trust is clearly detectable here. The more positive the opinion of an EU member is towards an accession country, the higher their trust of this country will be. Disdier and Mayer (2007) also try to separate economic effects from the cultural affinity factors influencing the positive public opinions towards the accession of the respective countries.

The dependant variable is the percentage of respondents that support the enlargement to a given CEEC country in a Eurobarometer survey of the EU15 countries. The regressions use robust OLS estimators with country and time fixed effects. *Table 4.6* contains the

[236]The countries covered were Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia. Romania and Bulgaria only joined in 2007.

	(1) Opin.	(2) Opin.	(3) Opin.	(4) Opin.	(5) Opin.	(6) Opin.	(7) Opin.	(8) Opin.
Lang. prox.	**0.54*** **	**0.59*** **						
	(4.64)	(5.22)						
Relig. prox.	**-0.30*** **	**-0.35*** **						
	(-2.90)	(-3.26)						
Asylum seekers	0.04**	0.04**	0.03**	0.04**	0.03*	0.03*		
	(2.14)	(2.21)	(2.06)	(2.14)	(1.66)	(1.70)		
Book imports	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00		
	(-1.29)	(-1.32)	(-0.86)	(-0.83)	(-1.21)	(-1.19)		
Conflict years	-0.02***	-0.01***	-0.01***	-0.01**	-0.01**	-0.01**		
	(-3.04)	(-2.89)	(-2.60)	(-2.39)	(-2.58)	(-2.41)		
UN voting	3.71***	3.46***	3.73***	3.45***	3.42***	3.17***		
	(5.75)	(5.37)	(5.72)	(5.29)	(5.42)	(5.06)		
$\mathbf{DELF_L}$			**-0.46*** **	**-0.51*** **				
			(-4.13)	(-4.60)				
$\mathbf{DELF_R}$			**7.02**	**7.38**				
			(1.20)	(1.24)				
DELF					**-0.92*** **	**-0.99*** **	**-0.98*** **	**-1.01*** **
					(-5.29)	(-5.85)	(-6.08)	(-6.59)
Ln (Imports)	0.06***		0.06***		0.05***		0.03*	
	(3.15)		(3.52)		(2.93)		(1.79)	
Ln (Exports)		0.05***		0.05***		0.04**		0.05***
		(2.67)		(2.69)		(2.26)		(2.69)
GDP/cap. diff.	-0.11*	-0.11*	-0.11*	-0.11*	-0.09	-0.09	-0.14***	-0.15***
	(-1.82)	(-1.92)	(-1.80)	(-1.87)	(-1.51)	(-1.54)	(-3.59)	(-3.89)
EU budget cont.	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***	0.17***	0.16***
	(6.09)	(6.19)	(6.03)	(6.13)	(6.20)	(6.30)	(5.79)	(5.61)
EC benefits	0.66***	0.66***	0.66***	0.66***	0.66***	0.66***	0.57***	0.55***
	(6.32)	(6.36)	(6.29)	(6.33)	(6.41)	(6.46)	(6.40)	(6.28)
Ln (Distance)	-0.32***	-0.34***	-0.26***	-0.28***	-0.27***	-0.29***	-0.36***	-0.32***
	(-5.35)	(-5.74)	(-4.27)	(-4.57)	(-4.55)	(-4.87)	(-7.85)	(-6.06)
Constant	-16.93	-20.82	-16.01	-19.00	-14.28	-16.74	64.22***	60.85***
	(-0.65)	(-0.80)	(-0.63)	(-0.74)	(-0.56)	(-0.66)	(3.70)	(3.53)
Observations	677	677	677	677	677	677	860	860
Adjusted R^2	0.825	0.824	0.822	0.821	0.826	0.825	0.808	0.809
F-Test	104.03	102.11	100.47	98.52	103.76	102.42	126.38	124.89

Country and year fixed effects were used; robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.6: Influence of economic and cultural affinity factors on bilateral opinions, based on Disdier and Mayer (2007)

replicated and extended regressions of Disdier and Mayer (2007). The first two regressions are those replicated without any changes. As cultural affinity factors, Disdier and Mayer (2007) include *Language proximity* and *Religious proximity*,[237] as well as the share of

[237]For the continuous language proximity measure, Disdier and Mayer (2007) use *Ethnologue* data (Lewis, 2009) with language distances calculated comparable to Fearon (2003). For the religious proximity, data from the Encyclopædia Britannica (2007) are used.

Asylum seekers and the volume of *Book imports* from the accession country. The *Language proximity* index shows a significant, positive sign, as one would expect. The *Religious proximity* index, however, displays a significant negative impact on bilateral opinion. This is rather surprising and upon inquiry, unfortunately, also the authors could not offer an explanation for this finding. The higher share of *Asylum seekers* shows the expected positive sign and is significant at the 5% level. The final proxy for affinity between two countries, the amount of *Book imports*, is, in contrast, never significant. To assess historical frictions between countries, the number of military incidents in the period 1870–1989 (*Conflict years*) were included and show a negative impact. Recent political proximity is accounted for through correlation in voting behavior in the General Assembly of the United Nations (*UN voting*). Political cooperation on global topics influences opinion in a positive way, and all economic factors display the expected direction of influence.[238]

In regressions (3) and (4), the indices of language and religion proximity are replaced by the language and religion $DELF$ values. This substitution leaves all other variables and the overall fit of the model nearly unchanged. A higher language distance deteriorates bilateral opinion as language differences probably reduce the information one has about the other country, for example, due to less news coverage.[239] The religious distance, however, has no significant impact.[240] Regressions (5) and (6) include the composite $DELF$, instead of the ones with single characteristics. The $DELF$ coefficient is higher than the language proximity and $DELF_L$ index. Again, all other variables are only impacted upon marginally. As the $DELF$ is supposed to be a good proxy for the cultural affinity between nations, all the affinity factors of Disdier and Mayer (2007) are replaced by the composite $DELF$ index in the last two regressions. This leads to a noticeably increased number of observations. The coefficients for the $DELF$ variable increase in size, remaining highly significant. A higher cultural distance between two countries is associated with a more negative opinion towards the accession of the other respective country. This effect is robust and enters the regression with a higher value than the other cultural affinity proxies.[241] The overall fit of the model is more or less unaffected.[242] Based on these results, the $DELF$ index is a very good proxy for trust or opinions between countries and may substitute a whole range of affinity factors deemed relevant for bilateral opinions.

[238]Other than the displayed variables in the regression table, variables for population, unemployment rate differences, common border and imports of newspapers were included. Because they were not significant in any of the regressions, they are not displayed here.

[239]Note that the proximity measures and the $DELF$ index enter the regression with opposite signs, because the former measures affinity and the latter, distance.

[240]This finding points to a possible mismeasurement in the religious proximity index of Disdier and Mayer (2007), and thus, the potential source of the unexpected negative influence found in the original two regressions.

[241]The beta coefficient of the $DELF$ is at least twice the size of that for asylum seekers.

[242]The biggest change is found for the differences in GDP per capita levels, which is now significant, even at the 1% level. The share of asylum seekers in the former regression probably absorbed most of this influence.

4.6 Implications of ethnic diversity on trade

There are two main channels through which cultural affinity between nations is supposed to promote trade (Combes et al., 2005). Higher cultural affinity is aligned with better mutual understanding and knowledge. For trade, this translates into reduced transaction costs. Both agents better understand the conditions in the other country, and dealing with judgment on legal matters, for instance, as well as activity planning, is somewhat easier. Access to information on legal restrictions, consumer behavior or the practices of their local business partners is less costly. The second channel promotes trade via preferences, i.e., migrants often entrain their preferences for goods and services from their home country. Spreading these new products throughout their new host countries expands demand beyond their own migrant group, and intensifies mutual trade flows. Both channels are boosted by a higher stock of immigrants, as well as generally higher cultural affinity and understanding between respective nations.[243]

The trade increasing effect of cultural proximity is the focus of Felbermayr and Toubal (2010). In a standard gravity trade model, they show that trade volumes are increased by a higher cultural affinity between both nations. Their sample consists of 32, mainly European, countries and covers the period from 1965 to 2003. Felbermayr and Toubal (2010) proxy cultural affinity by using the mutual voting behavior from the Eurovision Song Contest (ESC).[244] The major advantage of using ESC voting, as a cultural affinity measure is that it does not necessarily need to be symmetric between two countries. Indeed, it seldom is. Additionally, it may vary over time, as the contest is held on a yearly basis. Basically, all conventional measures lack these features. Felbermayr and Toubal (2010) find that the trade increasing effect of cultural proximity is much higher for differentiated goods than for homogeneous goods, where essentially no significant effect is found.

Again, the main findings of Felbermayr and Toubal (2010) are reproduced in *Table 4.7*. As the ESC data are time variant and not symmetric between countries, Felbermayr and Toubal (2010) can apply more elaborate econometric models to take advantage of this additional information. As the *DELF* lacks this additional information, all regressions in *Table 4.7* are performed in a slightly limited way by using cluster robust OLS models with importer and year fixed effects.[245]

[243] In general, most papers find a positive correlation between migration and trade. See, for example, Rauch (2001) or Combes et al. (2005). Wagner et al. (2002) compare a broader set of articles and outline their different approaches, leading to different elasticities of migration regarding trade. *The Economist* just recently chose the role diasporas play economic activities across borders as its cover story (The Economist, 2011).

[244] The ESC is an annual song competition, where each country casts votes for the song from other countries to determine the winner of the competition.

[245] In their gravity models, Felbermayr and Toubal (2010) use a complete set of interaction terms for importer/exporter and year fixed effects. Indeed, they show that standard OLS regression would significantly underestimate the effect of cultural proximity. If anything, applying more standard econometric strategies is likely to underestimate the results. As a consequence, the discussed results here are thus not an exact replication, but adapted regressions.

	Aggregate imports				Homogeneous goods			Differentiated goods		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln (Distance)	-0.578***	-0.570***	-0.522***	-0.517***	-0.835***	-0.824***	-0.822***	-0.606***	-0.544***	-0.540***
	(-6.33)	(-6.19)	(-4.87)	(-4.79)	(-6.92)	(-6.69)	(-6.65)	(-8.76)	(-7.26)	(-7.18)
Common border	-0.175	-0.162	-0.266	-0.253	0.184	0.178	0.187	-0.272	-0.275	-0.262
	(-0.88)	(-0.82)	(-1.27)	(-1.21)	(0.73)	(0.71)	(0.74)	(-1.45)	(-1.47)	(-1.41)
Common FTA	0.454***	0.454***	0.392***	0.396***	0.531***	0.517***	0.518***	0.254***	0.187**	0.190**
	(5.34)	(5.34)	(4.73)	(4.78)	(4.71)	(4.54)	(4.55)	(3.05)	(2.26)	(2.30)
Common legal origin	-0.021	-0.023	-0.072	-0.076	0.393**	0.397**	0.396**	0.080	0.095	0.089
	(-0.17)	(-0.19)	(-0.58)	(-0.62)	(2.51)	(2.54)	(2.53)	(0.79)	(0.93)	(0.87)
Common language	-0.115	-0.134	-0.216	-0.237	0.252	0.267	0.254	0.002	0.031	0.013
	(-0.46)	(-0.53)	(-0.85)	(-0.93)	(0.98)	(1.03)	(0.99)	(0.01)	(0.18)	(0.07)
Ethnic ties (Migration stock)	0.623***	0.621***	0.631***	0.629***	0.442***	0.443***	0.442***	0.541***	0.541***	0.540***
	(34.02)	(33.73)	(33.35)	(33.14)	(15.06)	(15.09)	(15.06)	(28.57)	(28.55)	(28.53)
Religious proximity	0.283	0.270	0.019	0.011	-0.421	-0.454*	-0.459*	0.022	-0.148	-0.157
	(1.52)	(1.45)	(0.10)	(0.06)	(-1.59)	(-1.67)	(-1.69)	(0.13)	(-0.86)	(-0.91)
ESC_{ij}		**0.163*** **		**0.146*** **	**0.088**		**0.083**	**0.107** **		**0.083***
		(2.83)		(2.65)	(1.17)		(1.12)	(2.07)		(1.69)
ESC_{ji}		**-0.000**		**0.017**	**-0.007**		**-0.010**	**0.082** **		**0.069***
		(-0.01)		(0.33)	(-0.12)		(-0.17)	(2.00)		(1.75)
DELF			**-0.844** **	**-0.825** **		**-0.179**	**-0.168**		**-0.873*** **	**-0.856*** **
			(-2.45)	(-2.43)		(-0.48)	(-0.45)		(-3.28)	(-3.25)
Constant	14.738***	14.658***	14.885***	14.803***	13.942***	14.012***	13.975***	15.366***	15.431***	15.385***
	(18.46)	(18.17)	(18.24)	(17.96)	(12.61)	(12.76)	(12.66)	(23.68)	(23.94)	(23.70)
Observations	10457	10457	9547	9547	7135	7135	7135	7792	7792	7792
Adjusted R^2	0.772	0.773	0.777	0.777	0.634	0.634	0.634	0.826	0.828	0.828
RMSE	1.19	1.19	1.17	1.17	1.45	1.45	1.45	1.00	1.00	1.00

Dependent variable is measured as Ln(Value of bilateral imports)
Cluster robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.7: Cultural affinity factors and bilateral trade volumes (imports) based on Felbermayr and Toubal (2010)

The first four regressions use aggregate imports as the dependent variable. Regression (1) includes standard control variables for trade costs and a set of cultural affinity variables. Transportation costs are covered in the controls for geographical proximity (*Distance* between main cities and a *Common border* dummy), and the formal trade policy is covered by the joint participation in a free trade area (*Common FTA*). A higher distance lowers the volume of the bilateral trade, but this is not to say that two nearby countries necessarily trade more. FTA membership shows a significant effect on aggregate imports, whereas a *Common legal origin* does not. The included standard set of cultural affinity variables is meant to account for the reduced transaction costs in more proximal countries. A *Common language* is not significant, whereas *Ethnic ties*, as expected, promote trade at the 1% level of significance. *Religious proximity* does not exhibit any impact.

Regression (2) then includes the core measure for cultural affinity used by Felbermayr and Toubal (2010), the ESC scores. As they are not symmetric, both voting behaviors are included. ESC_{ij} is thus the voting behavior of the importing country towards the exporting country and ESC_{ji} depicts the reverse situation. In contrast to the set of cultural affinity variables in regression (1), the mutual ESC scores are attributed to the second channel influencing trade volume, i.e., in the form of higher preferences (Felbermayr and Toubal, 2010).[246] Due to the standard regression methods used, the ESC variables emerge less significant than in the original regressions of Felbermayr and Toubal (2010) and only ESC_{ij} is significant at the 1% level. Still, a higher affinity, measured by the higher ESC_{ij} voting behavior, increases aggregate trade volumes. All other variables are only marginally affected. Finally, regression (3) includes the $DELF$ measure. As the $DELF$ measures the cultural distance between countries instead of affinity, the fact that the resulting sign is the opposite is in line with what is expected. A higher cultural distance lowers aggregated imports. The $DELF$ and the ESC scores are conjointly included in regression (4). The coefficients and significance levels are only marginally affected, if at all. Both variables measuring cultural affinity are jointly relevant, whereas neither *Common language* nor *Religious proximity* are significant. The stock of migrants, however, is still highly significant and remains so throughout all regressions. The trade reducing effect of a higher diversity between two countries is sizeable. A by one standard deviation higher $DELF$ values (0.22) is associated with nearly 30% lower imports.[247]

Regressions (5)–(7) and (9)–(11) re-run the estimations (2)–(4), this time splitting imports between homogeneous and differentiated goods. Trade of homogeneous goods is executed through organized exchanges that partly overcome the information and transaction costs, with differences in preferences being irrelevant for these kinds of goods. A *Common FTA* remains highly significant. For homogeneous goods, a *Common legal origin* turns out to increase imports. This suggests that these variables have an influence on the

[246] At least for the ethnic ties and religious proximity variables, one could argue that they promote both channels.

[247] For example, is the $DELF$ between Germany and Switzerland 0.31, whereas it is between Germany and Cyprus 0.50.

transaction cost channel (translating/ contracting) rather than the channel based on preferences (Felbermayr and Toubal, 2010). The $DELF$ index, in contrast, has no significant influence on trade of homogeneous goods at conventional levels; nor do the ESC scores. For differentiated goods, the $DELF$ becomes highly significant at the 1 % level. Also, both ESC variables impact imports significantly, although at a lower significance level of 5%. Additionally, the beta coefficient for the $DELF$ variable is more than seven times the size of any of the two ESC variables. The *Common legal origin* variable again becomes insignificant at conventional levels. This performance of the $DELF$ underlines that it indeed seems to be a more accurate measure of cultural proximity, in the form of common preferences, compared to the other applied variables. In addition, the $DELF$ data have the considerable advantage that they allow researchers to expand their analyses onto a global scale, going beyond the small set of countries participating in the Eurovision Song Contest.

	(1) Imports	(2) Imports	(3) Imports	(4) Imports
Ln (Distance)	-2.18***	-2.09***	-2.21***	-2.20***
	(-21.76)	(-18.30)	(-25.63)	(-22.08)
Common border	0.01	-0.01	0.08	0.06
	(0.10)	(-0.09)	(0.87)	(0.59)
Asylum seekers	0.07**	0.08**		
	(2.24)	(2.43)		
Language proximity	1.18***	0.94***		
	(4.10)	(2.80)		
Book imports	0.01**	0.01		
	(2.07)	(1.35)		
Newspaper imports	-0.01*	-0.01		
	(-1.73)	(-1.33)		
Ln (Bilateral opinion) - lagged		**0.38****		**0.23**
		(2.23)		(1.22)
DELF			**-2.03*****	**-1.97*****
			(-5.24)	(-4.41)
Constant	-10.09***	-11.85***	-9.11***	-9.71***
	(-14.35)	(-10.71)	(-14.98)	(-8.57)
Observations	679	585	864	747
Adjusted R^2	0.773	0.770	0.710	0.726
F-Test	117.95	101.54	121.58	108.67

Robust t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Imports are measured as Imports / product of GDPs

Table 4.8: Influence of cultural affinity factors on EU imports, based on Disdier and Mayer (2007)

A comparable result is found in Disdier and Mayer (2007). Besides the determinants of bilateral opinions, they also analyze trade between EU member countries and the 10 prospective CEEC accession countries over the period 1988–2001. The aim of their study is to identify the role potential affinity variables between countries play on their trade

volume. Their OLS regressions are replicated in *Table 4.8*. Imports are regressed on a set of geographical and cultural distance variables.[248] *Distance* between the major cities again has a large, and significant influence, because most trade between the countries in the data set is handled on the road. Having a *Common border* has no impact, however. Comparable to Felbermayr and Toubal (2010), the share of *Asylum seekers*, a *Language proximity* index and *Book imports* are intended to proxy for bilateral affinity. *Newspaper imports* are seen as a proxy for information access (reduced transaction costs). *Asylum seekers* and *Language proximity* have the expected significant positive sign. *Book imports* and *Newspaper imports* are only significant when the opinion variable is not included. Except for the opinion variable, all affinity factors (share of *Asylum seekers*, the *Language proximity* index, *Book imports*) are substituted in regressions (3) and (4) by the composite $DELF$. The $DELF$ covers all the cultural affinity factors excellently, leaving the other economic and distance factors unchanged. What's more, bilateral opinion, used by Disdier and Mayer (2007) as their main variable of interest, becomes insignificant at conventional levels when the $DELF$ is included.[249]

The results of the replication of Felbermayr and Toubal (2010) and Disdier and Mayer (2007), show that the $DELF$ index indeed covers the cultural distance between two countries extremely well, in a way that reflects its influence on preferences. These preferences, in turn, are one of the main reasons why cultural proximity increases trade volumes.

4.7 Conclusion

The $DELF$ is constructed to overcome two limiting factors in the analysis of ethnicity in the economic context. It covers a rather new, but important aspect of ethnicity, that being its diversity. In doing so, it is not intended to render all previous indices and measures irrelevant, but to improve economic analysis in fields where diversity is more important than fractionalization and polarization. Additionally, it offers the possibility to measure cultural affinity between nations, which is not covered by the ELF and POL indices.

Concerning the incidence, onset and duration of conflicts, it is obvious to assume that, besides the sheer number of groups (fractionalization), the differences between these groups also play a role. The $DELF$ was tested on the incidence of conflict, in a replication of Garcia-Montalvo and Reynal-Querol (2005b). It shows a stronger significance for the assertion of conflict onset in Garcia-Montalvo and Reynal-Querol (2005b), than the polarization index. The possible discrimination of outside groups, during and after the war, decisively determines the size of the potential gains in economic and political power. This information, included in the $DELF$, seems to affect the decision to start a civil conflict.

[248] All regressions use country and time fixed effects.

[249] Disdier and Mayer (2007) include also a non-lagged opinion. Using this alternative delivers comparable results.

For economic growth, ethnic fractionalization and diversity reveal a quite comparable negative effect. This effect, however, greatly disappears when a whole set of other control variables are included. A deeper analysis into how heterogeneity affects these channels and the subsequent effects on economic growth seems necessary. A new extension of the established analyses show that this negative effect is not universal, but depends on the level of development in a country. Countries with a higher level of human development (HDI) are not negatively affected. As this effect is solely for the $DELF$ and not for the ELF, those countries can apparently harvest the innovation of productivity increasing positive effects of ethnic diversity.

Trust, opinions and well-being are the basis for a wide set of analyses. In determining their drivers, many authors find that, besides economic, institutional and political factors, a range of cultural aspects are equally important. The study of Bjørnskov (2008) on social trust is used to assess the $DELF$'s performance in this field *within* countries. In contrast, in the analysis of Disdier and Mayer (2007) the opinions *between* countries were the focus of the research. For its application in the regressions on social trust, the $DELF$ is not significant at conventional levels, which is no improvement upon the original setting using the ELF measure. Nevertheless, it is surprising that these factors do not show any impact and it appears that either a specific factor rendering the ethnic measures salient was omitted, or the appropriate aspect of ethnicity was not included in the regressions (Bjørnskov, 2008). Regarding the opinion of EU member states towards the new accession countries during the Eastern enlargement, the $DELF$ shows a significant influence (Disdier and Mayer, 2007). Countries that have a lower cultural distance, measured by the composite $DELF$, are more open to the accession of these countries. Therefore, the $DELF$ shows some indication that it can be used as a good proxy for opinions and trust between countries. Its influence on trust within countries remains unsupported.

To distinguish between the channels (transaction costs versus preferences) through which cultural proximity is meant to impact trade, the last section employs studies by Felbermayr and Toubal (2010) and Disdier and Mayer (2007). In both replications the $DELF$ index reveals a significant positive effect on imports. The study of Felbermayr and Toubal (2010) additionally showed that this effect is more prominent for heterogeneous goods than for homogeneous goods. A higher cultural proximity is reflected in more aligned preferences, increasing the trade volume between these countries, especially for more differentiated goods. Overall, the $DELF$ is a good substitute for a range of cultural affinity factors, without altering the regression performances. As both studies focused on European trade flows, its validity for global trade flows needs to be proved. In contrast to most of the other cultural affinity factors tested by the above articles, the $DELF$ offers global coverage and is thus well suited for these extensions.

This chapter shows the applicability of the $DELF$ index in fields where ethnic diversity is meant to play an important role: conflict, growth, trust and trade. It does not render the ELF and POL indices irrelevant, but advocates for the additional importance of the

diversity aspect in many settings. The considerable advantage of the *DELF* data set is its wide coverage of countries, allowing one to expand analyses onto a global scale, thus going far beyond the limited scope of most recent papers. Future research is especially encouraged to follow this route, expanding these analyses to examine their broader external validity.

Appendices

Appendix A

Appendix – Chapter 1

A.1 Mathematical Appendix

A.1.1 Partial derivatives

As in *Equation (1.6)*, the cost function is given through:[250]

$$b(\theta, a_i) = \log_\theta(a_i) = \frac{\ln(a_i)}{\ln(\theta)}$$

For the defined range of $1 \geq a_i > 0$ and $1\theta > 0$, it follows that $\ln(a_i) \leq 0$ and $\ln(\theta) < 0$. Subsequently, the partial derivates for the ability level a_i are given through:

$$\begin{aligned} \partial b/\partial a_i &= \frac{1}{a_i \cdot \ln(\theta)} && < 0 \\ \partial b/\partial^2 a_i &= (-1) \cdot \frac{1}{a_i^2 \cdot \ln(\theta)} && > 0 \end{aligned}$$

θ influences the overall cost function for all individuals of group g who want to learn the language of group h. From the above definition it follows that:

$$\begin{aligned} \partial b/\partial \theta &= \ln(a_i) \cdot (-1) \cdot \ln(\theta)^{-2} \cdot \frac{1}{\theta} \\ &= \underbrace{-\ln(a_i)}_{>0} \cdot \underbrace{\frac{1}{\theta}}_{>0} \cdot \underbrace{\frac{1}{\ln(\theta)^2}}_{>0} && > 0 \end{aligned}$$

[250] For simplification purposes, the subscript gh of θ_{gh} is dropped, and only θ is used as a result.

For the sake of completeness, the second derivative for θ is additionally given through:

$$\begin{aligned}
\partial b/\partial^2\theta &= -\ln(a_i)\cdot\left[(-1)\cdot\frac{1}{\theta^2}\cdot\frac{1}{\ln(\theta)^2}+\cdot\frac{1}{\theta^2}\cdot(-2)\cdot\frac{1}{\ln(\theta)^3}\right] \\
&= \ln(a_i)\cdot\left[\frac{1}{\theta^2\cdot\ln(\theta)^2}+\frac{2}{\theta\cdot\ln(\theta)^3}\right] \\
&= \ln(a_i)\cdot\frac{1}{\theta\cdot\ln(\theta)^2}\cdot\left[\frac{1}{\theta}+\frac{2}{\ln(\theta)}\right] \\
&= \underbrace{\ln(a_i)}_{<0}\cdot\frac{1}{\underbrace{\theta}_{>0}\cdot\underbrace{\ln(\theta)^2}_{>0}}\cdot\left[\underbrace{\frac{1}{\theta}}_{>0}+\underbrace{\frac{2}{\ln(\theta)}}_{<0}\right]
\end{aligned}$$

Thus, the sign of the second derivative is dependent on the expression in brackets. For this expression, it holds over the defined range of $\theta \in]\ 0,...,1\ [$ that:

$$\lim_{\theta\to 0}\left(\frac{1}{\theta}+\frac{2}{\ln(\theta)}\right) = +\infty$$
$$\lim_{\theta\to 1}\left(\frac{1}{\theta}+\frac{2}{\ln(\theta)}\right) = -\infty$$

The internal solution for change in sign is given through:

$$\begin{aligned}
\frac{1}{\theta} &= -\frac{2}{\ln(\theta)} \\
\ln(\theta) &= -2\theta \\
\ln(\theta)+2\theta &= 0 \\
\bar{\theta} &\cong 0.426
\end{aligned}$$

Finally, the second derivative of the cost function regarding $\bar{\theta}$ is defined through:

$$\partial b/\partial^2\theta = \begin{cases} >0 & \text{for } \theta \in]\ 0,...,\bar{\theta}\ [\\ <0 & \text{for } \theta \in]\ \bar{\theta},...,1\ [\end{cases}$$

A graphical representation of cost functions for various levels of θ is given in *Figure A.3* of *Appendix A.2*.

A.1.2 Implication of relative group sizes for overall ELF values

The ethno-linguistic fractionalization index (ELF) is based on a Herfindahl-Hirschman concentration index:

$$ELF = 1-\sum_{g=1}^{k} p_g^2, \qquad g = 1,...,k \tag{A.1}$$

where k is the number of groups and p_g their relative group sizes. Its value moves between zero and one and represents the probability that two randomly selected individuals from a population come from different groups. A higher value thus indicates a more fragmented country. With the definition that all p_g represent the relative group sizes of a given country, it also holds that:

$$1 = \sum_{g=1}^{k} p_g, \qquad g = 1, ..., k \tag{A.2}$$

For the case of three groups, which has mainly been used in this essay, it follows from the above equations that:

$$ELF = 1 - p_1^2 - p_2^2 - p_3^2 \tag{A.3}$$

$$1 = p_1 + p_2 + p_3 \tag{A.4}$$

Introducing *Equation (A.4)* into *Equation (A.3)* leads to:

$$\begin{aligned} ELF &= -2p_1^2 - 2p_2^2 + 2p_1 + 2p_2 - 2p_1p_2 \\ 0 &= -2p_1^2 - 2p_2^2 + 2p_1 + 2p_2 - 2p_1p_2 - ELF \end{aligned} \tag{A.5}$$

The group size of p_1 dependent on a given ELF level and on the relative size of p_2 is given through:

$$p_1 = \frac{(1 - p_2) + \sqrt{1 - 2ELF + 2p_2 - 3p_2^2}}{2} \tag{A.6}$$

In order for *Equation (A.6)* to deliver a solution, it must hold that:

$$1 - 2ELF + 2p_2 - 3p_2^2 \geq 0 \tag{A.7}$$

This, in turn, leads to the following requirement for p_2:

$$p_2 \leq \frac{1 + \sqrt{4 - 6ELF}}{3} \tag{A.8}$$

Finally, for this to hold, it additionally needs to satisfy:

$$\begin{aligned} 4 - 6ELF &\geq 0 \\ ELF &\leq \frac{2}{3} \end{aligned} \tag{A.9}$$

For the example in this essay, the above equation leads to some range limitation between which the respective group constellation can vary, delivering a given ELF value. For an

ELF value of 0.5 which satisfies *Equation (A.9)*, the range is limited to $p_2 \leq \frac{2}{3}$. *Figure A.1* shows the combinations of p_1 and p_3 depending on a range of possible values for p_2, leading to an equal ELF value of 0.5:

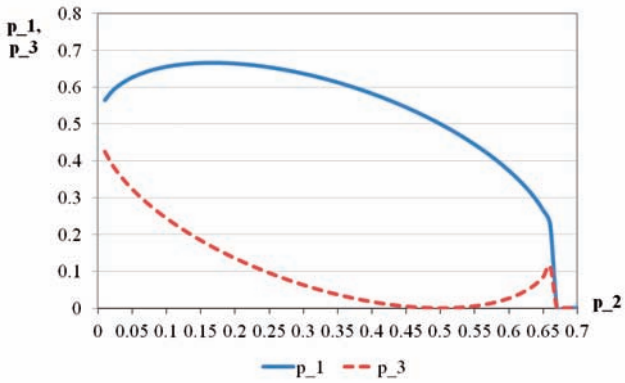


Figure A.1: Values of p_2 and p_3 for any a given value of p_1, delivering a constant ELF value of 0.5

A.2 Additional figures and tables

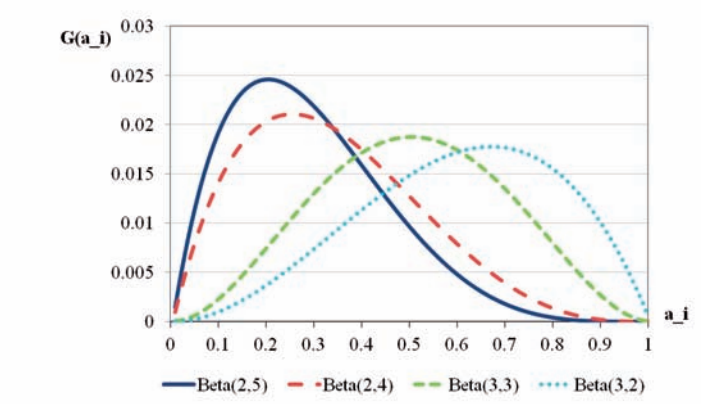


Figure A.2: Density functions for selected $B(\alpha, \beta)$ distributions

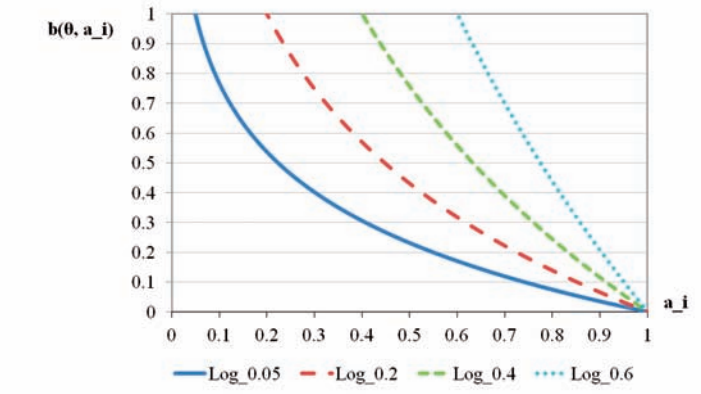


Figure A.3: Cost functions for selected levels of θ

Appendix B

Appendix – Chapter 2

B.1 Details of key variables

Table B.1: Overview of variables, definitions and sources

Variable name	Description	Source
ANM	Atlas Narodov Mira (ANM) Ethno-linguistic fractionalization index (ELF)	Roeder (2001)
Alesina	Ethno-linguistic fractionalization index (ELF) of Alesina	Alesina et al. (2003)
Fearon	Ethno-linguistic fractionalization index (ELF) of Fearon	Fearon (2003)
Latitude	Absolute value of the latitude of a country's capital, scaled to take values between 0 and 1, where 0 is the equator	Cepii (2011)
Altitude	Average absolute deviation of single grid and country mean altitudes (in 1,000m)	Based on G-Econ (2006)
Ln(Area)	Log of country area in square kilometers	World Bank (2009)
Agritime	Years since transition to agriculture (in 1,000 years) in relation to the base year 2000 A.D.	Putterman (2008)
Modern	State power over territory between 1800 and 1950 in years*	Putterman and Weil (2010)
Democratic tradition	Average Polity 2 score (ranging from -10 to 10), with lower values indicating less democratic, or autocratic (negative values) regimes for the years after WWII up until 1960. Only countries with observation for at least half of the years included	Marshall and Jaggers (2008)
Tropics	% land area in Koeppen-Geiger tropics and subtropics (Af+Am+Aw+Cw)	Sachs (2001)
Regional dummies	Dummy for Eastern Europe, Latin America, North Africa and Middle East, Sub-Saharan Africa, Western countries and Asia	Based on Fearon (2003)
Colony	Dummy variable that takes a value of one if a country was colonized and 0 if not	Based on data in Olsson (2007)

Continued on next page

Table B.1 – continued from previous page

Variable name	Description	Source
Duration	Total number of years under colonial rule*	Olsson (2007)
Colonial origin dummy	Dummy variable for Spanish, French, British or Portuguese colonization of the country	Cepii (2011)
Ln(Mortality)	Log of potential settler mortality, measured in terms of deaths per annum per 1.000 'mean strength' of settlers	Acemoglu et al. (2001)
Ln(Urbanization)	Log of % of population living in urban areas	World Bank (2009)
Immigration	International migrant stock (% of population)	World Bank (2009)
Ln(Population)	Log of total population	World Bank (2009)
Polity IV	Average Polity 2 score (ranging from -10 to 10), with lower values indicating a less democratic, or autocratic regimes (negative values)	Marshall and Jaggers (2008)
Conflicts	Years with summed magnitudes of all major events of political violence (MEPV) higher than 1	Marshall (2006)
Ln(Trade)	Log of trade (% of GDP)	World Bank (2009)
Ln(Telephones)	Log of mobile and fixed-line telephone subscribers (per 100 people)	World Bank (2009)
Ln(GDP/capita)	Log of real GDP per capita in constant international dollars (Laspeyres index) - Penn World Tables	Heston et al. (2009)
HDI	Human Development Indicator, measures development along three dimensions: healthy life, GDP per capita and education	UNDP - United Nations Development Programme (1994)
Prim., Sec., Tert. Enrollment	% of population aged 15 and over that attained respective level of schooling	Barro and Lee (2010)
Prim., Sec., Tert. Completion	% of population aged 15 and over that completed respective level of schooling	Barro and Lee (2010)
Prim., Sec., Tert. Schooling	Average years of respective school attainment of population aged 15 and over	Barro and Lee (2010)

* For better readability in regression tables, variables were rescaled to decades.

Table B.2: Summary statistics of geographic and historical variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
ANM '61	138	0.463	0.278	0.000	0.909
ANM '85	168	0.461	0.272	0.000	0.984
Fearon ELF	153	0.479	0.260	0.002	1.000
Alesina ELF	187	0.432	0.263	0.000	0.930
Latitude	187	0.280	0.185	0.002	0.668
Altitude	176	0.256	0.292	0.000	1.767
Ln (Area)	192	4.340	2.788	-6.215	9.747
Agritime	161	4.769	2.473	0.000	10.500
Modern	145	10.002	3.193	1.875	15.000
Democratic	72	0.354	7.257	-10.000	10.000
Tropics	156	0.367	0.433	0.000	1.000
Colony	192	0.641	0.481	0.000	1.000
Colonial duration	123	18.701	13.139	2.300	50.300
Ln (Mortality)	63	4.678	1.238	2.146	7.986

Table B.3: Summary statistics of change variables (1960/65–1975/80)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Ln (Urbanization)	191	0.287	0.259	-0.454	1.415
Immigration	163	0.534	6.039	-13.850	54.650
Ln (Population)	183	0.325	0.223	-0.154	1.895
Primary Schooling	141	0.697	0.407	-0.150	1.860
Secondary Schooling	141	0.597	0.443	-0.450	2.160
Tertiary Schooling	141	0.072	0.080	-0.200	0.520
Polity IV	112	-1.245	4.812	-15.500	17.000
Conflict	192	1.552	4.319	0.000	21.000
Ln (Trade)	96	0.273	0.340	-0.770	1.203
Ln (Telephones)	110	0.830	0.485	-0.182	2.028
Ln (GDP/cap.)	106	0.390	0.271	-0.213	1.169
HDI	112	0.068	0.042	0.009	0.189

B.2 Additional regressions and robustness checks

Table B.4: Influence of geographic and historical variables on Atlas Narodov Mira ELF scores. Replication for 1961 data

	(1) ANM '61	(2) ANM '61	(3) ANM '61	(4) ANM '61
Latitude	-0.880***	-0.701***	-0.373	-0.713***
	(-8.46)	(-5.88)	(-1.40)	(-5.24)
Altitude	0.101*	0.148**	0.149***	0.203**
	(1.82)	(2.01)	(2.71)	(2.56)
Ln (Area)	0.027***	0.041***	0.031**	0.037**
	(3.13)	(4.05)	(2.57)	(2.01)
Agritime	-0.016**	-0.013	-0.004	-0.007
	(-2.10)	(-1.65)	(-0.36)	(-0.60)
Modern		-0.027***		-0.023**
		(-4.45)		(-2.43)
Tropics			0.211**	
			(2.40)	
Asia			0.016	
			(0.15)	
E. Europe			-0.074	
			(-1.33)	
L. America			-0.097	
			(-0.97)	
MENA			0.033	
			(0.43)	
SSA			0.173*	
			(1.71)	
Democratic				0.006*
				(1.69)
Constant	0.609***	0.736***	0.257	0.651***
	(9.41)	(10.77)	(1.27)	(3.46)
Observations	130	114	124	66
Adjusted R^2	0.461	0.515	0.543	0.425
F-Test	38.464	25.091	32.019	12.886

Heteroscedasticity robust standard errors used;
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.5: Role of static factors on changes – dependent variable, change in Atlas Narodov Mira ELF scores

	(1) ANM change	(2) ANM change	(3) ANM change	(4) ANM change	(5) ANM change	(6) ANM change	(7) ANM change	(8) ANM change
Latitude	0.046	-0.003	0.016	-0.004	0.067	0.049	0.024	0.004
	(0.92)	(-0.06)	(0.27)	(-0.07)	(1.20)	(0.91)	(0.46)	(0.06)
Altitude	-0.031**	-0.010	-0.009	-0.010	-0.026	-0.019	-0.012	-0.004
	(-2.09)	(-0.59)	(-0.56)	(-0.58)	(-1.45)	(-0.77)	(-0.73)	(-0.21)
Ln (Area)	-0.003	-0.006	-0.006	-0.006	-0.010**	-0.004	-0.004	-0.006
	(-0.71)	(-1.17)	(-1.55)	(-1.15)	(-2.07)	(-1.15)	(-0.77)	(-1.23)
Agritime	0.003	0.004	0.002	0.004	0.001	-0.002	0.001	0.006
	(0.99)	(1.27)	(0.50)	(1.16)	(0.28)	(-0.76)	(0.34)	(1.46)
ANM '61	0.033	0.012	0.012	0.012	0.024	0.032	0.018	0.019
	(1.27)	(0.40)	(0.50)	(0.40)	(0.89)	(1.02)	(0.77)	(0.57)
Observations	130	116	101	116	86	89	91	116
Adjusted R^2	0.207	0.254	0.468	0.247	0.562	0.590	0.160	0.263
F-Test	2.947	2.753	3.127	2.515	9.871	4.403	3.162	2.365

Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.6: Test of various other model specifications (fixed effects, random effects) – dependent variable, Atlas Narodov Mira ELF scores

	(1) Fixed effects	(2) Fixed effects	(3) Fixed effects	(4) Fixed effects	(5) Random effects	(6) Random effects	(7) Random effects	(8) Random effects
Ln (Urbanization)	-0.061**	-0.108***	-0.074***	-0.061***	-0.061***	-0.091***	-0.077***	-0.059***
	(-2.57)	(-4.15)	(-3.61)	(-2.71)	(-3.09)	(-3.71)	(-4.21)	(-3.44)
Immigration	0.006*	0.013***	0.012***	0.005	0.005*	0.010**	0.012***	0.005*
	(1.91)	(3.57)	(4.22)	(1.15)	(1.66)	(2.55)	(4.84)	(1.86)
Ln (Population)	-0.006	0.139**	0.059	-0.035	0.010	0.042	0.032*	0.006
	(-0.10)	(2.31)	(1.22)	(-0.81)	(0.61)	(1.62)	(1.88)	(0.38)
D75	0.059***	0.031	0.032*	0.068***	0.053***	0.050***	0.052***	0.058***
	(3.16)	(1.50)	(1.69)	(3.78)	(4.91)	(3.68)	(4.71)	(4.94)
Primary Schooling	-0.050**	-0.052***	-0.040**	-0.034**	-0.049***	-0.046***	-0.037***	-0.044***
	(-2.27)	(-2.90)	(-2.43)	(-2.05)	(-4.90)	(-4.69)	(-3.63)	(-4.21)
Ln (Trade)		0.005				0.015		
		(0.18)				(0.56)		
Ln (Telephones)			0.008				-0.008	
			(0.58)				(-0.67)	
Ln (GDP/cap.)				-0.019				-0.013
				(-0.98)				(-0.69)
Constant	0.841	-1.288	-0.172	1.419**	0.593**	0.111	0.242	0.752***
	(0.95)	(-1.41)	(-0.24)	(2.09)	(2.52)	(0.26)	(0.96)	(2.71)
Observations	243	198	206	210	243	198	206	210
Overall R^2	0.180	0.098	0.175	0.141	0.195	0.171	0.231	0.193
F-Test	4.186	11.092	6.480	4.721				
Wald Chi^2					46.506	64.923	77.681	57.204

Cluster robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.7: Alternative time frame 1960/65-1980/85 – dependent variable, change in ANM ELF scores

	(1) ANM change	(2) ANM change	(3) ANM change	(4) ANM change	(5) ANM change	(6) ANM change	(7) ANM change	(8) ANM change
Ln (Urbanization)	-0.050**	-0.038*	-0.090***	-0.038*	-0.083***	-0.059***	-0.045**	-0.045*
	(-2.55)	(-1.96)	(-3.12)	(-1.96)	(-4.14)	(-2.74)	(-2.23)	(-1.71)
Immigration	0.005**	0.005**	0.010***	0.005**	0.010***	0.011***	0.005	0.005*
	(2.22)	(2.01)	(3.46)	(1.99)	(3.36)	(4.43)	(1.38)	(1.96)
Ln (Population)	-0.029	-0.003	0.097*	-0.003	0.159***	0.036	-0.012	-0.009
	(-0.55)	(-0.06)	(1.81)	(-0.06)	(3.04)	(0.79)	(-0.27)	(-0.16)
Primary Schooling		-0.045**	-0.039**	-0.045**	-0.050***	-0.042***	-0.029**	-0.044**
		(-2.59)	(-2.48)	(-2.56)	(-3.27)	(-2.67)	(-2.16)	(-2.59)
Polity IV			-0.001					
			(-0.51)					
Conflict				-0.000				
				(-0.05)				
Ln (Trade)					-0.001			
					(-0.03)			
Ln (Telephones)						-0.006		
						(-0.46)		
Ln (GDP/cap.)							-0.020	
							(-0.89)	
SSA								0.018
								(0.49)
L. America								0.016
								(0.53)
Asia								-0.033
								(-1.22)
Constant	0.016	0.073**	0.054	0.073**	0.051	0.086*	0.070**	0.058
	(0.51)	(2.33)	(1.41)	(2.32)	(1.18)	(1.78)	(2.40)	(1.25)
Level var. included	yes	yes	yes	yes	yes	yes	yes	yes
Observations	130	116	101	116	85	90	91	116
Adjusted R^2	0.218	0.275	0.468	0.268	0.578	0.583	0.197	0.285
F-Test	3.391	3.441	2.597	3.114	8.280	4.957	3.887	2.684

Included level variables (Z_i): *Latitude, Altitude, Area, Agritime* and the *ANM* values in 1961
Heteroscedasticity robust standard errors used; t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix C

Appendix – Chapter 3

C.1 Data robustness and alternative data

C.1.1 Data robustness checks

Although the discussion in this chapter already showed the general strength of the *WCE* data, some additional robustness check shall be applied. Two new data sets are created that add some noise to the original data. If all three datasets do not differ in a significant way, it should be reasonable to use the original data. In doing so, one accepts errors in the range of the noise added to the original data set. The noise data is created by altering the original group size p_i to the new size $\tilde{p_i}$ with a normal distributed random variable in a way that:

$$\tilde{p_i} = p_i \cdot (1+e) \qquad \text{, with} \qquad e \sim N(0;\sigma) \tag{C.1}$$

For σ two different values are assumed; σ_1 uses the standard deviation of the group distribution over all observations, and is thus equal for all countries. In contrast, σ_2 uses a country specific standard deviation. The scatter plot of *Figure C.1* shows $DELF$ values for both alternative data sets against the original data.

The Spearman rank correlation is over 0.99 for both data sets and confirms their high congruency. For the new data based on country specific variations, some small outliers are identifiable. These are rather homogeneous countries with a limited number of groups and a clear majority group. By construction, they have a much higher probability of being distant from the original data.

The granularity of the data, which is one of its major advantages, leads to a sizeable number of very small groups. The data quality, especially for these groups, might be debatable. Following Fearon (2003), a reduced data set is constructed excluding these very small groups.[251] Doing this reduces the number of groups from 12,432 down to 5,674.

[251] In contrast to Fearon (2003), who limits his ELF calculation to groups greater than 1%, here a lower threshold of 0.1% is used.

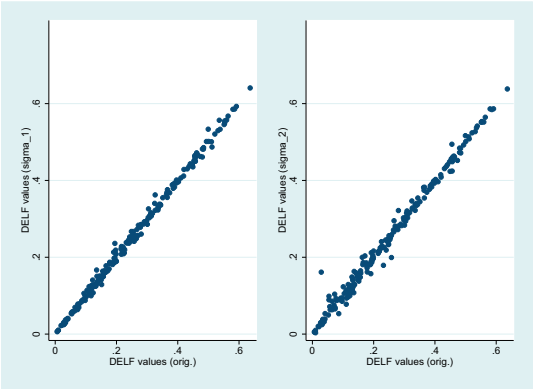


Figure C.1: Original *DELF* values against newly created random data sets

Excluding groups would either alter the group shares of all groups, because one would need to rescale them, or one can alternatively create new groups that differ from all existing groups. Subsequently the second approach is followed. Although the groups are small, they represent some part of the population that seems to be different from the rest. In some countries, that new group corresponds to a rather sizeable one. Thus, to not account for them at all would be incorrect. Combining them into one group lowers the potential individual data inaccuracies. Analogous to the figure above, *Figure C.2* compares the *DELF* values of the reduced data set against the full data.

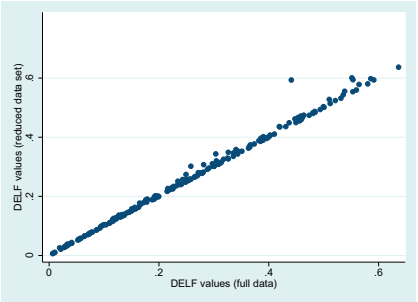


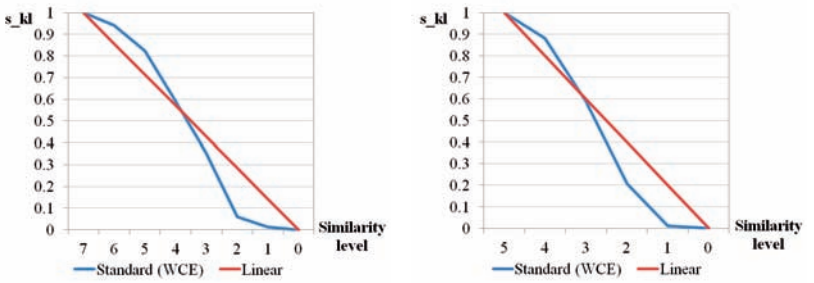
Figure C.2: Original *DELF* values against reduced data set

In this case, the most heterogeneous countries show an increased difference compared to the base data. Papua New Guinea is the most apparent outlier. Because Papua New Guinea has a huge number of small groups that are now combined into one group that differs completely from all other groups, it appears more diverse than when accounting for the mutual similarities of all the small groups. However, the similarity between both data sets is still very high.

C.1.2 Alternative similarity values

The assignment of the similarity values according to the language classification is rather clear. Here, one can easily leverage the lexical congruency between two languages and transfer these similarity levels to the assigned $\bar{s}_{kl}$ values. When the $\bar{s}_{kl}$ were differently assigned to correspond directly with the similarity levels and the values of 1, 0.85, 0.80, 0.70, 0.50, 0.30 and 0.05 for $\bar{s}_{kl}$ were used, the overall results show only marginal changes. However, for single countries, some slightly larger adjustments in their rank order accrue.

For the ethno-racial classification, however, the congruency is more ordinal in nature. In the essay, the assigned $\bar{s}_{kl}$ follow the same decreasing slope as that of the language classification. Nevertheless, one could also argue in favor of a linear assignment of the $\bar{s}_{kl}$ values to mirror the ordinal similarity levels. For both classifications, both similarity slopes are pictured in *Figure C.3*.



(a) Language classification (b) Ethno-racial classification

Figure C.3: Used similarity values $\bar{s}_{kl}$ vs. linear similarity levels

From the differences in the slopes, one can easily see that for both classifications, less distant groups are assigned higher $\bar{s}_{kl}$ values under the *WCE* method than under a linear assignment. For more distant groups, the opposite is the case. Countries with groups that speak more distant languages would exhibit lower $DELF$ values in the *WCE* case than under a linear $\bar{s}_{kl}$ allocation. *Figure C.4* contrasts the $DELF$ values used in the essay with the corresponding values calculated with a linear scale for the language and the ethno-racial classification.

The impact differs between both characteristics. Whereas the Spearman rank correlation between both scales is again over 0.99 for the ethno-racial values, it is slightly less, at 0.94, for the language classification. The countries with the highest downward adjustments are Papua New Guinea, Solomon Islands, Senegal, Vanuatu, Northern Mariana Islands, Niger, Uganda, Nigeria, Switzerland and Sierra Leone. The country with a significant upward adjustment is Trinidad and Tobago. Due to the high correlation values which remain, the results should not be significantly impacted.

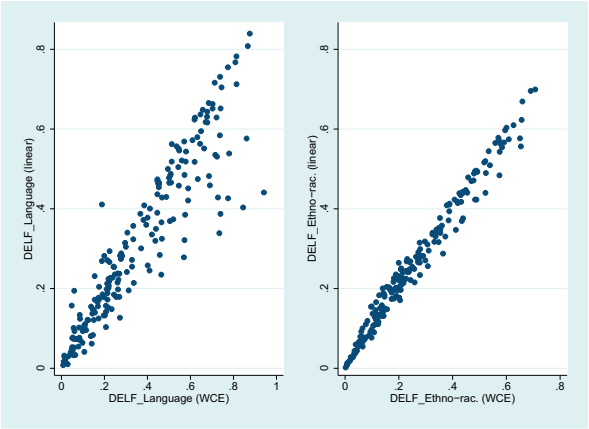


Figure C.4: *DELF* values based on *WCE* similarity values against linear scale *DELF* values per characteristic

Extending the discussion above, Fearon (2003) defines his measure of cultural diversity with:

$$r_{kl} = \left(\frac{n}{m}\right)^{\alpha} \tag{C.2}$$

where m are the highest number of classifications two groups may share and n the number they actual share. This naturally leads to linear similarity values. The parameter $\alpha \in [0, ..., 1]$ then influences the course of the similarity value function to give it a concave shape.[252] For the application here, this would translate into:

$$f(\hat{s}_{kl}) = (\hat{s}_{kl})^{\alpha} \tag{C.3}$$

The idea behind assigning such a function is that early divergence between two groups might signify more differences than small differences at a later stage. In other words, with a rising α, more severe differences are proportionally less important and small differences increase in importance. Desmet et al. (2012) assume that more severe splits (i.e., completely different languages) are more relevant for more drastic conflicts of interest (e.g., incidence of civil wars). More nuanced differences (i.e., different dialects), in contrast, affect the transaction costs of coordination for any economic activity and are relevant, for example, in explaining differences in economic growth. As a consequence, the choice of α might depend on the problem under scrutiny. The final selection of a value for α, however, remains completely arbitrary. Fearon (2003) uses a value of $\alpha = 0.5$, whereas Desmet et al.

[252] This is at least the range within which Fearon (2003) limits α. However, much larger values could still apply and for $\alpha = \infty$ any continuous distance measure fades and the indices merge with their dichotomous forms.

(2009) and Esteban et al. (2010) use a value of $\alpha = 0.05$.[253] *Figure C.5* shows the courses of the applied similarity values for different concavity assumptions.

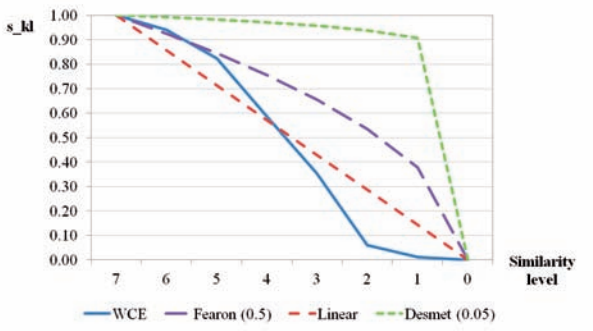


Figure C.5: Similarity functions depending on different concavity assumptions

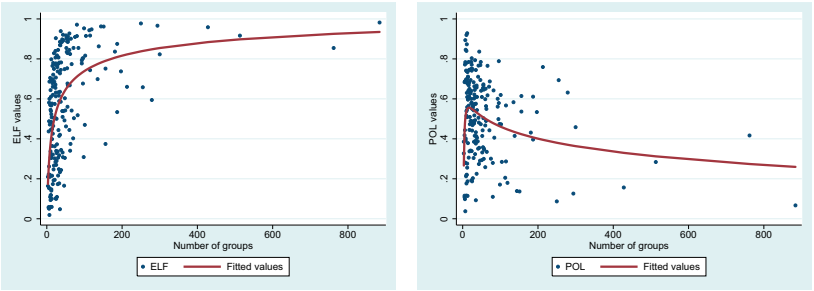
For the three highest similarity levels, the course for a linear similarity function with $\alpha = 0.5$ (Fearon, 2003) and assigned values of the *WCE* are quite comparable, yet somewhat distinct from the linear values. Thereafter, the *WCE* drops faster. With the assumption that $\alpha = 0.05$, the similarity between two groups stays very high for quite a while, dropping steeply afterwards. The latter thus assigns rather extreme (dis)similarity values, whereas the other functions are more continuous. As the *WCE* similarity classification has an inbuilt non-linearity of similarity measures, assigning values of α is less important here than it is for Fearon (2003), Desmet et al. (2009) and Esteban et al. (2010). In addition, as the similarity values assigned by Barrett et al. (2001) in the *WCE* seem to be more grounded in the real difficulties between two individuals to communicate, this essay refrains from assigning an arbitrary value to α.[254]

[253] Indeed, Desmet et al. (2009) vary the values of α and conclude that these low levels show the best performance in their analysis of redistribution.

[254] Nevertheless, $DELF$ and $D-POL$ values with the commonly used values of 0.05 and 0.5 for α, may be obtained from the author.

C.1.3 Characteristics of different ethnicity measures depending on the number of groups

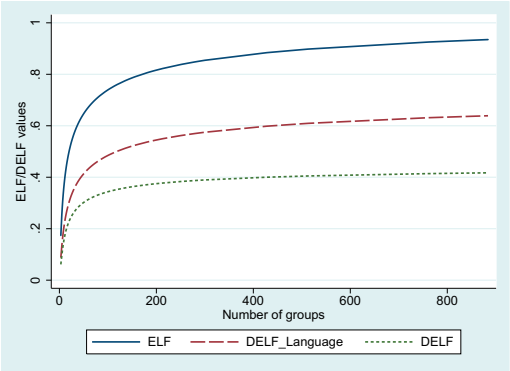
Figure C.6: ELF and POL values against number of groups for 210 countries based on *WCE* data



(a) ELF values

(b) Polarization (POL) values

Figure C.7: Fitted ELF and *DELF* values against number of groups for all 210 countries



C.2 Details on similarity calculations, weighting and its implication for the interpretation of results

C.2.1 Similarity matrix calculations

Groups, the integral component of all ELF, POL and *DELF* calculations, can generally be defined for each single characteristic or by all three at the same time.[255] For all 210 countries, he *WCE* data consists of 11,657 groups defined by language, 4,625 groups defined by culture, and 883 groups defined by religion. If the groups are defined by all three characteristics at the same time, more groups can emerge as characteristics might be combined. The definition of a group is the most granular possible, i.e., along all three characteristics, and results in 12,432 groups in the data set used. This means that any two groups differ slightly in at least one of the characteristics.

The following example shall illustrate the calculation of the similarity values per characteristic and the combination to arrive at the composite *DELF* values. The exemplary country consists of three groups. Thus, for the example, it follows that the number of K groups within this country is given by $K = \{A;B;C\}$. There exist two languages, L1 and L2, two ethno-racial groups, E1 and E2, and only one religion, R1. Combining these characteristics results in three groups with the specifications below:

Group	Language	Ethno-racial	Religion
A	L1	E1	R1
B	L2	E1	R1
C	L2	E2	R1

Table C.1: Specifications of characteristics per group

For each characteristic, language, ethno-racial, and religion, similarity values ($\bar{s}^L_{kl}$, $\bar{s}^E_{kl}$, and $\bar{s}^R_{kl}$), with $k,l \in K = \{A;B;C\}$ between two groups can be assigned. Based on these specifications, one can calculate a *DELF* value for each of the characteristics:

$$DELF_L = 1 - \sum_{k \in K} \sum_{l \in K} p_k p_l \bar{s}^L_{kl} \tag{C.4}$$

$$DELF_E = 1 - \sum_{k \in K} \sum_{l \in K} p_k p_l \bar{s}^E_{kl} \tag{C.5}$$

$$DELF_R = 1 - \sum_{k \in K} \sum_{l \in K} p_k p_l \bar{s}^R_{kl} \tag{C.6}$$

with $k,l \in \{A;B;C\}$ and p_k and p_l the relative group sizes. To arrive at the similarity values, one can set up a similarity matrix for each characteristic. For the above example, these matrices are shown in *Table C.2*.

[255] Naturally, one could also combine any two of the characteristics if such a combination was recommended for the research problem at hand.

(a)

	A	B	C
A	$\bar{s}^L_{AA}$	$\bar{s}^L_{AB}$	$\bar{s}^L_{AC}$
B	$\bar{s}^L_{BA}$	$\bar{s}^L_{BB}$	$\bar{s}^L_{BC}$
C	$\bar{s}^L_{CA}$	$\bar{s}^L_{CB}$	$\bar{s}^L_{CC}$

(b)

	A	B	C
A	$\bar{s}^E_{AA}$	$\bar{s}^E_{AB}$	$\bar{s}^E_{AC}$
B	$\bar{s}^E_{BA}$	$\bar{s}^E_{BB}$	$\bar{s}^E_{BC}$
C	$\bar{s}^E_{CA}$	$\bar{s}^E_{CB}$	$\bar{s}^E_{CC}$

(c)

	A	B	C
A	$\bar{s}^R_{AA}$	$\bar{s}^R_{AB}$	$\bar{s}^R_{AC}$
B	$\bar{s}^R_{BA}$	$\bar{s}^R_{BB}$	$\bar{s}^R_{BC}$
C	$\bar{s}^R_{CA}$	$\bar{s}^R_{CB}$	$\bar{s}^R_{CC}$

Table C.2: Exemplary similarity matrices for the three groups (a) with mutual language $\bar{s}^L_{kl}$ values, (b) with mutual ethno-racial $\bar{s}^E_{kl}$ values and (c) with mutual religion $\bar{s}^R_{kl}$ values

The assumptions that $\bar{s}_{kk} = 1$ and $\bar{s}_{kl} = \bar{s}_{lk}$ for all $k,l \in \{A;B;C\}$ hold, and for all groups that belong to one language or ethno-racial group, a respective similarity value of one is assigned. In the case of the religious classification, all belong to one religion, i.e., one group. Based on the characteristic definitions in *Table C.1*, it follows that $\bar{s}^E_{AC} = \bar{s}^E_{BC} = \bar{s}^E_{CA} = \bar{s}^E_{CB}$. The distance is labeled in the following simplified $\bar{s}^E$. This analogously holds for the language similarity values. The matrices of *Table C.2* can be further defined with:

(a)

	A	B	C
A	1	$\bar{s}^L$	$\bar{s}^L$
B	$\bar{s}^L$	1	1
C	$\bar{s}^L$	1	1

(b)

	A	B	C
A	1	1	$\bar{s}^E$
B	1	1	$\bar{s}^E$
C	$\bar{s}^E$	$\bar{s}^E$	1

(c)

	A	B	C
A	1	1	1
B	1	1	1
C	1	1	1

Table C.3: Similarity matrices for the three groups, taking into account the specifications of their (a) language, (b) ethno-racial and (c) religious characteristic

With the relative group sizes p_A, p_B and p_C, one obtains an exemplary $DELF_E$ index for the ethno-racial characteristic:

$$\begin{aligned} DELF_E &= 1 - \sum_{k\in K}\sum_{k\in K} p_k p_l \bar{s}^E_{kl} = \\ &= 1 - (p_A \cdot p_A \cdot 1 + p_A \cdot p_B \cdot 1 + p_A \cdot p_C \cdot \bar{s}^E + \\ &\quad + p_B \cdot p_A \cdot 1 + p_B \cdot p_B \cdot 1 + p_B \cdot p_C \cdot \bar{s}^E + \\ &\quad + p_C \cdot p_A \cdot \bar{s}^E + p_C \cdot p_B \cdot \bar{s}^E + p_C \cdot p_C \cdot 1) = \\ &= 1 - \Big((p_A + p_B)^2 \cdot 1 + 2 \cdot (p_A + p_B) \cdot p_C \cdot \bar{s}^E + p_C^2 \cdot 1\Big) \end{aligned}$$

One can clearly see that for the single characteristics $DELF$, the respective most granular split per characteristic is decisive. The group definition at a more detailed level does not add additional information. In the above example, this would lead to a reduced 2×2 matrix of the one found in *Table C.2(b)* with one group $(A+B)$, and the remaining group

C with the respective relative group sizes $(p_A + p_B)$ and p_C.[256] However, for the composite $DELF$, combining all three characteristics into a composite similarity measure $\hat{s}_{kl}$ is key. The general matrix for the composite $DELF$ calculation is then given in *Table C.4*.

	A	B	C
A	$\hat{s}_{AA}$	$\hat{s}_{AB}$	$\hat{s}_{AC}$
B	$\hat{s}_{BA}$	$\hat{s}_{BB}$	$\hat{s}_{BC}$
C	$\hat{s}_{CA}$	$\hat{s}_{CB}$	$\hat{s}_{CC}$

Table C.4: Similarity matrix for composite $DELF$ calculation

The calculation of the $\hat{s}_{kl}$ depends on the mode of weighting and combining the three characteristics. The averaging of the characteristics has important implications for the interpretation of the resulting $DELF$ values.[257] Extending the discussions in section 3.5, especially their mathematical attributes, is discussed in the following. In contrast to the exemplary case used here to demonstrate the similarity calculation, the following discussions apply to the general case.

C.2.2 Arithmetic mean

In the case of an arithmetic mean, as discussed in section 3.5, the composite $DELF$ value is calculated as:

$$DELF = 1 - \sum_{k=1}^{K} \sum_{l=1}^{K} p_k p_l \hat{s}_{kl} \tag{C.7}$$

with

$$\hat{s}_{kl} = \frac{1}{3} \left[\bar{s}_{kl}^{L} + \bar{s}_{kl}^{E} + \bar{s}_{kl}^{R} \right] \tag{C.8}$$

where $\bar{s}_{kl}^{L}$, $\bar{s}_{kl}^{E}$ and $\bar{s}_{kl}^{R}$ for all $k,l \in K$ are again the respective similarity values for the language, ethno-racial and religious classification. In the general case, K is again the total number of groups in the given country. For the specifications of the above example, the matrix in *Table C.4* transforms, with $k,l \in K = \{A;B;C\}$, to *Table C.5*.

For the arithmetic mean, there exists an identity between the calculation of the composite similarity value $\hat{s}_{kl}$, as in *Equation (C.8)*, to arrive at the composite $DELF$ values and the arithmetic mean of the single $DELF$ indices. With *Equations (C.4)–(C.6)*, for the

[256] This is equivalent to the discussion in section 3.2. Only perfectly similar individuals are grouped together and groups are meant to emerge 'endogenously'. Here, two identical groups merge into one group.

[257] All approaches portrayed here share a common, implicit assumption. They all assume that a combination follows the same pattern, independent of the specific combination of the single characteristics, and that the combination is equivalent in all countries. This assumption is further discussed in *Appendix C.2.5*.

	A	B	C
A	$\frac{1}{3}(1+1+1)$	$\frac{1}{3}(1+\bar{s}^L+1)$	$\frac{1}{3}(\bar{s}^E+\bar{s}^L+1)$
B	$\frac{1}{3}(1+\bar{s}^L+1)$	$\frac{1}{3}(1+1+1)$	$\frac{1}{3}(\bar{s}^E+1+1)$
C	$\frac{1}{3}(\bar{s}^E+\bar{s}^L+1)$	$\frac{1}{3}(\bar{s}^E+1+1)$	$\frac{1}{3}(1+1+1)$

Table C.5: Similarity matrix for the exemplary $DELF$ calculation

general case, one obtains :

$$
\begin{aligned}
DELF &= \frac{1}{3}(DELF_L + DELF_E + DELF_R) = \\
&= \frac{1}{3}\left[\left(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^L\right) + \left(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^E\right) + \left(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^R\right)\right] = \\
&= \frac{1}{3}\left[3-\left(\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^L + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^E + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^R)\right)\right] = \\
&= 1-\frac{1}{3}\left[\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^L + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^E + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^R\right] = \\
&= 1-\frac{1}{3}\left[\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \ \left(\bar{s}_{kl}^L + \bar{s}_{kl}^E + \bar{s}_{kl}^R\right)\right] = \\
&= 1-\left[\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \ \frac{1}{3} \ \left(\bar{s}_{kl}^L + \bar{s}_{kl}^E + \bar{s}_{kl}^R\right)\right] = \\
&= 1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \hat{s}_{kl} = \\
&= DELF
\end{aligned}
$$

Thus, in the case of the arithmetic mean, there is no difference between the $DELF$ calculation following *Equations (C.7)* and *(C.8)*, and an arithmetic mean over the single $DELF$ values. The arithmetic mean is therefore the most practical way of combining the single indices. Besides the arguments discussed in section 3.5, this is one of the main reasons why this approach is used.

C.2.3 Geometric mean and partly compensating methods

In the case of the geometric mean, there is no complementarity between the three characteristics. If two groups differ completely in one characteristic, which is quite often the case for religion, they are also classified to be completely different overall. For the geometric mean, the $\hat{s}_{kl}$ calculation follows:

$$
\hat{s}_{kl}^{Geo} = \left[\ \bar{s}_{kl}^L \ \cdot \ \bar{s}_{kl}^E \ \cdot \ \bar{s}_{kl}^R \ \right]^{\frac{1}{3}} \tag{C.9}
$$

Although the calculation of $\hat{s}_{kl}^{Geo}$ is not much more difficult than the standard $\hat{s}_{kl}$, it implies a further limitation. In contrast to the arithmetic mean, where one finds equality in the calculation of the $\hat{s}_{kl}$ and averaging the single $DELF$ values, this is not possible for the geometric mean. Relying on *Equation (C.9)*, one obtains:

$$\begin{aligned} DELF_{Geo} &= 1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \hat{s}_{kl}^{Geo} \\ &= 1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \left(\bar{s}_{kl}^{L}\ \bar{s}_{kl}^{E}\ \bar{s}_{kl}^{R} \right)^{\frac{1}{3}} \\ &= 1 - \left[\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{L})^{\frac{1}{3}} \cdot \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{E})^{\frac{1}{3}} \cdot \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{R})^{\frac{1}{3}} \right] \end{aligned} \tag{C.10}$$

In contrast, calculating the geometric average of the single indices under the consideration of *Equations (C.4)–(C.6)* leads to:

$$\begin{aligned} DELF_{Geo2} &= (DELF_L \cdot DELF_E \cdot DELF_R)^{\frac{1}{3}} \\ &= (DELF_L)^{\frac{1}{3}} \cdot (DELF_E)^{\frac{1}{3}} \cdot (DELF_R)^{\frac{1}{3}} \\ &= \left(1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^{L} \right)^{\frac{1}{3}} \left(1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^{E} \right)^{\frac{1}{3}} \left(1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \bar{s}_{kl}^{R} \right)^{\frac{1}{3}} \end{aligned} \tag{C.11}$$

That *Equations (C.10)* and *(C.11)* are not equivalent is straightforward to see.

Between the geometric mean, which does not mirror the complementarity of the characteristics at all, and the arithmetic mean, which does reflect this, Branisa et al. (2009) suggest a third alternative. They square the components before the calculation of the arithmetic mean. This leads to an adjusted $\hat{s}_{kl}$ with:

$$\hat{s}_{kl}^{Pc} = \frac{1}{3} \left[(\bar{s}_{kl}^{L})^2 + (\bar{s}_{kl}^{E})^2 + (\bar{s}_{kl}^{R})^2 \right] \tag{C.12}$$

Analogously one obtains:

$$\begin{aligned} DELF_{Pc} &= 1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \hat{s}_{kl}^{Pc} = \\ &= 1 - \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l \left(\frac{1}{3} \left[(\bar{s}_{kl}^{L})^2 + (\bar{s}_{kl}^{E})^2 + (\bar{s}_{kl}^{R})^2 \right] \right) = \\ &= 1 - \frac{1}{3} \left[\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{L})^2 + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{E})^2 + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{R})^2 \right] = \\ &= \frac{1}{3} \left[3 - \left(\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{L})^2 + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{E})^2 + \sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\bar{s}_{kl}^{R})^2 \right) \right] = \end{aligned}$$

$$= \frac{1}{3}\left[\underbrace{(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\tilde{s}_{kl}^{L})^2)}_{\neq (DELF_L)^2} + \underbrace{(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\tilde{s}_{kl}^{E})^2)}_{\neq (DELF_E)^2} + \underbrace{(1-\sum_{k=1}^{K}\sum_{l=1}^{K} p_k p_l (\tilde{s}_{kl}^{R})^2)}_{\neq (DELF_R)^2}\right] \tag{C.13}$$

As is the case with the geometric mean, one first needs to calculate the respective composite $\hat{s}_{kl}$ values on the most granular group setting and then follow *Equation (C.7)* to arrive at the composite $DELF$ values. *Figure C.8* shows a matrix scatter plot of the different weighting schemes. Their high correlation is again confirmed by the scatter outline:

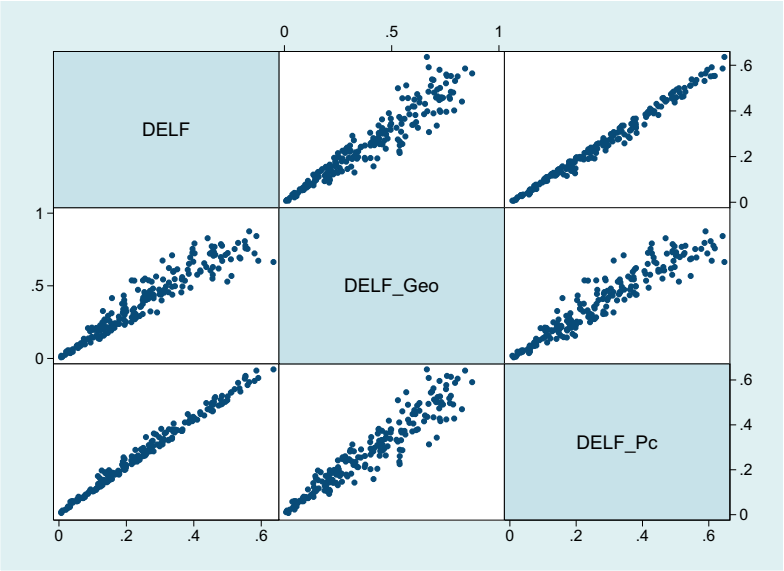


Figure C.8: Scatter plots of the differently weighted $DELF$ values

C.2.4 Principal component analysis

Principal component analysis (PCA) is becoming a more and more utilized approach to assess weights, not on theoretical grounds, but based on the data itself. Whenever one deals with continuous data, the PCA approach is indeed a promising one. Bossert et al. (2011) also use this approach to calculate the composite GELF values for different diversity characteristics in the US. However, they also used predominantly continuous data like income, for example. For categorical data, the PCA is much more difficult to apply (Kolenikov and Angeles, 2009). For a PCA calculation, the data need to be in a number format and not in categories. A possible solution for this is to turn the categories in

dummy variables and use them for the PCA calculation.[258] To apply this procedure, one would need to define fixed categories of groups, which would work against the credo of this essay to refrain from such an approach. Additionally, the granularity of the data would, in any case, yield a significant number of groups and thus subsequent dummy variables.[259]

To bypass these problems, a more straightforward approach is used. In contrast to the previous weighting methods between the characteristics, the single $DELF$ values for each individual characteristic are used as the starting point for the PCA. Thus, the principal components are calculated as linear combinations of the three single $DELF$ values per country. They are combined in a way that explains the largest part of their variation. The first principal component explains most of the variance (62%), followed by the second (27%), and third (11%) principal component. The assigned loading factors can then be used to weight the sub-indices. The results of the PCA based on the three components are displayed in *Table C.6*.

Components/Factors	Comp. 1	Comp. 2	Comp. 3
$DELF_L$	0.658	-0.018	-0.753
$DELF_E$	0.541	-0.684	0.490
$DELF_R$	0.523	0.730	0.441
Eigenvalue	1.860	0.798	0.342
Proportion of explained variance	0.620	0.266	0.114
Cumulative explained variance	0.620	0.886	1.000

Table C.6: Results of the principal component analysis and factor loadings for the components of $DELF$ sub-indices

The loading factors found for the components of 0.66 for $DELF_L$, 0.54 for $DELF_E$ and 0.52 for $DELF_R$, confirm the equal weighting rather strongly.[260] Nevertheless, two slightly different ways of using the loading factors can be applied in order to utilize the detailed information of the PCA. For both indices, only the first principal component is used as it explains most of the variance (Ogwang and Abdou, 2003).[261] The approaches differ in the way they apply the loading factors. The first uses the calculated principal components of each observation and follows the approach of Noorbakhsh (1998). It is calculated as:

$$DELF_{PCA} = 1 - \left(\frac{d_i}{\bar{d} + 2s_d} \right) \tag{C.14}$$

[258] This procedure was raised by Filmer and Pritchett (2001). If the categories can be transferred into an ordinal scale, then there exist procedures that improve the results (Kolenikov and Angeles, 2009). This, however, is not the case for the detailed group information on which the $DELF$ is build.

[259] For example, Bossert et al. (2011) only used five racial, and four unemployment categories in their GELF calculation.

[260] Nguefack-Tsague et al. (2011) show that PCA leads to a rather equal weighting scheme if its components more or less demonstrate comparable correlation values. Only when these values deviate significantly does PCA not deliver results near to an equal weighting.

[261] Additionally, the negative loading factors of the second principal component complicate the interpretation

with $\bar{d}$ and s_d representing the mean and the standard deviation of all d_i. d_i is the distance vector of country i from the most diverse country and is calculated as:

$$d_i = |z_i - z_{max}|$$

where z_i are the calculated principal components for each country i.

A simpler alternative multiplies the components by the PCA loading factors, and divides them by their sum (Ogwang and Abdou, 2003). As the first approach is the more accurate one, and the results do not differ significantly, it is used here.

C.2.5 Implications of similarity value construction and possible future extensions

One problem that all outlined methods share is the loss of information. The *WCE* data stick out because of their granularity and the advantage that all groups are defined along the three characteristics. In constructing the composite (average) index, one loses two pieces of information in the case of the $DELF$.

Firstly, information pertaining to the spread of groups and their mutual similarities is lost. This is a problem for any mean construction. Average values might emerge from very different base data setups. The mutual similarities might scatter only slightly around the mean, or be quite far apart. In the case of the $DELF$, one averages not only the group sizes, but also the similarity values. Covering the spread of similarity values is an important piece of information, but is hard to include in the $DELF$ index.[262]

To include this information, the most straightforward statistical measure would be to leverage the variance of the similarity values. A more elaborate method is found in Nguefack-Tsague et al. (2011), who, regarding the HDI, assess whether development is equal across all sub-indices, or if one or the other index deviates strongly from the overall mean of the composite index. For this, Nguefack-Tsague et al. (2011) suggest, calculating a balance of development index (BODI).[263] When adjusted for the $DELF$, it follows:

$$BODI = 1 - 1.5 \cdot \left((DELF_L - DELF)^2 + (DELF_E - DELF)^2 + (DELF_R - DELF)^2\right) \quad \text{(C.15)}$$

A BODI of one indicates that all components and the composite index are rather equal, whereas a BODI of zero characterizes countries where the sub-indices differ as much as possible from the composite index. *Figure C.9* displays the $DELF$ values versus their respective BODI values.

The most significant imbalance is for Papua New Guinea, which has a low BODI value due to the deviation in its language and religious diversity from the composite mean.

[262] A comparable thought was behind the introduction of the POL measure. Compared to the ELF, it covers other information about group size spread away from a equally sized duopoly.

[263] The acronym is adopted as it may very well stand for a 'balance of diversity index'.

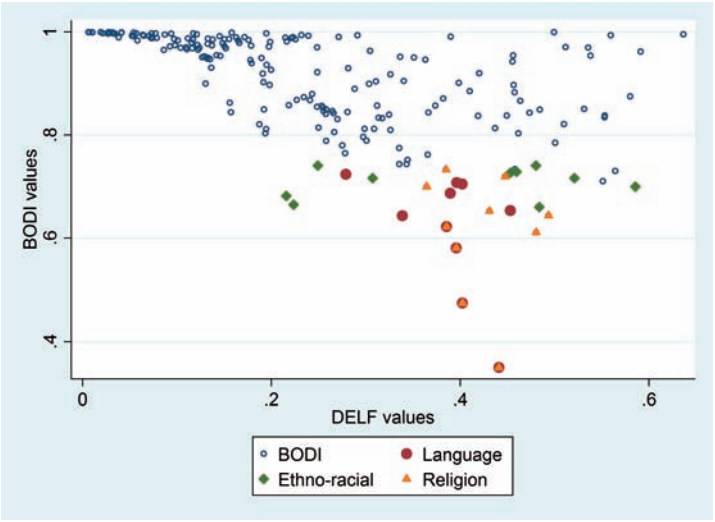


Figure C.9: Scatter plots of BODI and $DELF$ values. For countries with highest deviations, responsible characteristics marked

Equally imbalanced are some other small islands, where some differences in the setup of one characteristic have a large impact. The other most imbalanced countries are Bolivia and Belize (due to religion), Senegal and Mali (due to language), and Togo (due to the ethno-racial classification). On the other side of the coin, there are some countries that show remarkably equal values across all the single characteristics despite a high $DELF$ overall. These are Nepal, Kazakhstan, Mauritius, and Suriname. The BODI thus analyzes how differently the diversity of countries is spread, depending on the single characteristics.

The more serious problem is the second piece of information lost. By using any of the above methods, one does not utilize the complete granularity of the data. This is easiest seen in the case for the arithmetic mean. There is mathematically no difference between using the average per characteristic, and the calculation of the composite similarity values at the most granular level. This equally applies for all other methods. To use this level of detail, one would like to assign similarity values not only per characteristic, but also to take the specific combination of the characteristics into account. Thus, one would need to assign specific complementarity factors between the characteristics to answer the question, whether a Christian, German speaking, Austrian is more distant for a Muslim, English speaking, Brit than for a Muslim, Urdu speaking, Brit. Based on these combinations, their mutual similarities might be less similar than only defined by the difference in their languages. It is obvious that these differences might also vary between cultural areas. Differences in religions might affect (dis)similarities between groups more in the Middle

East than in Europe, whereas language differences are more important in the latter.[264] The mutual distance between an Christian, English speaking, American and a Muslim, Punjabi speaking Pakistani might be more profound in Pakistan than in the US. This is certainly a very important and interesting field of research. For the time being, however, the data to assess these differences are not available. Thus, for now it is assumed that the way of combining different characteristics is independent of the specific combination of single characteristics, and that it is comparable in all countries. Assessing the role of specific characteristic combinations in different cultural areas, and subsequently taking them into account, is a crucial step in improving the $DELF$ in the future.

C.2.6 Details of similarity interpretation between countries

Considering the $DELF$ between countries, it is obvious to explore how a theoretical country would look like to maximize (or minimize) this similarity measure with respect to a given country. Following its definition in chapter 3.6, the $DELF$ measures the expected dissimilarity between two individuals randomly drawn from each country. Thus, the similarity between two countries, as measured by the $DELF$, results not from the comparable structure of their respective people but from the consideration how similar two individuals are when they randomly meet.[265]

How would one expect a country j, whose group constellation (profile q) would make it most similar to country i, given its group profile p? Simplifying *Equation (3.10)* using p instead of p_i and q instead of p_j, p and q are row vectors of length K and M representing the respective group sizes/structures. Their elements range between zero and one and add up to a total of one. S is the $K \times M$ symmetric distance matrix with its elements equally ranging between zero and one. The $DELF$ between two countries is then given through:

$$DELF_{ij} = 1 - pSq' \tag{C.16}$$

As outlined earlier the key building bloc for the $DELF$ is the similarity vector S. If all its elements are zero (no group exist in both countries) the resulting $DELF$ is equal to one, attributed with two countries that are completely different. This is in line with what one would expect for two countries whose groups do not share any characteristic.[266] For the case when the groups in both countries share some characteristics (and more elements of S are non-zero) their group profiles p and q are relevant. If the group sizes p_{ik} and p_{jm}

[264] These group distances might even be problem specific. Some combinations might be more prone to conflicts (e.g., religion), whereas other combinations might be more important in the field of trade (e.g., language).

[265] This directly follows from the general construction of the GELF (Bossert et al., 2011) and taking the individual as the starting point of all considerations. However, the interpretation is slightly counter-intuitive as one would spontaneously regard two countries i and j as being 'similar' if their group profiles are similar, i.e., if $p_{ik} \approx p_{jm}$ and the corresponding $\hat{s}_{km} \approx 1$ for all $k = 1, 2, ..., K$ and $m = 1, 2, ..., M$.

[266] Note that the respective group constellations p and q for both countries are irrelevant in this case.

with a corresponding similarity value of $\hat{s}_{km} > 0$ are small enough both countries are still approximately completely different with a $DELF$ tending to one.

On the contrary, a $DELF$ value of zero between two countries is attained if both countries consist of only one, completely similar group in both countries. For any country i with more than one group ($K, M > 1$), which is the case in all countries covered by the *WCE* data, the extreme value of zero is not attained. The more elements of the similarity matrix S are non-zero the lower will be the resulting $DELF$ value. Thus, lower values of $DELF$ correctly indicate country pairs where the expected dissimilarity between two individuals is lower. However, given two countries have the identical groups ($\hat{s}_{km} \approx 1$), not the identical group constellations minimizes the $DELF$ value. *Equation (C.16)* is minimized with respect to the group constellation of the second country q when

$$pSq' = \sum_{k=1}^{K} a_k q_k \tag{C.17}$$

is maximized, where a_m is the m-th element of the vector pS. Now

$$\sum_{k=1}^{K} a_k q_k \leq a_n \sum_{k=1}^{K} q_k = a_n \tag{C.18}$$

where a_n is the largest entry of the vector $(a_1, a_2, ..., a_K)$, and this maximum is attained by setting $q_n = 1$ and $q_m = 0$ for all $m \neq n$. A country j would be most similar to country i is one in which the entire population of country j belongs to a single group, namely the group n, where n is the subscript of the largest entry of the vector $(a_1, a_2, ..., a_K)$.

Despite the maximization result, the general interpretation of lower levels of $DELF$ reflecting countries that share more groups with similar characteristics is still valid. As most countries have a high number of groups the result of the theoretical maximization process leading to a single group maximizing the similarity level between both is less relevant than the similarity values between those groups. However, one has to consider that the way the $DELF$ measures 'similarity' between two countries slightly deviates from ones general expectation of two 'similar' countries.

C.2.7 Details of population weighting for regional means

The $DELF$ values between countries represent the expected dissimilarity between two individuals randomly drawn, each from a different country. Thus, one individual is randomly drawn from country A and the other from country B, and their mutual diversity is then assessed. For this assessment different population sizes of the two countries do not matter, as only the relative group sizes determine the probabilities to be matched. This concept is thus only applicable for tuples.

As soon as an expected level of diversity between more than two countries is concerned, for example, in the case of regional averages, a different calculation applies and population

size matters. The two individuals are no longer drawn randomly from each country, instead two individuals are randomly drawn out of the region. To be drawn from one country or the other depends on the relative sizes of their population in relation to the region's overall population. The expected (average) diversity between any two individuals drawn is then easily given by the $DELF$ value between those two countries. Mathematically, the formula for the regional average of region r is given through:

$$\begin{aligned} DELF_r &= \sum_{i=1}^{R}\sum_{j=1}^{R} \frac{n_i}{N_r} \cdot \frac{n_j}{N_r} \cdot DELF_{ij} \\ &= \frac{1}{N_r^2} \cdot \sum_{i=1}^{R}\sum_{j=1}^{R} n_i \cdot n_j \cdot DELF_{ij} \end{aligned} \tag{C.19}$$

where region r consists of countries $i, j \in \{1, ...R\}$. Their between country $DELF$s are given by $DELF_{ij}$ for all $i, j \in \{1, ..., R\}$. n_i and n_j are the respective populations of country i and j and $N_r = \sum_{i=1}^{R} n_i \in \{1, ..., R\}$ the region's total population size.

In contrast to the $DELF$ formula in *Equation (3.8)*, the sum does not need to be subtracted from one. In *Equation (3.8)*, $\hat{s}_{kl}$ is a measure of similarity, whereas the $DELF$ in *Equation (C.19)* is already a measure of dissimilarity or diversity.

For dynamic regions it does, however, have an important implication when new countries join or members secede. When an additional country joins a specific region (e.g., the EU) it brings two different types of diversity into this region. First, it enters the new region with its internal (rather homogeneous) diversity. Secondly, it has its external (rather heterogeneous) diversity towards all members of the region. Depending on population size differences and the two types of diversity values, the additional country can either increase or decrease the diversity in the region.

C.3 Detailed DELF data per country

Table C.7: ELF and DELF values and ranks for 210 countries

Country	ELF	Rank	DELF	Rank	Delta	$DELF_L$	$DELF_E$	$DELF_R$
Papua New Guinea	0.982	1	0.441	36	-35	0.942	0.360	0.021
Congo, Dem. Rep.	0.977	2	0.258	91	-89	0.545	0.208	0.021
Solomon Islands	0.971	3	0.402	42	-39	0.845	0.349	0.013
Cameroon	0.966	4	0.553	7	-3	0.809	0.354	0.497
Chad	0.963	5	0.564	5	0	0.876	0.277	0.540
Tanzania	0.962	6	0.340	60	-54	0.307	0.181	0.533
India	0.958	7	0.326	66	-59	0.513	0.200	0.266
Central African Republic	0.953	8	0.437	37	-29	0.703	0.208	0.399
Vanuatu	0.948	9	0.386	49	-40	0.740	0.388	0.030
Cote d'Ivoire	0.943	10	0.586	3	7	0.867	0.243	0.648
United Arab Emirates	0.939	11	0.580	4	7	0.737	0.654	0.350
Mozambique	0.927	12	0.288	80	-68	0.278	0.102	0.485
Liberia	0.921	13	0.553	8	5	0.774	0.307	0.578
Singapore	0.917	14	0.501	16	-2	0.715	0.201	0.586
Nigeria	0.917	16	0.551	9	7	0.861	0.240	0.553
Kenya	0.917	15	0.382	51	-36	0.621	0.279	0.246
Ghana	0.915	17	0.458	27	-10	0.740	0.147	0.488
Zambia	0.914	18	0.127	158	-140	0.272	0.077	0.031
Togo	0.913	19	0.484	20	-1	0.723	0.099	0.629
Congo, Rep.	0.910	20	0.192	125	-105	0.367	0.201	0.007
Timor-Leste	0.904	21	0.458	28	-7	0.546	0.596	0.231
Israel	0.903	22	0.402	43	-21	0.738	0.116	0.352
Uganda	0.901	23	0.275	85	-62	0.570	0.219	0.036
Benin	0.885	29	0.460	26	3	0.671	0.115	0.593
South Africa	0.898	24	0.374	52	-28	0.520	0.478	0.123
Guinea-Bissau	0.898	25	0.521	13	12	0.814	0.201	0.548
Madagascar	0.892	26	0.255	94	-68	0.188	0.070	0.507
Mali	0.887	27	0.453	33	-6	0.814	0.407	0.139
Namibia	0.886	28	0.385	50	-22	0.575	0.539	0.041
Zimbabwe	0.884	30	0.148	144	-114	0.233	0.147	0.065
Ethiopia	0.863	34	0.453	32	2	0.721	0.127	0.512
Philippines	0.875	31	0.281	81	-50	0.457	0.210	0.177
Bhutan	0.869	32	0.512	14	18	0.619	0.425	0.491
Fiji	0.868	33	0.591	2	31	0.713	0.570	0.491
Indonesia	0.855	37	0.303	75	-38	0.501	0.140	0.269
Iran, Islamic Rep.	0.855	35	0.344	58	-23	0.536	0.483	0.014
Burkina Faso	0.855	36	0.462	25	11	0.703	0.193	0.489
New Caledonia	0.855	38	0.480	21	17	0.686	0.691	0.065
Sierra Leone	0.845	39	0.531	12	27	0.780	0.348	0.466
Angola	0.845	40	0.116	166	-126	0.199	0.113	0.035
Micronesia, Fed. Sts.	0.840	41	0.278	84	-43	0.580	0.229	0.026
Malaysia	0.836	42	0.510	15	27	0.685	0.231	0.614
Gabon	0.835	43	0.227	107	-64	0.453	0.189	0.039
Italy	0.829	44	0.122	161	-117	0.224	0.094	0.047
Qatar	0.828	45	0.484	19	26	0.572	0.651	0.230
Senegal	0.824	46	0.339	61	-15	0.734	0.181	0.101
United States	0.823	47	0.448	35	12	0.589	0.657	0.097
Suriname	0.818	48	0.636	1	47	0.657	0.660	0.592
Lao PDR	0.816	49	0.536	11	38	0.649	0.458	0.500

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Table C.7 – continued from previous page

Country	ELF	Rank	DELF	Rank	Delta	$DELF_L$	$DELF_E$	$DELF_R$
Niger	0.782	58	0.396	45	13	0.728	0.353	0.108
Brunei Darussalam	0.809	50	0.480	22	28	0.679	0.143	0.620
Malawi	0.807	51	0.138	148	-97	0.154	0.062	0.197
Mauritius	0.807	52	0.560	6	46	0.609	0.518	0.551
Peru	0.803	53	0.336	63	-10	0.421	0.576	0.010
France	0.802	54	0.336	62	-8	0.453	0.355	0.202
N. Mariana Islands	0.798	55	0.396	46	9	0.775	0.385	0.028
Thailand	0.793	56	0.216	113	-57	0.304	0.155	0.189
Belgium	0.782	57	0.314	69	-12	0.560	0.290	0.091
Belize	0.779	59	0.494	18	41	0.677	0.708	0.096
Kuwait	0.777	60	0.363	56	4	0.446	0.434	0.209
Pakistan	0.777	61	0.243	102	-41	0.410	0.299	0.021
Gambia, The	0.774	62	0.390	48	14	0.745	0.311	0.113
Afghanistan	0.774	63	0.297	78	-15	0.500	0.388	0.003
Morocco	0.770	64	0.187	128	-64	0.464	0.097	0.002
Monaco	0.765	65	0.190	127	-62	0.296	0.228	0.045
Oman	0.759	66	0.474	23	43	0.634	0.574	0.212
Guinea	0.753	67	0.464	24	43	0.647	0.233	0.512
Canada	0.751	68	0.419	40	28	0.632	0.455	0.171
Mauritania	0.750	69	0.265	90	-21	0.412	0.378	0.004
Bolivia	0.749	70	0.431	38	32	0.678	0.572	0.043
Spain	0.745	71	0.195	120	-49	0.313	0.240	0.032
Nepal	0.744	72	0.390	47	25	0.446	0.388	0.336
Sudan	0.738	73	0.538	10	63	0.664	0.534	0.417
Ecuador	0.737	74	0.307	73	1	0.282	0.627	0.013
Latvia	0.728	75	0.250	97	-22	0.510	0.226	0.014
Eritrea	0.721	76	0.398	44	32	0.508	0.189	0.498
Guyana	0.707	77	0.457	29	48	0.248	0.600	0.522
Nauru	0.705	78	0.449	34	44	0.690	0.432	0.226
Myanmar	0.699	79	0.420	39	40	0.589	0.264	0.408
Trinidad and Tobago	0.698	80	0.410	41	39	0.188	0.559	0.483
Andorra	0.693	81	0.137	149	-68	0.213	0.164	0.034
Cayman Islands	0.686	82	0.253	96	-14	0.237	0.480	0.043
Bosnia and Herzegovina	0.686	83	0.351	57	26	0.273	0.281	0.499
Guam	0.679	84	0.343	59	25	0.645	0.325	0.061
Switzerland	0.677	85	0.317	68	17	0.572	0.274	0.106
Colombia	0.677	86	0.224	109	-23	0.050	0.609	0.012
Montenegro	0.671	87	0.223	110	-23	0.219	0.167	0.283
Guatemala	0.668	88	0.364	55	33	0.571	0.522	0.000
New Zealand	0.667	89	0.366	53	36	0.505	0.491	0.103
French Polynesia	0.661	90	0.258	93	-3	0.447	0.325	0.001
Brazil	0.660	91	0.216	114	-23	0.048	0.591	0.008
Mexico	0.658	92	0.249	98	-6	0.168	0.575	0.005
Equatorial Guinea	0.655	93	0.266	88	5	0.543	0.214	0.042
Djibouti	0.644	94	0.279	83	11	0.619	0.180	0.037
Algeria	0.635	95	0.156	139	-44	0.401	0.065	0.003
Iraq	0.633	96	0.326	65	31	0.454	0.489	0.036
Estonia	0.631	97	0.299	77	20	0.449	0.437	0.010
Luxembourg	0.620	98	0.248	101	-3	0.468	0.250	0.028
Panama	0.616	99	0.366	54	45	0.465	0.584	0.048
Macedonia, FYR	0.613	100	0.456	30	70	0.578	0.332	0.459
Grenada	0.611	101	0.116	165	-64	0.156	0.193	0.000

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Table C.7 – continued from previous page

Country	ELF	Rank	DELF	Rank	Delta	$DELF_L$	$DELF_E$	$DELF_R$
Kazakhstan	0.603	102	0.499	17	85	0.513	0.487	0.498
St. Lucia	0.600	103	0.133	154	-51	0.197	0.168	0.033
China	0.594	104	0.234	105	-1	0.223	0.035	0.445
Egypt, Arab Rep.	0.589	105	0.065	185	-80	0.086	0.099	0.008
Georgia	0.586	106	0.311	71	35	0.506	0.272	0.155
Greenland	0.581	107	0.241	103	4	0.385	0.338	0.000
Bahrain	0.576	108	0.455	31	77	0.548	0.522	0.296
Nicaragua	0.575	109	0.301	76	33	0.371	0.524	0.008
Bermuda	0.574	110	0.192	124	-14	0.138	0.438	0.001
Virgin Islands (U.S.)	0.570	111	0.309	72	39	0.437	0.470	0.020
Comoros	0.567	112	0.041	192	-80	0.057	0.025	0.042
Mongolia	0.506	125	0.266	89	36	0.191	0.083	0.523
Turkey	0.560	113	0.255	95	18	0.328	0.430	0.006
Mayotte	0.545	114	0.335	64	50	0.495	0.492	0.019
Netherlands	0.542	115	0.215	115	0	0.261	0.237	0.147
Venezuela, RB	0.542	116	0.194	122	-6	0.059	0.484	0.040
Kyrgyz Republic	0.539	117	0.291	79	38	0.334	0.297	0.242
Albania	0.539	118	0.248	100	18	0.334	0.140	0.272
Ireland	0.539	119	0.194	123	-4	0.488	0.073	0.020
Australia	0.534	120	0.305	74	46	0.381	0.354	0.178
Sri Lanka	0.503	126	0.312	70	56	0.440	0.060	0.437
Bahamas, The	0.523	121	0.146	145	-24	0.220	0.215	0.002
Germany	0.518	122	0.165	135	-13	0.242	0.156	0.096
Tajikistan	0.510	123	0.325	67	56	0.467	0.449	0.058
St. Vincent & the Gr.	0.508	124	0.199	117	7	0.210	0.272	0.113
Sweden	0.503	127	0.179	130	-3	0.255	0.207	0.074
Chile	0.500	128	0.219	112	16	0.213	0.439	0.004
Norway	0.492	129	0.133	152	-23	0.202	0.124	0.072
Cape Verde	0.488	130	0.270	87	43	0.446	0.364	0.000
Liechtenstein	0.485	131	0.225	108	23	0.300	0.211	0.165
Dominican Republic	0.481	132	0.130	156	-24	0.048	0.340	0.003
Tuvalu	0.471	133	0.058	187	-54	0.141	0.033	0.000
United Kingdom	0.470	134	0.176	132	2	0.244	0.183	0.101
Bangladesh	0.341	153	0.098	172	-19	0.050	0.039	0.204
Botswana	0.462	136	0.158	137	-1	0.175	0.137	0.162
Tunisia	0.464	135	0.038	194	-59	0.107	0.006	0.002
Cuba	0.449	137	0.281	82	55	0.018	0.417	0.407
Puerto Rico	0.446	138	0.157	138	0	0.048	0.419	0.005
Argentina	0.444	139	0.249	99	40	0.245	0.412	0.089
Moldova	0.444	140	0.198	118	22	0.395	0.173	0.027
Palau	0.437	141	0.258	92	49	0.401	0.373	0.000
Netherlands Antilles	0.426	142	0.200	116	26	0.337	0.233	0.029
Saudi Arabia	0.420	143	0.197	119	24	0.263	0.243	0.086
Libya	0.415	144	0.117	164	-20	0.172	0.139	0.039
Ukraine	0.403	145	0.094	174	-29	0.115	0.110	0.057
Aruba	0.399	146	0.191	126	20	0.222	0.337	0.013
Uzbekistan	0.375	147	0.155	140	7	0.207	0.180	0.078
Russian Federation	0.374	148	0.271	86	62	0.328	0.272	0.215
Somalia	0.372	149	0.079	178	-29	0.147	0.063	0.026
Jamaica	0.364	150	0.087	176	-26	0.081	0.130	0.050
Costa Rica	0.363	151	0.136	150	1	0.083	0.308	0.018
Bulgaria	0.337	156	0.232	106	50	0.228	0.278	0.190
Turkmenistan	0.344	152	0.121	162	-10	0.151	0.136	0.076

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Table C.7 – continued from previous page

Country	ELF	Rank	DELF	Rank	Delta	$DELF_L$	$DELF_E$	$DELF_R$
Syrian Arab Republic	0.340	154	0.152	141	13	0.217	0.204	0.033
Dominica	0.337	155	0.110	169	-14	0.199	0.129	0.002
Austria	0.332	157	0.151	142	15	0.221	0.145	0.085
Belarus	0.329	158	0.041	193	-35	0.053	0.057	0.013
Barbados	0.324	159	0.122	160	-1	0.107	0.236	0.024
Jordan	0.321	160	0.057	188	-28	0.082	0.066	0.023
Serbia	0.318	161	0.171	133	28	0.214	0.194	0.106
Vietnam	0.309	162	0.221	111	51	0.265	0.149	0.250
Paraguay	0.308	163	0.179	129	34	0.269	0.252	0.016
Lesotho	0.308	164	0.034	195	-31	0.061	0.039	0.002
American Samoa	0.307	165	0.135	151	14	0.277	0.115	0.014
Uruguay	0.305	166	0.133	153	13	0.085	0.279	0.034
Greece	0.304	167	0.166	134	33	0.261	0.132	0.104
Swaziland	0.304	168	0.064	186	-18	0.098	0.078	0.016
Lebanon	0.302	169	0.239	104	65	0.276	0.259	0.183
Hungary	0.290	170	0.178	131	39	0.223	0.285	0.026
Lithuania	0.284	171	0.132	155	16	0.269	0.120	0.008
Honduras	0.270	172	0.129	157	15	0.124	0.257	0.006
West Bank and Gaza	0.266	173	0.150	143	30	0.155	0.052	0.243
Antigua and Barbuda	0.262	174	0.093	175	-1	0.072	0.198	0.008
Croatia	0.248	175	0.097	173	2	0.150	0.121	0.021
Slovak Republic	0.247	176	0.142	147	29	0.207	0.217	0.001
Azerbaijan	0.244	177	0.145	146	31	0.177	0.173	0.086
Cambodia	0.233	178	0.195	121	57	0.219	0.203	0.163
Isle of Man	0.222	179	0.027	204	-25	0.015	0.064	0.002
Kosovo	0.220	180	0.163	136	44	0.214	0.099	0.175
Romania	0.216	181	0.124	159	22	0.173	0.191	0.008
El Salvador	0.215	182	0.104	170	12	0.106	0.204	0.001
Marshall Islands	0.210	183	0.111	168	15	0.122	0.210	0.000
Samoa	0.210	184	0.086	177	7	0.207	0.051	0.000
Yemen, Rep.	0.195	185	0.074	180	5	0.137	0.063	0.023
Slovenia	0.192	186	0.054	190	-4	0.079	0.046	0.037
Finland	0.177	187	0.101	171	16	0.146	0.142	0.015
Cyprus	0.173	188	0.112	167	21	0.170	0.123	0.042
Portugal	0.173	189	0.074	181	8	0.056	0.144	0.023
Denmark	0.165	190	0.117	163	27	0.144	0.122	0.086
San Marino	0.164	191	0.010	207	-16	0.029	0.002	0.000
St. Kitts and Nevis	0.153	192	0.073	182	10	0.066	0.105	0.049
Sao Tome and Principe	0.153	193	0.052	191	2	0.058	0.098	0.000
Rwanda	0.147	194	0.032	198	-4	0.013	0.044	0.039
Iceland	0.141	195	0.054	189	6	0.107	0.052	0.004
Malta	0.119	196	0.073	183	13	0.110	0.108	0.001
Seychelles	0.117	197	0.070	184	13	0.087	0.110	0.014
Czech Republic	0.109	198	0.033	197	1	0.050	0.042	0.006
Haiti	0.108	199	0.010	208	-9	0.008	0.021	0.001
Poland	0.102	200	0.033	196	4	0.065	0.035	0.001
Armenia	0.100	201	0.077	179	22	0.099	0.090	0.042
Burundi	0.099	202	0.028	202	0	0.022	0.038	0.025
Tonga	0.094	203	0.031	200	3	0.055	0.035	0.004
Korea, Rep.	0.059	204	0.032	199	5	0.045	0.009	0.041
Maldives	0.059	205	0.028	203	2	0.043	0.018	0.022
Faeroe Islands	0.058	206	0.006	210	-4	0.010	0.009	0.000

Continued on next page

Table C.7 – continued from previous page

Country	ELF	Rank	DELF	Rank	Delta	$DELF_L$	$DELF_E$	$DELF_R$
Channel Islands	0.055	207	0.029	201	6	0.053	0.029	0.005
Kiribati	0.050	208	0.021	205	3	0.050	0.014	0.000
Japan	0.048	209	0.019	206	3	0.032	0.011	0.014
Korea, Dem. Rep.	0.019	210	0.007	209	1	0.015	0.006	0.000

Table C.8: Country-pairs with highest mutual (dis)similarities[267]

	Region	Country A	Region	Country B	DELF	$DELF_L$	$DELF_E$	$DELF_R$
Most similar countries	SSA	Burundi	SSA	Rwanda	0.047	0.068	0.041	0.032
	MENA	Jordan	MENA	Egypt	0.072	0.118	0.083	0.015
	MENA	Jordan	MENA	Yemen.	0.081	0.155	0.065	0.023
	MENA	Egypt	MENA	Yemen	0.083	0.151	0.082	0.015
	LA	Antigua	LA	St. Kitts	0.085	0.070	0.155	0.029
	Western	Iceland	Western	Faeroe I.	0.086	0.115	0.141	0.002
	MENA	Jordan	MENA	Tunisia	0.089	0.217	0.037	0.012
	MENA	Egypt	MENA	Tunisia	0.091	0.214	0.055	0.005
	MENA	Egypt	MENA	Libya	0.093	0.136	0.120	0.024
	MENA	Yemen	MENA	Tunisia	0.098	0.247	0.035	0.012
Most dissimilar countries	Asia	Kiribati	MENA	Algeria	1.000	1.000	1.000	1.000
	Asia	Korea, Rep.	SSA	Niger	1.000	1.000	1.000	1.000
	Asia	Lao PDR	SSA	Eritrea	1.000	1.000	1.000	1.000
	Asia	Bhutan	SSA	Gabon	1.000	1.000	1.000	1.000
	Asia	Bhutan	SSA	Congo, Rep.	1.000	1.000	1.000	1.000
	SSA	Djibouti	Asia	Lao PDR	1.000	1.000	1.000	1.000
	Asia	Lao PDR	MENA	Tunisia	1.000	1.000	1.000	1.000
	Asia	Lao PDR	SSA	Mauritania	1.000	1.000	1.000	1.000
	Asia	Lao PDR	MENA	West Bank	1.000	1.000	1.000	1.000
	Asia	Lao PDR	MENA	Morocco	1.000	1.000	1.000	1.000

Table C.9: Details of EU enlargement waves and respective $DELF$ averages

	Enlargement waves							Potential future enlargement		
EU group	**EU6**	**EU9**	**EU10**	**EU12**	**EU15**	**EU25**	**EU27**	**EU+B**	**EU+T**	**EU+B+T**
Year	1952	1973	1981	1986	1995	2004	2007	–	–	–
Countries	Belgium France Germany Italy Luxembourg Netherlands	Denmark Ireland Britain	Greece	Portugal Spain	Austria Finland Sweden	Cyprus Czech Rep. Estonia Hungary Latvia Lithuania Malta Poland Slovak Rep. Slovenia	Bulgaria Romania	Albania Croatia Iceland Macedonia Montenegro Serbia	Turkey	Albania Croatia Iceland Macedonia Montenegro Serbia Turkey
DELF	0.3685	0.3875	0.3940	0.3893	0.3987	0.4196	0.4206	0.4263	0.5383	0.5393
Delta		*0.019*	*0.006*	*-0.005*	*0.009*	*0.021*	*0.001*	*0.006*	*0.118*	*0.119*

Appendix D

Appendix – Chapter 4

D.1 Summary statistics for all replications

Table D.1: Summary statistics for replications of Garcia-Montalvo and Reynal-Querol (2005b)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Conflict	1,096	0.145	0.352	0.000	1.000
Ethnic fractionalization	1,096	0.442	0.277	0.010	0.959
Ethnic polarization	1,096	0.516	0.248	0.017	0.982
Religious fractionalization	1,096	0.284	0.235	0.001	0.782
Religious polarization	1,096	0.468	0.356	0.001	1.000
Ln (GDP/capita)	1,016	7.733	1.046	5.416	10.710
Ln (Population)	1,092	15.390	1.951	10.638	20.908
Primary exports	1,039	0.166	0.185	0.002	2.139
Mountains	1,088	15.311	20.074	0.000	82.200
Non contiguous	1,096	0.155	0.361	0.000	1.000
Democracy	896	0.459	0.499	0.000	1.000

Table D.2: Summary statistics for replications of Schüler and Weisbrod (2010)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Growth	476	0.018	0.027	-0.085	0.173
Africa	640	0.294	0.456	0.000	1.000
Latin America	640	0.238	0.426	0.000	1.000
Ln (GDP/cap.)	460	7.741	1.035	5.438	10.053
(Ln (GDP/cap.))^2	460	60.995	16.269	29.573	101.056
Ln (Schooling)	399	1.518	0.588	0.039	2.576
Assassinations	476	0.000	0.000	0.000	0.001
Financial depth	445	0.395	0.322	0.002	2.977
Black market premium	505	0.236	0.406	-0.064	3.181
Fiscal surplus/GDP	413	-0.234	4.102	-83.393	0.112
Ln (Telephones/worker)	553	1.266	0.898	-1.398	2.860
ELF (Alesina)	584	0.439	0.274	0.000	0.930

Table D.3: Summary statistics for replications of Bjørnskov (2008)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Trust	116	25.483	13.466	3.400	68.076
Income inequality	113	41.391	11.371	21.500	70.700
Post communist	116	0.216	0.413	0.000	1.000
Monarchy	116	0.164	0.372	0.000	1.000
Nordic country	116	0.043	0.204	0.000	1.000
Politial diversity	89	5.149	1.860	2.074	12.066
Political competition ('80–'05)	112	0.542	0.211	0.132	1.000
Protestant	116	15.022	23.779	0.000	95.000
Muslim	214	10.672	25.250	0.000	100.000
Catholic	116	30.266	36.561	0.000	98.000
Eastern	116	5.776	19.733	0.000	95.100
ELF (Alesina)	116	0.397	0.240	0.002	0.930

Table D.4: Summary statistics for replications of Disdier and Mayer (2007)

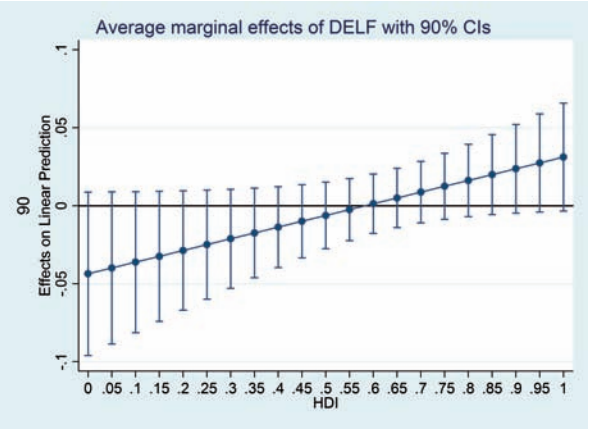
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Opinion	887	-0.239	0.529	-1.992	1.208
Language proximity	1,960	0.179	0.097	0.000	0.456
Religion proximity	1,960	0.373	0.202	0.073	0.843
Asylum seekers	1,540	1.443	1.403	0.000	4.615
Book imports	1,960	2.225	8.057	-4.605	16.872
Conflict years	1,960	2.064	3.248	0.000	12.000
UN voting	1,960	4.438	0.088	4.193	4.585
Ln (Exports)	1,287	-24.720	1.253	-31.859	-19.884
Ln (Imports)	1,287	-24.932	1.233	-32.797	-20.240
GDP/cap. differences	1,400	9.695	0.505	6.844	10.402
EU budget contribution	1,310	-0.757	1.615	-5.826	0.641
EC benefits	1,750	3.971	0.329	2.890	4.500
Ln (Distance)	1,960	7.164	0.527	5.479	8.106
Common border	1,960	0.057	0.232	0.000	1.000
Newspaper imports	1,960	-2.807	4.966	-4.605	16.396

Table D.5: Summary statistics for replications of Felbermayr and Toubal (2010)

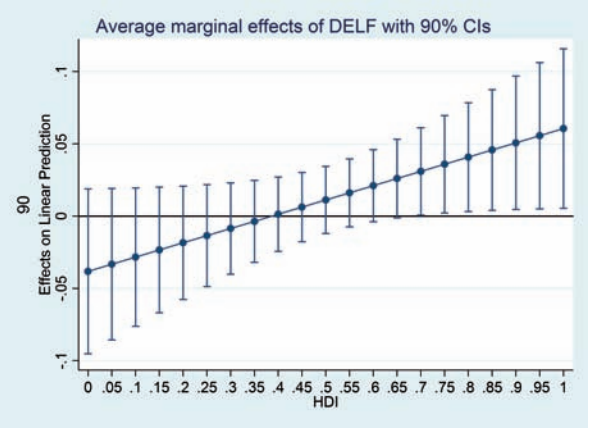
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Aggregate imports	10,560	19.096	2.540	7.084	25.081
Aggregate imports (hom. goods)	7,161	16.609	2.398	6.908	23.066
Aggregate imports (diff. goods)	7,826	18.490	2.409	8.006	24.282
Common law	10,560	0.183	0.387	0.000	1.000
Common language	10,560	0.061	0.240	0.000	1.000
Religion proximity	10,560	0.210	0.248	0.001	0.854
Ethnic ties	10,457	7.816	2.742	0.000	15.433
Common FTA	10,560	0.308	0.462	0.000	1.000
Ln (Distance)	10,560	7.306	0.627	4.394	8.565
Common border	10,560	0.091	0.287	0.000	1.000
ESC_{ij}	12,356	0.259	0.330	0.000	1.000
ESC_{ji}	12,356	0.259	0.330	0.000	1.000

D.2 Marginal effects of *DELF*

Figure D.1: Average marginal effects of *DELF* dependent on HDI levels with 90% confidence intervalls for regressions (4) and (5) of *Table 4.4*



(a) Regression (4)



(b) Regression (5)

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This book examines welfare effects of gender-related inequalities in Korean households and labor markets. It uses subjective well-being data to show that reductions of excessive levels of working hours did improve family well-being in the past decade. Moreover, benefits from major life events like marriage can differ greatly by sex if traditional gender roles dominate and women contribute much less than men to household earnings. Furthermore, the study examines dynamics in rural East Asian economies and their impact on individual welfare outcomes. Both land redistribution and productivity-enhancing reforms are found to have been highly beneficial for Korean development. The Indonesian case study demonstrates the importance of cash-crop decisions and the growing non-farm sector for rural development.

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