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Trust and economic growth: a robustness analysis

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This paper analyses the robustness of results on the relationship between growth and trust previously derived by Knack and Keefer (1997) and Zak and Knack (2001) along several dimensions, acknowledging the complexity of the concept of robustness. Our results show that the Knack and Keefer results are only limitedly robust, whereas the results found by Zak and Knack are highly robust in terms of significance of the estimated coefficients and reasonably robust in terms of the estimated effect size. The improvement in robustness is caused by the inclusion of countries with relatively low scores on trust (most notably, the Philippines and Peru). Overall, our results point at a relatively important role for trust. However, the answer to the question how large this payoff actually is depends on the set of conditioning variables controlled for in the regression analysis and—to an even larger extent—on the underlying sample.

1. Introduction

Economists increasingly pay attention to social capital as an important determinant of macroeconomic performance (see, for example, Durlauf, 2002a, for an introduction to a symposium on social capital in *The Economic Journal*). The revival in interest for social capital has been triggered by intuitively appealing studies of Putnam *et al.* (1993) and Fukuyama (1995). Putnam's 1993 *Making Democracy Work* has raised the interest of economists in more culturally-based factors that influence economic growth. Also Fukuyama's study on *Trust* has contributed to the increased attention for the relevance of social capital in economics. According to Fukuyama (1995), societies endowed with generalised trust enjoy a form of social capital that—complementary to traditional factor endowments such as labour and capital—contributes to their success in modern economic competition. Fukuyama argues that non-family or generalised trust is of importance for successful performance in advanced economies. Although the way economists use a traditionally sociological concept like social capital can be criticised (Fine, 2001), it is probably one of the most successfully introduced 'new' concepts in economics in the last decade.

Empirical evidence that aims to identify a role for social capital has been accumulated in various empirical research traditions. We refer to Durlauf (2002b) for a critical review and discussion of three leading studies in the field. Two seminal papers in the macroeconometric growth literature on social capital are Knack and Keefer (1997) and Zak and Knack (2001). Knack and Keefer investigate whether social capital has an economic payoff by studying a cross section of 29 market economies. For this purpose, they explore—amongst others—the relationship between interpersonal trust, norms of civic co-operation, and economic performance. In their empirical analysis, they primarily focus on the role of trust as they feel it is the most important indicator of social capital. The empirical measure that they use to proxy for trust is based on the World Values Survey (WVS) that contains extensive survey data on respondents in a number of countries. More specifically, the level of trust in a society is assessed by using the question: 'Generally speaking, would you say most people can be trusted, or that you cannot be too careful in dealing with people?'. Trust is measured as the percentage of respondents in each country that replied 'most people can be trusted'. The empirical results of Knack and Keefer point at a statistically significant effect of trust on growth. They state that 'the coefficient for trust...indicates that a ten percentage point rise in that variable is associated with an increase in growth of four-fifths of a percentage point' (Knack and Keefer, 1997, p.1260).

Zak and Knack (2001) extend the analysis by adding 12 countries to the sample of Knack and Keefer. Moreover, they exclusively concentrate on trust and the factors that produce trust. Most of the data that they use are taken from Inglehart *et al.* (2000) and are a mix of 1981, 1990, and 1995–6 WVS survey results. These data are complemented with data from the Eurobarometer and a government-sponsored survey in New Zealand. On the basis of their analysis for 41 countries, Zak and Knack conclude that trust has a significant impact on aggregate economic activity. They state explicitly that 'growth rises by nearly 1 percentage point on average for each 15 percentage point increase in trust (a one standard deviation increase)' (Zak and Knack, 2001, p.307–9).

The previously described empirical analyses fit in the class of Barro regressions (after Barro, 1991). These regressions aim at finding the factors that can explain the variation in economic growth performance across large cross sections of countries. This type of analysis was severely criticised in an influential article by Levine and Renelt (1992) for its perceived lack of robustness. For some time, this analysis was considered as a 'kiss of death' for the empirical analysis of economic growth using Barro regressions. More recently, the robustness criterion adopted by Levine and Renelt was challenged by Sala-i-Martin (1997), who developed an alternative criterion to judge robustness. His approach results in a more 'positive' view on the possibilities to explain growth in a satisfactory and robust way. Nevertheless, an important problem with this literature is that usually authors do not properly establish that their choice of regressors is rich enough to avoid that findings that are reported result from omitted variables that causally affect growth and are correlated with the variable of interest (in this case, trust). We refer to Durlauf (2002b) for an elaboration of this point. This problem points at the relevance of a properly conducted robustness analysis.

The evolution of the literature on robustness exemplified by the papers of Levine and Renelt (1992) and Sala-i-Martin (1997) in a sense reveals that there is a lack of a generally accepted definition of robustness. Or alternatively, it illustrates that robustness is a multi-dimensional concept that cannot be analysed with one single indicator. In this paper, we start from the latter notion regarding the concept of robustness. We analyse the robustness of the results obtained by Zak and Knack[1] along four dimensions of robustness. First we concentrate on the statistical significance of trust. We do not only apply the Extreme Bounds Analysis, but also consider the variations proposed by Sala-i-Martin. The second dimension along which we explore the robustness of the results on trust is the influence of changing sets of conditioning variables on the estimated effect of trust. Third, we analyse the sensitivity of the results for using different proxies or specifications for 'basic' variables like human capital. Finally, we investigate the effects on the significance and effect size when the sample of 29 countries of Knack and Keefer is extended with 12 countries as has been done by Zak and Knack.

Our results indicate that Zak and Knack's conclusion on trust is reasonably robust along most of the dimensions. In terms of significance, we show that their results are highly robust. This also holds—although to a lesser extent—when we explore robustness in terms of effect sizes. Interestingly, we find that the extension of the Knack and Keefer sample with 12 countries strongly influences the robustness of trust, both in terms of significance and effect size. This analysis reveals that the inclusion of less-developed countries with 'generally speaking' low scores on trust is relevant for finding robust results. The latter result strongly suggests that data limitations are much more relevant than omitted variable biases (as suggested by Durlauf, 2002b) in explaining the lack of robustness of the Knack and Keefer results. If it would have been omitted variable biases driving the fragility of results, the Zak and Knack results should have been equally fragile as the Knack and Keefer results.[2]

We proceed with a general discussion on the concept of robustness in Section 2. In Section 3, we discuss the data and the methods to analyse robustness along four dimensions. The results of the different tests of robustness are discussed in Section 4. Section 5 concludes.

[1] In the main text, we almost exclusively focus on the robustness of the study with the most extensive sample, i.e. Zak and Knack (2001). However, where appropriate, we will compare the results with those for the Knack and Keefer (1997) sample.

[2] We are grateful to one of the referees for suggesting this interpretation of our results.

2. Robustness

The empirical literature that has aimed at finding the factors that can explain variation in economic growth has predominantly made use of simple linear cross-section regression equations. This literature has resulted in a plethora of statistically significant correlations between growth and explanatory variables such as investments, initial income, openness to trade, degree of capitalism, etc. However, for almost all of these correlations, there are counter-examples indicating insignificant (or even opposite) correlations casting doubt on the robustness of the obtained results.

The issue of robustness was explicitly addressed in a seminal paper by Levine and Renelt (1992). Their analysis is based on the Extreme Bound Analysis as developed by Leamer (1985). The Extreme Bound Analysis (EBA) starts with the estimation of a series of regressions of the form

$$g = F\alpha_j + \beta_{ij}x_i + C_j\gamma_j + \varepsilon_j, \quad \forall\ i, j \tag{1}$$

where g is a vector of *per capita* GDP growth rates, F is a matrix of variables that are always included in the regressions (including a constant) with the associated parameter vector α_j, x_i is the variable of interest with parameter β_{ij}, and C_j is a matrix of a subset of conditioning variables taken from the full set of potentially relevant explanatory variables for economic growth, with γ_j for the corresponding vector of parameter estimates. ε_j is a well-behaved vector of errors. The subscript i indexes the variable of interest and j the different combinations of conditioning variables. The matrix F contains variables that are typically included in almost any empirical analysis of economic growth. Among these variables are indicators for initial income to capture (conditional) convergence, and indicators for physical and human capital accumulation to capture the effects of (changing) capital stocks on economic growth. In the paper by Levine and Renelt, these variables are initial income, the investment rate, the secondary school enrolment rate and the rate of population growth. In his modification of the Levine and Renelt analysis, Sala-i-Martin (1997) uses initial income, life expectancy and the primary school enrolment rate as F-variables. The variable of interest can be any variable that the researcher thinks to be of vital importance in explaining variation in economic growth. In this paper, the main variable of interest is trust. Finally, the pool of additional explanatory variables consists of a wide range of indicators that in at least some studies have been identified as potentially relevant to explain variation in economic growth. For an overview of the wide range of variables that can sensibly belong to this pool, we refer to Durlauf and Quah (1999).

The basic idea of an EBA is to analyse the consequences of changing the set of conditioning variables C for the estimated effect of x_i on the rate of growth. For each estimated model j (where the model is characterised by its specific set of conditioning variables included in C), one obtains an estimate $\hat{\beta}_{ij}$ and a standard deviation $\hat{\sigma}_{ij}$. Leamer defines the upper and lower extreme bounds as, respectively, the maximum value of $\hat{\beta}_{ij} + 2\hat{\sigma}_{ij}$ and the minimum value of $\hat{\beta}_{ij} - 2\hat{\sigma}_{ij}$. A variable x is labelled as robust if the upper and lower extreme bound are both of the same sign. This condition boils down to all estimated coefficients being statistically significant at (approximately) 95% and of the same sign.

In a critique on the application of the EBA approach to assess the robustness of growth results, Sala-i-Martin (1997) proposed to relax the criterion imposed by Leamer. His basic argument is that the EBA-condition that a relationship should be significant as well as of the same sign in each and every regression equation is too strict. Instead, he proposes to consider the entire distribution of the estimated coefficients. His assessment of robustness is based on the fraction of the density function of the estimated coefficient that is lying to the right of zero. Provided that this fraction is sufficiently large (small) for a positive (negative) relationship, the relationship can be labelled robust. In his application, Sala-i-Martin uses a 'critical fraction' of 95%. Obviously, the number of robust relationships to be found by applying this less strict criterion increases.[3]

This discussion illustrates that there is no uniform definition for robustness. This is explicitly recognised in Florax *et al.* (2002), who consider a range of definitions of robustness. They analyse the sign, size, and significance of regression results. The analysis extends the work by Levine and Renelt and Sala-i-Martin by not only considering a wide range of robustness definitions but also, and more importantly, by explicitly analysing the robustness of the sizes of the estimated effects. The robustness criteria adopted by Levine and Renelt and Sala-i-Martin focus very heavily on statistical significance. Whether the estimated effect sizes are robust to changes in the conditioning set of variables is hardly addressed. We refer here to McCloskey (1985), and McCloskey and Ziliak (1996), for a pervasive critique on this practice in economics. To assess robustness along this dimension, Florax *et al.* (2002) extend the definition of robustness by requiring that the average estimated effect sizes conditional upon the inclusion of a particular variable are within predetermined bounds from the overall average estimated effect size. On the basis of this analysis, they conclude that the range of robust variables is—in contrast to the positive conclusion by Sala-i-Martin—fairly limited.

In the remainder, we assess the robustness of the relationship between growth and trust as analysed by Zak and Knack (2001) along four dimensions. First, we concentrate on the statistical significance. Second, we explore the robustness of Zak and Knack's results on trust in terms of effect sizes. And thirdly, we analyse the sensitivity of their results by allowing for different proxies or specifications for the set of fixed variables, i.e., initial income and human capital accumulation. And finally, we explore the influence of the composition of the sample. Starting with the sample of 29 countries in Knack and Keefer, we investigate the effect of the

[3] An alternative way to relax the criterion is to apply to so-called Reasonable Extreme Bounds test as proposed by Granger and Uhlig (1990). This test constructs the Extreme Bounds on the basis of a subset of estimated coefficients derived from regression equations with a relatively high goodness of fit measure. The logic for this test resides in the notion that regression equations with a low goodness of fit are less likely to be the correct ones. This can be seen as a justification for the exclusion of estimated coefficients derived from those equations. An alternative for this approach is the procedure of weighing regression results as proposed by Sala-i-Martin (1997).

12 countries added in Zak and Knack on robustness in terms of significance and effect size of the trust variable.

3. Method and data

The dataset used in this study is an extended version of the dataset constructed and used by Zak and Knack. Its core consists of:

(i) the dependent variable, being *per capita* GDP growth over the period 1970–1992 (as constructed from the Penn World Table; Summers and Heston, 1991);
(ii) the independent variables used by Zak and Knack, being the initial level of GDP *per capita* in 1970, schooling attainment for 1970 (mean years for the population aged 25 and over) from Barro and Lee (1993), the price of investment goods in 1970 as a percentage of US prices (from Summers and Heston, 1991), and the trust variable.

This dataset is further extended by a range of variables that have previously been identified as potentially relevant explanatory factors for economic growth (see, for example, Durlauf and Quah, 1999, for an overview). However, we do not consider all potentially relevant variables identified in the literature for our robustness analysis of the relationship between trust and economic growth. Instead, we only include those variables that can reasonably be argued to be exogenous to trust. The reason for this restriction is that if one expects that the variable of interest (*viz.* trust) influences growth through the variable to test robustness, then a reduction in significance of this variable does not necessarily result in a valid conclusion about robustness, but instead confirms the underlying hypothesis of multicollinearity.[4] In order to limit the problem of multicollinearity affecting the conclusion regarding robustness too heavily, we have decided to select conditioning variables that have a correlation coefficient with trust of less than 0.25 (in absolute value). Furthermore, we have added the investment ratio.[5] This

[4] We are grateful to the referees for pointing this out.

[5] Although the investment ratio is generally acknowledged to be endogenous, we have decided to include it because it is one of the central variables in the Zak and Knack paper and because it is commonly included in most of the empirical growth studies. Zak and Knack estimate two different basic growth regressions. One in which the investment ratio is not included (model 2 in their Table 1) and one in which it is included (in addition to the price of investment goods (model 3 in their Table 1). In both cases, they obtain a statistically significant result for trust. They conclude that 'controlling for investment rates in the growth regression, the trust coefficient declines somewhat' (Zak and Knack, 2001, p.309). As they seem to be indifferent with respect to including or excluding the investment ratio we have decided to include it as one of the switch variables. It is to be noted that including the investment ratio as one of the fixed variables or excluding it entirely from the set of switch variables hardly influences our results on trust that we will present in this paper (see the background file to this paper with additional results that can be found at http://oep.oupjournals.org/cgi/data/ In so far that the results are influenced, they are in line with the findings reported by Zak and Knack. For example they write in footnote 17 on page 309 that trust was no longer significant when investment was included as a regressor in the Knack and Keefer sample. Our analyses confirm their conclusions on the role of the investment ratio and the effect on (the robustness of) trust.

leaves us with 22 switch variables used for the robustness analysis (see the appendix for an overview of these variables and their sources). In addition we have applied a 0.50 correlation criterion, resulting in 50 conditioning variables.[6] Logically, the 22 variables are a sub-sample of these 50.

Starting from this dataset, our analysis of the robustness of the results described by Zak and Knack proceeds in two steps. First, we construct a database with the Barro regressions that we use for our robustness analysis. The regressions contained in this dataset are estimated with a varying set of conditioning variables as was done in the sensitivity analyses that we have discussed before. The variables that we take as fixed (the *F*-variables) in our analysis are a constant term, initial income, schooling, the price of investment goods relative to the USA and the measure for trust. These are the variables that are also included in all the regression equations estimated by Zak and Knack (in their Table 1, p.308). The subset of conditioning variables is taken from the full set of 22 explanatory variables mentioned above. In each regression equation, we include three conditioning variables.[7]

The size of the database that results from estimating all potential regression equations by combining the 22 switch variables in all possible combinations of three is equal to 1540 equations ($=(22)!/(3!(22-3)!)$).[8] After the construction of the dataset along these lines, we can assess the robustness of the relationship between trust and growth along the four dimensions mentioned earlier.

4. Robustness analysis

This section describes the results of our robustness analyses. The different subsections correspond with the four dimensions along which we explore the robustness of the relationship between growth and trust. In Section 4.1, we report on a series of robustness tests, ranging from the Extreme Bounds Test to a simple sign test. Section 4.2 analyses the robustness of the results in terms of estimated conditional effect sizes. Third, in Section 4.3 we consider the sensitivity of the results for the choice of the set of fixed variables. And finally, in Section 4.4 we compare the sample of 29 countries of Knack and Keefer with the larger sample of Zak and Knack. We explore the statistical robustness of trust in terms of significance and mean effect size when adding the 12 new countries included in the Zak and Knack study to the Knack and Keefer sample.

[6] The dataset and the associated robustness results that are obtained when imposing the 0.50 selection criterion are available at www.http://oep.oupjournals.org/cgi/data/ The results are in line with the intuition that the 'degree' of robustness of the relationship between trust and growth declines, once more variables are allowed to be included in the set of switch variables that are (highly) correlated with trust. The inclusion of such variables exacerbates the problem of multicollinearity and therefore tends to reduce the significance level of the trust coefficient and increase its variability.

[7] This number is admittedly arbitrary. We have experimented with including two or four conditioning variables, but this hardly changes the results.

[8] The regression equations were estimated with a software package developed for robustness analysis, *MetaGrowth 1.0* (see Heijungs *et al.*, 2001).

Table 1 Main estimation and robustness results for growth regressions*

Variable name	Mean	St. dev.	Conf. Int. left	Conf. Int. right	Positive	Sign +	Sign −	T1	T2	T3	T4	T5	T6
Schooling	−0.084	0.063	−0.104	−0.064	8.8%	0.0%	0.0%	−	−	−	−	+	0.287
Real GDP *per capita* 1970	−0.110	0.0725	−0.133	−0.087	10.3%	0.0%	0.7%	−	−	−	−	+	0.144
Investment good price 1970	−0.035	0.008	−0.038	−0.033	0.0%	0.0%	87.5%	+	+	−	−	+	0.003
Trust	0.061	0.011	0.058	0.064	100.0%	99.9%	0.0%	+	+	−	+	+	0.999
Confucius	7.991	0.411	7.778	8.204	100.0%	100.0%	0.0%	+	+	+	+	+	0.999
Investment/GDP	0.128	0.014	0.120	0.135	100.0%	98.1%	0.0%	+	+	−	+	+	0.998
Outward orientation	0.774	0.224	0.658	0.891	100.0%	46.66%	0.0%	+	+	−	−	+	0.972
Buddhist	2.520	0.667	2.175	2.866	100.0%	31.90%	0.0%	+	+	−	−	+	0.967
Accessibility	0.372	0.253	0.241	0.503	90.0%	0.0%	0.0%	−	−	−	−	−	0.667
Area (*10^4)	0.316	0.245	0.189	0.443	94.7%	0.0%	0.0%	−	+	−	−	−	0.650
Black market premium	0.026	0.048	0.001	0.052	74.2%	0.0%	0.0%	−	−	−	−	−	0.577
Public investment	1.205	3.587	−0.652	3.063	65.2%	0.0%	0.0%	−	−	−	−	−	0.551
Terms of trade	−0.672	6.334	−3.954	2.608	35.7%	0.0%	0.0%	−	−	−	−	−	0.475
Exchange rate distortions	−0.001	0.002	−0.003	−0.0002	21.9%	0.0%	0.0%	−	−	−	−	−	0.409
Labour force (*10^5)	−0.204	0.806	−0.621	0.213	12.9%	0.0%	0.0%	−	−	−	−	−	0.391
Public consumption	−1.774	3.054	−3.357	−0.192	33.8%	0.0%	0.0%	−	−	−	−	−	0.374
Political assassinations	−2.009	1.935	−3.011	−1.007	16.6%	0.0%	0.0%	−	−	−	−	−	0.372
St. dev. black market premium	−0.001	0.001	−0.001	−0.001	8.6%	0.0%	0.0%	−	−	−	−	−	0.346
Jewish	−17.65	12.38	−24.06	−11.24	9.5%	0.0%	0.0%	−	−	−	−	−	0.314
British	−0.316	0.329	−0.486	−0.145	18.6%	0.0%	0.0%	−	−	−	−	+	0.279
GDP in mining	−4.089	1.431	−4.831	−3.348	0.0%	0.0%	0.0%	+	+	−	−	+	0.208
Chr. orthodox	−0.013	0.004	−0.015	−0.011	0.0%	0.0%	0.0%	+	+	−	−	+	0.167
Sub Saharan Africa	−1.182	0.379	−1.378	−0.986	0.0%	0.0%	1.9%	+	+	−	−	+	0.133
Political instability	−3.694	0.622	−4.016	−3.371	0.0%	0.0%	0.0%	+	+	−	−	+	0.085
Hindu	−2.896	1.708	−3.780	−2.011	0.0%	0.0%	6.6%	+	+	−	−	+	0.068
Ethnolinguistic fractionalisation	−0.015	0.003	−0.016	−0.013	0.0%	0.0%	37.1%	+	+	−	−	+	0.032

*The first three (*F*) variables are fixed in all regressions. Trust is also included in all regressions as our variable of interest (*x*). The results for these variables are based on 1540 regressions. The results for the other 22 (*C*) variables are based on 210 regressions. The columns with the test results refer to: the strong and weak sign test (T1 and T2, respectively), the strong and weak extreme bounds test (T3 and T4), the weighted weak extreme bounds test (T5), and the cumulative density function test (T6); + indicates 'pass', and − indicates 'fail'. For the cumulative density function test, a variable passes the test (at 5% significance level) if the value for this test score is less than 0.05 or exceeds 0.95. The conditioning variables are ordered according to a declining score on robustness test T6.

4.1 Dimension 1: significance

Table 1 contains the outcome of the exploratory robustness analysis that we performed on the rate of economic growth. The table contains for the three fixed variables, the trust variable and the 22 switch variables: the mean of the estimated coefficients, their standard deviation, an associated 95% confidence interval, the fraction of positive estimated coefficients, the fraction of significantly positive and negative estimated coefficients and the outcomes of six robustness tests. We are of course mainly interested in the robustness of the relationship between trust and growth. In addition, however, we have also considered the robustness of the switch variables themselves. In those cases, for reasons of comparability, we restrict the number of (additional) switch variables to be included to two (so that also in those cases, we have seven explanatory variables in each and every regression equation, apart from the constant). What thus remains is a set of 22 variables that can be added in groups of two. This leaves us with 210 ($= (22-1)!/(2!(22-3)!)$) regression equations to be estimated.

The first and second robustness test reported in Table 1 (T1 and T2) are the strong and weak sign test, respectively, indicating whether all or at least 95% of the estimated coefficients are of equal sign. The third and fourth robustness test are the strong and weak EBA test, indicating whether all or at least 95% of the estimated coefficients are statistically significant and of the same sign. The fifth column reports the results of the weighted weak EBA test that indicates whether the weak EBA test is passed after having weighted with the log-likelihood. The sixth column reports the fraction of cumulative density function that is to the right of zero.[9] For this criterion, we label a variable robust if this fraction exceeds 95% or is less than 5%.

The results reveal that only the variable Confucius passes the strong EBA test. Of most interest for the present study are the results for trust. Trust is statistically significant in 99.9% of the cases. Regarding trust, the strong and weak sign test (T1 and T2), the weak extreme bounds test (T4) and the weighted extreme bounds test (T5) are passed. The strong extreme bounds test (T3) is not passed.[10]

4.2 Dimension 2: effect size

The second dimension of robustness focuses on the effect sizes of the estimated coefficients. The robustness tests so far have exclusively focused on the sign and statistical significance of the estimated coefficients. In the spirit of McCloskey (1985), we would like to emphasise the relevance of analysing robustness in terms of estimated effect sizes. For this aim we have calculated the conditional mean effect size of the trust coefficient. As Table 1 shows, the overall mean estimated coefficient of the trust variable equals 0.061. An important question that

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[9] The last two tests were introduced and applied by Sala-i-Martin (1997).

[10] For the Knack and Keefer sample, the relationship is much less robust. Trust is significantly positive in only 4.5% of the cases and only the weak sign test (T2) is passed. The weighted CDF equals 0.89.

arises is to what extent the size of this coefficient is influenced by including or excluding specific conditioning variables. In order to test for this, we have calculated the conditional mean effect size of trust, *viz.* the mean effect size conditional on the inclusion of a specific variable of the set of 22 switch variables that we selected before. Figure 1 graphically illustrates the results of our analysis for the (conditional) mean effect sizes.

The vertical bars in the figure represent the 90% confidence intervals around the average (conditional) estimated trust coefficient (indicated by the bold squares). The 22 conditioning variables indicated on the horizontal axis are ranked according to increasing conditional mean effect sizes. For the trust variable, it clearly matters which conditioning variable is included. The conditional mean effect size ranges from 0.044 in case the fraction of Confucians is included to 0.070 in case the fraction of Hindus is included. However, Fig. 1 also shows that all confidence intervals overlap, suggesting no statistically significant effect of the choice of conditioning variables on the size of the relationship between trust and growth.

In order to provide some quantitative intuition for the implications of the observed variation, we have determined what the minimum and maximum average estimated coefficient imply in terms of the predicted growth differential. We compare a hypothetical country that is characterized by a value of trust that exceeds the average of all countries with one standard deviation and a hypothetical country characterized by a value of trust that is one standard deviation less than the average of all countries in the sample. The trust variable in our database has a mean value of 32.3 and a standard deviation of 15.0. We thus calculate the predicted growth differential between a country with a score on trust equal to 47.3 (close to, for example, Australia) and a country with a score equal to 17.3 (close to, for example, Mexico). If we take the highest conditional average effect size (in this case when the variable Hindu is included), the predicted growth differential equals 2.10%, whereas if we take the lowest conditional average (in this case when the variable Confucius is included), it equals 1.30%. Zak and Knack's statement that 'growth rises by nearly 1 percentage point on average for each 15 percentage point increase in trust (a one standard deviation increase)' is in other words surrounded with a wide band of uncertainty given the sensitivity of the estimated coefficients for the set of conditioning variables.

4.3 Dimension 3: sensitivity for fixed variables

So far, our robustness analysis has taken the fixed (*F*-) variables included in all the regression equations estimated by Knack and Keefer for granted. In this subsection, we analyse the sensitivity of their results for changing the set of fixed variables. First, we replace the schooling attainment used by Zak and Knack (the mean years of schooling for the population aged 25 and over) with enrolment rates in primary and secondary education (where all data are taken from the Barro-Lee dataset on human capital). The second change to the set of fixed variables is that we replaced initial income with the log of initial income, which is more common in empirical

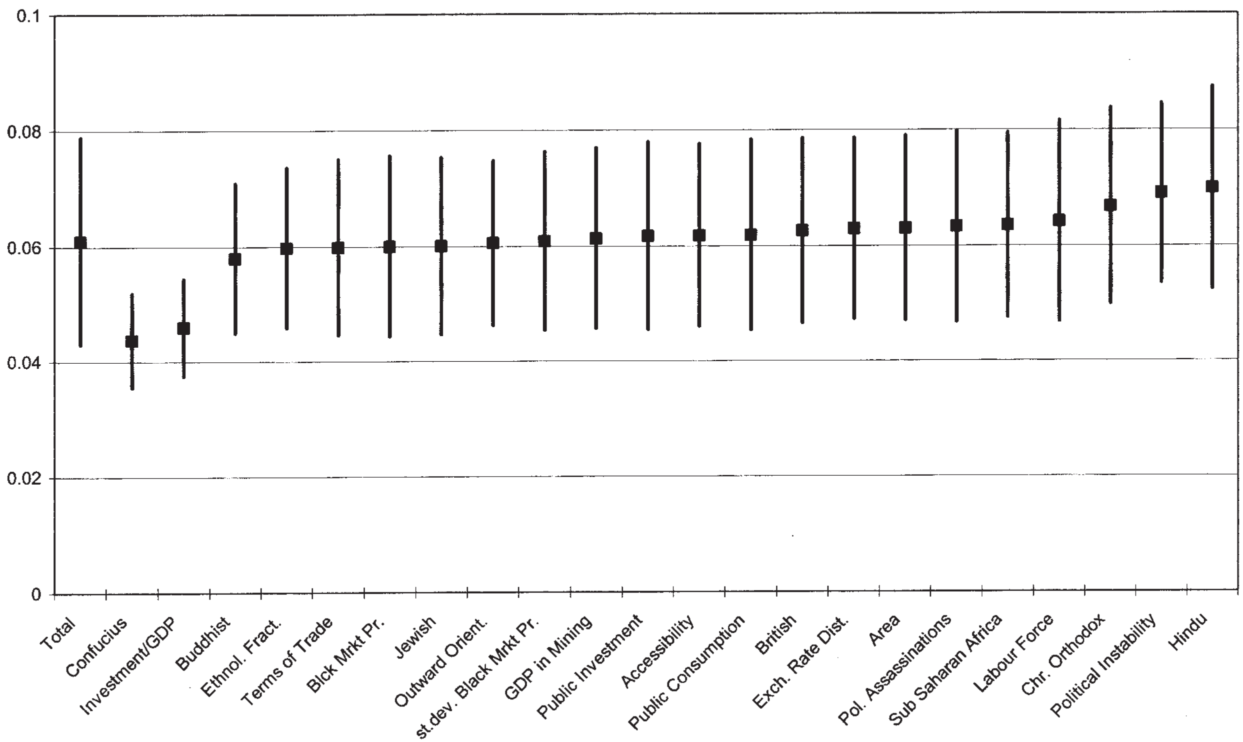

Fig. 1. Conditional mean effect size for trust coefficient (with 90% confidence interval). Note: The average and confidence interval for the TOTAL sample is based on 1540 estimated coefficients. The other conditional averages are based on 210 estimated coefficients.

Table 2 Sensitivity of trust for specification and choice of fixed variables

Model*	Mean	Positive	Sign +	T6
Basic model (see Table 1)	0.061	100%	99.9%	0.9995
Primary school enrolment rate instead of years of education (Barro and Lee)	0.059	100%	98.4%	0.9996
Secondary school enrolment rate instead of years of education (Barro and Lee)	0.058	100%	99.2%	0.9996
log (initial income) instead of initial income	0.059	100%	99.1%	0.9993

*The different models correspond to different specifications of the fixed variables. Labels of the columns are similar to those in Table 1.

growth studies. The results of changing the set of fixed variables are presented in Table 2. The results reveal that the overall result of Zak and Knack on trust is rather robust for alternative specifications of these fixed variables.

4.4 Dimension 4: composition of the sample

After the robustness in terms of significance, effect size, and alternative specifications, the final question that we will address is to what extent these robustness results differ between the analysis of Knack and Keefer (29 countries) and Zak and Knack (41 countries). Therefore we test the influence of the composition of the sample. To do so, we start with the sample of Knack and Keefer that included 29 countries. We subsequently add the 12 Zak and Knack countries according to decreasing values of trust (from Greece to Peru). Figure 2 summarises our results on the influence of the composition of the sample on the conditional mean effect size.

The vertical bars again represent the 90% confidence intervals of the conditional effect sizes of trust around their mean. The country added to the sample starting from the Knack and Keefer sample on the left-hand side of the Figure is shown on the horizontal axis. The result of including Peru (PER) logically corresponds with the earlier tests on the Zak and Knack sample of 41 countries.[11] The results reveal that as the size of the sample increases and countries with lower values of trust are added, the mean effect size of trust on growth also increases.[12] This result points at the potential relevance of substantial parameter heterogeneity. The increase in the robustness of the results furthermore suggests that the lack of robustness of the Knack and Keefer results is mainly due to data limitations and not so much to omitted variable biases (as suggested by Durlauf, 2002b).

[11] This is easy to check, since the conditional mean effect size on the far right in Fig. 2 is equal to the conditional mean effect size at the far left in Fig. 1 which equals the mean value of the trust coefficient in Table 1 (all 0.061).

[12] With the exception of Greece, our results in Fig. 2 support—although using a different methodology—the finding by Zak and Knack (2001, p.310) that the effect of the non-WVS observations (Greece, Luxembourg, and New Zealand) is limited.

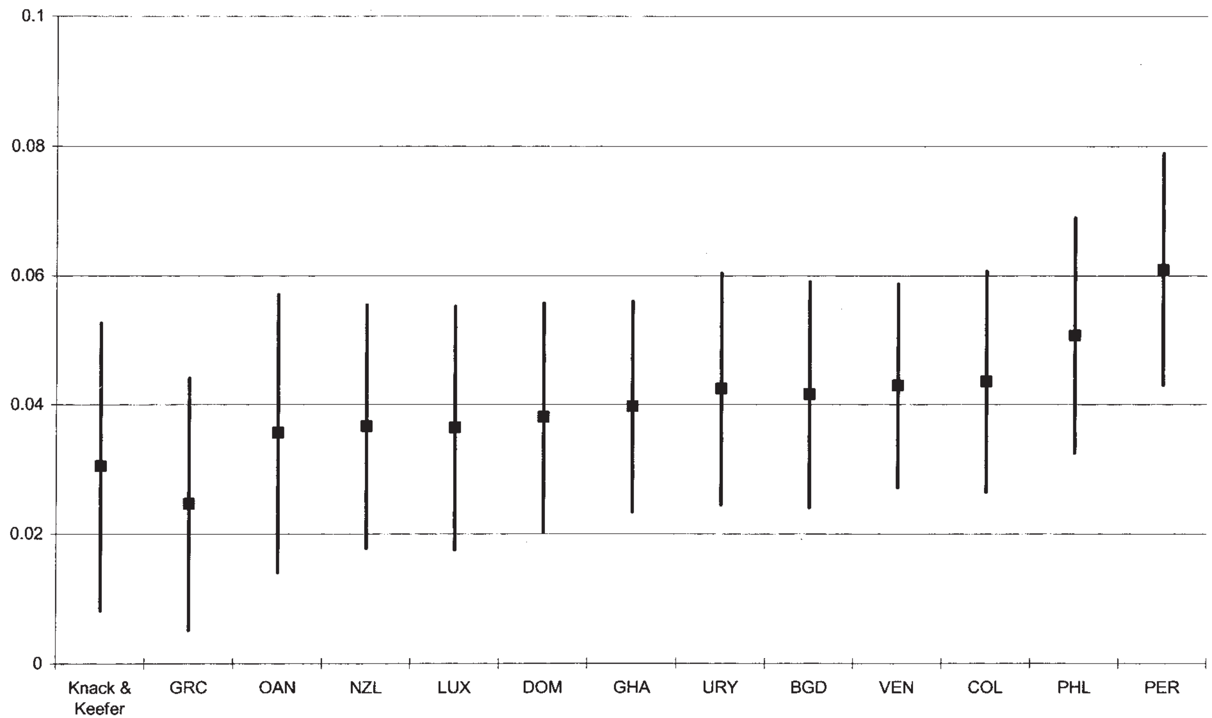

Fig. 2. Conditional mean effect size for trust coefficient with different underlying samples (with 90% confidence interval). Note: All averages and confidence intervals are based on 1540 estimated coefficients.

Table 3 Effects of the composition of the sample on trust*

Sample (country added to previous sample)	Mean	Positive	Sign +	T6
Knack and Keefer sample (29 countries)	0.030	98.6%	4.5%	0.894
Greece (GRC)	0.025	97.9%	0.9%	0.859
Oman (OAN)	0.036	99.4%	11.2%	0.930
New Zealand (NZL)	0.037	99.8%	16.6%	0.948
Luxembourg (LUX)	0.036	99.8%	17.6%	0.949
Dominican Republic (DOM)	0.038	100.0%	22.7%	0.958
Ghana (GHA)	0.040	100.0%	28.1%	0.967
Uruguay (URY)	0.042	100.0%	49.2%	0.977
Bangladesh (BGD)	0.042	100.0%	42.7%	0.975
Venezuela (VEN)	0.043	100.0%	56.2%	0.981
Colombia (COL)	0.044	100.0%	67.2%	0.987
Philippines (PHL)	0.051	100.0%	91.6%	0.997
Peru (PER)	0.061	100.0%	99.9%	1.000

*Labels of the columns are similar to those of Table 1. The countries are added to the sample according to decreasing scores on trust.

In Table 3 we have summarised some key results for each step in which one of the 12 countries is added to the sample. It shows that in the Knack and Keefer sample, the use of the earlier mentioned 22 conditioning variables results in a fraction of significant positive values for trust of only 4.5%. Also there are negative estimated coefficients for trust. Table 3 in combination with Fig. 2 shows that by adding mostly less developed countries to the sample of Knack and Keefer, the robustness of trust is increased both in terms of significance and in effect size.[13] More specific, especially the inclusion of Philippines and Peru increases the robustness of trust in Zak and Knack. The fraction of significant coefficients rises from 67.2% to 99.9% when these two countries are added.

5. Conclusion

In this paper, we have extensively analysed the robustness of the relationship between economic growth and trust, taking the analysis of Zak and Knack (2001) as a starting point and acknowledging the complexity of the robustness concept. Our analysis can be seen as a test on what can be learned from the macroeconometric literature on the relationship between trust and growth. Concerns on this literature were recently raised by Durlauf (2002b, p.F473) when he stated that 'the appropriate specification of cross country regressions is

[13] For reasons of expositional clarity, we have not shown the graph that shows the conditional mean effect size of trust in the Knack and Keefer sample. However, whereas Fig. 1 showed for the Zak and Knack sample that there were only overlapping confidence intervals, a similar analysis for the Knack and Keefer sample indicates that there are non-overlapping confidence intervals. This is another indication that the Knack and Keefer results are not very robust. Results are available on request.

very much an open question' and that 'they [Knack and Keefer] do not establish that their choice of regressors is rich enough to avoid the problem that their findings of social capital effects may be resulting from omitted variables. . .'. In our robustness analysis, we have tried to address this concern.

Our results reveal that the Zak and Knack results on trust in terms of statistical significance of the estimated coefficients are highly robust. Also in terms of the estimated effect sizes, the results are reasonably robust. These results are in sharp contrast with those for the Knack and Keefer (1997) paper that is only very limitedly robust. It turns out that the robust results obtained in Zak and Knack are to a large extent driven by the inclusion of countries that score low on trust (*viz.* the Philippines and Peru). The empirical literature on trust and economic growth therefore seems to be more plagued by data limitations than by econometric problems such as omitted variable biases. Our overall conclusion is that despite the variation in the size of the effect of trust on growth (both as a consequence of changes in the conditioning set of variables and of changes in the sample used for the analysis), our extensive robustness analysis further adds to the empirical evidence that trust matters for explaining variation in economic performance.

Supplementary material

Supplementary material can be found at http://oep.oupjournals.org/cgi/data/

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Appendix

This Appendix describes the variables that we have used in our analysis and their sources. In this Appendix, we restrict ourselves to the dependent and fixed variable and the 22 switch variables resulting from the 0.25 correlation criterion. The variables that resulted after imposing the 0.50 correlation criterion was applied are not shown. All datasets and a more extensive description of the variables are available at http://oep.oupjournals.org/cgi/data/ Our basic dataset starts from Zak and Knack (2001), further denoted as ZK. The human capital data used in Section 4.3 were taken from Barro and Lee (BL). The log of real GDP *per capita* in 1970 is just a transformation of real GDP *per capita* in 1970. The average investment ratio was constructed from the Penn World Table, Mark 5.6 (PWT56). The other institutional and geographical indicators included as switch variables were taken from Barro and Lee (BL), Sachs and Warner (SW), Sala-i-Martin (SiM) and Zak and Knack. We refer to the primary studies for more detailed information on the sources of these readily available data that are commonly used in empirical growth studies.

Dependent variable:	
Growth of GDP *per capita* 1970–1992	ZK
Fixed variables:	
Real GDP *per capita* 1970	ZK
Investment good price 1970	ZK
School attainment 1970	ZK
Trust	ZK
Primary school enrolment rate 1960	BL
Secondary school enrolment rate 1960	BL
log(Real GDP *per capita* 1970)	ZK

Conditioning variables		
1	Fraction of Confucians in population	SiM
2	Average Investment/GDP 1970—1992	PWT56
3	Outward orientation	SiM
4	Fraction of Buddhists in population	SiM
5	Accessibility to international waters	SW
6	Area (in km^2)	SiM
7	Black market premium	BL
8	Public investment	SiM
9	Terms of trade growth	SiM
10	Exchange rate distortions	SiM
11	Size of the Labour force	SiM
12	Political assassinations	SiM
13	Public consumption	SiM
14	St. dev. Black market premium	SiM
15	Fraction of Jews in population	SiM
16	Former British colony	SiM
17	Fraction of GDP in mining	SiM
18	Perc. Chr. Orthodox in population	ZK
19	Country in Sub Saharan Africa	SiM
20	Political instability	SiM
21	Fraction of Hindus in population	SiM
22	Ethnolinguistic fractionalisation	SW