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The Causal Effects of Ethnic Diversity: An Instrumental Variables Approach

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Abstract

Ethnic diversity is endogenous to economic development in the long run. Yet the standard approach in economic research is to treat ethnic diversity as an exogenous factor. By identifying instruments for ethnic diversity, we correct this misspecification and establish that ethnic diversity has an exogenous influence on income levels, economic growth, corruption, and provision of public goods. Earlier results based on OLS estimations may have underestimated the negative effects of high levels of ethnic diversity.

Keywords: economic development, ethnic diversity, instrumental variables, property rights.

JEL classification: O11, O43, P51

1 Introduction

High levels of ethnic diversity have been linked to various poor economic and political outcomes, e.g., lower income levels and lower economic growth (Easterly and Levine 1997, Alesina et al. 2003, Alesina and La Ferrara 2005) and more corruption and a lower provision of public goods (Mauro 1995, Easterly and Levine 1997, La Porta et al. 1999, Alesina et al. 2003).[1] The standard approach in this literature has been to treat ethnic diversity as if it were exogenous to economic development. However, we argue that this is a misspecification.

Two recent papers demonstrate that ethnic diversity is determined by historical forces and geographical factors. Ahlerup and Olsson (2007) show that the levels of ethnic diversity in different countries follow a number of predictable patterns. Ethnic diversity

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[1] A nice overview of this literature can be found in Alesina and La Ferrara (2005).

is higher in countries with a longer duration of human settlement, and in countries that have a naturally fragmented geography, that lie closer to the equator, and that have had low levels of territorial state capacity during the modern era. The prehistoric formation of ethnic groups is modeled as depending on the groups' ability to provide public goods to group members.

The duration of uninterrupted human settlements affects ethnic diversity because the formation of new ethnic groups takes a considerable amount of time. The fragmentation process will therefore have come further in areas where humans have lived for a longer time.[2] Indicators for geographical fragmentation capture the fact that a fragmented geography makes it harder for the groups to provide public goods (or broadcast power and control) over longer geographical distances. This reduces interaction and allows new ethnic identities to form over time.

The endogenous nature of ethnic diversity is also explored by Michalopoulos (2008), who models ethnic diversity as originating in differences in land quality. These differences generate localized human capital which reduces mobility, and allows local ethnicities to form.[3]

Historical accounts of how populations in more developed countries have become more homogenous in the last centuries, through a combination of deliberate homogenizing efforts and endogenous processes, can be found in Anderson (1983), Gellner (1983), and Tilly (1992). These processes are discussed in more detail below.

Ethnic diversity is thus endogenous to economic development in the long run. Yet, although this notion is widespread among economists who study the effects of ethnic diversity, ethnic diversity is generally treated as an exogenous explanatory factor in empirical analyses. Influential articles in this tradition include Easterly and Levine (1997) and La Porta et al. (1999). Only a few studies question the exogeneity of ethnic diversity. Mauro (1995) discusses how factors omitted from his estimation may have affected both colonial history and ethnolinguistic fractionalization, and Acemoglu et al. (2001), Fearon (2003), and Alesina and La Ferrara (2005) argue that contemporary levels of ethnic diversity are partly determined by long-run economic development.[4]

Let us briefly discuss how previous studies on ethnic diversity and long-run development may have obtained biased estimates due to omitted variables, simultaneity, or measurement error.

When two true determinants are correlated with each other but one of them is omitted, the estimate of the included variable can be biased. The direction of the bias will depend

[2] The effect of the duration of human settlements is demonstrated to be robust to a wide range of specifications and the omission of potential outliers, among both former colonies and countries never colonized by Europeans, and when global migration flows since 1500 AD are taken into account. The effect is not driven by the experiences of countries in sub-Saharan Africa or the Americas.

[3] In his empirical analysis, Michalopoulos (2008) finds higher ethnolinguistic fractionalization in countries with a greater range in the quality of land.

[4] For a model that endogenizes ethnicity, see Caselli and Coleman (2006).

on the sign of the correlation, and on whether the omitted variable has a positive or negative effect on the dependent variable.

Consider two hypothetical cases that can result in biased estimates. First, suppose that some societies have a culture that is more open to the inflow of new ideas and people. Over time, these societies will both be economically more successful and have more heterogenous populations. If the heterogeneity is included in an analysis of long-run development but the cultural openness is not, it will give a positive bias on the estimated effects of heterogeneity. Second, suppose instead that there are historical factors, such as a colonial policy of "divide-and-rule," that have had negative effects on economic development but positive effects on the level of heterogeneity. The omission of these factors will negatively bias the estimated effects of heterogeneity. All in all, the direction of the overall bias caused by the omission of relevant variables cannot be determined *a priori*.

Simultaneity, or reversed causality, arises if ethnic diversity is determined by long-run development. On the one hand, countries that are highly developed and have relatively homogenous populations today were more heterogenous only a few hundred years ago (Fearon 2003). One reason behind this development is that rich countries can afford bigger and more potent state apparatuses, and such states have tended to reduce heterogeneity, both passively and actively, over the centuries.[5] Another important mechanism is that members of minority groups have had individual incentives to join the majority culture, as frictionless communication has become more important in advanced economies. This homogenization process seen in developed countries suggests that OLS estimates of ethnic heterogeneity will have a negative bias. On the other hand, people have incentives to move from poor to affluent areas, and the resulting immigration flows can make developed countries more heterogenous over time. Hence, high contemporary levels of ethnic diversity could be a reflection of a well-functioning economy, positively biasing the estimated effects of ethnic diversity. Serious consideration of simultaneity therefore suggests that the estimated effects of ethnic diversity could be biased, although the direction of the bias is unclear.

The measures of ethnic diversity used in the literature may be noisy indicators of the true levels of ethnic diversity, or may only poorly reflect the theoretical mechanisms they are supposed to capture. What separates one ethnic group from another can to some degree be different (language, religion, traditions, history, physical attributes, etc.) in different countries, and how many people that belongs to each group can be subject to disagreement (Fearon 2003, Alesina et al. 2003). When an independent variable is

[5] Passive homogenization occurred when states engaged in activities that ethnic groups had been engaged in long before states even existed, e.g., to uphold order, to provide protection, and to supply public goods. Active homogenization policies were motivated by the beliefs that an economy where people have a common language and similar cultural references would work more smoothly, and that a homogenous population is more likely to fight for the country in the event of an external military threat.

measured with error, as ethnic diversity thus appears to be, its estimate can suffer from attenuation bias, i.e., be biased toward zero.

In sum, ethnic diversity cannot without problems be treated as an exogenous factor in matters related to long-run development. This insight casts doubts on the accuracy of a substantial amount of earlier research stating that ethnic diversity affects economic or political development.

Instrumental variables techniques allow us to deal with omitted variable bias, simultaneity, and measurement error. The main contribution of this paper is therefore that it demonstrates that instrumental variables techniques can be used to establish that high levels of ethnic fractionalization *are* associated with lower levels of GDP per capita, poor economic growth, less effective control of corruption, and higher levels of infant mortality, and that the true effects of ethnic diversity may have been underestimated in previous studies.

We also establish that the effect of ethnic diversity on income can be separated from that of (property rights) institutions. Main contributions on the long-run effects of formal institutions include those made by North (1990), Hall and Jones (1999), Sokoloff and Engerman (2000), and Acemoglu et al. (2001, 2002). Ethnolinguistic fractionalization has a significant effect when institutions are instrumented for in Acemoglu et al. (2001), while the contrary is found in Easterly and Levine (2003).

Acemoglu et al. (2001) note that contemporary levels of ethnolinguistic fractionalization are correlated with settler mortality (their main instrument for institutions), and Ahlerup and Olsson (2007) discuss how local pathogen loads may affect ethnic diversity. Over time, the evolution of immunological resistance to local pathogens means that mobility can have a high cost in terms of health risks. The isolation this implies facilitates the formation of ethnic groups. To the extent that settler mortality rates reflect local pathogen loads, they can quite possibly have direct causal effects not only on institutions but also on ethnic diversity. This adds to the econometric problems associated with including ethnic diversity as an exogenous regressor when institutions are instrumented for. We demonstrate that this issue can be dealt with directly, with the use of instruments for both institutions and ethnic diversity. The effect of ethnic diversity on income appears to be separate from, and not working through that of, worse institutions.

The remainder of this paper is structured as follows. Section 2 describes the data used in the analysis, Section 3 presents the results, and Section 4 concludes the paper.

2 Data

The full sample consists of a cross-section of 177 countries. We also have a smaller sample of 63 former European colonies where we can instrument for both ethnic diversity and property rights institutions. Ethnic diversity is included as *Ethnic Fractionalization*, which corresponds to the probability that two randomly selected individuals belong to different ethnic groups (Alesina et al. 2003). The quality of property rights institutions among former European colonies is included as the average protection against expropriation risk 1985-1995. This measure, *Property Rights*, is originally from Acemoglu et al. (2001), but we retrieved the data via Albouy (2008).

We have four dependent variables. First, *Income* is the log of real GDP per capita in 2000 in PPP terms from the Penn World Tables (Heston et al. 2008). We face a trade-off between slightly more recent income data and having a wide range of countries, and we choose to use the larger sample as this should be a stronger test of the generalizability of the results. Second, *Growth* is the annual growth rate of real GDP per capita from 1980 to 2000; we use national accounts data from WDI (2008). Third, *Corruption* represents the "Control of Corruption" in 2005 from Kaufmann et al. (2007), one of the World Bank Governance indicators. This measure indicates the perceived level of corruption, understood as when public power is used for private gains. Higher values on *Corruption* indicate less perceived corruption. Our fourth outcome measure, *Infant Mortality*, corresponds to the log of the mortality rate of infants per 1,000 live births in 2005 (WDI 2008). Following La Porta et al. (1999) we argue that a higher infant mortality indicates poor provision of public goods, although it is certainly also related to low income levels, high inequality, and more hostile environments.

We use four instruments for *Ethnic Fractionalization*. Our two main instruments for *Ethnic Fractionalization* are the duration of human settlements (*Origtime*) and the diversity of vegetation types (*VegDiversity*). The basic logic that makes *Origtime* relevant for contemporary ethnic diversity is that the formation of ethnic groups takes considerable time and that higher values of *Origtime* corresponds to more time for ethnic group formation. *Origtime* represents the historical duration of uninterrupted human settlements on a per country basis, and the dating is based on research in genetics, archeology, climatology and on fossils, as synthesized by primarily Oppenheimer (2003) and Bradshaw Foundation (2007). The area of Ethiopia and Kenya is the birthplace of modern humans and the two countries therefore obtain the earliest dates for *Origtime* (160,000 years). From Eastern Africa modern humans spread out over the African continent and in subsequent steps colonized the entire Earth. Due to space considerations, we kindly refer the interested reader to Ahlerup and Olsson (2007) for a more detailed account of how *Origtime* is constructed.

The G-Econ (2008) dataset, maintained by researchers at Yale University, lists dominant pre-agricultural vegetation types on a resolution of 1 degree latitude by 1 degree longitude. *VegDiversity* is the log of the number of different dominant vegetation types per country. The logic that makes *VegDiversity* an informative instrument is that it captures how fragmentation of the local geography enables and encourages isolation and separation of population groups, and over time enables them to evolve into distinct groups with different ethnic identities.[6]

Our third instrument for *Ethnic Fractionalization* is *Indtime*, the number of years since the date of independence. We obtain this figure from the Correlates of War (2008) project. The basic reason for why ethnic diversity decreases as more time has passed since the year of independence is that there has been both a deliberate homogenization process, where over centuries states have actively sought to homogenize their populations, and a more unintentional homogenization process, as individuals exert efforts to make communication easier with those they meet most frequently, who are often their fellow countrymen (Anderson 1983, Gellner 1983, Tilly 1992). Hence, the logic that makes *Indtime* a potentially good instrument differs from the logics that make *Origtime* and *VegDiversity* potentially good instruments.

Our fourth instrument for *Ethnic Fractionalization*, *MigDist*, is in principle the migratory distance in kilometers from Ethiopia to the centroid of each country. This variable proxies for the distance modern man had to cover to colonize a new area, and is therefore a central determinant of *Origtime*. Due to the way *Origtime* is constructed, *MigDist* has more units of variation; see Ahlerup and Olsson (2007) for details.

The two instruments for *Property Rights* are the same as in Acemoglu et al. (2001), and in order to use these our sample is naturally limited to a subset of the former European colonies. *Settler Mortality* is the log of European settler mortality. We retrieved the data on *Settler Mortality* from Teorell et al. (2008). *Settlements in 1900* is the ratio of European settlers to the total population in 1900, and is taken from Table A5 in Acemoglu et al. (2000).[7]

The first of our control variables is *Latitude*, the absolute value of latitude (CEPII 2008). Second, *Former Colony* is a binary indicator for countries colonized by Europeans (Olsson 2007). Third, *Initial Income* is GDP per capita in 1980 in PPP terms. Fourth, *Investment Rate* is the investment share of total GDP in 1980. Both *Initial Income* and *Investment Rate* are from the Penn World Tables (Heston et al. 2008).

The fifth control variable, *Imperialist*, is a binary indicator for countries whose colonization period, as coded by Olsson (2007), started during the "Imperialist" era, here taken to be after 1750 AD. There are two reasons for including *Imperialist*. First, the colonization process was by no means uniform and it is reasonable to distinguish between an early wave of colonization headed by largely mercantilist European countries and a later wave of colonization headed by capitalistic and industrialized European countries (Osterhammel 2005, Olsson 2007). Second, the countries in sub-Saharan Africa are special

[6] Ahlerup and Olsson (2007) use *GeoDiversity*, which is the number of different dominant "Great Soil" categories (also taken from the G-Econ dataset). The correlation between *VegDiversity* and *GeoDiversity* is 0.80, and as both indicate geographical frictions, which one to choose may be more a matter of taste. We choose *VegDiversity* as it has better statistical properties in the present analysis.

[7] For critical analyses of the instruments used in Acemoglu et al. (2001), see Glaeser et al. (2004) and Albouy (2008). For a more general critical discussion on the use of instruments, see Deaton (2009).

in that not only were they colonized rather late, they were also the first to be populated by modern humans and, consequently, have the highest levels of ethnic diversity (Ahlerup and Olsson 2007). Including *Imperialist* is therefore a way, albeit crude, to assure that our instruments do not capture differences in colonization strategies during the different historical eras.

To ensure that *VegDiversity* does not proxy for (natural) transaction costs, (natural) productivity, an unevenly distributed population, or country size, a number of additional variables will also be controlled for.[8] The following four controls are for the year 2000 and are taken from WDI (2008): *Population* is the log of the size of the population, *Agricultural Land* is the percentage share of total land used for agricultural purposes, *Forest* is the percentage of the total land that is covered by forests, and *Area* is the log of the land area of the country in km^2. The G-Econ (2008) dataset is used to create two additional control variables. The dataset lists mean altitude and population size in the 1 degree latitude by 1 degree longitude grid cells that each country is divided into. *Altitude Difference* is the log of one plus the difference between the highest and lowest figures per country. We calculate the share of the total population who live in each grid cell. As an indicator of the asymmetry of the population structure, we include *Population Asymmetry*, calculated as the skewness of the population shares.

We use Limited-Information Maximum Likelihood (LIML) in all regressions as this has better properties than Two-Stage Least Squares (2SLS) in the presence of weak instruments (Stock and Yogo 2002).[9] Descriptive statistics and pair-wise correlations for the main variables can be found in Tables A1 and A2 in the Appendix.

3 Results

In the first columns of Table 1, the dependent variable is *Income*. The first stage estimations of ethnic diversity are presented in Panel B, and we see that ethnic diversity is indeed higher in countries with a longer duration of human settlements and a more fragmented geography. The second stage results show that (instrumented) ethnic diversity has a highly significant negative effect on the income level. The F-values for the excluded instruments in (1.1) and (1.2) show that our instruments are sufficiently informative. The

[8] On average, larger countries are both poorer and ethnically more fractionalized. The number of different vegetation types naturally tends to be higher in larger countries. This is a potential concern as a country's area could have numerous direct and indirect effects on the income level of its inhabitants. A higher number of vegetation types could also signal that transaction costs, due to geographical factors, could be higher. It could be further hypothesized that a more diverse geography in some countries could mean that there is little land suitable for standardized agriculture or productive forestry. It could also be hypothesized that a more diverse geography means that a wider range of inputs is available within a shorter distance. A fragmented geography could also mean that the present population is spatially fragmented with little interaction. This can have a direct negative effect on the income level.

[9] The assumption of homoskedasticity of the residuals is tested in standard Pagan-Hall tests in all specifications, and robust standard errors are used if the assumption can be rejected at the 10% level.

standard overidentification test indicates that the instruments are valid. The first columns of Table 2 also confirm that this crucial assumption holds.

Table 1. Income, Growth, Corruption, and Infant Mortality.

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
Dependent Variable	Income	Income	Income	Growth	Corruption	Infant Mortality
			Panel A: Second Stage Results			
Ethnic Fract.	-4.422***	-4.185***	-3.079**	-6.853***	-2.791***	4.852***
	(0.927)	(0.815)	(1.416)	(1.557)	(0.681)	(0.842)
Former Colony	0.339	0.378	0.210	-0.007	0.553**	0.215
	(0.291)	(0.288)	(0.360)	(0.601)	(0.236)	(0.296)
Latitude	0.013	0.016		0.002	0.022***	-0.004
	(0.010)	(0.010)		(0.020)	(0.008)	(0.010)
Initial Income				-0.775***		
				(0.211)		
Investment Rate				0.089***		
				(0.025)		
Region dummies	-	-	Yes	-	-	-
			Panel B: First Stage Results for Ethnic Fractionalization			
Origtime	0.217***	0.158***	0.137*	0.159***	0.158***	0.162***
	(0.037)	(0.040)	(0.082)	(0.044)	(0.040)	(0.040)
VegDiversity		0.080***	0.058**	0.104***	0.080***	0.076***
		(0.024)	(0.027)	(0.027)	(0.024)	(0.025)
Former Colony	0.045	0.025	0.089	0.043	0.025	0.034
	(0.053)	(0.053)	(0.059)	(0.061)	(0.053)	(0.053)
Latitude	-0.003*	-0.005***		-0.007***	-0.005***	-0.004***
	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Initial Income				0.005		
				(0.022)		
Investment Rate				0.002		
				(0.002)		
Region dummies	-	-	Yes	-	-	-
Shea Partial R^2	0.170	0.215	0.085	0.225	0.215	0.215
F(excluded IVs)	35.41***	23.27***	6.87***	20.41***	23.27***	23.02***
Overid. test (p)	-	0.445	0.994	0.684	0.114	0.214
Endogeneity test (p)	0.000	0.000	0.106	0.003	0.001	0.000
Pagan-Hall (p)	0.163	0.106	0.045	0.684	0.200	0.221
CD (Size Dist.)	<10%	<10%	-	<10%	<10%	<10%
AR Wald Chi^2 (p)	0.000	0.000	0.053	0.000	0.000	0.000
Conf. Region	[-6.9, -2.9]	[-6.3, -2.8]	-	[-10.8, -4.0]	[-4.5, -1.6]	[3.5, 7.1]
			Panel C: OLS Results			
Ethnic Fract.	-1.386***	-1.346***	-0.943***	-3.242***	-0.914***	1.323***
	(0.310)	(0.312)	(0.348)	(0.736)	(0.277)	(0.278)
Observations	177	175	175	126	175	173

Estimated with LIML. Standard errors in parentheses; robust in (1.3). *** p<0.01, ** p<0.05, * p<0.1. Constants omitted from the table. Region Dummies: Sub-Saharan Africa, the Americas, Asia, and Pacific. Overid. test: a Hansen J test in (1.3), otherwise a Sargans test. Endogeneity test: from Baum et al. (2003). CD (Size Dist.) gives potential size distortions, see Footnote 10. AR (Anderson Rubin) Wald Chi^2 is robust to weak instruments. Conf. Region gives CLR confidence intervals robust to weak identification (Moreira 2003).

We can firmly reject the exogeneity of *Ethnic Fractionalization* in our benchmark specification (1.2), which means that *Ethnic Fractionalization* should indeed be treated as an endogenous variable and that the OLS results are inconsistent.[10] The coefficient for *Ethnic Fractionalization* is considerably larger when it is instrumented for than it is when OLS is used. Hence, the true effect of ethnic diversity on income appears to be substantially larger than our OLS results imply. In line with the discussion in the introduction, this can signal that the OLS estimates suffer from attenuation bias, or that the potential sources of positive bias due to omitted variables or simultaneity are stronger than those producing a negative bias.

When normal standard errors are used, we can test whether the instruments are weak.[11] The result in our benchmark specification tells us that we do not have weak instruments, if we tolerate a true significance level of up to 10 percent when the reported level is 5 percent. Nevertheless, we have tested all estimates of *Ethnic Fractionalization* using a test that is robust to weak instruments. The result from this Anderson-Rubin Wald Chi^2 test shows that the estimate in (1.2) is robustly significant.[12]

In the third column we have replaced the geographical variable *Latitude* with dummies for sub-Saharan Africa, the Americas, Asia, and the Pacific. The instruments have a significant effect in the first stage and ethnic diversity has a significant effect in the second stage. We cannot reject the exogeneity of *Ethnic Fractionalization* in (1.3).

In columns four to six in Table 1, the dependent variables are *Growth*, *Corruption*, and *Infant Mortality*, rather than *Income*.

Growth regressions routinely include initial income and investment rate as control variables, and so does specification (1.4). *Ethnic Fractionalization* has a significantly negative effect on growth of real GDP per capita. Specification (1.4) is misspecified if ethnic diversity is primarily a long-run determinant of GDP per capita, but dropping initial income from the specification has no substantial impact on the estimates.

The dependent variable in (1.5) is *Corruption*. Earlier findings that higher levels of *Ethnic Fractionalization* are associated with more corruption are corroborated, and the results obtained in OLS may actually have underestimated the magnitude of this effect. In (1.6), we find that countries with higher levels of instrumented ethnic diversity have lower provision of public goods, here included as *Infant Mortality*.

Overall, the results in Table 1 show that high levels of ethnic diversity can have problematic consequences. The fact that ethnic diversity is instrumented for should ease concerns about omitted variables, simultaneity, or measurement error.

[10] Baum et al.'s (2003) test for exogeneity of *Ethnic Fractionalization* is used throughout the analysis.

[11] The test statistic reported in the tables is the Cragg-Donald test statistic for maximal size distortion (Stock and Yogo 2005).

[12] A significant AR (Anderson-Rubin) Wald Chi^2 test statistic implies that the instrumented variable has a significant effect on the dependent variable also in the presence of weak instruments. Also reported is the *CLR Confidence Region*, which represents a 95% confidence interval (for the instrumented variable) that is robust to arbitrarily weak instruments (see Moreira 2003).

Table 2. Tests of the instruments, alternative instruments, and sample restrictions.

Dep. Variable	Income						
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)
Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Not SSA or Americas	Not Colonized[c]
Panel A: Second Stage Results							
Ethnic Fract.	-3.008**	-4.996***	-4.185***	-4.056***	-4.186***	-3.971**	-6.944***
	(1.487)	(1.519)	(1.423)	(0.753)	(0.869)	(2.022)	(2.073)
Origtime	-0.315						
	(0.363)						
VegDiversity		0.159					
		(0.229)					
Former Colony	0.323	0.373	0.013	0.377	0.378	0.192	
	(0.261)	(0.316)	(0.294)	(0.303)	(0.288)	(0.374)	
Latitude	0.019**	0.009	0.008	0.017	0.016	0.016	
	(0.009)	(0.015)	(0.015)	(0.011)	(0.010)	(0.013)	
Add. Controls	-	-	Yes[a]	-	-	-	-
Panel B: First Stage Results for Ethnic Fractionalization							
Origtime	0.158***	0.158***	0.128***			0.244**	0.275**
	(0.040)	(0.040)	(0.042)			(0.116)	(0.129)
VegDiversity	0.080***	0.080***	0.085*	0.107***	0.134***		
	(0.024)	(0.024)	(0.047)	(0.024)	(0.023)		
MigDist				-0.000***			
				(0.000)			
Indtime					-0.031***	-0.023**	-0.021**
					(0.010)	(0.010)	(0.009)
Former Colony	0.025	0.025	-0.009	0.066	-0.025	0.030	
	(0.053)	(0.053)	(0.056)	(0.059)	(0.053)	(0.068)	
Latitude	-0.005***	-0.005***	-0.006***	-0.007***	-0.007***	0.000	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
Add. Controls	-	-	Yes[b]	-	-	-	-
Shea Partial R^2	0.059	0.086	0.088	0.220	0.190	0.091	0.129
F(excluded IVs)	10.65***	15.94***	7.24***	30.37***	19.99***	4.54**	4.61**
Overid test (p)	-	-	0.362	0.608	0.396	0.238	0.865
Endog. test (p)	0.072	0.000	0.005	0.000	0.000	0.069	0.001
Pagan-Hall (p)	0.408	0.265	0.827	0.092	0.122	0.121	0.884
CD (Size Dist.)	<15%	<15%	<15%	-	<10%	<20%	<20%
AR Wald Chi^2 (p)	0.021	0.000	0.000	0.000	0.000	0.000	0.000
Conf. Region	[-8.4;-0.4]	[-10.2;-2.7]	[-9.5, -1.8]	-	[-6.5;-2.7]	[-16.0;-0.5]	[-18.1;-4.0]
Panel C: OLS Results							
Ethnic Fract.	-0.724*	-0.959**	-1.009***	-1.346***	-1.346***	-0.815	-2.508***
	(0.376)	(0.373)	(0.364)	(0.332)	(0.332)	(0.517)	(0.566)
Observations	175	175	165	175	175	96	65

Estimated with LIML. Standard errors in parentheses; robust in (2.4). *** p<0.01, ** p<0.05, * p<0.1. Constants omitted from the table. Overid. test: a Hansen J test in (2.4), otherwise a Sargans test. Endogeneity test: from Baum et al. (2003). CD (Size Dist.), AR Wald Chi^2, and Conf. Region: see Table 1. [a]Area: 0.141(0.142); Population: -0.070(0.097); Population Asymmetry: 0.031(0.030); Agricultural Land: -1.081***(0.417); Forest: -0.125(0.414); Altitude Difference: -0.211**(0.095). [b]Area: 0.044*(0.019); Population: -0.038(0.015); Population Asymmetry: -0.005(0.005); Agricultural Land: -0.052(0.080); Forest: 0.011(0.079); Altitude Difference: -0.029* (0.017). [c](2.7) also omits Ethiopia as it is an outlier on Origtime.

If the duration of human settlements or the diversity of vegetation types affected the income level directly rather than indirectly via their effect on ethnic diversity, they would not constitute valid instruments. Fortunately, the results in the first and second columns in Table 2 show no such direct effects once (instrumented) *Ethnic Fractionalization* is controlled for.[13] This supports the results from the formal tests of overidentification.

For reasons discussed in the introduction, it is of interest to hold factors such as (natural) transaction costs, (natural) productivity, an asymmetric population structure, and country size constant. In (2.3) we therefore include *Population*, *Population Asymmetry*, *Agricultural Land*, *Forest*, *Altitude Difference*, and *Area*. This means that the variation in *Ethnic Fractionalization* these factors could explain in the first stage is not attributed to the excluded instruments, and that the variation in *Income* that they could explain in the second stage is not attributed to (instrumented) *Ethnic Fractionalization*.

Both the first and second stage results in (2.3) are similar to the results in our benchmark specification.[14] The estimates are admittedly somewhat less precise than in the benchmark – the standard errors are larger as the additional variables are correlated both with the instruments (especially *VegDiversity*) and with each other.[15] In results not shown, we added the log of the length of the total road network in 2000 from WDI (2008) to (2.3) as a proxy for *actual* transaction costs. This variable is of course also endogenous to economic development wherefore we will not dwell on the results, yet although the size of the sample falls to 137 countries, both *Origtime* and *VegDiversity* in the first stage and *Ethnic Fractionalization* in the second stage stay significant at the 5% level.

The sensitivity of the results to the coding of *Origtime* is tested in (2.4), where we replace *Origtime* with the migratory distance from the birthplace of modern humans (*MigDist*). The effect of instrumented ethnic diversity is very similar to that in our benchmark specification. The estimate for *Ethnic Fractionalization* is fairly similar also when the time as an independent country (*Indtime*) replaces *Origtime* in the fifth column in Table 2, and the overidentification test results show that the exclusion restrictions hold.[16]

Before we, in Table 3, look closer at the sample of former European colonies, we omit all countries in sub-Saharan Africa and the American continents and restrict the sample to include only countries that have never been subject to European colonization; see specifications (2.6) and (2.7).[17] These restrictions give us fewer observations and lower F-

[13] In (2.1), we use *VegDiversity* as the only excluded instrument and add *Origtime* directly in the second stage. We do the opposite of this in (2.2).

[14] The estimates for the additional variables are reported in the notes to the table.

[15] There are indications that the instruments are weak, yet the potential distortion in the significance level is on the moderate side and the AR Wald Chi^2 test shows that *Ethnic Fractionalization* has a significant effect even if the instruments should be deemed weak.

[16] We included *Indtime* directly in the second stage of (2.5), and it was far from significant (not reported).

[17] Ethiopia was not colonized by Europeans but is not included in (2.7) as it is a clear outlier on *Origtime* in this subsample. When Ethiopia is included in (2.7), the effects are even stronger.

values for the excluded instruments in the first stage estimations. The important insight from the results in (2.6) and (2.7) is that we do not need to include sub-Saharan Africa, the Americas, or the former European colonies to identify the effects of ethnic diversity on income.[18]

The results so far show that there are several decent instruments for *Ethnic Fractionalization*. It is comforting to observe that instruments with different underlying logics produce quite similar results. The identification appears to be on the weak side in some specifications, which must be kept in mind when interpreting the magnitude of the resulting estimates. However, the test results reported in the tables make it clear that ethnic diversity has a negative effect also in specifications where our instruments are weak by normal standards.[19]

In order to simultaneously control for ethnic diversity and institutions, we turn to the sample of former European colonies. This will also ease concerns that the benchmark results in (1.2) may be driven by the omission of institutions, or by a fundamental difference between former colonies and other countries that cannot be captured by the dummy for former European colonies. As discussed above, Acemoglu et al. (2001) admit that ethnolinguistic fractionalization is likely to be endogenous to long-run development, and that its inclusion therefore will bias the estimate for institutions downwards. Since *Ethnic Fractionalization* is instrumented for, this will no longer be a concern, and we can simultaneously estimate the effects of institutions and ethnic diversity.

In the first two columns in Table 3 it is confirmed that the instruments for *Ethnic Fractionalization* are valid also in the sample of all former European colonies. The exogeneity of *Ethnic Fractionalization* can be rejected, which indicates that it should be treated as an endogenous variable. The significant and negative estimates for *Imperialist* indicate that countries whose colonization periods began during the "Imperialist" era have significantly lower incomes also when the other explanatory variables are held constant.

In their corresponding regressions, Acemoglu et al. (2001) have 64 observations, but the availability of our instruments limits our sample further.[20] Nevertheless, in (3.4) we obtain results regarding *Property Rights* that are similar to those reported in Acemoglu et al. (2001).

[18] The significant effect of *Ethnic Fractionalization* remains if we include *Latitude* in specification (2.7), but the first stage estimate for *Origtime* is then no longer statistically significant.

[19] The instruments are obviously not strong when the F-values for the excluded instruments are as low, and the potential size distortions indicated by the Cragg-Donald statistic are as high, as they are in some of the specifications in Table 2. However, the Anderson-Rubin Wald Chi^2 test and the CLR Confidence Regions clearly indicate that the estimates for (instrumented) *Ethnic Fractionalization* are always significantly different from zero.

[20] Other differences are that we use income in 2000 and ethnic fractionalization from Alesina et al. (2003) while they use income in 1995 and ethnolinguistic fractionalization from Easterly and Levine (1997).

Table 3. Ethnic Fractionalization and Property Rights in former European colonies.

Dependent Variable	Income					
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)
Panel A: Second Stage Results						
Ethnic Fract.	-2.788***	-2.355***	-2.664**		-2.067**	-1.922**
	(0.749)	(0.676)	(1.182)		(0.987)	(0.824)
Property Rights				0.912***	0.740***	0.713***
				(0.200)	(0.175)	(0.117)
Imperialist	-0.652***	-0.677***	-0.681***	-0.634***	-0.481**	-0.481**
	(0.208)	(0.194)	(0.248)	(0.222)	(0.199)	(0.195)
Latitude	0.024**	0.027**	0.012	-0.002	-0.016	-0.014
	(0.012)	(0.011)	(0.016)	(0.013)	(0.013)	(0.012)
Panel B: First Stage Results for Ethnic Fractionalization						
Origtime	0.180***		0.247***		0.232***	0.177***
	(0.056)		(0.076)		(0.066)	(0.066)
VegDiversity	0.102***	0.195***				0.071*
	(0.033)	(0.029)				(0.039)
Indtime		-0.143***				
		(0.029)				
Settler Mortality					0.023	0.038
					(0.026)	(0.026)
Settlements in 1900						0.002
						(0.001)
Imperialist	-0.063	-0.041	-0.054		-0.062	-0.010
	(0.051)	(0.041)	(0.081)		(0.063)	(0.064)
Latitude	-0.006**	-0.008***	-0.006*		-0.005*	-0.009***
	(0.002)	(0.002)	(0.003)		(0.003)	(0.003)
Shea Partial R^2	0.319	0.329	0.202		0.186	0.277
F(excluded IVs)	31.77***	26.88***	14.93***		7.83***	5.32***
Panel C: First Stage Results for Property Rights						
Origtime					0.176	0.359
					(0.456)	(0.446)
VegDiversity						-0.403
						(0.266)
Settler Mortality				-0.551***	-0.569***	-0.408**
				(0.170)	(0.178)	(0.174)
Settlements in 1900						0.029***
						(0.009)
Imperialist				0.075	-0.023	0.247
				(0.350)	(0.435)	(0.429)
Latitude				0.019	0.021	0.005
				(0.016)	(0.018)	(0.019)
Shea Partial R^2				0.151	0.133	0.295
F(excluded IVs)				10.47***	5.24***	5.80***
Overid. test (p)	0.980	0.154	-	-	-	0.459
Endogeneity test (p)	0.001	0.027	0.092	0.000	0.001	0.001
Pagan-Hall (p)	0.062	0.054	0.957	0.247	0.413	0.315
CD (Size Dist.)	-	-	<15%	<15%	<25%	<10%
AR Wald Chi^2 (p)	0.000	0.000	0.013	0.000	0.000	0.000
Conf. Region	-	-	[-6.3, -0.5]	[0.6, 1.9]	-	-
Panel D: OLS Results						
Ethnic Fract.	-0.797**	-0.797**	-1.023		-0.985***	-0.988***
	(0.366)	(0.366)	(0.650)		(0.330)	(0.344)
Property Rights				0.447***	0.446***	0.446***
				(0.053)	(0.050)	(0.050)
Observations	110	110	63	63	63	62

Estimated with LIML. Standard errors in parentheses; robust in (3.1) and (3.2). *** p<0.01, ** p<0.05, * p<0.1. Constants omitted from the table. Overid. test: a Hansen J test in (3.1) and (3.2), otherwise a Sargans test. Endogeneity test: from Baum et al. (2003). CD (Size Dist.), AR Wald Chi^2, and Conf. Region: see Table 1.

In columns 5 and 6 we include ethnic diversity and institutions simultaneously. The first-stage results presented in Panel B and Panel C show that the instruments for *Ethnic Fractionalization* are not significantly related to institutions once the instruments for institutions are controlled for, and vice versa. That this is the case is not a requirement for the equations to be identified, but since we cannot control for institutions in the full sample, these first-stage results give additional support for the exclusion restrictions for our instruments and are thus comforting for the findings presented in Tables 1 and 2.[21]

Further, the second-stage results reveal that the effects of both ethnic diversity and institutions are underestimated in OLS. When ethnic diversity and institutions are included separately, their respective effects tend to be overestimated. That this is the case is evident when the estimates for *Ethnic Fractionalization* and *Property Rights* in (3.5) and (3.6) are compared with the estimates in (3.1) to (3.4). The results show that the effects of ethnic diversity and formal institutions can be analytically separated, and that even if it is possible that ethnic diversity affects income levels partly through formal institutions, ethnic diversity has an effect on income levels in former colonies beyond its potential effect on formal institutions.

4 Conclusions

In this paper we first discuss how previous results on the effects of ethnic diversity may be affected by bias due to omitted variables, simultaneity, or measurement error. We then exploit recent findings on the determinants of ethnic diversity in order to identify instruments for ethnic diversity. With these instruments at hand, we investigate whether ethnic diversity has causal effects on a number of indicators of economic and political development.

We find evidence that ethnic diversity does indeed have exogenous effects on income levels, economic growth, corruption, and provision of public goods. Therefore, while previous studies have shown significant partial correlations between ethnic diversity and a number of economic outcomes, this paper demonstrates both that there are causal effects of ethnic diversity and that results obtained in OLS may underestimate the true effects.

[21] If we instrument for both ethnic diversity and institutions and find that the instruments for ethnic diversity have no effect on institutions, then we should worry less that they may have an effect on income levels in regressions where institutions are not included, besides the indirect effects they have via ethnic diversity.

We also find that the effects of ethnic diversity and property rights institutions on economic development among former European colonies can be separated from each other. This suggests that countries that have problems due to high levels of ethnic diversity could alleviate these problems with better enforcement of property rights.

On a more general level, the results presented in this paper promise that an acceptance of the endogenous nature of ethnic diversity does not preclude meaningful empirical analyses of the long-run effects of ethnic diversity.

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Appendix

Table A1. Descriptive Statistics

	N	Mean	Median	Std. Dev.	Min	Max
Income	182	8.48	8.51	1.17	5.88	10.78
Corruption	182	-0.07	-0.31	0.99	-1.79	2.49
Infant Mortality	179	3.11	3.14	1.14	0.86	5.07
Growth	137	0.95	0.85	2.27	-7.03	8.14
Former Colony	182	0.64	1	0.48	0	1
Latitude	182	25.59	23.37	16.90	0.20	64.15
Ethnic Fractionalization	177	0.44	0.44	0.26	0.00	0.93
Origtime	182	0.54	0.40	0.49	0.00	1.60
VegDiversity	180	1.42	1.39	0.74	0.00	3.18
Indtime	182	1.17	0.46	1.78	0.13	10.63

Table A2. Pair-wise Correlations

	1	2	3	4	5	6	7	8	9	10
1 Income	1									
2 Corruption	0.766	1								
3 Infant Mortality	-0.852	-0.770	1							
4 Growth	0.435	0.456	-0.447	1						
5 Former Colony	-0.359	-0.278	0.543	-0.226	1					
6 Latitude	0.522	0.480	-0.633	0.279	-0.783	1				
7 Ethnic Fractionalization	-0.478	-0.412	0.529	-0.435	0.355	-0.448	1			
8 Origtime	-0.549	-0.414	0.649	-0.327	0.266	-0.418	0.528	1		
9 VegDiversity	-0.188	-0.221	0.197	-0.172	-0.112	0.159	0.277	0.349	1	
10 Indtime	0.335	0.357	-0.371	0.199	-0.342	0.345	-0.279	-0.171	0.201	1