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Does investment spur growth everywhere? Not where institutions are weak

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Abstract: We investigate the impact of investment on growth in a sample of 85 developed and developing countries over 1984-2009, conditioning the marginal effect of investment on institutional quality. The panel structure of our dataset allows controlling for unobserved heterogeneity and dealing with the risk of endogeneity bias. We find that investment increases growth more in countries with high institutional quality than in countries with defective institutions. The results are robust to estimating the model separately for developed and developing countries, for each continent, and over two sub-periods. A jackknife experiment shows that they do not depend on any single country. The results are essentially driven by the quartiles of countries with the lowest and the highest institutional quality, and by the government instability, corruption, and rule of law sub-components of the ICRG index.

Keywords: growth, investment, institutions.

JEL classification: O11, E02, P48.

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1. Introduction

While a dollar of investment costs a dollar everywhere, it does not always and everywhere result in a dollar of efficient capital. In other words, as Pritchett (2000) points out, “cumulated, depreciated, investment effort” is not capital. As he points out, various mistakes, distortions, and inefficiencies drive a wedge between the cost of capital and the amount of accumulated capital. Private investors can make mistakes, and overestimate the value of an investment. Unforeseen technological changes or price shifts may turn the value of a costly investment to zero. There are good reasons to believe that public investment is even more likely to result in low capital accumulation. First, public investors make mistakes too. Second, they do not face the same incentives as private investors to equate the cost of an investment with its value, because return maximization is not necessarily their objective. Instead, they face incentives of their own, that may result in over-investment, unproductive spending, or excessive depreciation. Where the institutional environment is deficient, waste is likely. This is documented by Tanzi and Davoodi (2002), who observed that corruption correlates with larger public expenditures, but with smaller maintenance expenditures and lower infrastructure quality. Similarly, de la Croix and Delavallade (2009) find that poor countries with a lower rule of law invest more in housing and physical capital and less in education. Those results are in line with those of Oto-Peralías and Romero-Ávila (2013), who observe that the size of the public sector has no significant effect on growth in countries with high bureaucratic quality, but a significantly negative effect in countries with low bureaucratic quality. Moreover, inefficiencies in public investment are likely to spill over to private investment. Reinikka and Svensson (2002) thus observe that poor provision of public infrastructure services reduces both the quantity and the efficiency of investment by Ugandan firms. O’Toole and Tarp (2014) report firm-level evidence that the efficiency of investment is lower in countries where corruption is more widespread. Those findings point out to the notion that the marginal impact of recorded investment on growth in a country should be a function of the quality of that country’s institutions.

Nevertheless, empirical studies of growth, following classic papers such as Barro (1991), Mankiw *et al.* (1992), or Levine and Renelt (1992), routinely use the cost of investment as a proxy for capital accumulation in linear regressions. The impact of investment is, therefore, assumed independent of the quality of the institutional environment. The issue is that if the same cost of investment leads to different amounts of accumulated productive

capital in different countries, then the relation between investment and growth should not be homogeneous across countries. Moreover, the estimated impact of investment in growth regressions is likely biased downward, because linear growth regressions pool together countries where each invested dollar leads to a dollar of productive capital, and countries where an invested dollar leads to much less than a dollar of productive capital. Policy recommendations based on their results would consequently be equally biased.

Admittedly, several studies, such as Durlauf *et al.* (2001), Maasoumi *et al.* (2007), or Henderson *et al.* (2012), have used non-linear techniques following Durlauf and Johnson (1995) to examine the determinants of growth. Their common message is that there is indeed heterogeneity in the estimated coefficients. Mitnik and Neumann (2003) and Kalaitzidakis and Tzouvelekas (2011) reached a similar conclusion respectively applying time series techniques on growth in Germany and a quadratic model on a panel of countries. However, while the quality of institutions is central to the impact of investment on growth, the literature allowing for non-linearities in growth determinants has almost entirely neglected that possibility. Three exceptions stand out, but their conclusions are contradictory. Gwartney *et al.* (2006) estimate standard growth regressions on sub-samples of countries of increasing economic freedom. They find that the impact of investment on growth increases with economic freedom. Minier (2007) estimates standard cross-section growth regressions interacting investment with the initial level of constraint on the executive. She concludes that, while a greater constraint on the executive can condition the impact of economic policies, it does not condition the impact of investment. Also using standard cross-section growth regressions, Hall *et al.* (2010) interact the investment rate with a measure of the risk of expropriation, and reach the opposite conclusion. Namely, they find that the marginal impact of investment is positive in low-risk countries and negative in high-risk countries.

Despite their conflicting results, the reliance of Gwartney *et al.* (2006), Minier (2007) and Hall *et al.* (2010) on cross-country regressions prevents them from controlling for unobserved heterogeneity, as can be done in a panel setting. Moreover, neither controls for endogeneity, which is a key issue in the institutions and growth literature, as Acemoglu *et al.* (2001) point out.

The aim of the present paper is precisely to take into account the notion that the impact of investment on growth is conditional on institutional quality, while carefully addressing the issues of unobserved heterogeneity, thanks to the panel structure of our dataset. More specifically, we improve on the works of Gwartney *et al.* (2006), Minier (2007) and Hall *et al.* (2010) by using panel growth regressions *à la* Islam (1995) with fixed country-effects,

estimated with both OLS and GMM dynamic panel-data regressions *à la* Arellano-Bond (1991). The GMM estimator is used to deal with the risk of an endogeneity bias.. Moreover, we provide a careful investigation of the interaction of investment with institutional quality following Friedrich (1982), Braumoeller (2004), and Brambor et al. (2005).

We obtain evidence of a positive impact of investment on growth. However, in line with the notion that there may be a larger wedge between the cost of investment and capital accumulation in countries with ineffective institutions, we observe that the positive impact of investment on growth is only observable for countries where the quality of the institutional framework is high enough while the impact is insignificant in countries with weak institutions.

To reach those conclusions, the rest of the paper is organized as follows. The next section describes our empirical strategy. Section 3 reports our baseline findings, while section 4 provides a series of robustness checks. Section 5 concludes.

2. Empirical Strategy

Our key contention is that the quality of the institutional environment is crucial to the impact of investment on growth, and that the marginal effect of investment on growth is a function of institutional quality. In this section, we first present the econometric model that we use to test that contention, and then describe the data to which it was applied.

2.1. Econometric Specification

To measure how the marginal effect of investment on economic growth varies with institutional quality, we estimate a standard panel growth regression model *à la* Islam (1995) while controlling for the quality of institutions and an interaction term between the quality of institutions and investment.¹

$$g_{it} = \alpha_0 \log(y_{0it}) + \alpha_1 \log(I_{it}) + \alpha_2 Inst_{it} + \alpha_3 \log(I_{it}) \times Inst_{it} + \Omega' X_{it} + \delta_i + \tau_t + \varepsilon_{it} \quad (1)$$

where

- $g_{it} \equiv \log(y_{1it}) - \log(y_{0it})$ is the average growth rate of the real per capita GDP of country i over period t ;

¹ Following common practice in panel-data estimation, the sample period (1984-2009) is divided into five shorter periods of five years each, except the first sub-period which counts six years. More precisely, the periods are: 1984-1989, 1990-1994, 1995-1999, 2000-2004, and 2005-2009. Using five-year periods allows using a panel structure while abstracting from short-run output fluctuations.

- y_{0it} is the level of country i 's real per capita GDP at the beginning of period t ;
- I_{it} is the average ratio of real gross domestic investment to real GDP in country i over period t ;
- $Inst_{it}$ is the average value of an index measuring institutional quality in country i and period t ;
- X_{it} is a column vector that includes control variable;
- Ω' is a vector of coefficients;
- δ_i is the individual country-specific fixed effect;
- τ_t is the period-specific fixed effect;
- ε_{it} is the idiosyncratic error term with mean equal to zero.

The marginal effect of investment on economic growth in country i over sub-period t can be computed by differentiating Equation (1) with respect to the log of the investment ratio. It reads

$$\frac{\partial g_{it}}{\partial \log(I_{it})} = \alpha_1 + \alpha_3 Inst_{it} \quad (2)$$

The above expression clearly shows that our specification lets the marginal effect of investment be a function of the quality of institutions. The key parameters of interest, here, are α_1 and α_3 .²

Under the hypothesis we follow in this paper, the marginal effect of investment on growth should increase with institutional quality and be significantly positive in countries with high institutional quality. If the institutional indicator $Inst_{it}$ increases with institutional quality, then our assumption implies that α_3 be positive. The hypothesis does not allow us to a priori predict the sign of α_1 . That parameter could be positive and significant but small, if the marginal impact of investment remains positive in countries with low-quality institutions, where the index is close to zero. It may even be insignificant or negative, if the low quality of institutions completely mutes the impact of investment on growth, or if it leads investment to generate extra distortions that in fact slow down growth.

Beside its interaction with investment, institutional quality is expected to have a direct effect on growth. As North (1990), Knack and Keefer (1995), or Acemoglu and

² For a discussion of the specification of interactive models, the interested reader may refer to Friedrich (1982), Braumoeller (2004), and Brambor *et al.* (2005).

Johnson (2005) point out, the security of property rights and government effectiveness are probably the most relevant determinants of long-run economic growth, but other dimensions of a country's institutional framework, such as democratic accountability, may also play a role, as Groenewold and Tang (2007) observe. Moreover, not controlling for both terms of the interaction would therefore likely bias the estimated coefficient of the interaction term, which is why we control for the level of institutional quality.

To determine the other control variables, we follow the standard specification of Islam (1995). The first control variable is the initial level of real GDP per capita in each sub-period. Its inclusion aims at accounting for the absolute convergence hypothesis emphasized in neoclassic growth models. If economies converge, poor economies should grow faster than rich ones, and the growth rate of real GDP per capita should be negatively correlated to the initial level of real GDP per capita.

Secondly, we control for the stock of human capital. More precisely, we control for the secondary-school enrolment rate.³ It is defined as the ratio of total enrolment over the population of the age group corresponding to the secondary level of education. An improvement in the level of human capital is expected to have a positive impact on growth, in line with Mankiw *et al.*'s (1992) result.

Thirdly, we control for population growth. In a neoclassic framework, faster population growth slows down the increase of the per capita stock of physical capital. It should, therefore, reduce growth, and we expect its coefficient to be negative.

Fourthly, we control for average openness to international trade over the sub-period. Openness is used to proxy for the exposure of an economy to foreign markets. In Equation (1), openness to trade is defined as the ratio of the arithmetic mean between exports and imports to GDP. Although the literature is not consensual on the magnitude of the effect, the standard finding is that openness leads to faster growth, as Winters (2004) argues. We therefore expect a positively signed coefficient for openness.

Following Mankiw *et al.* (1992), and others, all variables are taken in logarithm, except for the composite index of institutional quality. As Méon and Sekkat (2005) point out, considering either the level or the logarithm of institutional variables does not affect regression results.

³ Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education complements the provision of basic education that began at the primary level, and aims at laying the foundations to lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers.

Finally, we introduce country fixed effects to control for unobserved heterogeneity across countries and period fixed effects to control for common trends. When estimating the model and making statistical inference, we use the approach suggested by Davidson and MacKinnon (1993, pp. 552-556) which allows dealing with different forms of heteroskedasticity and autocorrelation including those arising from clusters.

In contrast to Gwartney et al. (2006), Minier (2007), and Hall *et al.* (2010), who run cross-section regressions, the panel structure of our dataset allows us to address the issues of unobserved heterogeneity and, to some extent endogeneity. Namely, we can control for unobserved heterogeneity using panel growth regressions *à la* Islam (1995) estimated using fixed country-specific effects. Moreover, we complement those regressions with GMM panel-data regressions *à la* Arellano-Bond (1991). Another advantage of our approach is that it allows institutional quality to vary over time, while Minier (2007) had to use executive constraint in the first year of her forty year long period of study and Hall et al. (2010) used the average value of institutional quality over their period of study.

Our method also contrasts with that of Gwartney et al. (2006), Minier (2007), and Hall et al. (2010) in that we carefully include in the set of explanatory variables the two components of the interaction term, following the procedure advocated by Friedrich (1982), Braumoeller (2004), and Brambor et al. (2005). Accordingly, we systematically control not only for investment and its interaction with institutional quality, but also for the level of institutional quality. By doing so, we make sure that the coefficient of the interaction term does not capture the direct effect of institutional quality on growth, and correctly identifies the interaction between investment and institutional quality.

2.2. Data

We use two key sets of data to conduct the empirical analysis: institutional indicators and macroeconomic data. These two data sets are described hereafter.

2.2.1. Institutional Data

To gauge the quality of institutions, we follow Knack and Keefer (1995) and Hall and Jones (1999), and use the *International Country Risk Guide* (ICRG) political risk rating published by the *Political Risk Services Group*. As Knack and Keefer (1995) point out, that index measures the quality of institutions that are closely related to those emphasized by

North (1990). Moreover, the ICRG index has been published yearly since 1984, and can, therefore, be used in a panel setup. It is thus particularly suited for our analysis.

The ICRG political risk rating is computed as a weighted average of 12 individual political risk indicators, based on experts' subjective evaluations. It ranges from zero to ten, with higher values reflecting a better quality of institutions.⁴

To use the indicator in our panel regressions, we averaged it over each sample sub-period. In our sample, the composite measure of institutional quality, averaged over each sample sub-period, ranges from 13.60 to 93.48. These two extreme values respectively correspond to Ukraine (1995-1999) and Finland (2000-2004), while the country displaying a political risk close to the average is South Africa, with a value of 67.96 over 2000-2004.

Differences between our dataset and those of Gwartney et al. (2006), Minier (2007), and Hall *et al.* (2010) are worth pointing out. Gwartney et al. (2006) measure the quality of institutions by the Economic Freedom in the World index. This index essentially focusses on the constraints that governments impose on markets. Similarly, Minier (2007) measures institutions by the level of constraint on the executive. By contrast, we use a broader measure that is meant to encompass a large number of dimensions of the institutional framework. Moreover, both Gwartney et al. (2006) and Minier (2007) transform a continuous index into a categorical variable, thereby losing information. On the contrary, we use a continuous measure so as to let the marginal impact of investment on growth evolve continuously with the quality of institutions and avoid arbitrary thresholds.

We also differ from Hall *et al.* (2010) in that we focus specifically on investment in physical capital while they consider both human and physical capital. By doing so, we can devote more space to examining the statistical and quantitative significance of the marginal impact of investment on growth.

2.2.2. Macroeconomic Data

Most macroeconomic data are taken from the *Penn World Table* v7.0 constructed by Heston *et al.* (2011). In particular, data on real GDP per capita, real gross domestic investment, openness to trade, and population growth were found in the *Penn World Table*. Initial

⁴ Descriptive statistics and the correlation Matrix are reported in Tables A1 and A2 in the appendix.

secondary-school enrolment rates were retrieved from the *Global Development Finance and World Development Indicators* database of the World Bank.⁵

All variables are averaged over five-year spans, except for the initial levels of real GDP per capita. The full sample spans the 1984-2009 period and consists of both developed and developing countries, thereby mitigating any concern about sample selection bias. Due to missing data, the panel is unbalanced. The number of countries included in the regressions is 85 and the number of observations is 326.⁶

3. Baseline findings

Table 1 reports the results for country fixed effects and GMM regressions. Both regressions include time fixed effects.⁷ To see whether the inclusion of a multiplicative interaction term is warranted, Equation (1) is estimated both with and without the interaction term.

*** Insert Table 1 around here ***

Confronting the goodness-of-fit measures of the two estimated fixed-effects models, reported in columns 1.1 and 1.2, we observe that the inclusion of the interaction term results in a slightly larger adjusted *R*-squared. In other words, the multiplicative panel data model described in Equation (1) seems to explain more of the variation in the average growth rate of real GDP per capita than would a simple additive model. Moreover, the coefficient of the interaction term is significant at the 1% level. The evidence reported in Table 1, therefore, supports the contention that investment and institutional quality do indeed interact. Consequently, we will focus the discussion on the results for the interactive term.

Turning to the estimated coefficients, we see that control variables exhibit the expected sign or are insignificant at standard levels of statistical significance. The initial level of real GDP per capita enters the growth equation with a significantly negative sign, which validates the conditional convergence hypothesis. The estimated coefficient attached to international openness is positively signed and significant at the five-percent level. Schooling

⁵ Note that the mechanisms that we have so far emphasized could be amplified if the quality of investment data was poorer in countries with poorer institutions. This may be due to a sheer attenuation bias, or to the fact that governments in those countries artificially inflate investment figures.

⁶ Our sample is another difference between our study and those of Gwartney et al. (2006), Minier (2007), and Hall et al. (2010). Gwartney et al. (2006) study 85 countries over the 1980-2000 period. Minier (2007) studies 70 countries over the 1960-2000 period. Hall et al. (2010) study 96 countries over the 1980-2000 period. Our sample is therefore larger, and our period of study more recent than theirs. Moreover, our period of study is longer, except for Minier (2007).

⁷ We also ran random-effects regressions. However, as the Hausman test systematically rejects the random-effects model (see Table 1), we only report the results for fixed-effects regressions.

and population growth, do not appear to be significantly different from zero. Admittedly, schooling exhibits a negative sign, but that sign is only significant at the ten-percent level, and only for the least preferred specification, specification 1.1.

The key coefficients of interest are those attached to the investment ratio and the interaction term, and the marginal effect they imply. Those coefficients turn out to be consistent with the hypothesis that the wedge between cumulated investment and the increase in the capital stock is larger in countries with defective institutions. On the one hand, the estimated coefficient of investment is negative and significant at the ten-percent level, implying that the marginal effect of investment would be negative in countries with extremely deficient institutions. On the other hand, the estimated coefficient of the interaction term appears to be significantly positive at the one-percent level, indicating that the marginal effect of investment increases with the quality of institutions.

As individual coefficients are almost meaningless when looked at separately, the middle panel of Table 1 reports the point estimates and standard errors of the marginal effects implied by estimation 1.2, for the lowest (13.60), mean (67.96), and highest (93.48) values of the ICRG index in the sample.⁸ In line with our expectations, the marginal effect of investment on growth is significantly positive at the one-percent level for the highest level of institutional quality. It is still positive and significant at the one-percent level for the mean level of institutional quality. By contrast, the marginal effect of investment on growth is not statistically different from zero for the lowest value of the institutional index in regression 1.2. This is evidence that a poor quality of institutions is related to unproductive investment expenditure, or that the cost of capital (i.e. investment effort) significantly overstates capital accumulation in countries with weak institutions.

Next, we estimate expression 1 with GMM. The columns 1.3 and 1.4 of Table 1 report the results of panel-data regressions *à la* Arellano-Bond (1991).⁹ For both estimations, the p-value of the overidentifying restrictions test shows that we can reject the hypothesis that instruments are correlated with the residuals. The control variables still exhibit their expected sign or are statistically insignificant. The initial level of real GDP per capita is negatively signed and significant at the one-percent level. The estimated coefficient attached to the secondary school enrolment rate is non-significant. The coefficient of openness appears to be

⁸ 13.60 corresponds to the value of the ICRG index for Ukraine during the 1995-1999 period. The mean value of 67.96 is of the same order of magnitude as the index of Venezuela during the 1990-1994 period or South Africa during the 2005-2009 period. The 93.48 value corresponds to Finland during the 1990-1994 period.

⁹ The number of lags used as instruments is set so as to remove autocorrelation in the residuals.

significantly positive at the five- or ten-percent level. As before, population growth is statistically insignificant at standard levels of significance.

Most of all, we observe that the key estimated coefficients of interest – namely, those attached to the investment ratio and the interaction term – are respectively negative but non-significant, and significantly positive at the one-percent level, which is in line with previous results.

As before, we also report the point estimates and standard errors of the marginal effect of investment, computed at the minimum, mean, and maximum values of the ICRG index, in the middle panel of Table 1. Stealing a glance at that panel is enough to observe that marginal effects are in line with those presented in the previous sub-section. The marginal effect of investment is positive and statistically significant at the one-percent level for its mean and highest values. It remains positive and statistically significant for the lowest value of the ICRG index, but only at the ten-percent level. Moreover, its magnitude becomes very low. Again, the empirical evidence reported here suggests that the positive impact of investment on growth essentially materializes for countries where the quality of the institutional environment is high enough.

*** Insert Figure 1 around here ***

Figure 1 summarizes those results by displaying the point estimate and the five-percent confidence interval of the marginal effect of investment as a function of the sample values of the ICRG index, based on the GMM estimation 1.4. More precisely, the marginal effect of investment on growth is significantly positive for 311 observations (84 countries) out of the 312 observations in our sample. The threshold value of the ICRG index from which the marginal effect of investment becomes significantly positive is 28.93, corresponding to Sudan over 1996-2000.

Our estimations easily lend themselves to a quantitative interpretation. As both the dependent and the independent variables are taken in logarithms, estimated marginal effects indeed measure the elasticity of income to the investment ratio. The results of our favored specification, regression 1.4, imply that the elasticity of income to the investment ratio is 1.463 in Finland, the country with the highest ICRG score, around 1.051 in Venezuela, whose ICRG score is similar to our sample average, and only 0.174, i.e. eight times less than in

Finland, for countries with an ICRG equivalent to that of Ukraine in the second half of the 1990s.¹⁰

4. Robustness Checks and extensions

In this section, we test the robustness of our results to estimating the model separately for developed and developing countries, for each continent, and over two sub-periods. We then perform a jackknife experiment to test whether the results depend on any single country in the sample. We then consider another form of nonlinearity by allowing the marginal effect of investment to differ across quartiles of the ICRG index. Finally, we unbundle the ICRG index to estimate separately the interaction of investment with the basic individual sub-components of the index.

4.1. Distinguishing subsamples

We have so far used the largest sample of countries for which we could obtain data. This may hide differences across groups of countries. We therefore run our baseline estimations on various subsamples to see how general they are.

Our first test is to distinguish developed and developing countries, because their outputs tend to behave differently from developed countries, as Durlauf et al. (2005) argue. We therefore split our sample in two groups, based on the World Bank definition, and estimated our model separately on those two groups. The results of those estimations are reported in Table 2. The first column reports the results obtained for developed countries while the second reports the results for developing countries. To save space, Table 2 only reports our preferred estimation, namely GMM dynamic panel-data regressions *à la* Arellano-Bond (1991).

*** Insert Table 2 around here ***

The results are by and large similar to previous results in both sub-samples. For both estimations, the p-value of the overidentifying restrictions test shows that we can reject the hypothesis that instruments are correlated with the residuals. Control variables bear the same signs as in the baseline regressions. The only noticeable exception is openness to trade that

¹⁰ Note that those estimates are of the same order of magnitude as those obtained in previous studies, such as Mankiw et al. (1992) or Islam (1995).

now bears a positive sign significant at the one percent level in the subsample of developing countries, while it remains insignificant in the sample of developed countries.

In both regressions, the coefficient of the level of investment remains insignificant at standard levels of significance, like in the baseline regression. In both regressions, the coefficient of the ICRG index remains significant at the one-percent level. The key difference between the two regressions appears when looking at the coefficient of the interaction term, which was positive and significant at the one-percent level in our baseline regression. The coefficient is still significant in the sample of developing countries, though at the ten-percent level. It is insignificant in the sample of developed countries.

If we compute the marginal effect of investment in both sub-samples, we obtain results that are also similar to our baseline results. In the group of developing countries, we find that the marginal effect of investment increases with the ICRG index and is significantly positive for all the values of the index. In the group of developed countries, however, the marginal effect also increases with the ICRG index, but it is only significant below the mean value of the index. The finding may suggest that investment does not matter beyond a certain threshold of institutional quality in developed countries, because the physical capital stock is no longer the driver of growth. It may also be due to the greater homogeneity of the quality of institutions among developed countries. However, the impact of investment is indeed a function of the quality of institutions among developing countries, which is in line with our previous results.

In our next robustness check, we estimate our model separately for each continent, to check the geographic specificity of our results. The results of those estimations are reported in Table 3.

*** Insert Table 3 around here ***

In the four regressions, control variables exhibit the expected sign or are insignificant. If we turn to the coefficients of the variables of interest, the results look stable across continents. As in previous regressions, the coefficient of the level of investment is always insignificant at standard levels of significance. The coefficient of the ICRG index is positive in all regressions, and is significant beyond the ten-percent level, except in the first column, that reports the results of our estimations for Asian countries. One may note, however, that Asia is the smallest sub-sample, with only 11 countries.

If we turn to marginal effects, we obtain contrasted results across continents. The marginal effect is insignificant at standard levels of significance for all values of the ICRG index in Asia and America. This result may be surprising, but one should bear in mind that the two sub-samples are smaller than the other two and consist in only 11 and 18 countries. Conversely, the results that we obtain for Africa and Europe are in line with our previous estimations. In both sub-samples, the marginal effect of investment is positive and increases with the ICRG index. In Europe, it is insignificant if the ICRG index takes its lowest value, but is significant at the one-percent level beyond the mean value of the index. In Africa, the marginal impact of investment is significant at the one-percent level for all values of the ICRG index.

4.2. Distinguishing sub-periods

We have so far performed our estimations on the longest period over which data was available. Yet the general pattern may hide behaviors that differed across periods, as Durlauf et al. (2005) argue. To check whether our results are specific to a given time period, we split our period of study in two sub-periods: 1984-1995 and 1995-2009. The results of those estimations are reported in Table 4. Its first column pertains to 1984-1995 and the second to 1995-2009.

*** Insert Table 4 around here ***

The results do not differ markedly across the two columns. Control variables bear the same sign in the two columns or are insignificant. We can see in both regressions that the coefficient of the investment ratio is insignificant, that the coefficient of the ICRG index is positive and significant, and, most of all, that the coefficient of the interaction term is positive and significant. During the 1984-1995 period, the marginal effect of investment was insignificant for low values of the ICRG index, and positive and significant beyond the mean value of the index. During the 1995-2009 period, the marginal effect of investment was positive and significant at the ten-percent level for all values of the ICRG index. The two periods also differ insofar the marginal effect of investment was more than twice larger during the second period than during the first one when the quality of institutions is beyond the mean. These differences notwithstanding, the finding that the marginal effect of investment increases with the quality of institutions holds for the two periods.

4.3. Outliers

Irrespective of the sample size, there is always a risk that a single country could influence the estimates. To make sure that our results are not driven by a specific country, we perform a country jackknife. Specifically, we drop each individual country in turn, and estimate the same specification 85 times on a sample consisting of the remaining 84 countries. Table 5 reports the outcome of the two regressions that resulted in the largest and smallest absolute values of the coefficient of the interaction term.

*** Insert Table 5 around here ***

Table 5 shows that the estimated value of the coefficient of the interaction term ranges from 1.353 when the Russian federation is dropped to 1.998 when Trinidad and Tobago is dropped. The coefficient is significant at the five-percent level in both cases. In both cases also the coefficient of the level of investment is insignificant and the coefficient of the ICRG index is positive and significant at the one-percent level.

In both regressions, the marginal effect of investment is significantly positive regardless of the value of the ICRG index. As a result of the positive sign that the interaction term exhibits, the size of the marginal effect of investment increases with the value of the ICRG index in both regressions. Our main finding is therefore not driven by any single country in our sample.

4.4. Alternative form of nonlinearity

The specification that we have so far used implicitly assumes that the marginal impact of investment is a linear function of the ICRG index. However, this is not the only form of change in the effect of investment on growth that might exist. Here, we defined four dummy variables corresponding to the quartiles of the ICRG index, and interacted those dummy variables with the investment ratio. We then included the interaction term and the dummy variables in the regressions as explanatory variables. As a result, the marginal impact of investment can be different across quartiles of the ICRG index. Its point estimate in a given quartile simply corresponds to the coefficient of the interaction term between the investment

ratio and the relevant quartile dummy. The relations were estimated using the same method as before. The outcome of the estimation is reported in Table 6.

*** Insert Table 5 around here ***

The p-value of the overidentifying restrictions test shows that instruments are uncorrelated with the residuals in nonlinear estimation. Moreover, control variables bear their predicted sign, and are significant at the one-percent level. The impact of investment is significant in the first and fourth quartiles of the ICRG index.

More to the point, the evolution of the impact of investment refines previous results. We still find that its largest positive value appears in the quartile of countries with the highest ICRG score, denoting the highest institutional quality. In the quartile of countries with the lowest ICRG, the marginal impact of investment is negative. The outcome of the nonlinear estimation therefore suggests that previous results were essentially driven by the quartile of countries with the lowest and the highest institutional quality.

4.5. Distinguishing dimensions of governance

Our findings have so far relied on the ICRG index of governance. That index is computed as a weighted average of twelve individual components, each assessing a different dimension of institutions. All dimensions may not, however, affect the impact of investment on growth in the same way. To obtain a finer description of the impact of institutional quality on the marginal effect of investment, and as a robustness check, we now use individual components, instead of the global ICRG indicator, as measures of institutional quality and in the interaction term. Our key finding seems to be driven by three components out of twelve: Government stability, Corruption, and Law and Order. The relation of the other nine with growth and investment does not seem to exhibit any clear or significant pattern. Those components are Investment Profile, Socioeconomic Conditions, Internal Conflict, External Conflict, Military in Politics, Religious Tensions, Bureaucracy Quality, Democratic accountability, and Ethnic Tensions. Comparing the two sets of components gives an insight into the dimensions of the institutional framework that affect the efficiency of investment. By and large, those dimensions are all related to the safety of investment and the soundness of the legal and regulatory framework.

The meaning of the three sub-indices that lead to meaningful results can moreover be interpreted in light of the results of Berggren et al. (2012, 2013). Berggren et al. (2012) apply principal component analysis to the twelve basic sub-indices of the ICRG political risk index. The first component that their analysis determines, and that they label “legal quality”, precisely loads heavily on Corruption and Law and Order. Moreover, they find that that component positively correlates with growth. They also find that the government stability index has the largest factor loading on the second component of their analysis, to which they refer to as the “policy” component. Berggren et al. (2013) also consider the twelve basic ICRG political sub-indices, but apply principal factor analysis, and only consider European countries and Israel. They find that Corruption and Law and order heavily load on the same dimension, while Government stability loads heavily on the third dimension representing policies.¹¹ In our sample, a factor analysis also reveals that the first factor loads heavily on Corruption and Law and Order, while the third factor loads heavily on Government stability. Our findings may thus be interpreted as generally meaning that it takes a minimum level of legal quality and stability for investment to affect growth. By contrast, the components of the ICRG index that are not consistently related to growth tend to measure various forms of political tensions, but are unrelated to the regulatory environment. A first finding of this section is therefore that tensions as such do not affect the quality of investment. Conversely, the efficiency of investment is affected by facets of governance that affect the quality and the stability of the regulatory framework.

*** Insert Table 7 around here ***

The results presented in Table 7 are consistent with previous results. In particular, the estimated coefficient of the interaction term is positively signed and significant at the one-percent level in all regressions. In any case, only marginal effects are really meaningful. As in the previous sub-section, the middle panel of Table 7 reports the estimated values of the marginal effect of investment on growth, using the minimum, mean, and maximum values of the three individual political risk components considered in this sub-section. The same pattern appears for each of those indices. Namely, the elasticity of income to investment is the lowest in weak institutional environments and increases with the quality of institutions. The ratio of

¹¹ However, their findings contrast with those of Seldadyo et al. (2007) who apply confirmatory factor analysis to the democratic accountability, government stability, bureaucracy quality, corruption, and rule of law sub-indices of the ICRG index, and find that they can be combined into a single index.

the elasticity of income to investment between the country with the largest institutional score and the country with the worst score ranges from 3.19, for the Government stability component, to 7.75, for the Corruption component. It is 4.88 for the Law and order component. All those results are in line with the hypothesis that the wedge between investment and accumulated capital is lower in countries with more deficient institutions.

5. Conclusion

In this paper, we tried to disentangle the relation between the quality of institutions and the marginal effect of investment on growth. We tested the hypothesis that the impact of investment on growth is conditional on the quality of institutions. We empirically tested this hypothesis on a panel of up to 85 countries spanning the 1984-2009 period. Practically, we did so by adding a multiplicative interaction between investment and institutional quality to the set of usual control variables, allowing to compute estimated marginal effects that vary with institutional quality. Firstly, using panel growth regressions *à la* Islam (1995) with fixed country-effects, we could control for unobserved heterogeneity. Then, we used the GMM panel-data regressions *à la* Arellano-Bond (1991). By doing so, and by carefully interpreting the interaction of investment with institutional quality, we extended the works of Gwartney et al. (2006), Minier (2007) and Hall *et al.* (2010), who performed cross-country regressions. Finally, we also conducted the latter type of regressions using the relevant components of the ICRG index of institutional quality, individually, in order to see whether the results are affected, as a robustness check. That robustness check revealed that the dimensions of the institutional framework that affect the efficiency of investment are related to how secure investment is, and to the quality of the regulatory framework. Conversely, political tensions *per se* do not seem to affect the marginal impact of investment.

Our findings suggest that the marginal impact of investment on growth is an increasing function of institutional quality. Moreover, that marginal impact becomes very small, or even insignificant, in countries where the quality of institutions is very low.

The key policy implication of our findings is that the success of policies encouraging investment to foster growth, such as big push programs, is conditional on institutional quality. Governments and international organizations wishing to implement such policies should therefore first make sure that the country's institutional framework is sufficiently strong. If not, then institutions should be improved before the investment program is implemented. Otherwise, the invested capital will be wasted.

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7. Appendix

*** Insert Table A1 around here ***

*** Insert Table A2 around here ***

Figure 1: Marginal effect of investment on growth as a function of the ICRG index
(Based on regression 1.4)

The solid line plots the point estimate of the marginal effect. Dotted lines plot the confidence interval. Each point plots the point estimate corresponding to a value of the ICRG in a country in the sample.

Table 1: Baseline regression.

Dependent variable: Average growth rate of real per capita GDP.

Estimation method: Fixed-effects and GMM regression results.

	FE without interaction	FE with interaction	GMM without interaction	GMM with interaction
	1.1	1.2	1.3	1.4
Initial real GDP per capita	-0.383 (5.602)***	-0.42 (6.599)***	-0.453 (5.515)***	-0.448 (5.951)***
School enrolment rate	-0.053 (1.802)*	-0.029 (1.029)	0.01 (0.164)	0.012 (0.220)
Openness	0.116 (2.818)***	0.137 (3.349)***	0.087 (2.025)**	0.081 (1.906)*
Population growth	-0.026 (0.967)	-0.017 (0.666)	-0.008 (0.283)	-0.015 (0.603)
Investment ratio	0.118 (3.124)***	-0.267 (1.645)*	-0.076 (0.629)	-0.046 (0.425)
ICRG index	0.007 (5.18)***	1.541 (3.961)***	0.515 (4.402)***	0.46 (4.475)***
Investment ratio $\times$ ICRG index		0.601 (2.553)***		1.614 (2.382)***
Marginal effect of investment at min. ICRG	-	-0.185 (1.411)	-	0.174 (1.832)*
Marginal effect of investment at mean ICRG	-	0.142 (3.931)***	-	1.051 (2.561)***
Marginal effect of investment at max. ICRG	-	0.295 (4.123)***	-	1.463 (2.520)***
Number of observation.	324	324	312	312
Number of countries	85	85	85	85
Adjusted R ²	0.72	0.74	-	-
Random effect test; P-value	0.00	0.00	-	-
Fixed effect test; P-value	0.00	0.00	-	-
Test of overidentifying restrictions; P-value	-		0.25	0.12

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 2: Developed vs. developing countries.

Dependent variable: Average growth rate of real per capita GDP.

Estimation method: GMM regression results.

	Developed countries	Developing countries
	2.1	2.2
Initial real GDP per capita	-0.406 (3.244)***	-0.416 (5.219)***
School enrolment rate	-0.011 (0.048)	-0.088 (1.332)
Openness	-0.002 (0.017)	0.329 (2.250)***
Population growth	-0.071 (0.752)	-0.039 (1.378)
Investment ratio	0.161 (0.649)	-0.038 (0.282)
ICRG index	0.273 (2.374)***	0.381 (3.122)***
Investment ratio $\times$ ICRG index	0.689 (0.440)	1.574 (1.957)*
Marginal effect of investment at min. ICRG	0.254 (1.684)*	0.176 (1.747)*
Marginal effect of investment at mean ICRG	0.629 (0.714)	1.032 (2.215)***
Marginal effect of investment at max. ICRG	0.805 (0.630)	1.433 (2.147)**
Number of observation	102	210
Number of countries	26	59
Test of overidentifying restrictions; P-value	0.67	0.87

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 3: Continent-specific regressions.

Dependent variable: Average growth rate of the real per capita GDP.

Estimation method: GMM regression results.

	Asia	America	Africa	Europe
	3.1	3.2	3.3	3.4
Initial real GDP per capita	-0.111 (0.981)	-0.444 (1.294)	-0.423 (4.366)***	-0.511 (3.554)***
School enrolment rate	-0.122 (0.477)	-0.069 (0.271)	0.098 (1.742)*	-0.616 (1.375)
Openness	0.153 (0.764)	0.127 (1.768)*	0.044 (0.937)	0.058 (0.706)
Population growth	-0.100 (0.598)	-0.094 (1.043)	-0.153 (4.959)***	0.049 (1.002)
Investment ratio	0.141 (0.898)	0.384 (0.649)	-0.019 (0.145)	-0.106 (0.398)
ICRG index	0.276 (1.473)	0.361 (2.306)***	0.412 (3.366)***	0.459 (1.767)*
Investment ratio $\times$ ICRG index	-1.014 (0.910)	-3.356 (1.038)	2.707 (4.396)***	2.958 (3.046)***
Marginal effect of investment at min. ICRG	0.003 (0.016)	-0.073 (0.404)	0.349 (3.081)***	0.34 (1.612)
Marginal effect of investment at mean ICRG	-0.548 (0.732)	-1.897 (1.170)	1.82 (4.954)***	1.563 (3.564)***
Marginal effect of investment at max. ICRG	-0.807 (0.785)	-2.753 (1.126)	2.511 (4.836)***	2.559 (3.447)***
Number of observation	47	72	105	88
Number of countries	11	18	35	21
Test of overidentifying restrictions; P-value	0.87	0.32	0.85	0.69

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 4: Period-specific regressions.

Dependent variable: Average growth rate of the real per capita GDP.
 Estimation method: GMM regression results

	1984-1995	1995-2009
	4.1	4.2
Initial real GDP per capita	-0.363 (3.919)***	-0.589 (7.574)***
School enrolment rate	-0.013 (0.199)	-0.031 (0.579)
Openness	0.158 (2.612)***	0.026 (0.307)
Population growth	-0.045 (1.155)	-0.002 (0.053)
Investment ratio	0.027 (0.223)	-0.344 (1.477)
ICRG index	0.55 (4.239)***	0.355 (2.118)**
Investment ratio $\times$ ICRG index	1.535 (2.014)***	2.958 (1.748)*
Marginal effect of investment at min. ICRG	0.236 (1.530)	0.331 (1.694)*
Marginal effect of investment at mean ICRG	0.610 (2.001)*	1.539 (1.772)*
Marginal effect of investment at max. ICRG	0.848 (2.039)**	2.308 (1.766)*
Number of observation	150	162
Number of countries	85	85
Test of overidentifying restrictions; P-value	0.47	0.08

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 5: Country jackknife.

Dependent variable: Average growth rate of the real per capita GDP.
 Estimation method: GMM regression results

	Largest coefficient of the interaction term	Smallest coefficient of the interaction term
Excluded country	Trinidad and Tobago	Russian Federation
Investment ratio	-0.089 (0.838)	0.024 (0.257)
ICRG index	0.449 (4.508)***	0.463 (4.151)***
Investment ratio $\times$ ICRG index	1.998 (2.994)***	1.353 (2.047)**
Number of observations	310	309
Number of countries	84	84
Test of over identifying restrictions; P-value	0.12	0.10
Marginal effect of investment at min. ICRG	0.182 (1.924)*	0.208 (2.324)***
Marginal effect of investment at mean ICRG	1.269 (3.131)***	0.944 (2.314)***
Marginal effect of investment at max. ICRG	1.779 (3.106)***	1.289 (2.245)***

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 6: Nonlinear interaction between investment and institutional quality.
Dependent variable: Average growth rate of the real per capita GDP.
Estimation method: GMM regression results

	6.1
Initial real GDP per capita	-0.662 (4.105)***
School enrolment rate	0.066 (0.66)
Openness	0.231 (1.655)*
Population growth	-0.048 (0.570)
Investment ratio $\times$ 1 st quartile dummy	-0.822 (2.011)**
Investment ratio $\times$ 2 nd quartile dummy	0.329 (0.244)
Investment ratio $\times$ 3 rd quartile dummy	-1.116 (1.129)
Investment ratio $\times$ 4 th quartile dummy	2.471 (1.707)*
1 st quartile dummy	0.05 (1.705)*
2 nd quartile dummy	0.057 (1.213)
3 rd quartile dummy	0.104 (3.220)***
4 th quartile dummy	0.055 (1.271)
Number of observations	312
Number of countries	85
Test of overidentifying restrictions; P-value	0.27

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table 7: Institutional quality measured by individual political risk components.

Dependent variable: Average growth rate of the real per capita GDP.

Estimation method: GMM regression results

	Government Stability	Corruption	Law and Order
	2.3	2.1	2.2
Initial real GDP per capital	-0.333 (6.71)***	-0.359 (8.027)***	-0.366 (7.418)***
Initial school enrolment rate	0.035 (0.721)	-0.021 (0.688)	-0.001 (0.063)
Openness to trade	0.036 (0.918)	0.217 (1.977)*	0.024 (0.586)
Population growth	-0.092 (3.197)***	-0.078 (2.324)***	-0.083 (2.513)***
Investment ratio	0.137 (4.194)***	0.117 (3.085)***	0.115 (3.723)***
ICRG component	0.013 (3.133)***	-0.04 (1.374)	0.018 (2.129)***
Investment ratio $\times$ ICRG component	0.05 (2.572)***	0.131 (2.020)***	0.125 (2.883)***
Marginal effect of investment at min. ICRG	0.137 (4.194)***	0.117 (3.085)***	0.177 (5.585)***
Marginal effect of investment at mean ICRG	0.324 (4.614)***	0.507 (2.687)***	0.572 (3.767)***
Marginal effect of investment at max. ICRG	0.437 (3.925)***	0.907 (2.357)***	0.864 (3.428)***
Number of observation.	263	273	274
Number of countries	85	85	85
Test of overidentifying restrictions; P-value	0.27	0.17	0.16

Absolute t-statistics in parentheses. Standard errors are heteroskedastic- and autocorrelation-consistent. ***: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. All regressions include country fixed effects and period fixed effects.

Table A1: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
<i>Real GDP growth per capita</i>	346	0.095	0.131	-0.663	0.482
<i>Initial real GDP per capita</i>	346	8.795	1.218	5.535	11.027
<i>School enrolment rate</i>	346	4.156	0.606	1.675	5.053
<i>Openness to trade</i>	346	1.875	0.211	0.560	2.182
<i>Population growth</i>	346	-2.226	0.706	-8.022	-1.119
<i>Investment ratio</i>	346	-1.537	0.265	-2.669	-0.845
<i>ICRG index</i>	346	67.964	13.673	13.600	93.483
<i>Investment ratio x ICRG index</i>	346	-103.768	24.503	-154.457	-18.454

Table A2: Correlation matrix

	<i>Real per capita GDP growth</i>	<i>Initial real per capita GDP</i>	<i>School enrolment rate</i>	<i>Openness to trade</i>	<i>Population growth</i>	<i>Investment ratio</i>	<i>ICRG index</i>	<i>Investment ratio × ICRG index</i>
<i>Real GDP growth per capita</i>	1.000							
<i>Initial real GDP per capita</i>	0.123	1.000						
<i>School enrolment rate</i>	0.227	0.824	1.000					
<i>Openness to trade</i>	0.227	0.514	0.487	1.000				
<i>Population growth</i>	-0.170	-0.315	-0.443	-0.210	1.000			
<i>Investment ratio</i>	0.477	0.206	0.317	0.125	-0.099	1.000		
<i>ICRG index</i>	0.342	0.747	0.616	0.580	-0.287	0.192	1.000	
<i>Investment ratio x ICRG index</i>	-0.004	-0.545	-0.360	-0.443	0.202	0.470	-0.762	1.000