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# Youth Dependency, Institutions, and Economic Growth

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# YOUTH DEPENDENCY, INSTITUTIONS, AND ECONOMIC GROWTH

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*The present paper shows empirically that the youth dependency ratio (the population below working age divided by the population of working age) reduces economic growth even after controlling for institutions. The institutional variable, the paper controls for, is the measure for institutions that is recently preferred in prominent work by Acemoglu and co-authors. Institutions turn out to have a significant and positive effect on economic growth. The significance of the youth dependency ratio and of institutions appears to be robust to controlling for various variables, including malaria prevalence. Hence, the paper finds evidence that demography, as well as institutions, both matter for economic growth.*

## 1. INTRODUCTION

By introducing demography, this paper aims to contribute to a recent debate in the empirical growth literature on whether geography has a direct effect on economic development (the *geography hypothesis*) or affects it only indirectly through the choice of institutions (the *institutions hypothesis*). Empirical support for the geography hypothesis is found in Sachs (2003) and Carstensen and Gundlach (2006). Empirical evidence in favour of the institutions hypothesis is found in Hall and Jones (1999), Acemoglu et al. (2001, 2002), Easterly and Levine (2003) and Rodrik et al. (2004).[1] Within the literature supporting the institutions hypothesis, the most convincing case has been made by Acemoglu et al. (2002). They discovered that, among former colonies, those colonies that were among the richest countries in 1500 are now among the poorest countries. The authors explain this *reversal of fortune* with the argument that Europeans set up extractive and therefore bad institutions in relatively rich colonies that happened to have high settler mortality rates. In contrast, they settled in relatively poor colonies that happened to have low settler mortality, setting up good institutions in those

[1] Both, the literature supporting the geography hypothesis and the literature supporting the institutions hypothesis, apply two-stage-least-squares estimation techniques. The literature supporting the institutions hypothesis only finds a significant effect of geography in a first-stage regression of institutions (the instrumented variable) on geographical instrumental variables. In contrast, geographical variables do not have a significant effect in a second-stage regression of income per capita on institutions and geography. Hence, geography has only an indirect effect on income per capita through its effect on institutions. The literature supporting the geography hypothesis does exactly the same empirical exercise as the literature supporting the institutions hypothesis, but uses malaria prevalence as a proxy for geography in the second-stage regression. The authors argue that malaria prevalence is a better proxy for geography. Consistent with this view, this literature does find a direct effect of geography on economic development.

colonies. In turn, according to this work, institutions persisted even after independence and had a positive effect on income per capita today. The reversal of fortune is very convincing evidence against a direct effect of geography on economic development. The reason for this is the fact that, if geography had a dominant direct effect on economic development, then the relatively rich former colonies should still be rich today, which however is not the case.[2]

A forerunner of the aforementioned literature supporting the geography hypothesis is important work by Bloom and Sachs (1998), then both Harvard economists. Using OLS estimation, their paper demonstrates that geography, as well as demography, both have direct effects on economic growth. After this joint work, the authors separately elaborated their hypothesis in different directions. On the one hand, Sachs advanced with co-authors the hypothesis that geography has a direct effect on income per capita or economic growth (e.g., Gallup et al., 1999, Gallup and Sachs, 2001, and Sachs and Malaney, 2002). On the other hand, Bloom advanced with co-authors the hypothesis that demographic change has a direct effect on economic growth (e.g., Bloom and Williamson, 1998, Bloom et al., 2001, and Bloom et al., 2003b). The latter literature argues that there is only temporary demographic change during the demographic transition (a change from a situation with high mortality and high fertility to a situation with low mortality and low fertility). Since in former colonies the demographic transition occurred only (if at all) in the second half of the 20th century, an important temporary contribution of demographic change on economic growth does not imply that former colonies that were rich in 1500 have also to be rich today. As a consequence, it is consistent with the aforementioned reversal of fortune. Moreover, the aforementioned literature on the geography hypothesis versus the institutions hypothesis seems to assume that countries are in steady state and therefore has in its regression equations the level of income as regressand and no lagged level of income as regressor. In contrast, demographic change implies an unstable population and therefore economies cannot be in steady state. Therefore, the literature by Bloom and co-authors includes in its regression equations the lagged level of income as regressor. In addition, it has the rate of economic growth as the regressand, following the set-up of Barro (1991).[3]

The present paper is most closely related to the work by Bloom and co-authors on the effect of demographic change on economic growth and a literature that developed thereafter. The present paper's novel contribution is to conduct a horse race between demography and institutions as determinants of economic growth, similar to the aforementioned literature on the geography hypothesis versus the institutions hypothesis. In addition, it uses for the institutional variable the measure for institutions that Acemoglu and Johnson (2005) prefer, which is Polity IV's constraint on the executive. The work of Acemoglu and co-authors is definitively the most prominent and presumably also the most convincing work within the aforementioned

[2] For excellent reviews on the reversal of fortune, see Acemoglu (2003) and Hall and Papell (2005, pp. 151-158).

[3] As long as the regression equation includes, as regressor, the lagged level of income, both, the rate of economic growth and the level of income as regressand, are consistent with transitional dynamics, as the latter equation can be derived from the former equation by rearranging terms (cf. Caselli et al., 1996).

literature supporting the institutions hypothesis. Further, Acemoglu and Johnson (2005) is the most recent work of Acemoglu and co-authors of the effect of institutions on economic development and therefore reflects their most recent view on which measure is the most appropriate measure for institutions. An important by-product of this choice of the measure for institutions is that the present study is able to apply a measure of the average quality of institutions from 1960-2000 to gauge the effect of institutions on long-run growth.[4] Previous literature on the effect of demography on economic growth that controlled for institutions applied for this purpose only measures of the quality of institutions in the 1990s as proxies for their average quality over a longer time frame. Within its improved framework, the present study shows that demography and institutions both matter for economic growth. This result survives even after controlling for various variables, including malaria prevalence – the proxy for geography mostly preferred by Sachs and co-authors.

The next section reviews in more detail the literature initiated by Bloom and co-authors on the effect of demography on economic growth (the *demographic dividend hypothesis*). Section 3 explains the empirical strategy of the paper and section 4 presents the basic empirical result of the present study. Finally, Section 5 and 6 examine whether the basic result is robust to controlling for various variables.

## 2. THE DEMOGRAPHIC DIVIDEND HYPOTHESIS

As Bloom and Williamson (1998) stress, until the 1980s, there has been a debate between *population pessimists* (e.g., Ehrlich, 1968) and *population optimists* (e.g., Kuznets, 1967, Boserup, 1981 and Simon, 1981). Population pessimists believed in a negative effect of population growth on economic growth through dilution of resources (the neoclassical growth model is consistent with this view). Population optimists believed in a positive effect of population growth on economic growth because it would promote technical progress (today, growth models with endogenous technical progress are consistent with this view, see, e.g., Kremer, 1993). In the 1980s, studies using cross-country data did not find a significant effect of population growth on economic growth (Bloom and Freeman, 1986, and Kelley, 1988), giving rise to a *population neutralists* view.

In more recent work, Bloom and Williamson (1998) confirm that there is no robust evidence for a significant effect of population growth on economic growth. However, they show that population growth has a significant and negative effect on economic growth, once one includes in the regression equation, as further regressor, growth of the working-age population, where the coefficient of growth of the working-age population is significant and positive.[5] Bloom and Williamson interpret their finding as evidence for a

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[4] Acemoglu et al. (2001) use instead, as their measure for institutions, average protection against expropriation risk from Political Risk Services. However, this variable is only available since the 1980s. In addition, it is highly correlated with one of the present paper's instruments for the youth dependency ratio. Therefore, identification with this variable is impossible.

[5] After confirming this result, Kelley and Schmidt (2005) argue that without inclusion of growth of the working-age population, its positive growth effect is incorporated into the estimated coefficient of population growth and therefore population growth shows up as insignificant.

growth effect from changing age structure of the population.[6] In the early phase of a demographic transition, in which mortality of the population below working-age declines strongly and fertility changes slowly, growth of the total population exceeds growth of the working-age population. For this reason, in the early phase, the demographic transition leads to a *demographic burden*. In a later phase of the demographic transition, in which fertility falls strongly and the previously young population with an improved survivor rate ages into working-age, growth of the working age population exceeds growth of the total population. As a consequence, in this later phase, the demographic transition leads to a *demographic dividend* (see Bloom et al, 2003b). Using their qualitative results, Bloom and Williamson (1998) argue that age structure changes during the demographic dividend phase contributed to one-third of the East-Asian economic growth miracle.

Bloom et al. (2001) interpret the growth effect from the difference in growth of the total population and growth of the working age-population as an *accounting effect* (in contrast, Kelley and Schmidt, 2005, label it *translations effect*). This effect occurs because a changing ratio of the working-age population to the total population increases the number of "producers" to the number of "consumers" of output. Bloom et al. (2001) improve the insight of Bloom and Williamson (1998) by pointing out that there is an additional *behavioral effect* from changing age structure (Kelley and Schmidt, 2005, label this effect a *productivity effect*). In developing countries, a changing ratio of the working-age population to the total population arises mainly because of a changing youth dependency ratio (the population below working age divided by the population of working age). However, a changing youth dependency ratio affects savings (recent work that shows empirical support for such an effect is, e.g., Kelley and Schmidt, 1996, Higgins and Williamson, 1997, and Bloom et al., 2003a). In turn, savings, of course, affect economic growth.

Using the notation that $\tilde{y}$ is output per capita and $y$ is output per working-age person, the accounting effect and the behavioral effect can mathematically be decomposed from:

$$(1) \qquad \tilde{y} \equiv \frac{Y}{N} = \frac{Y}{L}\frac{L}{N} \equiv y\frac{L}{N} \quad \Rightarrow \quad \hat{\tilde{y}} = \hat{y} + (\hat{L} - \hat{N}),$$

where $N$ denotes total population, $L$ denotes the working-age population and a "hat" on top of a variable indicates the growth rate. In (1), in the second equation, $\hat{y}$, i.e. growth of output per working-age person, contains the behavioral effect. In the same equation, the terms within parenthesis represent the difference between growth of the working-age population and growth of the total population. This is the accounting effect.

Bloom et al. (2001) use growth of output per capita as the regressand in their growth regressions. However, the second equation in (1) reveals that growth of output per capita contains both, the behavioral and the accounting effect. Bloom et al. show that it is possible to test for a behavioral effect with growth of output per capita as the regressand . However, the assessment of a behavioral effect is rather complicated in this case and Kelley and Schmidt

[6] Earlier work arguing in favour of a growth effect from changing age structure is Coale and Hoover (1958).

(2005) argue that in this case there are problems from high multicollinearity. In contrast, growth of output per working-age person is free of an accounting effect. For this reason, Kelley and Schmidt (2005) and Prskawetz et al. (2004) use growth of output per working-age person as the regressand in their growth regressions.[7] Kögel (2005) uses for the same reason growth of output per worker as the regressand . However, this is probably not a good choice, as the labor force participation rate is highly endogenous and it is difficult to come about with appropriate instruments to account for its endogeneity.

Demographic variables are probably endogeneous in growth regressions. Bloom and Williamson (1998) and Bloom et al. (2001) apply two-stage least squares regressions (2SLS) and instrument growth of the working-age population and growth of the total population with lagged demographic variables. However, due to serial correlation, lagged demographic variables seem to be endogenous as well. Kelly and Schmidt (2005) and Prskawetz et al. (2004) regress growth of output per working-age person on the youth dependency ratio and control variables. The former study uses OLS, while the latter study uses geographical variables as instruments. Further, similar to Hall and Jones (1999), Prskawetz et al. (2004) control for social infrastructure and measure it with the average of (i) the indicator of rule of law in Kaufman et al. (2003) and (ii) a measure of openness to trade. Moreover, they instrument social infrastructure with further geographical variables. The authors find significant effects of the youth dependency ratio and of social infrastructure on economic growth. However, the indicator of rule of law is only available for the 1990s and is only a proxy for its average quality over a longer time frame. The present study improves the approach of Prskawetz et al. by using Polity IV's constraint on the executive, which is available for 1960-2000 and is the recently preferred measure for institutions of Acemoglu and Johnson (2005).

## 3. THE EMPIRICAL STRATEGY

The empirical analysis applies cross-country regressions to average values for 1960-2000. Following the work of Acemoglu and co-authors, the empirical analysis is based on former colonies, which allows the use of former colonies' settler mortality rates in the early 19th century as an instrument for institutions. This approach follows the aforementioned argument of Acemoglu et al. (2001) that, in colonies with high settler mortality rates, Europeans set up extractive and therefore bad institutions, while, in colonies with low settler mortality, they settled and set up good institutions. For a few former colonies, data for output per working-age person in 1960 or 2000 or data for geographical variables as instruments for the youth dependency ratio are not available. This limits the number of countries in the sample to 55. (A list of all countries is shown in the appendix, together with descriptions and data sources of all variables used in this study).

The paper's empirical strategy is to use the following cross-country regression equation for the time interval [1960, 2000]:

[7] If of interest, the additional accounting effect can directly be calculated from the difference between growth of the working-age population and growth of the total population (see Prskawetz et al., 2004).

$$(2)\quad GROWTH_{i,[1960,2000]} = \alpha_0 + \alpha_1 LNYWA_{i,1960} + \alpha_2 LNYOUTHDEP_{i,[1960-2000]} + \alpha_3 XCON_{i,[1960,2000]} + \alpha_4 Z_{i,[1960,2000]} + \varepsilon_i,$$

where $GROWTH$ represents the annual growth rate of output per working-age person, $LNYWA_{i,1960}$ denotes the natural logarithm of output per working-age person in country $i$ in year 1960 and $LNYOUTHDEP$ is the natural logarithm of the youth dependency ratio. Further, $XCON$ denotes constraint on the executive, $Z$ denotes one or more control variables and $\varepsilon_i$ is the error term. Eq. (2) contains $LNYWA_{i,1960}$ because according to the conditional convergence hypothesis, which is in particular a feature of the neoclassical growth model, a country grows the faster the further its income level is below its steady state level. The coefficient of $LNYWA_{i,1960}$ is hence predicted to be negative and the other variables in eq. (2) are predicted to determine a country's income level in the steady state.

The youth dependency ratio is likely to be endogenous. Therefore, in the present study, it is instrumented with the following instruments:

- KGPTEMP. Percentage of a country's population in temperate zones, based on the Köppen-Geiger ecozone classification system (Gallup et al., 1999, and Sachs, 2003).
- KGPTR. Percentage of a country's population in Köppen-Geiger tropical ecozones (Gallup et al., 1999).

According to mainstream population economics, fertility is mainly driven by socioeconomic variables. However, socioeconomic variables are likely to be endogenous and hence are inappropriate as instruments. In addition, according to classical demographic transition theory, reductions in infant mortality cause a fertility decline during the demographic transition. However, as Bloom and Sachs (1998) show, despite of significant reductions in Africa's infant mortality rate, Africa's fertility rate remained very high, contrary to Asia and Latin America. Furthermore, Bloom and Sachs argue that, according to literature, part of Africa's high fertility remains unexplained even after accounting for socioeconomic variables in addition to infant mortality. For this reason, further unknown determinants must have contributed to Africa's persistently high fertility rate. In quest of exogenous proxies for all these determinants of fertility and therefore as instruments for the youth dependency ratio, the present paper uses the two abovementioned Köppen-Geiger ecozones, which turn out to have quite a nice statistical fit.

The paper's measure for institutions, $XCON$, is also likely to be endogenous, as is argued in the aforementioned recent literature. In addition, measures of institutions contain measurement errors. For both reasons, this paper's strategy is to instrument it with the following instruments: [8]

[8] I would like to thank Simon Johnson for providing the data for these instruments.

- LNMORT. Natural logarithm of settler mortality in the early 19th century.
- LEGALENG. A dummy variable that takes on value of 1 if a country has a British legal origin (all countries in the paper's sample have either British or French legal origin).

The use of settler mortality as an instrument for institutions follows Acemoglu and co-authors, for the reasons explained before. The use of legal origin as an instrument follows La Porta et al. (1999), Beck et al. (2003) and Levine (2005). Using for XCON average values from 1990 to 2000, Acemoglu and Johnson (2005) find that XCON is insignificantly correlated with legal origin. However, it can be shown that this is only true for the 1990s. Before the 1990s, XCON was significantly correlated with legal origin and is therefore an appropriate instrument for the average value of XCON from 1960 to 2000.

## 4. THE BASIC RESULT

Table 1 contains the results of the first-stage regressions for the youth dependency ratio and the paper's measure for institutions. It is evident from the table that settler mortality, one of the instruments of institutions, is not only highly correlated with institutions, but also with the youth dependency ratio. This causes some identification problems and is, most likely, due to the fact that infant and child mortality affect the youth dependency ratio and both mortality rates are also correlated with settler mortality. However, it is also evident from Table 1 that last section's first set of instruments (KGPTEMP and KGPTR) mainly affects the youth dependency ratio, while LEGALENG, from last section's second set of instruments, mainly affects institutions. Therefore, an important feature of the aforementioned two sets of instruments is that all instruments, apart from settler mortality, have a nice separable form. If this were not the case, problems would arise from high multicollinearity between the fitted values of the youth dependency ratio and those of institutions, making identification impossible (see, Kraay and Dollar, 2003). That the two sets of instruments have to some extent a nice separable form is confirmed by the fact that, in each first stage regression, the Shea Partial $R^2$ does not differ much from the Partial $R^2$ (see the two bottom rows of Table 1). Both statistics

TABLE 1

First stage regression for LNYOUTHDEP & XCON, 1960-2000

| **First-stage regression** | LNYOUTHDEP | XCON |
|---|---|---|
| LNYWA in 1960 | -0.07 (0.01) | 0.87 (0.00) |
| KGPTEMP | -0.42 (0.00) | -1.02 (0.17) |
| KGPTR | -0.10 (0.05) | 0.25 (0.60) |
| LNMORT | 0.03 (0.03) | -0.57 (0.00) |
| LEGALENG | -0.05 (0.16) | 1.96 (0.00) |
| Partial $R^2$ | 0.51 | 0.55 |
| Shea Partial $R^2$ | 0.47 | 0.51 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted.

measure, for each first-stage regression, the correlation between the instruments and the instrumented variable. However, the degree to which the instruments take a nice separable form is only measured in the Shea Partial $R^2$. If the value of the Shea Partial $R^2$ dropped a lot in comparison to the Partial $R^2$, then this would show that too many instruments are correlated with both instrumented variables and identification would be impossible.[9]

Table 2 shows the second-stage regression results of the paper's basic regression equation, which is last section's equation (2), without any control variable $Z$ other than possibly dummy variables for world regions. The table contains results from two different estimators, namely, the more common 2SLS and the Fuller estimator. In addition, the table shows results from Fuller estimations with dummy variables for Sub-Saharan Africa and the East Asian Pacific Region (which turned out to be the only significant regional dummies).[10] Stock et al. (2002) and Hahn and Hausman (2003) suggest Fuller estimation in case of weak instruments (i.e. in case the instruments are only weakly correlated with the instrumented variables).[11] In case instruments are correlated with more than one instrumented variable (as discussed above), a weak instrument problem might arise.

A glance at Table 2 shows evidence for conditional convergence, as in all three regressions the coefficient of LNYWA in 1960 is significant and negative. More importantly, in all three regressions, the youth dependency ratio has a significant and negative effect on economic growth, while institutions have a significant and positive effect on economic growth (with a p-value of 0.09 for XCON in case of Fuller estimation with regional dummies). This shows that demography, as well as institutions, both matter for economic growth.

The row above the bottom row of Table 2 shows the Cragg-Donald

TABLE 2

Explaining annual growth of output per working-age person, 1960-2000.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -0.86 (0.00) | -0.86 (0.00) | -1.00 (0.00) |
| LNYOUTHDEP | -2.84 (0.02) | -2.59 (0.05) | -2.81 (0.00) |
| XCON | 0.30 (0.01) | 0.34 (0.01) | 0.16 (0.09) |
| Sub-Saharan Africa | | | -0.99 (0.00) |
| East Asian Pacific Region | | | 1.21 (0.03) |
| Cragg-Donald Statistic (critical value) | 10.58 (11.04) | 10.58 (8.53) | 11.90 (8.53) |
| Sargan Statistic (OIR) | 0.09 | 0.09 | 0.56 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT and LEGALENG.

[9] In Table 1, the first-stage regressions include also LNYWA in 1960. This is due to the fact that, in 2SLS, the first-stage regressions include all exogenous variables and these are, apart from the instruments that appear only in the first-stage regressions, also the exogenous variables that appear in the second-stage regression, i.e. in last section's equation (2).

[10] Throughout the paper, results with 2SLS with regional dummies are similar to the results with Fuller estimation and are therefore not shown.

[11] Throughout the paper, as has been suggested in case of Fuller estimation, the user-supplied Fuller parameter alpha is set equal to one. All estimations were done in STATA using the command "ivreg2".

Statistics. This statistic shows whether or not the instruments are weak. In the table, below the Cragg-Donald Statistics in parenthesis are shown the five percent critical values compiled by Stock and Yogo (2005). A Cragg-Donald Statistic below this critical value implies that the instruments are weak at the 5 percent significance level. In turn, weak instruments cause a distortion of the conventional significance test of the instrumented variables. Stock and Yogo show that this conventional significance test is severely distorted, if the Cragg-Donald Statistic is below seven (cf. Carstensen and Gundlach, 2006). In Table 2 the Cragg-Donald Statistic is always above seven. Furthermore, in case of Fuller estimation the Cragg-Donald Statistic is always above the critical value, while it is only slightly below the critical value, in case of 2SLS. Hence, in case of the basic regression, there is no weak instrument problem.

The bottom row of Table 2 shows the Sargan Statistics. This statistic shows the p-value of the Sargan-Hausman test of overidentifying restrictions. A high p-value indicates that none of the instruments belongs into the second-stage regression. In case of estimation without regional dummies, the Sargan Statistics show that some instruments might possibly belong into the second-stage regression. However, the third regression estimation with regional dummies shows that in this case clearly none of the instruments belongs into the second-stage regression.

## 5. ROBUSTNESS WITH RESPECT TO OTHER DEMOGRAPHIC OR DEMO-GEOGRAPHICAL VARIABLES

As mentioned in section 2, Bloom and Williamson (1998) and Bloom et al. (2001) included, in their growth regressions, growth of the total population and growth of the working age population as regressors and used growth of output per worker as their regressand. Further, Bloom et al. (2001) point out that coefficients of -1 and +1 for growth of the total population and growth of the working age population, respectively, implies a pure accounting effect from these variables. In contrast, if the absolute values of these coefficients exceed one, then these two variables also have behavioral effects. As discussed in section 2, the present study uses, in growth regressions, growth of output per working-age person as regressand because this measure of economic growth is free of the accounting effect. In case of growth of output per working-age person as regressand, significance of growth of the total population and growth of the working age population implies presence of behavioral effects from these variables. As Kelley and Schmidt (2005) and Prskawetz et al. (2004) argue, from the point of view of economic theory, it seems more reasonable to think of a behavioral effect from the level of the dependency ratio (the population below and above working age divided by the population of working age) than from growth of the dependency ratio. The reason for this is the fact that, according to economic theory, savings are only affected from the level of the dependency ratio and not its growth rate. Nevertheless, this paper follows the approach in Kelley and Schmidt (2005) and Prskawetz et al. (2004) to let the data speak and tests explicitly for a growth effect from growth of the dependency ratio. For this purpose, the variable DEPRATIOGROWTH has been calculated as the difference between growth of the total population and growth of the working-age population.

Table 3 contains the result from adding DEPRATIOGROWTH as an instrumented control variable to the basic regression.[12] As instrument for this control variable the paper uses a malaria ecology index, abbreviated ME, which turned out to be significant for DEPRATIOGROWTH. The malaria ecology index is taken from Kiszewski et al. (2004) and is, in the aforementioned literature supporting the geography hypothesis, used as an exogenous instrument for malaria prevalence. In the table, the first two regressions, which do not contain regional dummies, suggest a significant growth effect of growth of the dependency ratio. However, the third regression, which contains regional dummies, reveals that in this case growth of the dependency ratio is insignificant and therefore does not imply a behavioral effect. A glance at the bottom of the table, though, reveals a very low Cragg-Donald Statistic in all three regressions, implying that there is a weak instrument problem in these regressions.

TABLE 3

Explaining annual growth of output per working-age person, 1960-2000, controlling for DEPRATIOGROWTH as instrumented variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -1.08 (0.00) | -1.08 (0.00) | -1.08 (0.00) |
| LNYOUTHDEP | -3.76 (0.00) | -3.76 (0.00) | -3.45 (0.01) |
| XCON | 0.05 (0.74) | 0.05 (0.74) | 0.09 (0.62) |
| DEPRATIOGROWTH | 2.45 (0.01) | 2.45 (0.01) | 1.26 (0.60) |
| Sub-Saharan Africa | | | -0.57 (0.46) |
| East Asian Pacific Region | | | 0.95 (0.19) |
| Cragg-Donald Statistic (critical value) | 2.56 (9.53) | 2.56 (NA) | 0.70 (NA) |
| Sargan Statistic (OIR) | 0.56 | 0.56 | 0.33 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT, LEGALENG and ME. NA means non-available.

The aforementioned literature supporting the geography hypothesis argues that there is a direct growth effect from malaria prevalence. Hence, it could be that, in the last section's basic regression, the youth dependency ratio captured spuriously the growth effect from malaria prevalence. To check for this possibility, Table 4 contains the results from controlling malaria prevalence, MALFAL, as a further instrumented variable. Following the aforementioned literature, malaria prevalence is instrumented with the malaria ecology index, ME. Table 4 reveals an insignificant growth effect from malaria prevalence in all three regressions. In contrast, the youth dependency ratio remains in all cases significant. The Cragg-Donald Statistics at the bottom of the table seem to be below the critical values. However, in the regressions without regional dummies they are only slightly below seven. Hence, the instruments are weak, but they seem not to be very weak. Therefore, it seems

[12] Use of this variable as control variable implies the same magnitude of the coefficient of growth of the total population and growth of the working-age population (with opposite sign). In principle, this does not have to be the case. However, it is difficult to find different instruments for both variables. In addition, population growth is highly correlated with the youth dependency ratio, giving rise to a multicollinearity problem.

TABLE 4

Explaining annual growth of output per working-age person, 1960-2000, controlling for MALFAL as instrumented variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -1.00 (0.00) | -0.99 (0.00) | -0.89 (0.00) |
| LNYOUTHDEP | -2.69 (0.02) | -2.48 (0.04) | -2.98 (0.00) |
| XCON | 0.24 (0.08) | 0.28 (0.06) | 0.19 (0.10) |
| MALFAL | -0.67 (0.25) | -0.59 (0.34) | 1.53 (0.30) |
| Sub-Saharan Africa | | | -2.01 (0.06) |
| East Asian Pacific Region | | | 0.71 (0.33) |
| Cragg-Donald Statistic (critical value) | 6.65 (9.53) | 6.65 (NA) | 2.02 (NA) |
| Sargan Statistic (OIR) | 0.15 | 0.16 | 0.50 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT, LEGALENG and ME. NA means non-available.

sensible to conclude that the significant growth effect of the youth dependency ratio is robust to controlling for malaria prevalence.[13]

## 6. ROBUSTNESS WITH RESPECT TO NON-DEMOGRAPHIC VARIABLES[14]

Among others, Bloom and Sachs (1998) argued that other geographical variables than malaria prevalence could affect economic growth as well. Masters and McMillan (2001) show evidence for a growth effect of climate conditions. Indeed, climate conditions could affect economic growth indirectly though its effect on agricultural productivity. Gallup et al. (1999) point to a growth effect from high transport costs in Africa that hamper participation in the major world markets and could therefore negatively affect economic growth. For these reasons, it could be that, in the basic regression of section 3, the youth dependency ratio captured the growth effect from other geographical variables than malaria prevalence.

Table 5 shows the results from including PLFST5 as an exogenous control variable. PLFST5 measures the proportion of land with more than 5 frost-day per month in winter and is the preferred measure for climate conditions of Masters and McMillan (2001). The table shows that there is clearly no significant growth effect from PLFST5, while, by and large, the youth dependency ratio remains significant. In addition, the Cragg-Donald Statistics reveal that there is not a serious weak instrument problem.

[13] In defence of the literature supporting the geography hypothesis, it should be mentioned though, that, in the regressions of Table 4, MALFAL is the average of MALFAL in 1966 and 1994. It is quite possible that MALFAL in 1966 contains measurement errors leading to a downwards bias of the coefficient of MALFAL.

[14] Levine and Renelt (1992) find the investment rate to be the most robust determinant of growth. However, investment rates are highly endogenous. Related, as Kelley and Schmidt (2005) argue, according to growth theory, significance of investment rate would suggest that the set of exogenous variables determining the steady state income level is incomplete. For these reasons, this section does not control for investment rates.

TABLE 5
Explaining annual growth of output per working-age person, 1960-2000, controlling for PLFST5 as exogenous variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -0.82 (0.00) | -0.80 (0.00) | -0.97 (0.00) |
| LNYOUTHDEP | -2.46 (0.08) | -1.77 (0.28) | -2.09 (0.07) |
| XCON | 0.28 (0.02) | 0.35 (0.01) | 0.17 (0.10) |
| PLFST5 | 0.37 (0.51) | 0.48 (0.42) | 0.51 (0.26) |
| Sub-Saharan Africa | | | -1.02 (0.00) |
| East Asian Pacific Region | | | 1.37 (0.01) |
| Cragg-Donald Statistic (critical value) | 8.00 (11.04) | 8.00 (8.53) | 8.52 (8.53) |
| Sargan Statistic (OIR) | 0.02 | 0.03 | 0.11 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT and LEGALENG.

In the regressions of Table 6 LANDLOCK is added as an exogenous control variable to the basic regression. LANDLOCK is a dummy variable that takes on value of 1 if a country is landlocked. The variable is supposed to capture a growth effect from high transport costs. A glance at Table 6 reveals that also LANDLOCKED is insignificant, while the youth dependency ratio remains quite robustly significant. The Cragg-Donald Statistics show absence of a weak instrument problem.

TABLE 6
Explaining annual growth of output per working-age person, 1960-2000, controlling for LANDLOCKED as exogenous variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -0.80 (0.00) | -0.79 (0.00) | -0.97 (0.00) |
| LNYOUTHDEP | -2.43 (0.06) | -2.22 (0.10) | -2.64 (0.01) |
| XCON | 0.29 (0.02) | 0.32 (0.01) | 0.15 (0.12) |
| LANDLOCKED | -0.40 (0.32) | -0.40 (0.34) | -0.24 (0.44) |
| Sub-Saharan Africa | | | -0.99 (0.00) |
| East Asian Pacific Region | | | 1.21 (0.02) |
| Cragg-Donald Statistic (critical value) | 10.14 (11.04) | 10.14 (8.53) | 11.36 (8.53) |
| Sargan Statistic (OIR) | 0.13 | 0.13 | 0.11 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT and LEGALENG.

Finally, there could also be an effect from culture on economic growth (see, e.g., Weil, 2005, Ch. 14). Easterly and Levine (1997) argue that high ethnic fractionalization contributes to Africa's low economic growth. Moreover, Grier (1997) and Barro and McCleary (2003) argue that religion affects economic growth. Again, omission of cultural variables could lead to a spuriously significant coefficient of the youth dependency ratio.

Table 7 shows that there is a significant growth effect of ethnic fractionalization, ETHNICFRAC, in regressions that do not control for regional dummies. Nevertheless, the youth dependency remains significant with p-

TABLE 7

Explaining annual growth of output per working-age person, 1960-2000, controlling for ETHNICFRAC as exogenous variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -0.94 (0.00) | -0.94 (0.00) | -1.00 (0.00) |
| LNYOUTHDEP | -2.41 (0.05) | -2.25 (0.07) | -2.70 (0.00) |
| XCON | 0.32 (0.01) | 0.34 (0.01) | 0.18 (0.08) |
| ETHNICFRAC | -1.20 (0.05) | -1.21 (0.05) | -0.33 (0.59) |
| Sub-Saharan Africa | | | -0.88 (0.01) |
| East Asian Pacific Region | | | 1.30 (0.02) |
| Cragg-Donald Statistic (critical value) | 10.23 (11.04) | 10.23 (8.53) | 11.25 (8.53) |
| Sargan Statistic (OIR) | 0.20 | 0.20 | 0.57 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT and LEGALENG.

values of 0.05 and 0.07. The third regression shows that ethnic fractionalization becomes insignificant, once one controls for regional dummies. In contrast, the youth dependency ratio is highly significant in this regression. The Cragg-Donald Statistics reveal that, in the regressions of Table 7, there is no weak instrument problem.

Table 8 includes, as exogenous control variables, dummy variables for the principle religion in a country. The table shows, for each of the three regressions, the p-value of a test of joint significance of these dummy variables. It is evident that religion is always clearly insignificant. In addition, the youth dependency ratio is always significant. As before, the Cragg-Donald Statistics show absence of major problems from weak instruments.

TABLE 8

Explaining annual growth of output per working-age person, 1960-2000, controlling for religion as exogenous variable.

| **Second-stage regression** | 2SLS | Fuller | Fuller |
|---|---|---|---|
| LNYWA in 1960 | -1.06 (0.00) | -1.07 (0.00) | -1.07 (0.00) |
| LNYOUTHDEP | -3.22 (0.01) | -3.01 (0.03) | -3.05 (0.00) |
| XCON | 0.37 (0.00) | 0.42 (0.00) | 0.21 (0.08) |
| P-value for religion | (0.57) | (0.55) | (0.87) |
| Sub-Saharan Africa | | | -0.87 (0.01) |
| East Asian Pacific Region | | | 1.32 (0.02) |
| Cragg-Donald Statistic (critical value) | 9.60 (11.04) | 9.60 (8.53) | 8.16 (8.53) |
| Sargan Statistic (OIR) | 0.09 | 0.10 | 0.57 |

Notes: The p-values are in parentheses behind the values of the coefficients. The constant is omitted. The instruments are KGPTEMP, KGPTR, LNMORT and LEGALENG.

APPENDIX

TABLE A1
LIST OF COUNTRIES IN SAMPLE

| | | | | |
|---|---|---|---|---|
| Algeria | Colombia | Ghana | Mali | Rwanda |
| Argentina | Congo Rep. of | Guatemala | Mexico | Senegal |
| Australia | Costa Rica | Guinea | Morocco | South Africa |
| Benin | Côte d'Ivoire | Guinea-Bissau | New Zealand | Sri Lanka |
| Bolivia | Dominican Rep. | Honduras | Nicaragua | Tanzania |
| Brazil | Ecuador | India | Niger | Togo |
| Burkina Faso | Egypt | Indonesia | Nigeria | Trinid. & Tobago |
| Cameroon | El Salvador | Jamaica | Pakistan | Uganda |
| Canada | Ethiopia | Kenya | Panama | United States |
| Chad | Gabon | Madagascar | Paraguay | Uruguay |
| Chile | Gambia | Malaysia | Peru | Venezuela |

TABLE A2
VARIABLE DEFINITIONS AND SOURCES

| Variable | Description | Source |
|---|---|---|
| GDPpercapita | GDP per capita, in international dollars of 2000 according to Laspeyres method. | Penn World Table 6.2. |
| PopPWT | Total population. | Penn World Table 6.2. |
| Pop15-64 | Working age-population (i.e. population of age 15-64). | World Population Prospects: The 2006 Revision Population Database (WPP 2006). |
| LNYWA | Natural logarithm of initial GDP per working-age person (i.e. of age 15-64). Calculated as natural logarith of (GDPpercapita*PopPWT)/(Pop15-64). | Own calculations. |
| GROWTH | Average annual growth rate of GDP per working age-person as an average of 1960 to 2000 (calculated as, (1/40)*(LNYWA2000-LNYWA1960)*100) | Own calculations. |
| Pop0-14 | Population of age 0-14. | WPP 2006. |
| LNYOUTHDEP | Natual logaithm of youth dependency ratio (calculated as ln of Pop0-14/Pop15-64), average of 1960-2000. | Own calculations. |
| XCON | Constraint on executive, average over all available years from 1960 to 2000 (treating interregnums as missing values). | Policy IV Project, Center for Global Policy. |
| KGPTEMP | Percentage of population 1995 in Köppen-Geiger temperate zones. | GIS Data, Physical Geography, Center for International Development, Harvard University. |
| KGPTR | Percentage of population 1995 in Köppen-Geiger tropics. | GIS Data. |
| LNMORT | Natural logarithm of settler mortality in the early 19th century. | Acemoglu and Robinson (2005). |

TABLE A2
VARIABLE DEFINITIONS AND SOURCES

| Variable | Description | Source |
|---|---|---|
| LEGALENG | Dummy that takes on value of 1 if country is British legal origin. | Acemoglu and Robinson (2005). |
| Sub-Saharan Africa | Dummy that takes on value of 1 if country is located in Sub-Saharan Africa. | Global Development Network. |
| East Asian Pacific Region | Dummy that takes on value of 1 if country is located in the East Asian Pacific Region | Global Development Network. |
| POPUN | Total Population according to WPP 2006. | WPP 2006. |
| DEPRATIOGROWTH | Difference between growth of total population (1/40)*(POPUN2000-POPUN1960)*100) and growth of the working-age population (1/40)*(Pop15-64,2000-Pop15-64,1960)*100) | Own calculations. |
| ME | Malaria ecology index. | Home page of Jeffrey Sachs. |
| MALFAL | Percentage of the population at risk of contracting falciparum malaria in a country, average 1966 and 1994. | Gallup et al. (1999). |
| PLFST5 | Proportion of land with more than 5 frost-day per month in winter. | Masters and McMillan (2001). |
| LANDLOCKED | Dummy that takes on value of 1 if country is landlocked. | Global Development Network. |
| ETHNICFRAC | Index of ethnical fractionalization of a country. | Alesina et al. (2003). |
| Catholic, Muslem, Protestant | Dummy that takes on value of 1 if principle religion in country is catholic, muslim or protestant | La Porta et al. (1999). |
| Orelig | Dummy that takes on value of 1 if principle religion in country is other than catholic, muslim, or protestant. | La Porta et al. (1999). |

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