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INVESTMENT AND GROWTH IN RICH AND POOR COUNTRIES

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ABSTRACT

This paper revisits the association between investment and growth. The empirical findings highlight substantial heterogeneity for the effect of investment on growth and suggest a possible negative association. Results based on a battery of cross-sectional and time-series regressions show that the link between investment and growth has weakened over time and that investment in high-income countries is more likely to have a negative effect on growth. The adverse effect for high-income countries appears to have increased over time. An implication is that uphill capital flows could be associated with negative or zero returns. The result is robust to the presence of control variables that are commonly included in growth studies.

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1. Introduction

This paper revisits the association between investment and growth. In the context of neoclassical growth theory and a canonical concave production function, marginal returns to capital are presumed to be positive but to diminish as the capital-output ratio rises. As capital-output ratios rise, and countries grow richer over time, the effect of lagged investment on growth should diminish and *could* even turn negative. An implication is that public policy designed to promote growth via stimulating investment *could* be ineffective; especially for high-income countries.

Diminishing returns are a property of production relationships and this property is independent of the source of savings that make investment possible. Investment matched by either foreign or domestic savings would depress marginal returns. Recently, there have been a few empirical studies examining effects of foreign savings on domestic growth; or alternatively, the link between current account imbalances and growth.[1] In this paper, we investigate the direct evidence of the marginal effect of investment on growth and whether high and low income countries experience the same or similar effect.

There are reasons to doubt that we will observe zero or negative returns to investment. One motivation for international capital flows is presumably to arbitrage the returns offered by domestic and foreign markets. The well-documented pattern of capital flows from poor to rich countries (going back to Feldstein and Horioka, 1980), and among poor countries from rapidly growing economies to slowly growing economies (Gorinchas and Jeanne, 2007), however, has cast considerable doubt on the view that savings follow returns across national borders. There is now a substantial literature on distortions to cross-border capital flows that might generate zero or negative returns on capital in individual countries.[2]

Even if investment follows return opportunities a large influx of capital could depress returns in the presence of diminishing returns to scale. To further complicate the situation, the actual

1 See, for example, Aizenman *et al* (2004), Prasad *et al.* (2007)

2 See, for example, Taylor (1996), French and Poterba (1999), Portes and Rey (2005), Nieuwerburgh and Veldkamp (2009).

capital flow and hence investment could be driven by non-profit considerations including the saving gluts story. If the non-profit driven capital flows are quantitatively important, the observed link between investment and growth could be weakened. We briefly review some of these possibilities in the next section.

There are reservations on the research strategy of using direct econometric tests to detect the relationship between investment and growth. Barro (2008), for example, argues that two-way causation between investment and growth could make direct econometric evaluation of limited value. The alternative strategy for evaluating the contribution of investment to growth is growth accounting where the causation problem is sidestepped at the cost of assuming that aggregate payments to factors of production are determined by their marginal products.[3]

The empirical research that has looked at econometric evidence is quite mixed. In the examination of a cross-section of countries, Houthakker (1961), Modigliani (1970) and Carroll and Weil (1994) find a positive association between investment and growth. Barro (1991) and Barro and Lee (1993) also obtain a positive coefficient using a growth-regression approach. In contrast, Attanasio, Picci and Scorcu (2000) conduct a battery of Granger causality tests in a panel setting to find that lagged investment rate Granger-causes growth rate with a negative sign. Unlike the previous studies, these authors also emphasize the importance of time-series over cross-sectional asymptotics. Finally, using a panel regression approach, Aghion, Comin and Howitt (2006) find that a higher savings rate is associated with higher growth in poorer countries while the association is significantly smaller and only marginally statistically significant for richer countries.

[3] In a recent review, Hulton (2009) observes "(T)he non-parametric (non-econometric) nature of growth accounting is made possible by the assumption of competitive markets in which prices are equal to marginal cost. In this case, cost shares are equal to the corresponding output elasticities. This equality does not hold in non-competitive markets where prices are likely to deviate from marginal cost." Clearly, if we assume capital is paid its marginal product, and capital's income share of GDP is substantial, it cannot be true that the marginal product of capital is zero or negative. But the assumption that the marginal and average products of capital are the same is a very demanding one. See Caselli and Feyrer (2007) for measures of the marginal product of capital based on growth accounting.

We adopt an empirical framework that offers some direct inferences regarding the investment effect on growth. Data from a large number of countries from 1950 through 2007 are considered. To anticipate the results, our cross-sectional regressions show that the investment-growth link is quite variable and appears to have weakened over time. The link also displays a discernable difference between high and low income countries with high-income countries more likely to generate negative growth effects. These results are robust in the presence of the standard control variables used in the empirical growth literature. The country-specific regression results affirm the heterogeneous investment and growth patterns experienced by different countries – even among the G7 countries.

In the next section, we briefly review the link between investment and growth. Section 3 gives the basic empirical structure and discusses the empirical findings. Some concluding remarks are offered in Section 4

2. Investment and Growth

2.1 Are zero or negative returns to investment plausible?

Conventional assumptions about aggregate production functions include the property that, other things equal, the marginal return on investment declines, and at some point turns negative, as the capital-output ratio increases. Conventional analysis also suggests that we are unlikely to *observe* investment that generates zero or negative returns. High-income countries, with high capital output ratios and capital that incorporates the best technology, are likely to be closer to zero or negative marginal products for capital as compared to low-income countries. But if there are alternative investment (or storage) strategies that generate positive expected returns, we would not often observe investment with negative *ex post* returns. The obvious investment alternative for savings generated in high-income countries is investment in poor countries where the marginal return from investment has been assumed to be positive. To be sure, returns are uncertain and negative *ex post* returns might occasionally be observed, but average returns over the business cycle are generally assumed to be positive.

Gordon Getty (2010a, 2010b) has challenged these assumptions by asking a straightforward question. What direct evidence do we have concerning the relationship for the United States between changes in savings or investment ratios and the subsequent behavior of growth rates? His interpretation of US data is that there is no evidence that increases in savings rates or investment rates are associated with subsequent increases in income growth rates. That is, the marginal contribution to growth of unusually high rates of investment is zero. His interpretation of the evidence is that US savings behavior is not a constraint on economic growth and that public policies designed to raise savings rates are misguided.

Even though increases in productivity might cause savings, investment and subsequent growth rates to rise, the reverse causation from savings and investment to growth is not at all obvious. Getty (2010b), for example, quotes John Stuart Mill (1848):

> "If it were said, for instance, that the only way to accelerate the increase of capital is by increase of saving, the idea would probably be suggested of greater abstinence, and increased privation. But it is obvious that whatever increases the productive power of labor creates an additional fund to make savings from, and enables capital to be enlarged not only without additional privation, but concurrently with an increase of personal consumption."

Our approach to the problem is to assume that it is *possible* that investment booms in high-income countries are associated with increases in savings and investment that are not a response to productivity increases and therefore might have no effect or even a negative effect on subsequent growth.

2.2 Capital flows and growth

In an environment where international capital flows are widely associated with bad outcomes for investment in high-income countries, we find the lack of direct tests of the relationship between investment and growth surprising. A number of distortions to private investment decisions might generate aggregate negative returns. One interpretation of recent history for high-income countries (Bernanke *et al*., 2011) is that savings gluts in the rest of the world or shifts in portfolio preferences for US assets by private (Caballero *et al*., 2006) or official investors (Dooley *et al*., 2003, 2009) have pushed foreign savings into the US.[4] This inflow of foreign savings reduced the incentives for US government and private savings, but the offset was incomplete, and the resulting level of investment caused marginal returns to investment to fall. The fact that US real interest rates have remained quite low by historical standards throughout the period seems to us consistent with this hypothesis.

The implications of "uphill" capital flows for subsequent growth performance are obvious. Foreign savings attracted by high expected returns are likely to contribute to growth. Foreign savings attracted by other factors depress returns, and if these other factors are powerful enough, could be associated with zero or negative expected returns.

A related idea is that the inflow of foreign savings not only depressed *expected* real yields in the US but also overwhelmed in an *unexpected* manner the ability of the US financial system to efficiently and honestly intermediate the augmented flow of savings. In this interpretation productive investment opportunities are available but the financial system is unable or lacks the incentives to find them. The negative externality from an increased flow of savings and investments can generate negative ex post rates of return on investment. In this view savings were misallocated and the recent financial crisis was the inevitable result of the capital losses generated by *ex post* valuation of investment projects.

Another line of research suggests that various types of distortions turn investment booms into growth busts (Reinhart and Rogoff, 2009). Moreover, investors fail to learn through experience. These arguments are largely based on historical analysis of financial crises and their antecedents. The idea that investment booms, particularly in housing, have been generated by speculative bubbles, unsustainable government subsidies or distortions in financial markets has dominated recent discussions of the subprime crisis.

In this paper we do not distinguish among the many possible reasons why investment might fail to drive growth. Since our sample ends in 2007 we are not capturing the subprime

[4] See Alfaro, Kalemli-Ozcan and Volosovych (2005) for empirical evidence that official capital inflows are not associated with increases in productivity.

crisis. We do test the idea that some unknown cause of unproductive investment has generated over time increasingly weak and finally negative returns for investment in high-income countries. The implication would be that the subprime crisis may have been the most recent manifestation of a secular trend in investment returns for high-income countries.

To explore Getty's conjecture that savings are not a constraint on growth we conduct an extensive battery of econometric tests both for US data and for a large sample of rich and poor countries. We consider both cross-section and time-series evidence. Our priors are that it is important to consider high- and low-income countries as having different characteristics. This is clearly the case for studies of the convergence hypothesis. The empirical literature on convergence tests the prediction that investment returns are higher in poor relative to rich countries. If this is the case, similar rates of investment will eventually lead to a convergence of per capita income. The conventional result from that literature is that there is some support for the convergence hypothesis within groups of poor and rich countries but not between these groups. In this paper we investigate the possibility that within the high-income group convergence is associated with zero or even negative marginal contributions to growth from investment. This is a different type of convergence in that the high-income countries are moving back to the pack.

3. The Results

3.1 Data

The baseline regression uses country level data on real gross domestic product at purchasing power parity *per capita* (henceforth GDP for brevity) and investment share in GDP. Annual data from 1950 to 2007 and on up to 188 countries were retrieved from the Penn World Tables, Version 6.3 (Heston and Aten, 2009).

Some control variables are employed to evaluate the robustness of the baseline regression results. They include a) economic openness (openness) given by the ratio of export and import volume to GDP, b) the ratio of general government consumption to GDP (govtcons), c) annual percentage change in consumer prices (inflation), d) secondary school enrollment rate among male population (schooling), e) infant mortality rate per 1,000 live births (mortality), and f) total births per woman in logarithm (fertility); see, for example, Barro (1991) and Barro and i Martin (2003). These data were obtained from the World Bank *World Development Indicators* database. In addition, we consider the political stability indicator, Polity2 , that is defined by the difference between institutional autocracy and institutional democracy scores; these scores assume a value between -10 to 10. The data on Polity2 are from the Marshall and Jaggers (2002). Table 1 summarizes the variables used in the regression analysis and their sources.

3.2 Bivariate Regression

Let y_j be country *j*'s average annual GDP growth over an *n*-year period and i_j be the average of its annual investment share in GDP in the same *n*-year period. The basic growth-investment regression is given by the bivariate equation:

$$y_j = \alpha + \beta i_{j,-n} + \varepsilon_j, \qquad (1)$$

where the β coefficient gives the lagged investment effect on growth and ε is the regression error. The use of lagged investment in the regression is meant to alleviate the possible feedback effect between growth and investment so that the β coefficient could be properly interpreted as the growth effect of investment.

Table 2 summarizes the cross-sectional regression results based on equation (1) using non-overlapping data with a three-year sampling window ($n = 3$). The year-heading gives the last year of the sampling window. Essentially, the results are in accordance with the notion that (lagged) investment promotes growth; the investment share coefficient estimates are mostly positive. For the 18 cross-sectional regression estimates, 10 are positive and statistically significant. Note that the investment effect on growth has declined over time and become statistically insignificant after 1995.

The explanatory power given by the adjusted R-squared estimate is quite high for the 1956 regression – the investment share explains 31.6% of the variation in GDP. The adjusted R-squared estimate, however, tends to decline over time and is less than 2% after the 1995 regression. Both the coefficient estimates and the R-squared estimates suggest that the link between investment and growth has weakened over time.[5]

3.3 High-Income vs. Low-Income Countries

As noted in Section 2, investment in high-income and low-income countries could have different implications for growth. To allow for the differential effects, we consider the cross-sectional regression specification:

$$y_j = \alpha + \gamma_1 D_j + \beta i_{j,-n} + \gamma_2 (D_j \times i_{j,-n}) + \varepsilon_j. \qquad (2)$$

The zero-one dummy variable D_j is deployed to differentiate the growth behaviors of high and low income countries; D_j is set to 1 if country j's GDP is above the cross-sectional sample mean during that year and to 0 otherwise.[6] The interaction variable $D_j \times i_{j,-n}$ captures the (additional) marginal effect of investment on growth, given by γ_2, experienced by high-income countries. Under (2), the marginal growth effect of investment is given by $\beta + \gamma_2 \times D_j$ ($\cong \partial y_j / \partial i_{j,-n}$) and of being a high income country is given by $\gamma_1 + \gamma_2 \times i_{j,-n}$ ($\cong \partial y_j / \partial D_j$).

Table 3 presents the results controlling for high-income country effects based on specification (2). Compared with the baseline specification, the inclusion of the two high-income related terms tends to improve the explanatory power, as proxied by the adjusted R-squared. High income countries, on the average, have high growth rates. The dummy variable D_j always yields a positive coefficient estimate and 12 of these 18 estimates are statistically significant.

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5 Table A1 in the appendix presents analogous cross-section regression results based on the sampling window of $n = 5$. These results are qualitatively similar. We also considered the cases of n equals 2 and 10; the results based on these sampling windows are again qualitatively similar to those reported in text and are available upon request.

6 The use of sample median instead of sample mean gives similar results.

Perhaps, a more interesting result is that all the 18 coefficient estimates of the interaction variable $D_j \times i_{j,-n}$ are negative and are mostly statistically significant.

While the lagged investment itself in general has a positive impact on growth (the β estimate has a positive value in 17 of the 18 regressions) investment has a *net* negative impact on growth in high-income countries. The marginal effect of investment for high-income countries, measured by the $\beta + \gamma_2$ estimate, is mostly negative for the 18 cross-sectional samples. In the 2000s, the interaction variable effect clearly dominates the lagged effect – investment in high-income countries is negatively associated with future economic growth.

Figure 1 offers a view on the statistical significance and the time profile of the combined $\beta + \gamma_2$ estimates. The figure plots the marginal growth effect of investment, $\beta + \gamma_2$, from each annual cross-sectional regression (with $n = 3$) along with the associated 95 percent confidence interval.[7] The combined $\beta + \gamma_2$ estimate exhibits a discernible downward trend over time. For the sample period up to 2000, the zero mark is within the 95 percent confidence band, indicating that up to that period investment has no statistically significant impact for high income countries on growth. In contrast, during the 2000s the marginal investment effect is not just negative but is also statistically significant. That is, investment in high income countries tends to have a significant negative growth effect.

The analogous plot for the case of $n = 5$ is given in Appendix, Figure A1. The pattern is essentially the same as the one in Figure 1. For high income countries, the marginal growth effect of investment is negative for most of the sample period with the negative effect being statistically significant at the 5 percent level or higher in the 2000s.

The estimation results illustrate the differential investment effects. As discussed in Section 2, there are a few possible reasons for growth not responding to investment. Our estimation results indicate that the general investment effect on growth (given by the linear β-estimate) has declined over time while the adverse contribution of the high income dummy

[7] The confidence interval takes into account the variances and the covariance of the estimates of β and γ_2.

variable to the investment effect on growth (given by the γ_2 coefficient on the interaction term) holds up quite well. The phenomenon could be due to, for example, a) a reduction of productive investment opportunities in high-income countries over time and/or b) some congestion externality such as the reduction in the ability of the financial system to intermediate capital to productive investment opportunities. The current setting does not allow us to isolate the underlying causes of the evolution of investment effects. Nevertheless, it is important to document the empirical regularity concerning the declining investment effect on growth and the possibility that investment flows into high income countries could have a negative expected return.

3.4 Additional Control Variables

Arguably, both specifications (1) and (2) over-simplify growth dynamics since they omit some common determinants of cross-country variations in economic growth. To assess the robustness of our results, we consider the regression

$$y_j = \alpha + \gamma_1 D_j + \beta i_{j,-n} + \gamma_2 (D_j \times i_{j,-n}) + \delta Controls_{j,-n} + \varepsilon_j, \qquad (3)$$

where *Controls* is a vector containing the relevant control variables and δ is the corresponding coefficient vector. The control variables that are commonly used in cross-country growth analysis were listed in Subsection 3.1 and are added to the regression sequentially. The estimation results are presented in Table 4. For brevity, we present the results pertaining to the cross-sectional analysis based on the annual averages of the 2005 to 2007 period.[8]

Two preliminary observations about the controls are in order. First, these control variables as a group help explain growth variation across countries. The adjusted R-squared estimates of the benchmark regression (2) are noticeably smaller than the corresponding ones reported in Table 4 based on equation (3). The marginal explanatory powers of individual control variables, however, depend on the presence of other regressors in the equation. Second, the

[8] Qualitatively, the results are similar for other time periods. However, as suggested by Figure 1, the results on the parameter γ_2, that captures the (additional) marginal effect of investment on growth experienced by high income countries, are less robust to the inclusion of controls in the earlier time periods.

inclusion of the geographic dummy variables (specification (9) in Table 4) does not improve the regression performance. After controlling for the relevant economic variables, the Asian countries, for example, do not have a stronger or weaker growth.

Next, we move to the interpretation of the coefficients on linear and interaction investment terms. The growth effect of investment is reinforced by these control variables: the coefficient estimates on the lagged investment variable increases in both magnitude and statistical significance with the inclusion of additional country controls. Nevertheless, the marginal effect of investment in high-income countries during the 2005-2007 period, as given by the $\beta + \gamma_2$ estimate, remains negative in all specifications reported in Table 4.

The coefficient estimates on the two high-income related explanatory variables remain positive and statistically significant in all the specifications. The interaction variable, on the other hand, yields a slightly larger (more negative) coefficient estimate in some cases compared to the benchmark without control variables. In other words, the adverse investment effect on growth experienced by high income countries reported in Table 3 is robust to the inclusion of additional economic control variables. Investment in a high-income country could lead to a slow growth rate. The result naturally raises the question: Will a policy of promoting saving and investment be effective in pulling the high income countries out of recession in the post 2007 era?

3.5 Results from Time Series Regressions

The non-overlapping cross-sectional regression results reported in Tables 2 and 3 show that, on the average, the investment effect on growth could be negative for high income countries. Does an individual country's own experience give the same inference? To offer an alternative perspective on the interpretation of the investment effect on growth, we consider the following regression for each country:

$$y_t = \alpha + \beta_1 i_{t,-n} + \beta_2 y_{t,-n} + \varepsilon_t, \qquad (4)$$

where the time subscript indicates non-overlapping time series data used. Given the paucity of time series data, the lagged growth variable is included to capture factors other than investment that affect growth and to minimize the serial correlation in the error term ε_t. Table 5 reports the results for the 26 OCED countries. To facilitate comparison with results in the previous subsections, the sampling window parameter n is set to 3. The countries are ranked by the year 2000 level of income *per capita* to shed some light on the implications of income for the investment effect on growth.

The positive investment effect is not a common phenomenon for these OECD countries. After controlling for the lagged growth effect, lagged investment is found to have a negative coefficient estimate for 13 countries and a positive one for the remaining half of the OECD countries included in the analysis. The negative coefficient estimates on lagged investment tend to concentrate among countries with a higher level of income. For the top 13 high income countries, 8 display a negative estimate.

Among the G-7 countries, the four that have the highest incomes (the USA, Canada, Germany, and Japan) have a negative investment coefficient estimate and the other three (France, Great Britain, and Italy) have a positive one. Indeed, the standard Chow-test results indicate that the investment effects of these two groups of G-7 countries are usually different from each other.

Table 6 presents results from the 15 fastest growing emerging market economies in the sample. These countries are not rich. Investment in these countries, however, does not necessarily have a positive growth implication – indeed, investment has a statistically significant negative effect in four countries. Thus, investment by itself may not be the main cause of fast economic growth.

In passing, we note that similar time series analyses were conducted for other countries. Within a selected group of countries, high income countries are more likely to experience a negative investment effect on growth. For instance, for a group of 9 selected developing countries with the 2000 per capita income between $2.5K and $9K, only Mexico (income at the $9K level) has a negative investment effect on growth.

When we pooled all the data together, the investment variable has a statistically significant coefficient estimate of 0.036; that is, on the average over time and across these countries, investment has a small positive impact on growth. Of course, the significant pooled estimate of 0.036 downplays the heterogeneous investment effect across countries with diverse economic and political characteristics.

While the cross-sectional regressions illustrate the different behaviors of high- and low-income countries on average, the country specific results in Tables 5 and 6 highlight the degree of heterogeneity, even among some high income countries. In general, the negative investment effect on growth tends to be observed for countries with a high level of income within a selected group. In that sense, the findings are in line with the main cross-sectional regression results.

4. Concluding Remarks

The empirics reported above suggest that the investment effect on growth has declined over time to a quite low value in the 2000s. While the average lagged effect of investment on growth across all the countries is positive, it is negative for high income countries. For high-income countries, the negative coefficient on the interaction term high income dummy in the growth equation on average dominates so that the combined marginal effect of investment on growth is negative throughout most of the sample period and is more negative toward the end of the sample time period: the 2000s. This result is robust to the inclusion of other variables that have proven useful in cross-section growth studies.

The time series evidence from individual countries illustrates the degree of the heterogeneity of investment effect on growth. Within any one of the selected groups discussed in the previous section, a higher income country is more likely to display a negative investment effect on growth. However, individual time-series results indicate that not all the high income countries display a negative investment effect and not all low income countries have a positive effect. The level of income is not likely to be the sole determinant of the direction of the investment effect on growth. Nonetheless, the time series evidence is in accordance with cross-sectional regression results in the sense that, on average, investment has a negative growth effect in high-income countries.

Our results show that the investment effect varies over time and across countries. Thus, a panel regression approach could lead to biased results. As pointed out in Section 3.5, the pooled regression result ignores the heterogeneity of investment effects. Notwithstanding the caveat, we note that the β and γ_2 estimates from estimating equation (3) under a panel data setting are, respectively, positive and negative. That is, the results (available upon request) are qualitative similar to those reported in Section 3.

The evidence does not support any one theory of why investment in high income countries is not associated with growth. However, recent uphill international capital flows to the United States may have moved one high-income country to a region of decreasing and even negative returns to investment. More generally, a policy of increasing saving and investment is not a panacea, especially for high-income countries, for promoting economic growth.

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Tables and Figures:

Table 1: Variable definitions and sources

Variable:	Description:	Source:
Real GDP per capita	Real PPP adjusted GDP per capita, unit %	Penn World Tables (PWT) Version 6.3
Investment share	Investment share of real PPP adjusted GDP per capita, unit %	Penn World Tables (PWT) Version 6.3
High income dummy	If GDP per capita is above that year's sample mean	Authors' calculations
Inflation	Inflation, consumption prices (annual %)	World Development Indicators (WDI), World Bank Data
Govtcons	General government final consumption expenditure (% GDP)	World Development Indicators (WDI), World Bank Data
Mortality	Infant mortality rate (per 1000 live birth)	World Development Indicators (WDI), World Bank Data
Fertility	Log of total birth per woman	World Development Indicators (WDI), World Bank Data
Schooling	Secondary school enrollment, male (% of gross)	World Development Indicators (WDI), World Bank Data
Openness	Imports + Exports (% GDP)	World Development Indicators (WDI), World Bank Data
Polity2	Political stability indicator institutionalized autocracy minus democracy score (-10 to 10)	Polity IV project, Marshall and Jaggers (2002)

Table 2: Cross-sectional regression results; *n* = 3. Dependent variable: 3-year average real GDP per capita growth rate

	1956	1959	1962	1965	1968	1971	1974	1977	1980
Investment Share(-3)	0.136***	0.011	0.008	0.120***	0.098***	0.133***	0.115***	0.024	0.119***
	(0.022)	(0.036)	(0.028)	(0.032)	(0.026)	(0.031)	(0.042)	(0.030)	(0.037)
Constant	0.013**	0.042***	0.037***	0.022***	0.041***	0.056***	0.078***	0.083***	0.074***
	(0.005)	(0.008)	(0.006)	(0.006)	(0.006)	(0.007)	(0.009)	(0.008)	(0.009)
Observations	64	71	75	113	113	113	163	163	163
Adjusted R-squared	0.316	-0.012	-0.013	0.147	0.096	0.157	0.044	-0.003	0.048
	1983	1986	1989	1992	1995	1998	2001	2004	2007
Investment Share(-3)	0.027	0.046*	0.074**	0.091**	0.058*	0.023	0.055	-0.039	0.037
	(0.043)	(0.025)	(0.031)	(0.038)	(0.033)	(0.039)	(0.052)	(0.034)	(0.029)
Constant	0.048***	0.025***	0.035***	0.005	0.016**	0.026***	0.033***	0.060***	0.069***
	(0.010)	(0.007)	(0.007)	(0.010)	(0.008)	(0.009)	(0.010)	(0.008)	(0.006)
Observations	163	163	163	165	176	187	187	188	188
Adjusted R-squared	-0.002	0.009	0.032	0.027	0.021	-0.003	0.015	0.005	0.007

Notes: Results of estimating (1) in the text with n = 3 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Table 3: Cross-sectional regression results – high income versus low income countries; *n* = 3. Dependent variable: 3-year average real GDP per capita growth rate.

	1956	1959	1962	1965	1968	1971	1974	1977	1980
Investment Share(-3)	0.144***	0.009	0.001	0.165***	0.115***	0.133**	0.159***	0.068*	0.163***
	(0.023)	(0.051)	(0.031)	(0.050)	(0.032)	(0.058)	(0.042)	(0.038)	(0.042)
High Income Dummy	0.025***	0.012	0.031***	0.041***	0.007	0.013	0.086***	0.027	0.086***
	(0.009)	(0.018)	(0.011)	(0.010)	(0.011)	(0.010)	(0.019)	(0.024)	(0.018)
Dummy x Investment Share(-3)	-0.086**	-0.028	-0.069*	-0.184***	-0.045	-0.036	-0.290***	-0.142*	-0.282***
	(0.035)	(0.067)	(0.041)	(0.051)	(0.041)	(0.056)	(0.064)	(0.080)	(0.066)
Constant	0.009*	0.041***	0.032***	0.017**	0.039***	0.055***	0.067***	0.078***	0.061***
	(0.005)	(0.008)	(0.007)	(0.006)	(0.006)	(0.008)	(0.008)	(0.009)	(0.009)
Observations	64	71	75	113	113	113	163	163	163
Adjusted R-squared	0.365	-0.031	0.067	0.216	0.087	0.146	0.159	0.011	0.181

	1983	1986	1989	1992	1995	1998	2001	2004	2007
Investment Share(-3)	0.055	0.075***	0.073**	0.078*	0.102***	0.023	0.07	-0.006	0.054
	(0.050)	(0.026)	(0.035)	(0.044)	(0.036)	(0.049)	(0.074)	(0.034)	(0.036)
High Income Dummy	0.002	0.043***	0.061***	0.039***	0.043***	0.013	0.038***	0.081***	0.048***
	(0.019)	(0.015)	(0.023)	(0.011)	(0.012)	(0.016)	(0.012)	(0.020)	(0.010)
Dummy x Investment Share(-3)	-0.074	-0.170***	-0.149*	-0.079**	-0.147***	-0.03	-0.122*	-0.266***	-0.164***
	(0.068)	(0.049)	(0.087)	(0.039)	(0.047)	(0.061)	(0.064)	(0.077)	(0.038)
Constant	0.047***	0.018***	0.027***	0.000	0.006	0.024**	0.028**	0.050***	0.063***
	(0.010)	(0.007)	(0.007)	(0.010)	(0.008)	(0.010)	(0.012)	(0.008)	(0.007)
Observations	163	163	163	165	176	187	187	188	188
Adjusted R-squared	0.011	0.07	0.132	0.046	0.097	-0.01	0.035	0.129	0.063

Notes: Results of estimating (2) in the text with n = 3 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Table 4: Cross-sectional regression results – the 2005-2007 sampling window. Dependent variable: 3-year average real GDP per capita growth rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Investment Share(-3)	0.054	0.074*	0.119***	0.110***	0.112***	0.100**	0.105***	0.109**	0.099*
	(0.036)	(0.040)	(0.035)	(0.037)	(0.038)	(0.039)	(0.038)	(0.049)	(0.052)
High Income Dummy	0.048***	0.049***	0.054***	0.047***	0.049***	0.044***	0.047***	0.033***	0.034***
	(0.010)	(0.010)	(0.011)	(0.013)	(0.013)	(0.015)	(0.015)	(0.010)	(0.011)
Dummy x Investment Share(-3)	-0.164***	-0.187***	-0.210***	-0.207***	-0.209***	-0.195***	-0.201***	-0.173***	-0.170***
	(0.038)	(0.040)	(0.040)	(0.041)	(0.042)	(0.046)	(0.048)	(0.041)	(0.042)
Openness(-3)		0.015***	0.012**	0.013**	0.012*	0.01	0.015**	0.009	0.009
		(0.005)	(0.005)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Govtcons(-3)			-0.072	-0.092*	-0.111**	-0.103*	-0.107**	-0.105*	-0.104
			(0.046)	(0.048)	(0.053)	(0.054)	(0.054)	(0.057)	(0.070)
Schooling(-3)				0.018	0.016	-0.002	0.019	0.022	0.021
				(0.014)	(0.014)	(0.019)	(0.024)	(0.026)	(0.026)
Inflation(-3)					0.008	0.006	0.005	0.003	0.002
					(0.006)	(0.005)	(0.005)	(0.007)	(0.007)
Fertility(-3)						-0.015	-0.032**	-0.051***	-0.054***
						(0.012)	(0.016)	(0.013)	(0.013)
Mortality(-3)							0.001*	0.001**	0.001**
							(0.000)	(0.000)	(0.000)
Polity2								-0.002**	-0.002**
								(0.001)	(0.001)
Latin Amer.									0.005
									(0.010)
Africa									-0.001
									(0.013)
Asia									-0.002
									(0.011)
Constant	0.063***	0.050***	0.054***	0.047***	0.051***	0.082***	0.061**	0.085***	0.087***
	(0.007)	(0.007)	(0.009)	(0.011)	(0.012)	(0.027)	(0.030)	(0.029)	(0.030)
Observations	188	177	172	153	144	143	141	119	119
Adjusted R-squared	0.063	0.114	0.162	0.16	0.146	0.145	0.181	0.303	0.287

Notes: Results of estimating (3) in the text with n = 3 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Table 5: Country-Specific Regression Results – OECD Countries. Dependent variable: 3-year average real GDP per capita growth rate.

Sample:	2000 GDP/capita	Inv. Share (t-3)	S.E.	Growth Rate (t-3)	S.E	Constant	S.E.	Obs.	Adj. R2
LUX	$54,109	-0.553***	(0.065)	-0.291***	(0.098)	0.245***	(0.026)	18	0.207
USA	$34,608	-0.256*	(0.139)	0.693***	(0.061)	0.072**	(0.028)	18	0.522
NOR	$34,524	0.044	(0.123)	0.478***	(0.124)	0.018	(0.046)	18	0.134
CHE	$29,877	-0.272	(0.177)	0.539***	(0.113)	0.110**	(0.054)	18	0.291
IRL	$28,310	0.138	(0.143)	0.135	(0.152)	0.021	(0.033)	18	0.022
NLD	$27,983	0.207***	(0.060)	0.563***	(0.087)	-0.03	(0.018)	18	0.382
ISL	$27,664	0.299**	(0.137)	-0.104	(0.096)	-0.034	(0.051)	18	-0.007
AUT	$27,575	-0.184	(0.156)	0.751***	(0.106)	0.067*	(0.039)	18	0.472
CAN	$26,685	-0.835**	(0.341)	0.398***	(0.099)	0.237***	(0.081)	18	0.397
DNK	$26,129	0.031	(0.073)	0.460***	(0.156)	0.025***	(0.010)	18	0.105
BEL	$26,073	-0.033	(0.280)	0.474***	(0.058)	0.041	(0.072)	18	0.118
JPN	$25,126	-0.113*	(0.061)	0.746***	(0.070)	0.053***	(0.015)	18	0.581
AUS	$24,825	-0.227	(0.240)	0.431***	(0.081)	0.1	(0.071)	18	0.100
SWE	$24,614	0.171*	(0.089)	0.489***	(0.047)	-0.01	(0.021)	18	0.216
FRA	$23,981	0.308**	(0.133)	0.538***	(0.085)	-0.053**	(0.027)	18	0.510
GBR	$23,764	0.219	(0.225)	0.565***	(0.078)	-0.018	(0.045)	18	0.295
FIN	$23,709	0.174**	(0.068)	0.026	(0.067)	0.005	(0.019)	18	-0.077
ITA	$23,572	0.14	(0.085)	0.493***	(0.118)	-0.011	(0.036)	18	0.215
ESP	$21,345	-0.024	(0.109)	0.196	(0.209)	0.065***	(0.024)	18	-0.088
ISR	$20,221	0.059	(0.103)	0.14	(0.128)	0.036	(0.025)	18	-0.095
NZL	$18,366	-0.406***	(0.147)	0.023	(0.027)	0.151***	(0.037)	18	0.049
GRC	$17,737	0.232***	(0.084)	0.169	(0.138)	-0.011	(0.023)	18	0.354
PRT	$16,919	-0.227	(0.211)	0.289***	(0.063)	0.114*	(0.062)	18	0.111
KOR	$16,890	-0.071*	(0.041)	0.643***	(0.082)	0.055***	(0.019)	17	0.318
HUN	$11,329	0.198	(0.128)	0.402*	(0.216)	-0.007	(0.021)	12	0.135
POL	$9,486	-0.741***	(0.251)	0.434**	(0.202)	0.201***	(0.047)	12	0.080

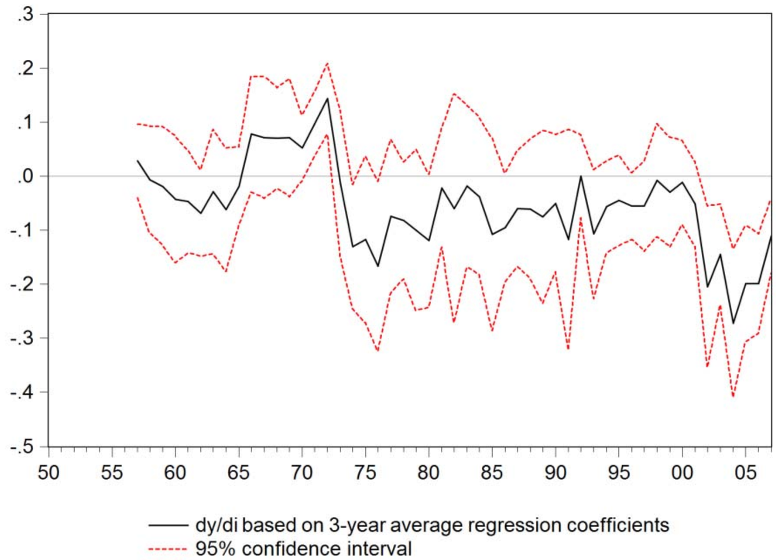
Notes: Results of estimating (4) in the text with n = 3 are reported. Robust and autocorrelation corrected (HAC) standard errors are given in parentheses. HAC was estimated using the Parzen kernel and the lag parameter chosen by the Newey-West method. *, **, and *** indicate significance at the 10%, 5% and 1% levels. Only countries with 10 or more non-overlapping observations are included.

Table 6: Country-Specific Regression Results – the 15 Fastest Growing Emerging Countries. Dependent variable: 3-year average real GDP per capita growth rate.

Sample:	Inv. Share (t-3)	S.E.	Growth Rate (t-3)	S.E	Constant	S.E.	Obs.	Adjusted R2
GNQ	0.657***	(0.099)	-0.277***	(0.099)	0.038	(0.025)	15	0.486
KNA	-0.432***	(0.082)	-0.084	(0.129)	0.268***	(0.049)	12	0.282
MAC	-0.553***	(0.140)	0.436***	(0.121)	0.155***	(0.017)	12	0.149
MDV	2.774***	(0.364)	-0.230***	(0.056)	-0.781***	(0.117)	12	0.019
TWN	-0.021	(0.108)	0.704***	(0.125)	0.029***	(0.009)	18	0.399
CHN	0.246***	(0.069)	0.220***	(0.064)	0.014	(0.013)	18	0.031
BWA	0.244***	(0.047)	0.053	(0.139)	0.033	(0.025)	15	-0.055
BTN	0.233***	(0.041)	-0.755***	(0.229)	0.045	(0.036)	12	0.442
HKG	-0.033	(0.082)	0.458*	(0.235)	0.059	(0.043)	15	0.075
SGP	-0.032	(0.027)	0.338***	(0.100)	0.076***	(0.012)	15	-0.039
KOR	-0.071*	(0.041)	0.643***	(0.082)	0.055***	(0.019)	17	0.318
GRD	-0.257***	(0.022)	-0.034	(0.050)	0.221***	(0.005)	12	0.604

Notes: Results of estimating (4) in the text with n = 3 are reported. Robust and autocorrelation corrected (HAC) standard errors are given in parentheses. HAC was estimated using the Parzen kernel and the lag parameter chosen by the Newey-West method. *, **, and *** indicate significance at the 10%, 5% and 1% levels. Only countries with 10 or more non-overlapping observations are included.

Figure 1: The marginal growth effect of investment given by $\beta + \gamma_2$ and its 95% confidence interval; n = 3



Notes: The figure plots the marginal growth effect of investment, $\beta + \gamma_2$, from each annual cross-sectional regression (with $n = 3$) based on equation (2) along with the associated 95 percent confidence interval. The confidence interval takes into account the variances and the covariance of the estimates of β and γ_2.

Appendix:

As a robustness check, the appendix presents some cross-sectional results based on the sampling window of 5 years; that is $n = 5$.

Table A1: Cross-sectional regression results; $n = 5$. Dependent variable: 5-year average real GDP per capita growth rate.

	1957	1962	1967	1972	1977	1982	1987	1992	1997	2002	2007
Investment Share(-5)	0.111***	0.001	0.101***	0.104***	0.065**	0.076**	0.063**	0.062**	0.033	0.006	0.001
	(0.021)	(0.028)	(0.020)	(0.028)	(0.026)	(0.033)	(0.029)	(0.027)	(0.032)	(0.025)	(0.025)
Constant	0.020***	0.038***	0.029***	0.057***	0.087***	0.070***	0.022***	0.022***	0.027***	0.034***	0.070***
	(0.005)	(0.006)	(0.004)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.005)	(0.006)
Observations	62	71	113	113	163	163	163	164	176	187	188
Adjusted R-squared	0.268	-0.014	0.189	0.14	0.025	0.036	0.024	0.018	0.005	-0.005	-0.005

Notes: Results of estimating (1) in the text with n = 5 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Table A2: Cross-sectional regression results – high income versus low income countries; n = 5. Dependent variable: 5-year average real GDP per capita growth rate.

	1957	1962	1967	1972	1977	1982	1987	1992	1997	2002	2007
Investment Share(-5)	0.130***	-0.009	0.121***	0.103**	0.114***	0.106**	0.092***	0.063*	0.071**	0.014	0.033
	(0.029)	(0.027)	(0.031)	(0.051)	(0.027)	(0.042)	(0.031)	(0.036)	(0.029)	(0.034)	(0.030)
High Income Dummy	0.018**	0.027**	0.017**	0.017**	0.050***	0.042***	0.042***	0.050***	0.035***	0.050**	0.062***
	(0.009)	(0.011)	(0.007)	(0.007)	(0.010)	(0.014)	(0.013)	(0.014)	(0.008)	(0.021)	(0.010)
Dummy x Investment Share(-5)	-0.078**	-0.054	-0.081**	-0.05	-0.206***	-0.169***	-0.157***	-0.110**	-0.125***	-0.146*	-0.202***
	(0.033)	(0.040)	(0.032)	(0.036)	(0.035)	(0.053)	(0.046)	(0.055)	(0.033)	(0.081)	(0.038)
Constant	0.017***	0.032***	0.027***	0.056***	0.079***	0.064***	0.014**	0.014*	0.019***	0.029***	0.059***
	(0.006)	(0.006)	(0.005)	(0.007)	(0.006)	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)
Observations	62	71	113	113	163	163	163	164	176	187	188
Adjusted R-squared	0.286	0.103	0.211	0.137	0.132	0.105	0.105	0.102	0.075	0.088	0.128

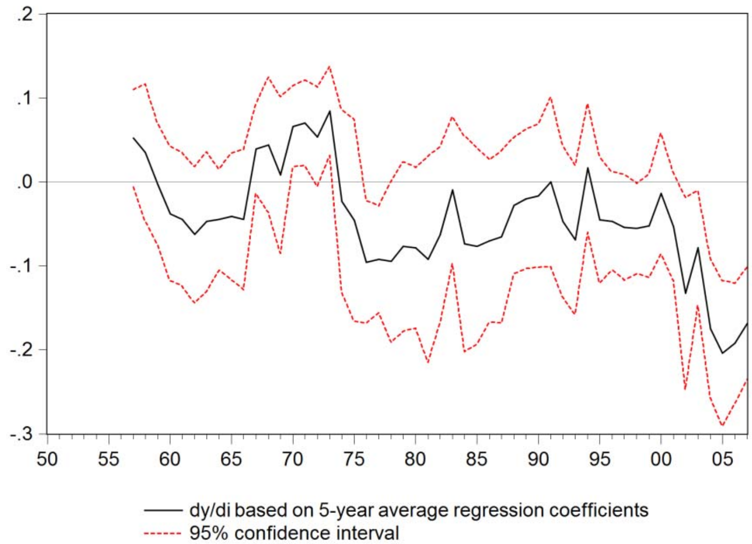
Notes: Results of estimating (2) in the text with n = 5 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Table A3: Cross-sectional regression results – the 2003-2007 sampling window. Dependent variable: 5-year average real GDP per capita growth rate.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Investment Share(-5)	0.033	0.060*	0.101***	0.091**	0.077**	0.063	0.084**	0.086	0.061
	(0.030)	(0.036)	(0.032)	(0.036)	(0.038)	(0.041)	(0.042)	(0.057)	(0.065)
High Income Dummy	0.062***	0.063***	0.070***	0.068***	0.066***	0.059***	0.064***	0.048***	0.045***
	(0.010)	(0.010)	(0.010)	(0.012)	(0.013)	(0.015)	(0.015)	(0.013)	(0.012)
Dummy x Investment Share(-5)	-0.202***	-0.234***	-0.264***	-0.263***	-0.257***	-0.239***	-0.259***	-0.211***	-0.192***
	(0.038)	(0.040)	(0.038)	(0.042)	(0.042)	(0.050)	(0.052)	(0.050)	(0.052)
Openness(-5)		0.010**	0.009*	0.008	0.006	0.004	0.007	0.004	0.005
		(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Govtcons(-5)			-0.084**	-0.098**	-0.083*	-0.063	-0.063	-0.111**	-0.089
			(0.041)	(0.041)	(0.050)	(0.051)	(0.046)	(0.051)	(0.061)
Schooling(-5)				0.007	0.005	-0.016	0.007	0.011	0.007
				(0.014)	(0.015)	(0.016)	(0.018)	(0.018)	(0.019)
Inflation(-5)					0.002	0.002	-0.005	-0.007	-0.008
					(0.011)	(0.009)	(0.011)	(0.010)	(0.010)
Fertility(-5)						-0.018	-0.035**	-0.057***	-0.058***
						(0.012)	(0.015)	(0.013)	(0.014)
Mortality(-5)							0.001**	0.001***	0.001***
							(0.000)	(0.000)	(0.000)
Polity2								-0.002***	-0.002***
								(0.001)	(0.001)
Latin Amer.									0.002
									(0.008)
Africa									-0.012
									(0.013)
Asia									-0.003
									(0.009)
Constant	0.059***	0.049***	0.057***	0.059***	0.063***	0.098***	0.071***	0.099***	0.102***
	(0.006)	(0.007)	(0.009)	(0.012)	(0.013)	(0.026)	(0.027)	(0.027)	(0.028)
Observations	188	178	172	157	144	144	142	120	120
Adjusted R-squared	0.128	0.158	0.194	0.174	0.157	0.167	0.202	0.306	0.294

Notes: Results of estimating (3) in the text with n = 5 are reported. Robust standard errors are given in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

Figure A1: The marginal growth effect of investment given by $\beta + \gamma_2$ and its 95% confidence interval; $n = 5$



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Notes: The figure plots the marginal growth effect of investment, $\beta + \gamma_2$, from each annual cross-sectional regression (with $n = 5$) based on equation (2) along with the associated 95 percent confidence interval. The confidence interval takes into account the variances and the covariance of the estimates of β and γ_2.