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Public Debt and Growth

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This paper explores the impact of high public debt on long-run economic growth. The analysis, based on a panel of advanced and emerging economies over almost four decades, takes into account a broad range of determinants of growth as well as various estimation issues including reverse causality and endogeneity. In addition, threshold effects, nonlinearities, and differences between advanced and emerging market economies are examined. The empirical results suggest an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 0.2 percentage points per year, with the impact being somewhat smaller in advanced economies. There is some evidence of nonlinearity with higher levels of initial debt having a proportionately larger negative effect on subsequent growth. Analysis of the components of growth suggests that the adverse effect largely reflects a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital stock.

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I. INTRODUCTION

The sharp increase in advanced country sovereign debts as a result of the global economic and financial crisis has led to serious concerns about fiscal sustainability, and their broader economic and financial market impact. A key issue relates to the extent to which large public debts are likely to have an adverse effect on capital accumulation, as well as productivity, and reduce economic growth. This can occur through a variety of channels including higher long-term interest rates, possibly higher future distortionary taxation, higher inflation, greater uncertainty and vulnerability to crises. If economic growth is negatively affected, fiscal sustainability issues are likely to be exacerbated, which further increases the premia on early and decisive fiscal adjustment efforts to reduce the debts to more sustainable levels. Despite the importance of the issue, there is little systematic evidence on the extent to which large debts are likely to reduce potential growth.

This paper provides empirical evidence on the impact of high public debt on subsequent growth of real per capita GDP for a panel of advanced and emerging market economies in the period 1970–2007. Methodologically, the paper builds on two strands of literature: (i) a large literature on the determinants of medium- and long-run growth (see Barro and Sala-i-Martin 2003, Aghion and Durlauf 2005 among others), and (ii) a much more limited literature, pertaining primarily to low-income countries, that explores the impact of high *external* debt on growth via crowding out and debt overhang.

In the empirical estimation, the paper utilizes two main approaches, growth regressions and growth accounting, and pays particular attention to a variety of methodological issues that can have an important bearing on the results. These include reverse causality and simultaneity bias, resulting from the possibility that while high debt may have an adverse effect on growth, low growth—for reasons unrelated to debt—could also lead to high debt, or that government debt and growth might be jointly determined by a third variable. In addition, it explores nonlinearities and threshold effects—that is, whether there is a certain level of debt only beyond which debt begins to have the adverse effect on growth. The growth regression estimation is complemented by the growth accounting framework which allows an exploration of the channels (factor accumulation versus factor productivity) through which public debt may influence growth.

The results, based on a range of econometric techniques, suggest an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 0.2 percentage points per year, with the impact being somewhat smaller in advanced economies. There is some evidence of nonlinearity with higher levels of initial debt having a proportionately larger negative effect on subsequent growth. Analysis of the growth decomposition suggests that the adverse effect largely reflects a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital stock. Extensive robustness checks confirm these results.

The rest of the paper is organized as follows: Section II discusses the channels through which high debt may affect growth, and summarizes related existing studies. Section III discusses a number of methodological issues and estimation strategy. Section IV describes data and some stylized facts relating to public debt and growth; Section V presents the main panel regression results on the relationship between debt and growth, followed by analysis of growth components based on growth accounting exercises. Section VII concludes. Appendixes 1–4 provide additional discussion regarding econometric methodology, the magnitude of debt impact for the United States based on a simple production framework, growth accounting, and cross-country regressions. Two additional Appendixes discuss data sources and country sample.

II. Channels and Existing Studies

Public debt has important influence over the economy both in the short- and the long run. The conventional view is that debt (reflecting deficit financing) can stimulate aggregate demand and output in the short run (assuming no non-Keynesian effects) , but crowds out capital and reduces output in the long run (see Elmendorf and Mankiw, 1999 for a literature survey on public debt).[2] This paper focuses on the long-run effects of public debt.

There are several channels through which high debt could adversely impact medium- and long-run growth which have received attention in the literature: high public debt can adversely affect capital accumulation and growth via higher long-term interest rates (Gale and Orzag, 2003; Baldacci and Kumar, 2010), higher future distortionary taxation (Barro, 1979; Dotsey, 1994), inflation (Sargent and Wallace 1981; Barro 1995; Cochrane 2010), and greater uncertainty about prospects and policies. In more extreme cases of a debt crisis, by triggering a banking or currency crisis, these effects can be magnified (Burnside et al., 2001; Hemming et al., 2003). High debt is also likely to constrain the scope for countercyclical fiscal policies, which may result in higher volatility and further lower growth (see Aghion and Kharroubi (2007) on the effects of countercyclical fiscal policy on growth, and Woo (2009) on the effects of procyclicality and volatility of fiscal policy on growth).

Despite these considerations, there is little systematic analysis of the impact on GDP growth of high public debt in advanced economies. A notable exception is the recent path-breaking study by Reinhart and Rogoff (2010) which examines economic growth and inflation at different levels of government debt in advanced and emerging economies based on long

[2] Standard growth theory predicts that an increase in government debt (due to a fiscal deficit) leads to slower growth—temporary decline in growth along the transition path to a new steady state in the neoclassical model, such as the Solow model, and a permanent decline in growth in the endogenous growth model (Saint-Paul, 1992).

historical data series. The authors find that the difference in median growth rates of GDP between low debt (below 30 percent of GDP) and high debt (above 90 percent of GDP) groups is 2.6 percentage points in advanced economies over the period.[3] The difference in average growth rates between low and high debt is even larger (4.2 percentage points). By contrast, the differential in median growth between low and high debt groups in emerging economies is smaller (2.1 percentage points). Their study however only considers correlations between debt and growth, and does not take into account other determinants of growth as well as issues such as reverse causality (i.e., low growth can lead to large public debt).

A number of other studies have looked at the impact of external debt on economic growth in developing economies. Most of these studies were motivated by the "debt overhang" hypothesis—a situation where a country's debt service burden is so heavy that a large portion of output accrues to foreign lenders and consequently creates disincentives to invest (Krugman, 1988, and Sachs, 1989). Imbs and Ranciere (2009) and Pattillo, Poirson, and Ricci (2002, 2004) find a nonlinear effect of external debt on growth: that is, a negative and significant impact on growth at high debt levels (typically, over 60 percent of GDP), but an insignificant impact at low debt levels. In contrast, Cordella, Ricci, and Arranz (2005) find evidence of debt overhang for intermediate debt levels, but an insignificant debt-growth relationship at very low and very high levels of debt.

III. Estimation Strategy

As the empirical growth literature has expanded, some shortcomings of growth regressions have become apparent (Durlauf et al., 2005). A dominant concern relates to *robustness.* Many studies have regressed output growth on an array of potential determinants. But the usefulness of this approach has increasingly been called into question, largely because the resulting parameter estimates are often sensitive to other conditional variables (Sala-i-Martin, 1997 and Levine and Renelt 1992). Against this background, recent studies such as Bosworth and Collins (2003) suggest that it is better to focus on a core set of explanatory variables that have been shown to be consistently associated with growth and evaluate the importance of other variables conditional on inclusion of the core set. This is the approach adopted in this paper.

Specifically, the findings of Sala-i-Martin et al. (2004) are closely followed in selecting the core set of growth determinants. To check the robustness of results, parsimonious

[3] The study also provides a similar analysis for 44 countries spanning about two hundred years (for the United States, dating back to 1790). It finds no systematic positive relationship between public debt and inflation in advanced economies as a group (with some individual exceptions such as the United States). By contrast, inflation rates are markedly higher in emerging market economies with higher public debt levels.

specifications are tried, and additional variables are also considered. It is worth noting the main findings of Sala-i-Martin et al. (2004) regarding the robust growth determinants: in comprehensive cross-country growth regressions, they examine the robustness of 67 explanatory variables and identify 18 that have high posterior inclusion probabilities (that is, high marginal contribution to explanatory power of the regression model, relative to models not including it), which they view as being significantly and robustly correlated with long-term growth. Among these 18 variables, there are only a few economic variables, such as the initial level of real per capita GDP, primary school enrollment, the initial government consumption share, trade openness, and the relative price of investment. The rest are regional variables (Africa, East Asia, Latin America), and a variety of socio-political factors (including religious and ethnic variables). These results confirm those obtained earlier by Sala-i-Martin (1997).[4]

In addition to taking into account the "core set" of growth determinants which are mostly embodied in the initial conditions, the estimation uses initial level of debt to avoid the reverse causality problem. Reverse causality may not be a trivial issue as slower economic growth can lead to high debt buildup, rather than high debt lowering growth.[5]

We consider a variety of estimation methodologies, such as pooled OLS, robust regression, between estimator (BE), fixed effects (FE) panel regression, and system GMM (SGMM) dynamic panel regression. Each of the estimators involves a trade-off. Estimators that may seem attractive to address a specific econometric problem can lead to a different type of bias. For example, when an omitted variables bias coexists with measurement errors that are likely in the cross-country data, dealing with the first problem may exacerbate the second. Thus, in order to deal with the different types of econometric issues, and ensure robust results, the following estimation methods are employed: pooled OLS, robust regression, BE, FE, and SGMM regression.

It is worth emphasizing that while the paper uses *initial* level of government debt to examine the impact on *subsequent* growth and thereby may avoid reverse causality, this approach does not necessarily resolve the endogeneity problem: that is, growth and government debt might be jointly determined by third variables. Given the difficulty of finding appropriate external

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[4] Sala-i-Martin (1997) looks at the distribution of the OLS estimates of the coefficient of the variable of interest by running the regressions with initial per capita GDP, primary school enrollment, life expectancy, the variable of interest, and all possible triplets of conditioning variables from a pool of 58 potential explanatory variables. He finds a similar list of variables to be significant in the sense that more than 95 percent of fraction of the density function for the estimated coefficients of each of the variables lie on each side of zero.

[5] See Easterly (2001) for this argument. But Imbs and Ranciere (2009)'s findings contradict Easterly's argument that slow growth contributed to debt explosion in the developing countries in 1980s in an event study of external debt. In general, investment actually builds up prior to the onset of debt overhang, which argues against the possibility that an investment slump predates the overhang and explains the debt build-up.

instrumental variables for initial government debt and other economic variables, the paper addresses the endogeneity issue by using the SGMM approach of Arellano and Bover (1995) and Blundell and Bond (1998), which uses suitable lagged levels and lagged first differences of the regressors as their instruments. This approach has recently gained popularity, and is widely used in a variety of applied economic research.

On the other hand, the OLS estimates tend to be sensitive to outliers, either observations with unusually large errors or influential observations with unusual values of explanatory variables (often called leverage points). In a recent evaluation of growth regressions in relation to macroeconomic policy variables, Easterly (2005) argues that some of the large effects on growth of a policy variable in the earlier empirical studies are often caused by outliers that represent "extremely bad" policies. Thus, to ensure that our results are not unduly driven by outliers, robust regression is also implemented.[6]

Lastly, we also run a single cross-country regression of the type that is most commonly used in the empirical growth literature for longer time periods. This helps address the issue that the five-year time interval in the panel may not be long enough to smooth out short-term business cycle fluctuations. The results of this cross-country regression results however turn out to be broadly similar to those from panel regressions.

IV. Data and Stylized Facts

Data for the key variables such as GDP, population, investment, and government size are obtained primarily from the Penn World Table (PWT) version 6.3 of Heston et al. (2009). Fiscal data including government debt are primarily from the IMF's World Economic Outlook database, and other explanatory variables are from World Bank's World Development Indicators (2009). The availability of data on public debt and other variables included in the regression dictated the sample size: the main analysis is based on a panel of 38 advanced and emerging economies with a population of over 5 million, for the period 1970–2007.

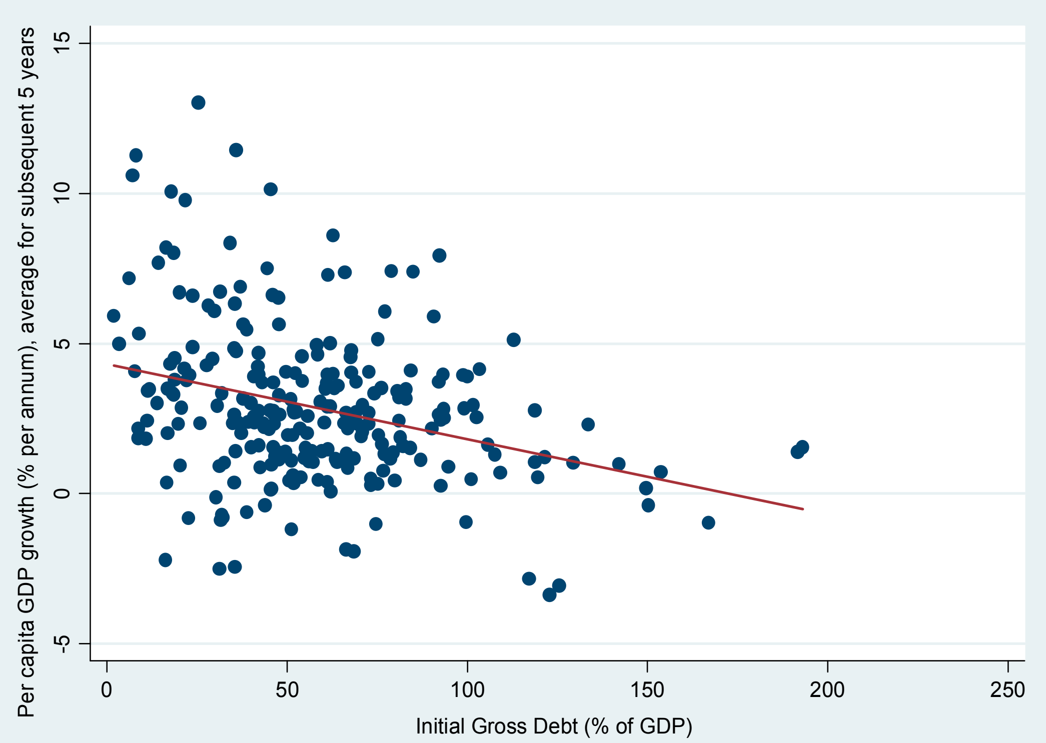
Some stylized facts: First, data on government debt and growth clearly show that there is a negative correlation between *initial* government debt and *subsequent* growth of real per capita GDP. Figure 1 shows a scatter plot of initial debt against subsequent growth of real per capita GDP over five-year periods in the full sample. According to the OLS fitted line, the coefficient of initial debt is -0.025. Taken at face value (i.e., ignoring the potential endogeneity problem, and not controlling for other growth determinants), it suggests that a 10 percentage point increase in initial debt-to-GDP ratio is associated with a subsequent

[6] It is essentially an iterated re-weighted least squares regression in which the outliers are dropped (if Cook's distance is greater than 1) and the observations with large absolute residuals are down-weighted.

slowdown in per capita GDP growth of 0.25 percentage points. At shown below, this magnitude turns out to be quite consistent with that obtained using econometric analysis.

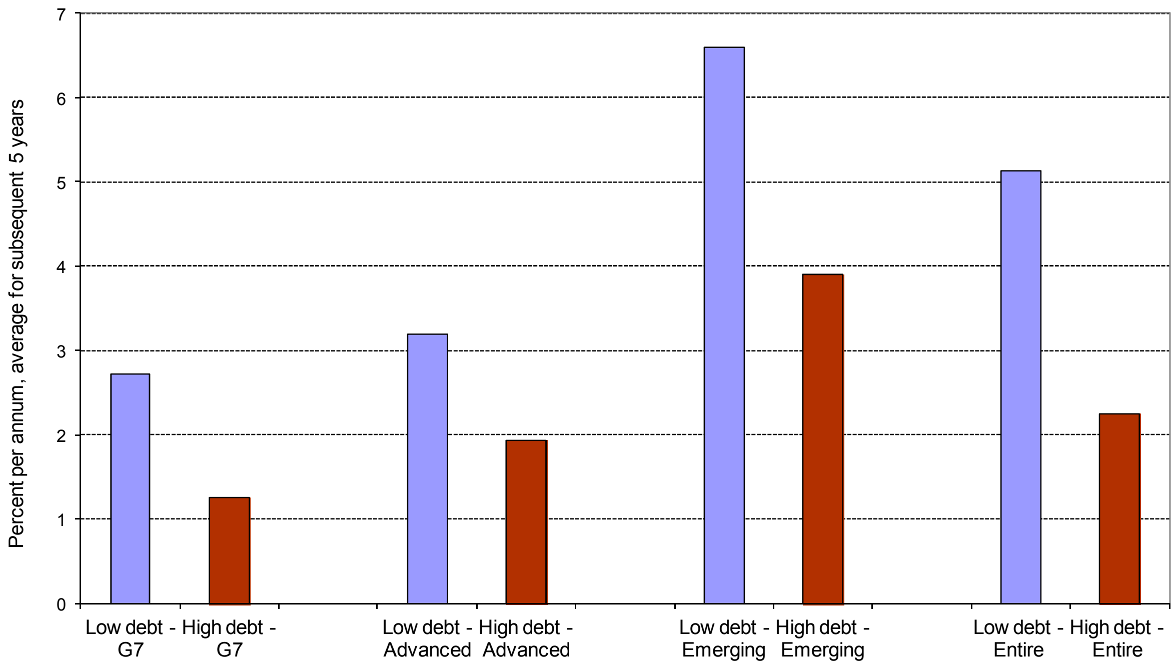
Second, the *subsequent* growth rate of per capita GDP over five-year periods during high *initial* debt episodes (above 90 percent of GDP) is on average lower than that during low *initial* debt episodes (below 30 percent of GDP) across various groups of countries (Figure 2). In advanced economies, the difference in the average growth rates between low initial debt and high initial debt episodes is 1.3 percentage points; in emerging economies, it is more than twice that (2.7 percentage points). This pattern is consistent with econometric results discussed later. Similarly, the average growth differential in G7 countries between low and high initial debt periods is 1.5 percentage points. In the full sample, the growth differential is 2.8 percentage points. (See Appendix Table 1 for summary statistics on average growth rates of real GDP per capita, output per worker, TFP, capital stock per worker, as well as average levels of domestic investment at different levels of initial government debt for various country groupings).

Figure 1. Initial Government Debt and Subsequent Growth of Real per Capita GDP



Fitted line: Growth=4.31-0.025*Initial debt, where the intial debt coefficient is significant at 1%.

Figure 2. Growth of Real per Capita GDP Between High and Low Initial Government Debt Episodes (low debt <30% of GDP, and high debt >90% of GDP)



V. ECONOMETRIC ANALYSIS

A. Model Specification

The formal analysis focuses on the medium/longer-run relationship between initial government debt and subsequent economic growth, while exploiting both cross-sectional and time-series dimensions of the data. Our panel spans 38 years from 1970 to 2007, and comprises eight non-overlapping five-year periods (1970–74, 1975–79, … , 2000–04, 2005–07), except for the last period spanning three years. In addition, cross-country OLS regressions were estimated for longer time periods (see Appendix 4 for the results).

The baseline panel regression specification is as follows:

$$y_{i,t} - y_{i,t-\tau} = \alpha y_{i,t-\tau} + \mathbf{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta_t + \nu_i + \varepsilon_{i,t}, \quad (1)$$

where a period is a five-year time interval (i.e., τ=4); t denotes the end of a period and t- τ denotes the beginning of that period; i denotes country; y is the logarithm of real per capita GDP; ν_i is the country-specific fixed effect; η_t is the time-fixed effect; $\varepsilon_{i,t}$ is an unobservable error term; $\mathbf{X}_{i,t-\tau}$ is a vector of economic and financial variables; $Z_{i,t-\tau}$ is the initial government debt (in percent of GDP).[7]

As noted above, a core set of explanatory variables that have been shown to be consistently associated with growth in the literature is fully taken into account. The variables **X** in the baseline specification are as follows: initial level of real GDP per capita, to capture the catching-up process; human capital, to reflect the notion that countries with an abundance of it are more likely have a greater ability to attract investors, absorb ideas from the rest of the world, and engage in innovation activities (Grossman and Helpman, 1991). As a proxy for human capital, we use the log of average years of secondary schooling in the population over age 15 in the initial year, taken from Barro and Lee (2000).

Initial government size (as measured by government consumption share of GDP) is also included, in the light of the robust results obtained by Sala-i-Martin et al. (2004).[8] In addition, we include initial trade openness (sum of export and import as a percent of GDP), initial financial market depth (liquid liabilities as a percent of GDP), initial inflation as measured by CPI inflation (to be precise, logarithm of (1+ inflation rate)), and terms of trade growth rates (averaged over each time period). A measure of banking crisis incidence is also included (based on Reinhart and Reinhart (2008)), reflecting Reinhart and Rogoff's (2009) finding that banking crises are typically accompanied by large increases in government debt.[9] At the same time, banking crises typically result in slow growth. The fiscal deficit is included to take into account the finding that fiscal deficits are negatively associated with longer-run growth (see Fischer, 1993 and Baldacci et al. 2004).

To check the robustness of results, parsimonious specifications were tried and additional variables also considered: these included population size (a proxy of country size), aged-

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[7] To be precise, the average growth rate of real per capita GDP per year over the period t-τ and t is $(y_{i,t} - y_{i,t-\tau})/\tau$, which is actually used in the empirical application of equation (1). All the explanatory variables in $\mathbf{X}_{i,t-\tau}$ are measured at the beginning of period, except for the terms of trade growth, incidences of banking crisis, and fiscal deficit that are measured over the period *t-τ* and *t*.

[8] Also, it can be motivated by a consideration of fiscal sustainability. Huang and Xie (2008) derive a fiscal sustainability frontier in an endogenous growth framework, and show that higher levels of government spending reduce the sustainable level of government debt. This implies that estimating a threshold effect on growth based on a widely used single-dimensional perspective of fiscal sustainability such as debt in excess of a particular level may be difficult. What matters is the ability to finance any given level of debt, which in part depends on the availability of savings and the preferences of the savers. Related, Woo (2003) finds that financial market depth is one of the robust determinants of public deficits for various estimation techniques and extensive robustness checks including an extreme-bounds analysis. Thus, a measure of financial depth is included in the baseline regression.

[9] An average of 86 percent increase in the major episodes. The main drivers of debt increases are the inevitable collapse in tax revenues that governments suffer in the wake of deep and prolonged output contractions, as well as often ambitious countercyclical fiscal policies aimed at mitigating the downturn.

dependency ratio (a proxy of population aging), investment,[10] fiscal spending volatility, urbanization, private saving, and checks and balances or constraints on executive decision-making (as a proxy of durable institutionalized constraints; see Glaeser et al., 2004).

B. Sources of Bias

There are a number of sources of biases that can cause inconsistent estimates of the coefficients in panel growth regressions. The first is the omitted-variables bias (so-called heterogeneity bias) resulting from possible correlation between country-specific fixed effects (ν_i) and the regressors, affecting the consistency of pooled OLS and BE (between estimator) estimates. The second is the endogeneity problem due to potential correlation between the regressors and the error term, which would affect the consistency of pooled OLS, BE and FE. Specific to dynamic panels, there is a dynamic panel bias which will make FE estimates inconsistent.[11] The third is classical measurement errors (errors in variables) in the independent variables, which affects the consistency of pooled OLS, BE, and FE estimator, although the bias tends to be exacerbated in FE and moderated in BE.

Specifically, the BE estimator tends to reduce the extent of measurement error via time averaging of the regressors, but does not deal with the omitted-variables bias; pooled OLS and BE suffer from both omitted-variables bias and measurement errors but will reduce the heterogeneity bias because other things equal, measurement errors tend to reduce the correlation between the regressors and the country fixed effects; FE addresses the problem of the omitted-variables bias via controlling for fixed-effects, but tends to exacerbate the measurement error problem, relative to BE and OLS. This measurement error bias under FE tends to get even worse when the explanatory variables are more time-persistent than the errors in the measurement (Hauk and Wacziarg 2009).[12] Furthermore, in the dynamic panel setting, the within-transformation in the estimation process of FE introduces a correlation between transformed lagged dependent variable and transformed error, which also makes FE inconsistent. Theoretically, the dynamic panel GMM estimator addresses a variety of biases

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[10] The *proximate* causes of growth, such as investment or capital per worker, are not included in the core set of growth determinants, but are examined in the growth accounting exercises instead. Nonetheless, we check whether including investment in the regression changes the estimated coefficients of initial government debt.

[11] To see this more clearly, one can rewrite the equation (1) as $y_{i,t} = (1+\alpha)y_{i,t-\tau} + \mathbf{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta_t + \nu_i + \varepsilon_{i,t}$. The endogeneity bias (often called dynamic panel bias) arises due to inevitable correlation between $y_{i,t-\tau}$ and ν_i in the presence of lagged dependent variable because $y_{i,t-\tau}$ is endogenous to the fixed effects (ν_i) in the error term. In the FE, the fixed effects (ν_i) are eliminated via within-transformation, but there is now a correlation between the transformed lagged dependent variable and the transformed error term, causing the FE to be inconsistent and biased downward.

[12] Intuitively, the within-transformation (i.e., demeaning) under FE may exacerbate the measurement error bias by decreasing the signal-to-noise ratio (Grilliches and Hausman, 1986; Hauk and Wacziarg, 2009).

such as the omitted-variables bias, endogeneity, and measurement errors (as long as instruments are uncorrelated with the errors in measurement, for example, if they are white noise as in the classical case), but it may be subject to a weak instruments problem (Roodman, 2009 and Bazzi and Clemens, 2009). While the SGMM that is used in this paper is generally more robust to weak instruments than the difference GMM, it can still suffer from weak instrument biases.[13] In sum, it is difficult to see which estimator yields the smaller *total bias* in the presence of various sources of bias a priori.

However, an important conclusion from the Monte Carlo study of growth regressions by Hauk and Wacziarg (2009) is that the BE (between estimator that applies the OLS to a single cross-section of variables averaged across time periods) performs the best among the four estimators (pooled OLS, BE, FE, and difference GMM) in terms of the extent of *total bias* on each of the estimated coefficients in the presence of both potential heterogeneity bias and a variety of measurement errors.[14] Therefore, the BE and SGMM estimators are the preferred estimation techniques in this paper, although we utilize the other techniques also (see Appendix 1 for more about SGMM).

Basic results

The main results for advanced and emerging economies are presented in Table 1. Columns 1–4 show that the coefficients of initial debt are negative and are significant at the 1 percent level, with their values ranging from -0.019 to -0.029 across the various estimation techniques.[15] The BE regression in Column 1 suggests that a 10 percentage points of GDP increase in initial debt is associated with a slowdown in subsequent growth in real GDP per capita of around 0.26 percent per year. The pooled OLS and FE in Columns 2 and 3 yield

[13] A standard test of weak instruments in dynamic panel GMM regressions does not currently exist (Bazzi and Clemens, 2009). See Stock, Wright, and Yogo (2002) on why the weak instrument diagnostics for linear IV regression do not carry over to the more general setting of GMM.

[14] The BE estimator applies the OLS to perform estimating of the following equation: $\overline{y_{i,} - y_{i,-1}} = \alpha \overline{y_{i,-1}} + \overline{X_{i,-1}}\beta + \gamma \overline{Z_{i,-1}} + v_i + \bar{\varepsilon}_i$, where the upper bar indicates the average of each variable across time periods (up to eight periods), for example, $\overline{X_{i,-1}} = \sum_t X_{i,t-\tau} / T_i$. Thus, time-fixed effects are not appropriate and suppressed by the BE. As one can see, the BE estimator does not correspond to the cross-sectional estimator most commonly used in the literature in which in which the dependent and explanatory variables are averaged, say, over 1970–2007, except for the initial income level in 1970. Hauk and Wacziarg (2009) show that the properties of the cross-sectional estimators are very similar to the properties of the BE estimator, but that BE performs slightly better.

[15] In the OLS and robust regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are included. Results for robust regressions are similar to those of pooled OLS, so they are not reported to save space.

results similar to that of the BE regression, while their estimates of initial debt coefficient become somewhat smaller (around -0.02). The SGMM estimate of initial debt coefficient is also in a similar range (-0.029) and significant at the 1 percent level.

The coefficients on other explanatory variables (initial income per capita, average years of schooling, financial market development, inflation, banking crisis, and fiscal deficit) are of the expected sign and mostly significant at conventional levels across various estimation techniques. The OLS and FE estimators are likely to be biased in the opposite direction in the context of lagged dependent variables in short panels, with OLS biased upwards, and FE downwards. The *consistent* GMM estimator should lie between the two (Bond 2002). In the growth regressions, this means that the OLS understates the convergence rate (reflected by the coefficient of initial income per capita), while the FE estimator overstates it. Consistent with this reasoning, the OLS coefficient of initial real per capita GDP is -2.26, whereas the FE coefficient is -3.6. The SGMM coefficient of the initial income per capita (-2.56) is between those two estimates, indicating that the reported SGMM estimate in Column 4 is likely to be a *consistent* parameter estimate of the convergence rate.

Consistency of the SGMM estimator depends on the validity of the instruments. We consider two specification tests, suggested by Arellano and Bover (1995) and Blunedell and Bond (1998). The first is a Hansen J-test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. This indicates that we cannot reject the null hypothesis that the full set of orthogonality conditions are valid (*p*-value=0.28).[16] The second test examines the hypothesis that the error term $\varepsilon_{i,t}$ is not serially correlated. We use an Arellano-Bond test for autocorrelation, and find that we cannot reject the null hypothesis of no second-order serial correlation in the first-differenced error terms (*p*-value=0.64).[17]

The regressions in Columns 2–4 do not include the time-fixed effects. It is possible that global factors can simultaneously affect both domestic growth and public debt which may

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[16] Importantly, the difference-in-Hansen tests of exogeneity of instrument subsets do not reject the null hypothesis that the instrument subsets for the level equations are orthogonal to the error (*p*-value=0.34), that is, the assumption that lagged differences of endogenous explanatory variables that are being used as instruments in levels is uncorrelated with the errors. This is the additional restriction that needs to be satisfied for the SGMM estimator.

[17] The dynamic panel GMM can generate too many instruments, which may overfit endogenous variables and run a risk of a weak-instruments bias (Roodman 2009, Bazzi and Clemens 2009). Given that, one recommendation when faced with a weak-instrument problem is to be parsimonious in the choice of instruments. Roodman (2009) suggests restricting the number of lagged levels used in the instrument matrix or collapsing the instrument matrix or combining the two. Beck and Levine (2004) and Carkovic and Levine (2005) also use the technique of collapsing instrument matrix. The reported SGMM results in our paper are obtained by combining the “collapsed” instrument matrix with lag limits.

bias the results toward finding a stronger relationship between debt and growth. At the same time, however, as global factors can be correlated with domestic fiscal or economic variables, one can expect that the inclusion of time-fixed effects may understate the estimated effects of these variables. Columns 5–7 include time-fixed effects in the regression to allow for global factors. The pooled OLS and SGMM coefficients of initial debt remain significant at 1–5 percent, and the size of those coefficients is reduced as expected. The estimated effects of debt suggest that a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in growth of per capita GDP around 0.2 percent per year (Appendix 2).

In contrast, the FE results on initial debt turn out to be particularly sensitive to whether time-fixed effects are included or not in the regression (compare Column 6 with Column 3). The FE coefficient of initial debt is now insignificant and reduced to -0.004. It is well known in the literature that the FE can bias toward zero the slope estimates on the determinants of the steady-state level of income—the accumulation and depreciation variables in the Solow model (Islam, 1995). Given that the FE estimator tends to identify parameters on the basis of within-country variation, compared to cross-sectional alternatives such as pooled OLS and BE, it is not surprising that the within-country variation in each of regressors (especially time-persistent variables) is further reduced once time-fixed effects are accounted for.[18] Moreover, the measurement error bias can also be exacerbated under FE. With these caveats, time-fixed effects are included in the remaining regressions.

C. Robustness of Results

A variety of robustness checks were conducted: First, to account for the possibility that there may have been structural changes over the sample period, including changes in global trend growth or global risk factors, time-fixed effects were included. But in addition, we restricted the sample to the second half of the period to check whether there are significant changes in the estimated coefficients. Thus Columns 1–4 in Table 2 repeat the same sets of regressions (BE, pooled OLS, FE, and SGMM) for the period of 1990–2007. The results are quite similar to those for the entire period. Except for the FE estimate, the impact of initial debt is significant, ranging from -0.021 to -0.028, indicating that a 10 percentage point increase in initial debt-to-GDP ratio is associated with decline in per capita GDP growth of around 0.2-0.3 percent per year.

Second, Columns 5–8 of Table 2 show the results for 46 advanced and emerging economies regardless of the population size (that is, without imposing the over 5 million population size restriction) for the entire period. Again, the results remain much the same as those from the 38 advanced and emerging economies with a population of over 5 million.

[18] With the time-fixed effects included, the coefficients of years of schooling and initial debt are often insignificant under FE in contrast to those under SGMM, as one can see throughout this paper.

Third, Table 3 presents the results based on a parsimonious specification that excludes the fiscal deficit term.[19] The coefficients of initial debt are negative and significant at 1–5 percent, ranging from -0.014 to -0.026, except for the FE result in which the coefficient of initial debt loses statistical significance (Columns 1–4). It is noteworthy that the BE estimates of initial debt coefficient are stable around 0.23 to 0.26 across different samples, periods, and specifications. Using average debt instead of initial debt also yields a similar range of -0.019 to -0.027 for the debt coefficients under BE, OLS and SGMM, which are all significant at 1–5 percent (Columns 5, 6, 8), except for the FE in Column (7).

Fourth, additional variables are considered, such as population size (a proxy of country size), aged-dependency ratio (a proxy of population aging), investment, fiscal volatility, urbanization, and checks and balances or constraints on executive decision-making (as a proxy of durable institutional quality; see Glaeser et al., 2004). The results do not change significantly (Table 4). Columns 1–4 add the log of initial population to the baseline specification: the coefficients of initial debt are negative and significant at 1 percent level except for the FE in Column 3 in which it is insignificant. According to the BE, OLS, and SGMM, the estimated effects of initial debt suggest that a 10 percentage point increase of initial debt-to-GDP ratio is associated with slowdown in growth of per capita GDP of around 0.18 percent to 0.25 percent per year. In contrast, the coefficients of population size are insignificant except for FE in which it becomes significant.

The results when initial domestic investment (as a percent of GDP) is added to the baseline specification are shown in Columns 5–8 of Table 4. Under BE, OLS, and SGMM, the coefficients of initial debt are significant at 5 percent level, while they tend to be slightly smaller. The coefficients of investment are of the expected positive sign and significant at 5–10 percent under BE and OLS. Under SGMM, the investment coefficient becomes insignificant, but its coefficient size is similar to that under BE. However, the FE estimates of the coefficients of initial debt and initial investment are not only insignificant, but the coefficient of initial investment even changes its sign to negative.

In Columns 9–12 of Table 4, we include a measure of fiscal spending volatility (as measured by a logarithm of standard deviations of annual growth in real general government expenditures) in the regressions. Recently, Fatas and Mihov (2003) argue that excessive discretionary fiscal policies that are not related to dealing with business cycle fluctuations can lead to higher output volatility and lower growth.[20] At the same time, this excessive fiscal

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[19] Qualitatively similar results are obtained in various parsimonious specifications, such as also dropping a measure of banking crisis and/or financial market depth.

[20] Ideally, the measure of fiscal policy volatility (that is, excessive discretionary policy changes undertaken for reasons other than smoothing out business cycle fluctuations) can be constructed in a more sophisticated

(continued)

activism may lead to a large debt buildup. According to this view, excessive fiscal discretion may be an underlying force behind the negative relation between government debt and growth. If this is correct, one may expect the coefficient of initial debt in the growth regression to become insignificant or at least to get smaller in its absolute value, once the fiscal volatility term is included in the regression. However, we do not find support for this view.[21] The coefficients of fiscal volatility are insignificant, and even change sign across different estimations. By contrast, the coefficients of initial debt remain significant, and the size of estimated coefficients is quite similar to that in the baseline regressions.

Finally, we run a single cross-country regression of the type that is most commonly used in the empirical growth literature for longer time periods. One might be concerned that the five-year time interval in our panel data may not be long enough to smooth out the short-term business cycle fluctuations. The cross-country regression results are presented in Appendix Tables 2 and 3. They are broadly similar to the above panel regression results. In particular, the size of estimated initial debt coefficients is similar to that found in the baseline panel regression (see Appendix 4 for details).

D. Nonlinearities and Differences between Advanced and Emerging Economies

To explore potential nonlinearities, Table 5 (Columns 1–4) shows regressions that include the interaction terms between initial debt and dummy variables for three ranges of initial debt: Dum_30 for low debt (below 30 percent of GDP); Dum_30–90 for medium debt (30–90 percent of GDP); and Dum_90 for high debt (over 90 percent of GDP). The coefficients of low initial debt (i.e., initial debt*Dum_30) are insignificant and even change sign under FE and SGMM. In the OLS, the coefficient of medium level of debt (initial debt*Dum_30-90) is significant at 5 percent, and its estimated coefficient is -0.025. But they are all insignificant in other estimations (BE, FE and SGMM). By contrast, the coefficients of high debt (initial debt*Dum_90) are negative and significant under BE, OLS, and SGMM (again except for the FE).

The negative effect of initial debt on growth in advanced economies tends to be smaller than that in emerging economies. Columns 5–8 in Table 5 use the interaction terms between initial

manner. For example, it can be obtained as a standard deviation of the residuals from time-series regression of government spending growth on macroeconomic variables such as output growth and inflation. Given such a short time duration of each period, it is impossible to run a meaningful time-series regression for each five-year period. However, the qualitative behavior of such a measure of fiscal volatility is very similar to that of a crude measure of fiscal volatility as used in this paper (Woo, 2009).

[21] While there is significant evidence that fiscal volatility is positively correlated with output volatility and that output volatility is negatively associated with growth (Fatas and Mihov, 2003 and Ramey and Ramey, 1995), there is little analysis in the literature regarding the relationship between government debt and fiscal behavior such as fiscal volatility or fiscal cyclicality.

debt and dummy variables for advanced and emerging economies.[22] The coefficients of both interaction terms are negative and significant at various levels, except for the FE results. Under BE, OLS, and SGMM, the coefficients of initial debt in advanced economies range from -0.014 to -0.021, whose absolute size is smaller than that of emerging economies (-0.034 to -0.041): a 10 percentage point increase in initial debt-to-GDP ratio is associated with growth slowdown around 0.15–0.2 percent in advanced economies, compared to 0.3–0.4 percent in emerging economies.[23] This may reflect limited borrowing capacity of emerging economies due to less-developed domestic financial markets or fragile access to international capital markets.

We also computed the impact on growth of a given proportionate increase in the debt to GDP ratio. This was undertaken to allow an appropriate comparison of the impact of debt on growth at different levels of initial debt, and simly reflects the fact that an increase in the ratio from 10 to 20 percent constitutes a doubling, while an increase from 100 to 110 percent raises it only by one-tenth. Table 6 summarizes the results for debt ratios in four groupings: <30%; 30-60%; 60-90%; and >90%. For each of these groupings, we obtained the sample average debt ratio (Row 1), and then multiplied a given increase (10 percent) in this ratio, by the estimated coefficient of the interaction term (Row 2, based on the three estimation techniques—BE, OLS, and SGMM).[24] The results (Row 3) indicate that the higher the initial level of debt, the greater the negative impact of a given increase on subsequent growth. For instance, a 10 percent increase in the debt ratio in countries with debt ratio above 90 percent is associated with a decline in growth of 0.19 percent, while an identical increase in the debt ratio in the 30–60 percent group is associated with a decline in growth of around 0.11 percent. The results are robust to different groupings of debt levels, and are very similar to those obtained using the three groupings in Columns 1–4 of Table 5.

VI. Growth Accounting

A detailed growth accounting exercise was also undertaken to explore channels (factor accumulation versus total factor productivity) through which government debt influences growth.[25] Taking a standard neoclassical framework, we consider a Cobb-Douglas production

[22] See Appendix 6 for the list of advanced and emerging economies.

[23] The same pattern is also found in the regressions on components of output per worker growth that the negative effects on growth of high debt are greater in emerging economies than in advanced economies.

[24] Note that these results need to be interpreted with care because the coefficients of low debt level (initial debt*Dum_30) are not statistically different from zero, and the statistical significance of coefficients of other interaction terms varies across estimations.

[25] See Appendix 3 for details about the growth accounting. The relation between labor force participation and initial debt is also examined, but the results are not significant (not reported).

function $Y=AK^{\alpha}(HL)^{1-\alpha}$, where α is capital income share; K is physical capital; L is labor input; H is human capital; and A is TFP (total factor productivity). In terms of per worker, the production function can be written as $y=Ak^{\alpha}H^{1-\alpha}$, where $y=Y/L$ (output per worker) and $k=K/L$ (capital per worker). Then, growth of output per worker ($\dot{y}/y$) can be decomposed to TFP growth ($\dot{A}/A$) and contributions from growth of capital per worker ($\dot{k}/k$) and growth of human capital ($\dot{H}/H$).

$$\dot{y}/y = \dot{A}/A + \alpha(\dot{k}/k) + (1-\alpha)(\dot{H}/H) \quad (2)$$

Table 7 presents results from panel regression on output per worker growth and its components (TFP growth ($\dot{A}/A$) and growth of capital per worker ($\dot{k}/k$)), using the same baseline specification (Equation 1).[26] First, the coefficients of initial debt in the output per worker growth regressions are significant at 5–10 percent under BE, OLS, and SGMM, ranging from -0.013 to 0.022, whereas it becomes insignificant under FE (Columns 1-4). The estimated coefficients of initial debt from the preferred estimators (BE and SGMM) indicate that a 10 percentage point increase in initial debt-to-GDP ratio is associated with a slowdown in growth of labor productivity (output per worker) of around 0.2 percent per year.

Columns 5–8 show the regression results for TFP growth. There seems to be significant (conditional) convergence in the level of TFP, as indicated by the significant and negative coefficients of the log of initial level of TFP (in the first row). However, the coefficients of initial debt are insignificant across all four regressions, although they have a negative sign. The estimated coefficients of initial debt under BE and SGMM are around -0.01.

The regression results for growth of capital per worker are stronger (Columns 9–12 of Table 7). The initial debt coefficients are all significant at the conventional levels across estimation techniques, ranging from -0.02 to -0.05. Since the capital income share (α) is assumed to be 0.35 in the growth accounting exercise, the estimated coefficients of initial debt under BE and SGMM suggest that a 10 percentage point increase in initial debt-to-GDP ratio induces slowdown in growth of output per worker around 0.1–0.2 percent per year via the channel of reduced growth in capital per worker. Taken together, the individual effects of initial debt on TFP growth and capital per worker growth roughly add up to 0.2–0.3 percent per year, which is approximately in line with the regression outcomes for growth of output

[26] In terms of regression specification, y now denotes the logarithm of output per worker (Y/L) in the regressions on growth of output per worker (Columns 1-4 of Table 7); y is the logarithm of level of TFP in the TFP growth regressions (Columns 5-8); y is the logarithm of capital stock per worker (K/L) in the regressions on growth of capital stock per worker (Columns 9–12). In the investment regressions of Table 8, the dependent variable is the average level of domestic investment (percent of GDP) over the period t and t-τ.

per worker shown in Columns 1–4. However, there are no significant effects on human capital growth from debt and are not reported.

Table 8 presents panel regressions for domestic investment (percent of GDP, averaged over each five-year time period). Columns 1–3 show the regression results using the baseline specification except for the dependent variable which is the average domestic investment. The coefficients of initial debt are all significant at 1–10 percent, ranging from -0.05 to -0.1. Columns 4 and 5 present the dynamic panel SGMM regressions in which the lagged term of the average investment is included instead of initial income per capita. The coefficient of initial debt in Column 4 is significant at 10 percent, and its estimate suggests that a 10 percentage point increase in initial debt-to-GDP ratio is associated with decline in domestic investment by about 0.4 percentage points of GDP. Column 5 includes interaction terms between initial debt and dummy variables for advanced and emerging economies. The coefficients of both interaction terms are significant at 10 percent, and the estimated effects suggest that the adverse impact on domestic investment from debt in emerging economies is almost twice as large as that in advanced economies.

In addition, we considered the potential relationship between high debt and macroeconomic volatility. Intuitively, high debt may not only increase uncertainty about economic perspectives and policies but also raise vulnerability to crises, which may be accompanied by higher macroeconomic volatility. A simple scatter plot of macroeconomic volatility against initial government debt suggests a mild positive correlation. We ran regressions on macroeconomic volatility as measured by the log of standard deviation of annual real GDP growth rates using the baseline specification. The coefficient of initial debt in the regressions for volatility is only significant and of expected positive sign under FE when time-fixed effects are not included. However, they are all insignificant in all other estimations (with or without time dummies). Similarly, the coefficient of high debt (as captured by the interaction term, initial debt*Dum_90) is only significant under FE with no time-fixed effects included, as is the coefficient of initial debt for advanced economies (i.e., initial debt*Dum_advance) in a separate FE regression (not reported to save space).

From the growth accounting perspective, therefore, the adverse effects on growth of initial debt largely reflect a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital per worker.

VII. Concluding Remarks

Given the sharp increase in advanced country sovereign debts as a result of the global economic and financial crisis, there have begun to be serious concerns about their broader economic and financial market impact. In particular, a number of observers have alluded to the potential risk that large debts may discourage capital accumulation and reduce economic growth. This could occur through higher long-term interest rates, higher future distortionary taxation, higher inflation, greater uncertainty and macroeconomic volatility. If growth is indeed reduced, fiscal sustainability issues are likely to be exacerbated, with further adverse consequences.

This paper has provided empirical evidence on the impact of high initial debt on subsequent growth for a panel of advanced and emerging market economies over the period of 1970–2007. Methodologically, the paper builds on the large empirical literature on the determinants of long-term growth and a much more limited literature, pertaining primarily to low-income countries, that explores the impact of high external debts on growth via crowding out and the debt overhang. In the empirical estimation, the paper employs a variety of econometric techniques and pays particular attention to a range of estimation issues including reverse causality, endogeneity, and outliers. In addition, it explores nonlinearities and threshold effects. The above estimation is complemented by the growth accounting framework which allows an exploration of the channels (factor accumulation versus factor productivity) through which government debt may influence growth.

The results, based on a range of econometric techniques, suggest an inverse relationship between initial debt and subsequent growth, controlling for other determinants of growth: on average, a 10 percentage point increase in the initial debt-to-GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 0.2 percentage points per year, with the impact being smaller (around 0.15) in advanced economies. There is some evidence of nonlinearity, with only high (above 90 percent of GDP) levels of debt having a significant negative effect on growth. This adverse effect largely reflects a slowdown in labor productivity growth, mainly due to reduced investment and slower growth of the capital stock per worker. On average, a 10 percentage point increase in initial debt is associated with a decline of investment by about 0.4 percentage points of GDP, with a larger impact in emerging economies. Various robustness checks yield largely similar results. They underline the need to take measures to not just stabilize public debts but to place them on a downward trajectory in the medium and long term.

Table 1. Baseline Panel Regression—Growth and Initial Government Debt, 1970–2007 (Five-year Period Panel)
Sample: Advanced and Emerging Economies
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) Pooled OLS	(6) FE	(7) SGMM
Initial per capita real GDP	-2.616***	-2.257***	-3.598***	-2.555***	-2.187***	-4.506***	-2.823***
	(-6.66)	(-3.26)	(-3.03)	(-3.04)	(-2.74)	(-3.31)	(-3.33)
Initial years of schooling	4.246***	2.965***	5.622***	4.333*	2.863***	4.138**	4.161**
	(4.58)	(2.96)	(3.66)	(1.70)	(2.72)	(2.34)	(2.12)
Initial inflation rate	0.931	-2.351***	-2.571***	-3.062**	-2.234***	-2.467***	-2.296
	(0.47)	(-3.81)	(-4.65)	(-2.27)	(-3.49)	(-6.93)	(-1.43)
Initial government size	0.1**	0.086**	0.125	0.113	0.087**	0.012	0.168
	(2.45)	(2.30)	(1.41)	(0.99)	(2.29)	(0.15)	(1.20)
Initial trade openness	0.002	0.001	0.024	-0.006	-0.001	0.020	-0.004
	(0.39)	(0.18)	(1.71)	(-1.14)	(-0.25)	(1.47)	(-0.71)
Initial financial depth	0.024***	0.018***	-0.001	0.033***	0.019***	0.006	0.026***
	(2.98)	(2.76)	(-0.07)	(2.98)	(2.87)	(0.71)	(2.72)
Terms of trade growth	0.111*	-0.015	0.011	-0.024	-0.019	-0.003	-0.025
	(1.67)	(-0.64)	(0.41)	(-0.97)	(-0.88)	(-0.14)	(-0.96)
Banking crisis	-1.143	-0.819**	-0.782***	-1.196*	-0.728**	-0.673**	-1.519
	(-0.85)	(-2.50)	(-3.62)	(-1.91)	(-2.27)	(-2.64)	(-1.42)
Fiscal deficit	0.012	-0.048***	-0.051***	-0.056***	-0.044***	-0.037***	-0.036*
	(0.44)	(-4.89)	(-4.60)	(-3.42)	(-4.91)	(-4.63)	(-1.78)
Government debt, initial	-0.026***	-0.020***	-0.019***	-0.029***	-0.018***	-0.004	-0.020**
	(-3.04)	(-3.64)	(-3.23)	(-3.24)	(-2.66)	(-0.79)	(-2.49)
Arellano-Bond AR(2) test p-value 1/				0.64			0.12
Hansen J-statistics (p-value) 2/				0.28			0.26
Number of observations	166	166	166	166	166	166	166
R^2	0.78	0.55	0.4		0.66	0.60	
Time-fixed effects	N/A	No	No	No	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 2. Robustness Checks—Time Period and Sample: Advanced and Emerging Economies
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
	Period: 1990-2007 Sample: OECD and Emerging Countries				**Period: 1970-2007 Sample: OECD and Emerging Countries without Population Size Restriction**			
Initial per capita real GDP	-2.262***	-2.114***	-3.578**	-2.517***	-2.255***	-1.626**	-5.422***	-2.289*
	(-6.00)	(-2.73)	(-2.65)	(-3.09)	(-5.36)	(-2.63)	(-4.09)	(-1.99)
Initial years of schooling	3.448***	2.993***	3.393	4.464*	3.363***	1.854*	5.767***	3.691
	(3.78)	(3.02)	(0.82)	(1.95)	(3.28)	(1.93)	(3.95)	(1.58)
Initial inflation rate	0.123	-2.548***	-2.334***	-0.697	1.549	-0.888	-2.116***	-1.481
	(0.06)	(-3.57)	(-6.25)	(-0.44)	(0.76)	(-1.72)	(-6.52)	(-1.59)
Initial government size	0.108**	0.094**	-0.037	0.113	0.004	-0.035	-0.023	-0.255**
	(2.70)	(2.46)	(-0.36)	(1.23)	(0.11)	(-0.89)	(-0.42)	(-2.69)
Initial trade openness	0.003	-0.003	0.026*	-0.003	0.010***	0.006*	0.021**	0.011
	(0.76)	(-0.91)	(1.78)	(-0.39)	(3.33)	(1.83)	(2.61)	(1.54)
Initial financial depth	0.019**	0.023***	0.004	0.03***	0.004	-0.0004	0.008	0.001
	(2.57)	(3.08)	(0.37)	(2.96)	(0.57)	(-0.08)	(0.98)	(0.06)
Terms of trade growth	0.118*	-0.029	-0.038	-0.031	0.096	-0.009	0.002	-0.033
	(1.86)	(-0.63)	(-0.85)	(-0.58)	(1.29)	(-0.31)	(0.09)	(-0.78)
Banking crisis	0.337	-0.616	-0.793*	-1.884	-1.726	-0.998***	-0.951***	-1.928
	(0.26)	(-1.32)	(-1.67)	(-1.25)	(-1.13)	(-2.79)	(-3.28)	(-1.37)
Fiscal deficit	-0.008	-0.053***	-0.05***	-0.043*	0.037	-0.037***	-0.046***	-0.059**
	(-0.31)	(-4.74)	(-3.54)	(-1.68)	(1.50)	(-3.63)	(-4.83)	(-2.26)
Government debt, initial	-0.024***	-0.021***	-0.011	-0.028*	-0.023***	-0.02***	-0.013*	-0.025*
	(-3.56)	(-2.72)	(-1.03)	(-1.78)	(-2.79)	(-2.98)	(-1.98)	(-1.76)
Arellano-Bond AR(2) test p-value 1/				0.33				0.78
Hansen J-statistics (p-value) 2/				0.22				0.24
Number of observations	124	124	124	124	208	208	208	208
R^2	0.79	0.68	0.58		0.64	0.53	0.6	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 3. Robustness Checks—Parsimonious Specification: Advanced and Emerging Economies
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
Initial per capita real GDP	-2.564***	-2.517***	-5.467***	-2.738**	-2.117***	-2.150**	-6.243***	-2.548***
	(-6.94)	(-2.96)	(-3.38)	(-2.25)	(-5.62)	(-2.65)	(-4.22)	(-2.76)
Initial years of schooling	4.161***	3.123***	2.982	3.771	3.055***	2.48**	1.229	3.712*
	(4.66)	(2.90)	(1.15)	(1.01)	(3.31)	(2.40)	(0.40)	(1.73)
Initial inflation rate	0.672	-1.11*	-1.642***	-6.525	2.145	-1.08	-2.134*	-6.499*
	(0.36)	(-1.65)	(-5.86)	(-1.05)	(1.31)	(-1.16)	(-1.73)	(-1.97)
Initial government size	0.103**	0.067*	-0.042	0.330	0.085**	0.064*	-0.0004	0.153
	(2.61)	(1.79)	(-0.47)	(1.50)	(2.14)	(1.92)	(-0.00)	(0.88)
Initial trade openness	0.001	0.003	0.035**	-0.003	-0.001	0.001	0.023*	-0.004
	(0.24)	(1.14)	(2.74)	(-0.44)	(-0.28)	(0.32)	(1.91)	(-0.53)
Initial financial depth	0.024***	0.012**	0.002	0.026**	0.027***	0.016**	0.002	0.020
	(3.28)	(2.10)	(0.29)	(2.50)	(3.50)	(2.48)	(0.30)	(1.12)
Terms of trade growth	0.097*	0.004	0.002	-0.021	-0.026	-0.009	0.014	-0.007
	(1.69)	(0.13)	(0.07)	(-0.71)	(-0.36)	(-0.35)	(0.45)	(-0.24)
Banking crisis	-1.072	-0.601*	-0.545**	-0.134	-1.686	-1.458***	-1.334***	-0.77
	(-0.81)	(-1.70)	(-2.05)	(-0.11)	(-1.44)	(-3.28)	(-3.32)	(-0.73)
Government debt, initial	-0.026***	-0.014**	0.010	-0.024***				
	(-3.13)	(-2.33)	(1.31)	(-3.31)				
Government debt, average					-0.027***	-0.019**	-0.006	-0.020**
					(-3.31)	(-2.54)	(-0.68)	(-2.12)
Arellano-Bond AR(2) test p-value 1/				0.01				0.1
Hansen J-statistics (p-value) 2/				0.46				0.27
Number of observations	166	166	166	166	181	181	181	181
R^2	0.77	0.59	0.54		0.70	0.56	0.56	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 4. Robustness Checks—Additional Variables: Advanced and Emerging Economies
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM	(9) BE	(10) Pooled OLS	(11) FE	(12) SGMM
Initial per capita real GDP	-2.254***	-2.029***	-4.128***	-3.198**	-2.8***	-2.773***	-3.975**	-3.207***	-2.611**	-2.233***	-4.617***	-2.495***
	(-4.51)	(-2.84)	(-3.61)	(-2.27)	(-7.34)	(-3.12)	(-2.31)	(-2.95)	(-5.66)	(-2.79)	(-3.28)	(-2.85)
Initial years of schooling	4.053***	2.711***	1.335	5.232**	3.920***	3.221***	3.992**	4.85**	4.247***	2.752**	3.876**	3.463
	(4.33)	(2.77)	(0.55)	(2.25)	(4.41)	(3.17)	(2.17)	(2.03)	(4.49)	(2.63)	(2.21)	(1.17)
Initial inflation rate	1.423	-2.050***	-2.601***	-8.396	0.782	-2.434***	-2.478***	-3.477	0.931	-2.112***	-2.40***	-3.572
	(0.70)	(-3.42)	(-6.70)	(-1.45)	(0.41)	(-3.73)	(-6.57)	(-0.89)	(0.46)	(-3.21)	(-5.95)	(-1.57)
Initial government size	0.087**	0.085**	0.029	0.234	0.111***	0.089**	-0.026	0.078	0.1**	0.083**	0.012	0.146
	(2.10)	(2.47)	(0.33)	(1.50)	(2.86)	(2.42)	(-0.30)	(0.73)	(2.33)	(2.18)	(0.15)	(1.19)
Initial trade openness	0.006	0.003	0.034**	-0.013	0.004	0.001	0.019	-0.004	0.002	0.0002	0.021	0.005
	(1.06)	(0.76)	(2.52)	(-0.85)	(0.90)	(0.15)	(1.22)	(-0.55)	(0.30)	(0.06)	(1.46)	(0.67)
Initial financial depth	0.017*	0.016**	0.007	0.028	0.023***	0.019***	0.005	0.014	0.024**	0.017**	0.005	0.019*
	(1.75)	(2.59)	(0.87)	(1.18)	(3.11)	(3.32)	(0.63)	(1.23)	(2.74)	(2.58)	(0.68)	(1.66)
Terms of trade growth	0.127*	-0.015	-0.010	-0.048	0.169**	-0.014	-0.004	-0.014	0.112	-0.018	-0.003	-0.038*
	(1.88)	(-0.70)	(-0.40)	(-1.36)	(2.46)	(-0.65)	(-0.16)	(-0.40)	(1.59)	(-0.80)	(-0.11)	(-1.66)
Banking crisis	-1.587	-0.816**	-0.512*	-0.521	-0.697	-0.678*	-0.606**	-2.020	-1.139	-0.709**	-0.648**	-0.968
	(-1.14)	(-2.68)	(-1.93)	(-0.35)	(-0.54)	(-1.94)	(-2.17)	(-1.11)	(-0.82)	(-2.25)	(-2.61)	(-1.25)
Fiscal deficit	0.022	-0.042***	-0.035***	-0.050**	0.002	-0.046***	-0.038***	-0.045*	0.012	-0.042**	-0.036***	-0.042**
	(0.80)	(-4.71)	(-4.65)	(-2.02)	(0.07)	(-5.29)	(-4.61)	(-1.74)	(0.42)	(-4.69)	(-4.36)	(-2.29)
Initial government debt	-0.025***	-0.018***	0.001	-0.023***	-0.019**	-0.015**	-0.007	-0.018**	-0.026***	-0.017**	-0.004	-0.019*
	(-2.98)	(-2.94)	(0.16)	(-2.84)	(-2.29)	(-2.94)	(-1.00)	(-2.59)	(-2.97)	(-2.67)	(-0.72)	(-2.01)
Initial population size	0.244	0.233	6.861**	-0.294								
	(1.16)	(1.43)	(2.30)	(-0.34)								
Initial investment					0.065**	0.052*	-0.045	0.063				
					(2.07)	(1.97)	(-0.86)	(1.02)				
Fiscal volatility									0.009	-0.229	-0.114	-0.081
									(0.02)	(-1.11)	(-0.52)	(-0.25)
Arellano-Bond AR(2) test p-value 1/				0.12				0.20				0.16
Hansen J-statistics (p-value) 2/				0.66				0.53				0.91
Number of observations	166	166	166	166	166	166	166	166	166	166	166	166
R^2	0.79	0.66	0.63		0.81	0.67	0.61		0.78	0.66	0.61	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 5. Panel Regression—Different Levels of Initial Debt and Advanced vs. Emerging Economies
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM
Initial per capita real GDP	-3.684***	-2.369***	-4.486***	-2.367**	-3.052***	-2.750***	-4.405***	-3.331**
	(-3.06)	(-3.39)	(-3.52)	(-2.42)	(-5.64)	(-3.33)	(-3.43)	(-2.55)
Initial years of schooling	5.634***	2.931***	4.001**	3.882	4.109***	2.776***	3.823**	3.837*
	(3.75)	(3.17)	(2.25)	(1.61)	(4.43)	(2.89)	(2.24)	(1.88)
Initial inflation rate	-2.564***	-2.469***	-2.312***	-2.073	-0.271	-2.802***	-2.336***	-6.258**
	(-4.44)	(-3.82)	(-5.96)	(-1.55)	(-0.12)	(-3.32)	(-5.81)	(-2.21)
Initial government size	0.122	0.097***	-0.014	0.104	0.091**	0.067*	0.013	0.213**
	(1.35)	(2.83)	(-0.17)	(1.01)	(2.22)	(1.83)	(0.16)	(2.10)
Initial trade openness	0.025*	-0.0004	0.022*	-0.001	0.002	-0.001	0.020	-0.004
	(1.73)	(-0.14)	(1.67)	(-0.17)	(0.55)	(-0.16)	(1.47)	(-0.75)
Initial financial depth	-0.001	0.019***	0.006	0.014*	0.024***	0.019***	0.005	0.031***
	(-0.06)	(3.37)	(0.76)	(1.68)	(3.05)	(3.25)	(0.58)	(3.89)
Terms of trade growth	0.012	-0.019	-0.006	-0.011	0.126*	-0.012	-0.002	-0.02
	(0.44)	(-0.77)	(-0.27)	(-0.36)	(1.88)	(-0.54)	(-0.07)	(-0.88)
Banking crisis	-0.755***	-0.678**	-0.655**	-0.689	-0.996	-0.711**	-0.66**	-0.903
	(-3.23)	(-2.05)	(-2.39)	(-0.57)	(-0.74)	(-2.23)	(-2.58)	(-0.86)
Fiscal deficit	-0.051***	-0.045***	-0.035***	-0.036	0.004	-0.048***	-0.034***	-0.054***
	(-4.44)	(-4.80)	(-4.14)	(-1.58)	(0.15)	(-5.07)	(-3.91)	(-3.48)
Initial debt*Dum_30	-0.003	-0.001	0.001	0.031				
	(-0.11)	(-0.02)	(0.03)	(0.82)				
Initial debt*Dum_30-90	-0.015	-0.025**	0.005	-0.018				
	(-1.56)	(-2.61)	(0.59)	(-1.24)				
Initial debt*Dum_90	-0.017**	-0.016***	-0.002	-0.018*				
	(-2.67)	(-2.93)	(-0.30)	(-1.78)				
Initial debt*Dum_Advanced					-0.021**	-0.014***	-0.005	-0.017*
					(-2.27)	(-2.77)	(-0.94)	(-1.74)
Initial debt*Dum_Emerging					-0.036***	-0.034**	0.007	-0.041*
					(-2.90)	(-2.64)	(0.51)	(-1.65)
Arellano-Bond AR(2) test p-value 1/				0.22				0.14
Hansen J-statistics (p-value) 2/				0.68				0.74
Number of observations	166	166	166	166	166	166	166	166
R^2	0.6	0.68	0.61		0.79	0.67	0.61	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 6. Impact on Real per Capital GDP Growth of a 10 Percent Increase in the Debt-to-GDP Ratio

	Initial Debt Ratios (in percent of GDP)			
	<30	30-60	60-90	>90
(1) Sample average of Initial Debt/GDP	15.8	45.1	70.3	111.9
(2) Regression coefficient, average 1/	0.022	-0.025	-0.023	-0.017
(3) Growth impact of 10 percent increase in Debt/GDP from sample average 2/	0.04	-0.11	-0.16	-0.19

1/ Average of the esimates (from BE, OLS, SGMM) on the coefficients of interaction terms between initial debt-to-GDP and dummy variables for four categories of levels of initial debt-to-GDP (below 30 percent, between 30 and 60 percent; between 60 and 90 percent; above 90 percent of GDP) for the 1970-2007 period. The results need to be interepreted with caution because the coefficients of low debt level (initial debt*Dum_30) are not statistically different from zero. Also, the statistical significance of coefficients of other interaction terms varies across estimations.

2/ This estimate of growth impact of 10 percent increase in debt ratio is obtained as the product of the regression coefficient (Row 2) and 10 percent of the sample average debt ratios (Row 1).

Table 7. Growth Accounts and Panel Regression: Advanced and Emerging Economies

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) BE	(6) Pooled OLS	(7) FE	(8) SGMM	(9) BE	(10) Pooled OLS	(11) FE	(12) SGMM
	Dependent variable: Growth of output per worker				**Dependent variable: Growth of TFP**				**Dependent variable: Growth of capital stock per worker**			
Lagged dependent Variable 1/	-2.341***	-2.279***	-5.889**	-2.810**	- 2.867***	-3.472***	-8.544***	-4.459*	-0.693	-0.352	-4.151**	-1.440
	(-5.76)	(-2.90)	(-2.37)	(-2.19)	(-6.94)	(-4.25)	(-2.84)	(-1.96)	(-1.21)	(-0.64)	(-2.42)	(-0.97)
Initial years of schooling	2.748***	2.310**	1.874	3.493	0.588	0.481	1.492	0.29	1.430	1.03	0.707	8.894**
	(2.97)	(2.24)	(0.78)	(0.87)	(1.18)	(0.80)	(0.52)	(0.13)	(0.84)	(0.81)	(0.16)	(2.20)
Initial inflation rate	3.382	-1.137*	-2.256***	-6.987*	2.148	-0.867	-1.632***	-6.839*	2.363	-2.041***	-2.602***	-6.444
	(1.57)	(-1.77)	(-4.49)	(-1.79)	(1.47)	(-1.56)	(-4.06)	(-1.92)	(0.66)	(-3.16)	(-4.83)	(-0.82)
Initial government size	0.085*	0.074*	-0.078	0.080	0.046	0.031	-0.023	0.077	0.144*	0.115**	-0.22**	0.296
	(1.85)	(1.94)	(-0.82)	(0.74)	(1.47)	(0.98)	(-0.26)	(0.79)	(1.88)	(2.08)	(-2.16)	(1.31)
Initial trade openness	0.002	-0.000	0.0004	-0.009	0.006*	0.005*	0.011	0.002	-0.01	-0.011	-0.029***	-0.030
	(0.46)	(-0.01)	(0.03)	(-0.85)	(1.87)	(1.98)	(0.84)	(0.18)	(-1.22)	(-1.66)	(-2.93)	(-1.12)
Initial financial depth	0.022**	0.018**	0.007	0.025**	0.013**	0.011**	0.007	0.018*	0.024	0.016	0.004	0.021
	(2.38)	(2.40)	(0.93)	(2.36)	(2.07)	(2.33)	(0.95)	(1.86)	(1.52)	(1.49)	(0.60)	(1.00)
Terms of trade growth	0.013	-0.047**	-0.026	-0.063	0.064	-0.048*	-0.042*	-0.053**	-0.091	-0.033	-0.007	-0.042
	(0.17)	(-2.54)	(-1.07)	(-1.44)	(1.20)	(-1.68)	(-1.74)	(-2.27)	(-0.71)	(-0.67)	(-0.17)	(-0.37)
Banking crisis	-0.087	-0.582	-0.684*	0.063	0.339	-0.358	-0.539	0.425	0.522	-0.305	-0.312	0.304
	(-0.06)	(-1.15)	(-1.75)	(0.11)	(0.33)	(-0.78)	(-1.47)	(0.26)	(0.21)	(-0.66)	(-0.89)	(0.39)
Fiscal deficit	0.014	-0.027**	-0.026**	-0.007	0.002	-0.023**	-0.017*	-0.028	0.022	-0.014	-0.024***	0.054
	(0.43)	(-2.21)	(-2.53)	(-0.22)	(0.10)	(-2.49)	(-2.00)	(-0.91)	(0.42)	(-1.09)	(-2.74)	(0.56)
Government debt, initial	-0.019**	-0.013**	-0.002	-0.022**	-0.008	-0.005	0.003	-0.011	-0.029*	-0.022**	-0.021**	-0.053***
	(-2.06)	(-2.06)	(-0.25)	(-2.29)	(-1.23)	(-1.43)	(0.51)	(-1.12)	(-1.91)	(-2.06)	(-2.75)	(-2.81)
Arellano-Bond AR(2) test p-value 2/				0.16				0.94				0.11
Hansen J-statistics (p-value) 3/				0.24				0.48				0.40
Number of observations	159	159	159	159	159	159	159	159	159	159	159	159
R^2	0.73	0.53	0.46		0.8	0.52	0.42		0.37	0.36	0.55	
Time-fixed effects	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses.
Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.
For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.
1/ The log of initial level of output per worker for Columns 1-4; the log of initial level of TFP for Columns 5-8; and the log of initial level of capital stock per worker for Columns 9–12, respectively.
2/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
3/ The null hypothesis is that the instruments used are not correlated with the residuals.

Table 8. Panel Regression on Investment: Advanced and Emerging Economies

Explanatory Variables	(1) BE	(2) Pooled OLS	(3) FE	(4) SGMM	(5) SGMM
	Dependent variable: Domestic Investment (percent of GDP), averaged over five-year period				
Lagged dependent variable				0.828***	0.797***
				(7.16)	(6.24)
Initial per capita real GDP	2.369	10.074***	7.516**		
	(1.08)	(2.76)	(2.64)		
Initial years of schooling	6.365	-4.849	-0.953	6.985**	4.553
	(1.23)	(-1.01)	(-0.16)	(2.30)	(0.80)
Initial inflation rate	2.635	1.188	-3.256***	-3.924**	-5.088**
	(0.24)	(0.57)	(-3.18)	(-2.57)	(-2.62)
Initial government size	-0.147	0.011	-0.485**	0.332	0.293*
	(-0.65)	(0.06)	(-2.27)	(1.29)	(1.67)
Initial trade openness	-0.031	-0.035	-0.054*	-0.044**	-0.043*
	(-1.39)	(-1.23)	(-1.75)	(-2.36)	(-2.01)
Initial financial depth	0.007	0.004	-0.001	0.029	0.03
	(0.16)	(0.11)	(-0.10)	(1.02)	(1.20)
Terms of trade growth	-0.685*	-0.075	0.020	0.173*	0.093
	(-1.85)	(-0.89)	(0.30)	(1.80)	(1.01)
Banking crisis	-8.081	-1.614	0.641	-0.420	-0.499
	(-1.08)	(-1.07)	(0.76)	(-0.31)	(-0.27)
Fiscal deficit	0.183	0.005	-0.07***	-0.01	-0.059
	(1.24)	(0.16)	(-4.71)	(-0.20)	(-1.25)
Government debt, initial	-0.099**	-0.051*	-0.062***	-0.038*	
	(-2.12)	(-1.70)	(-5.00)	(-1.78)	
Initial debt*Dum_advanced					-0.041*
					(-1.88)
Initial debt*Dum_emerging					-0.085*
					(-1.86)
Arellano-Bond AR(2) test p-value 1/				0.99	0.99
Hansen J-statistics (p-value) 2/				0.42	0.41
Number of observations	166	166	166	159	159
R^2	0.59	0.60	0.57		
Time-fixed effects	N/A	Yes	Yes	Yes	Yes

Note: Heteroskedasticity and country-specific autocorrelation consistent *t-statistics* are in parentheses. Time dummies are not reported. Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. In the OLS regressions, dummies for OECD, Asia, Latin America, and sub-Saharan Africa are also included in each regression (not reported to save space). FE refers to the fixed effects panel regressions and BE is the between estimator.

For the dynamic panel estimation, a two-step system GMM (SGMM) with the Windmeijer's finite-sample correction for the two-step covariance matrix.

1/ The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

2/ The null hypothesis is that the instruments used are not correlated with the residuals.

Appendix 1. Econometric Methodologies: BE, FE, and SGMM

Recall the baseline regression specification (dropping time-fixed effects η_t for simplicity)

$$y_{i,t} - y_{i,t-\tau} = \alpha y_{i,t-\tau} + \mathbf{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \nu_i + \varepsilon_{i,t} \qquad (1)$$

First, the BE (between estimator) is applying the OLS to perform the estimating of the following equation: $\overline{y_{i,} - y_{i,-1}} = \alpha \overline{y_{i,-1}} + \overline{X_{i,-1}}\beta + \gamma \overline{Z_{i,-1}} + v_i + \overline{\varepsilon}_i$, where the upper bar indicates the average of each variable across time periods (up to eight periods), for example, $\overline{X_{i,-1}} = \sum_t X_{i,t-\tau} / T_i$.

Second, the FE (fixed effects) estimator is using the OLS to perform the estimation of the equation (obtained by applying first the within transformation to Equation 1, that is, demeaning):
$(y_{i,t} - y_{i,t-\tau}) - (\overline{y_{i,t} - y_{i,-1}}) = \alpha(y_{i,t-\tau} - \overline{y_{i,-1}}) + (X_{i,t-\tau} - \overline{X_{i,-1}})\beta + \gamma(Z_{i,t-\tau} - \overline{Z_{i,-1}}) + (\varepsilon_{i,t} - \overline{\varepsilon_i})$.

Third, the dynamic panel GMM (generalized method of moments) estimator can be described as follows. First, rewrite Equation (1) as $y_{i,t} = (1+\alpha)y_{i,t-\tau} + \boldsymbol{X}_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + v_i + \varepsilon_{it}$. For further simplicity, let us consider $\boldsymbol{X}_{i,t-\tau}$ as including initial debt $Z_{i,t-\tau}$, and let t denote the 5-year time period. Now it can be written as $y_{i,t} = \lambda y_{i,t-1} + \boldsymbol{X}_{i,t-1}\beta + v_i + \varepsilon_{i,t}$, t=1,2,…,T (T=8 in our data).

Assumption 1 (error components): $E(\nu_i)=E(\varepsilon_{it})=E(\nu_i\,\varepsilon_{it})=0$
Assumption 2 (serially uncorrelated shocks): $E(\varepsilon_{it}\varepsilon_{is})=0$, for $t\neq s$.
Assumption 3 (predetermined initial conditions): $E(y_{i1}\,\varepsilon_{it})=E(\boldsymbol{X}_{i1}\varepsilon_{it})=0$, for t=2,…,T

The DGMM (difference GMM) estimator uses the first-differencing transformation to eliminate the time-invariant country-fixed effects ν_i:
For example, $y_{i3} - y_{i2} = \lambda(y_{i2} - y_{i1}) + (\boldsymbol{X}_{i2} - \boldsymbol{X}_{i1})\beta + \varepsilon_{i3} - \varepsilon_{i2}$, for t=3.

Then, the lagged level y_{i1} and $\boldsymbol{X}_{i,1}$ are valid IV (instrumental variables) for $\Delta y_{i2}=(y_{i2} - y_{i1})$ and $\Delta X_{i2}=(\boldsymbol{X}_{i2} - \boldsymbol{X}_{i1})$, respectively, because $E(y_{i1}\Delta\varepsilon_{i3})= E(X_{i1}\Delta\varepsilon_{i3})=0$, which follows from Assumption 3. Similar arguments establish the following moment conditions that the DGMM can exploit: $E(y_{it-s}\Delta\varepsilon_{it})=0$ and $E(X_{it-s}\Delta\varepsilon_{it})=0$, $\forall t=3,..,T;\ s\geq 2$.

The SGMM (system GMM) estimator exploits additional moments available for the original level equation under an additional assumption.

Assumption 4: $E(\Delta y_{i2}v_i)=E(\Delta \boldsymbol{X}_{i2}v_i)=0$

Then, additional moment conditions: $E(\Delta y_{is}(v_i+\varepsilon_{iT}))=0$, and $E(\Delta X_{is}(v_i+\varepsilon_{iT}))=0$, s=2,…,T-1.

The SGMM estimator exploits the moment conditions for both the first-differenced equation and level equation to gain efficiency and reduce finite sample bias, compared to DGMM (see Bond (2002) and Roodman (2006) for more on dynamic panel GMM estimators).

Appendix 2. Debt and Growth: An Analytical Perspective for the United States

The above econometric results can be supplemented by an analytical assessment for the United States based on a simple Cobb-Douglas production framework. The starting point is the premise, which has support in the literature, that in the United States, each dollar of debt crowds out one dollar of capital in the long run (Elmendorf and Mankiw, 1999). If factors of production earn their marginal product, then the marginal product of capital equals the capital share of income divided by the capital-output ratio. Historically, the capital income share has been about one-third, and the capital-output ratio in the United States is around 3.7 in 2008. The implied marginal product of capital (MPK) is about 9 percent.[27] An increase in the ratio of net debt to GDP of 40 percent over the next five years amounts to an increase in net debt of around \$6,450bn (in real terms based on the projection of 2 percent average growth of real GDP).[28] Other things equal, a full crowding out implies that output would decline by about 4.4 percent in total (that is, a multi-product of MPK and decrease in capital stock as a percent of initial real GDP). This is approximately equivalent to growth slowdown of around 0.8 percent; or 0.2 percent per year on average for a 10 percent of GDP increase in government debt (assuming that the output decline mostly occurs in the following five-year period).

However, the above result should be viewed as an upper bound on the effects of U.S. debt on national income. It implicitly makes two assumptions: a closed economy and no impact on net private saving of fiscal policy. In an open economy, capital inflows partly offset the crowding out of capital by government debt. Also, private saving may rise in response to an increase in public debt (Ricardian argument), which would then mitigate the crowding out. Thus, the full crowding out assumption may exaggerate the magnitude of effects of debt on growth.[29] However, there may be externalities that are not captured in standard economic models. The endogenous growth models suggest that the accumulation of capital stimulates technological change and increase economy-wide productivity (Romer 1987). The opposite will occur in the case of (partial) crowding out. Moreover, increased uncertainty and vulnerability to a crisis that are often associated with high government debt would discourage investment and growth further. These may at least partially offset the dampening effects from foreign capital flows and private saving reaction. On balance, the magnitude of impact of debt on growth reported above can be viewed as a first approximation, although it is still likely to be on the upper end.

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[27] Elmendorf and Mankiw (1999) estimate the MPK to be 9.5 percent in the United States at the time of writing. Similarly, Caselli and Feyrer (2007) report MPK=0.114 in developed countries.

[28] The U.S. real GDP was \$13.3 trillion (in real) and public debt held by the public was 40.8 percent of GDP in 2008.

[29] If we relax the full crowding-out assumption and use conservative estimates about private saving increase (20 percent of fall in government saving) and inflow of foreign saving (25 percent of the decrease in national saving) in Gale and Orzag (2003), then output would decline by 2.6 percent in total, instead of 4.4 percent.

Appendix 3. Growth Accounting

Taking a standard neoclassical approach, let us consider a Cobb-Douglas production function $Y=AK^{\alpha}(HL)^{1-\alpha}$, where α=capital income share; K=physical capital; L=labor input; H=human capital; and A= TFP (total factor productivity). In terms of per worker, the production function can be written as $y=Ak^{\alpha}H^{1-\alpha}$, where $y=Y/L$ (output per worker) and $k=K/L$ (capital per worker). Then, growth of output per worker ($\dot{y}/y$) can be decomposed to TFP growth ($\dot{A}/A$) and contributions from growth of capital per worker ($\dot{k}/k$) and growth of human capital ($\dot{H}/H$): $\dot{y}/y=\dot{A}/A+\alpha(\dot{k}/k)+(1-\alpha)(\dot{H}/H)$.

The growth accounting is consistent with a wide range of alternative production functional forms linking the factor inputs and output. It is only necessary to assume a degree of competition sufficient so that the earnings of the factors are proportionate to their factor productivity. Then we can measure TFP growth rates, using the shares of income paid to the factors to measure their importance in the production process as described above (see Caselli, 2005; Bosworth and Collins, 2003 for details about TFP). Since consistent measures of factor income shares are often difficult to obtain for individual countries, most studies assume that income shares are identical across time and space. Yet, Gollin (2002) provides strong evidence in support of such an assumption of constant income shares across time and space, which is consistent with the Cobb-Douglas function approach. Also, Bernanke and Gürkaynak (2001) find no systematic tendency for labor shares to vary with real GDP per capita or the capital-labor ratio nor systematic tendency to rise or fall over time, and most estimated labor income shares lie between 0.6 and 0.8, the average being 0.65. In this paper, we tried both a fixed labor share of 0.65 and actual income shares from Gollin (2002) and Bernanke and Gürkaynak (2001). The results using alternative income share measures are very similar, suggesting that using a fixed labor income share is not a serious problem.

We construct a new data set on TFP for a large number of developed and developing countries in the period 1970–2007. National income and product account data and labor force data are obtained from the latest version 6.3 of the Penn World Table (PWT) of Heston et al. (2009). To construct the labor quality index for human capital (H), we take average years of schooling in the population over 15 years old from the international data on educational attainment by Barro and Lee (2000). Data on years of schooling in 2005 and 2007 are obtained by extrapolation. We follow Hall and Jones (1999), and Klenow and Rodriguez-Clare (1997) to give larger weight to more educated workers as follows: $H=e^{\phi(E)}$, where E is average years of schooling; the function $\phi(E)$ is piece linear with slope of 0.134 for $E \leq 4$, 0.101 for $4 < E \leq 8$; and 0.068 for $8 < E$. The rationale behind this functional form for human capital is as follows. The wage of a worker with E years of education is proportional to her human capital. Since the wage-schooling relationship is widely believed to be log-linear, this would imply that human capital (H) and education (E) would have a log-linear relation as well, such as H=exp($const \times E$). However, international data on education-wage profiles

(Psacharopulos, 1994) suggests that in sub-Saharan Africa (which has the lowest levels of education), the return to one extra year of education is about 13.4 percent, the world average is 10.1 percent, and the OECD average is 6.8 percent.

We estimate the capital stock, K, using the perpetual inventory method: $K_t = I_t + (1-\delta)K_{t-1}$, where I_t is the investment and δ is the depreciation rate. Data on I_t are from PWT 6.3 as real aggregate investment in PPP. For many countries in our sample, investment data go back to as early as 1950–1955. We estimate the initial value of the capital stock, say, in year 1950 as $I_{1950}/(g+\delta)$ where g is the average compound growth rate between 1950 and 1960, and δ is the depreciation rate (δ=0.06 is assumed). We further adjust these capital stocks for the portion of residential capital stock that is not directly related to production activity.[30] Batteries of consistency checks suggest that our estimates of TFP growth are reasonable.

[30] PWT 5.6 provides data on residential capital per worker as a fraction of nonresidential capital per worker for 63 countries. For these countries, we use the average ratio of nonresidential capital to total capital to impute the nonresidential capital stock in our data set. For the remaining countries, we assume that nonresidential capital is two-thirds of the total capital, which is about the average value of 0.69 for the countries for which the data are available.

Appendix 4. Cross-Country Regressions

The baseline cross-country regression specification is as follows:

$$g_{yi} = \alpha + \beta \mathbf{X}_i + \gamma Z_i + \lambda \mathbf{D}_i + \varepsilon_{i,}$$

where *i* denotes the country; α is a constant term; ε_i is an unobserved error term; $\mathbf{X}_i$ is a vector of economic and financial variables that are mostly initial values in the sample period; Z_i is the initial gross government debt (in percent of GDP); and $\mathbf{D}_i$ is a vector of dummy variables for OECD, Asia, Latin America, and sub-Saharan Africa. The dependent variable denoted by g_{yi} is the average growth rate of real GDP per capita (in percent per annum) over the sample period.

Appendix Table 2 shows the OLS results for the sample of all advanced and emerging economies (without the restriction on population size of over 5 million) for various time periods.[31] Columns 1–5 show that there is a negative relationship between initial government debt (percent of GDP) and subsequent growth of per capita real GDP. The coefficients of initial government debt are all of the expected negative sign and significant at conventional levels, except for Column 2 for the 1985–2007 period in which it becomes insignificant. The significant coefficients range from -0.017 to -0.026, indicating that a 10 percentage point increase in initial debt-to-GDP ratio is associated with decline in per capita GDP growth of around 0.17-0.26 percent per year.[32] Importantly, this range of coefficients of initial debt is consistent with that found in panel regressions.

Since government debt data are available for only a handful of countries in the 1970s and 1980s, the remaining discussion focuses on the later periods, 1990–2007, 1995–2007, and 2000–2007, for which more observations are available. Columns 6–8 present the regression results using the average level of government debt (percent of GDP) over the relevant time periods, instead of initial level of debt. They are all significant at the 5 percent level. The size of estimated coefficients is still in a similar range to that of the coefficients of initial debt, ranging from -0.018 to -0.022.

Appendix Table 3 shows the cross-country regressions using a parsimonious specification for growth account components (output per worker growth, TFP growth, and capital per worker

[31] In order to maintain the largest possible number of observations, the reported OLS regression results are based on a parsimonious specification that excludes initial financial market depth and fiscal deficit terms. For the 1970s and 1980s, the number of available observations on initial debt is very limited.

[32] Repeating the same set of cross-country regressions by using the largest available sample of countries including developing countries also yields largely similar to those for industrialized and emerging economies, although estimated coefficients of initial government debt become slightly smaller, ranging from -0.013 to -0.020 (not shown to save space).

growth) for the periods 1990–2007 and 1995–2007. First, we note that the coefficients of initial debt in the regressions for growth of output per worker (Columns 1–2) are significant at 5 percent, ranging around -0.019 to -0.24, which is on average in an order of magnitude similar to that found in the panel data. Similarly, the coefficients of average debt are significant and in a similar range (Columns 3–4). Columns 5–8 show the results for TFP growth. The coefficients of initial debt are significant at 1 percent, and the size of coefficients of initial debt in TFP growth regressions is about two-thirds of that in the regressions for growth of output per worker. In the regressions for growth of capital per worker, however, the coefficients of initial debt are not significant, albeit of the correct sign (-). Yet the coefficients of average debt are significant at 5 percent, and they suggest that a 10 percent of GDP increase in debt is associated with a slowdown in growth of capital per worker by about 0.25 percent per year.

Appendix 5. Description of Data

A. Dependent variables:

The following dependent variables are measured over the five-year period in the panel (or the relevant time period in the cross-country regression).

(1) Growth of real per capita GDP, PWT6.3 (2009)
(2) Growth of output per worker, PWT6.3 (2009)
(3) TFP growth, constructed using PWT6.3 (2009) and Barro and Lee (2000)
(4) Growth of capital per worker PWT6.3 (2009)
(5) Domestic investment (percent of GDP), PWT6.3 (2009)
(6) Volatility of output (log of standard deviation of annual real GDP growth rates over the five-year period), PWT6.3 (2009)

B. Explanatory variables:

Initial values of explanatory variables—for example, initial real GDP per capita or initial government size—are measured at the measured at the beginning of each five-year period in the panel (or the relevant time period in the cross-country regression). Otherwise, the variables, such as terms of trade growth or average government debt, are averaged over the five-year period.

(1) Initial real GDP per capita (in log), PWT6.3 (2009)
(2) Initial average years of schooling of population of age over 15 (in log), Barro and Lee (2000)
(3) Initial government size (percent of GDP), PWT6.3 (2009)
(4) Initial trade openness (percent of GDP), PWT6.3 (2009)
(5) Initial inflation rate (log of $(1+\pi)$), WDI (2009)
(6) Initial financial market depth (liquid liabilities, percent of GDP), WDI 2009
(7) Terms of trade growth (in percent), IMF, *WEO* 2009
(8) Banking crisis (total number of incidences over five-year period), Reinhart and Reinhart (2008)
(9) Initial population size (in log), PWT6.3 (2009)
(10) Fiscal deficit (percent of GDP), IMF, *WEO* (2009)
(11) Population growth (in percent), PWT6.3 (2009)
(12) Initial domestic investment (percent of GDP), PWT6.3 (2009)
(13) Fiscal volatility (log of standard deviation of annual growth rates of real general government expenditures over the five-year period), WDI (2009)
(14) Aged-dependency ratio (ratio of population of age over 65 to working population), WDI (2009)
(15) Urbanization, WDI (2009)
(16) Checks and balances, Database of Political Institutions (2009)
(17) Constraints on executive decision-making, Polity IV (2009)
(18) Initial gross government debt (percent of GDP), IMF, *WEO* (2009)
(19) Average gross government debt (percent of GDP), IMF, *WEO* (2009)

Appendix 6. Country List

The sample of countries is dictated by the availability of data. The following 38 advanced and emerging economies with a population of over 5 million are included in the panel regressions.

Country	Country
Australia	Japan
Austria	Korea
Belgium	Malaysia
Brazil	Mexico
Canada	Netherlands
Chile	Pakistan
China	Peru
Colombia	Philippines
Czech Republic 1/	Poland
Denmark	Portugal
Egypt	Russian Federation 1/
France	Slovak Republic 1/
Germany	South Africa
Greece	Spain
Hong Kong	Sweden
Hungary	Switzerland
India	Turkey
Indonesia	United Kingdom
Italy	United States

Note: Eight additional countries are also available in the panel regressions for all available advanced and emerging economies without the over-5-million-population size restriction: Finland, Iceland, Ireland, Israel, Jordan, Norway, New Zealand, and Singapore.
The list of advanced economies includes Australia, Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Greece, Hong Kong, Hungary, Italy, Japan, Korea, Mexico, Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States, which are mostly the OECD member nations.

1/ Not included in the growth accounting exercise because necessary data in computing TFP are not available.

Appendix Table 1. Level of Initial Government Debt, Growth, and Investment, 1970–2007: Countries with a Population of over 5 million

Group of Countries	Initial Debt below 30 percent of GDP	Initial Debt between 30 and 60 percent of GDP	Initial Debt between 30 and 60 percent of GDP	Initial Debt above 90 percent of GDP	Initial Debt above 60 percent of GDP, yet Rising	Initial Debt above 60 percent of GDP, yet Falling
	Average: Real per capita GDP Growth Rate (annualized percent change over the subsequent 5 years)					
Entire	5.1	2.8	2.7	2.3	1.4	3.1
Advanced	3.2	2.3	2.2	1.9	1.6	2.4
Emerging	6.6	2.6	3.7	3.9	2.1	4.7
Developing	7.2	4.5	2.6	2.3	0.7	3.0
	Average: Output per worker Growth Rate (annualized percent change over the subsequent 5 years)					
Entire	4.5	2.1	2	2	1.0	2.5
Advanced	2.7	1.7	1.7	1.9	1.6	2
Emerging	6.0	2.1	2.6	3.4	1.1	3.7
Developing	6.4	3.6	1.9	1.8	0.2	2.5
	Average: TFP Growth Rate (annualized percent change over the subsequent 5 years)					
Entire	1.5	0.7	0.9	1.4	0.5	1.5
Advanced	0.8	0.5	0.7	0.9	0.6	0.9
Emerging	3.2	1	1.9	2.1	0.5	3
Developing	1.8	1.3	0.7	1.8	-0.2	1.7
	Average: Capital stock per worker Growth Rate (annualized percent change over the subsequent 5 years)					
Entire	4.1	2.4	1.8	1.6	1.1	2.1
Advanced	3.9	2	2.2	2.2	2.1	2.3
Emerging	6.9	1.2	1.7	1.5	1.4	1.9
Developing	1.2	5.2	1.0	1.3	-1	2
	Average: Domestic Investment (percent of GDP over the subsequent 5 years)					
Entire	26.7	22.7	20	16.4	18.9	18.1
Advanced	32	26.7	27.5	29.4	27.6	28.6
Emerging	27.4	15.7	15.4	11.4	14.1	15.2
Developing	18.6	15.6	11.1	9.4	8.1	10.8

Note: Initial debts are the government gross debt to GDP (percent) in the first year of each five-year sub-period (i.e., 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005). Average growth rates (percent per annum) are over each five-year sub-period (i.e., 1970-74, 1975-79, 1980-84, 1985-89, 1990-94, 1995-99, 2000-04, 2005-07).

Appendix Table 2. Cross-country Regression—Government Debt and Real per Capita GDP Growth: Advanced and Emerging Economies (without restriction on population size)
Dependent Variable: Real per Capita GDP Growth

Explanatory Variables	(1) OLS 1975-2007	(2) OLS 1985-2007	(3) OLS 1990-2007	(4) OLS 1995-2007	(5) OLS 2000-2007	(6) OLS 1990-2007	(7) OLS 1995-2007	(8) OLS 2000-2007
Initial per capita real GDP	-0.968	-3.383	-2.737**	-1.851*	-0.902	-1.626*	-1.364**	-0.828
	(-1.65)	(-1.68)	(-3.27)	(-1.75)	(-0.89)	(-1.80)	(-2.17)	(-0.98)
Initial years of schooling	3.195***	0.225	2.461*	2.15	0.944	1.504	1.962**	0.991
	(5.81)	(0.14)	(1.84)	(1.35)	(0.56)	(1.29)	(2.15)	(0.71)
Initial inflation rate	10.317***	-1.243	0.228	9.015	1.005	-0.07	2.738*	0.766
	(13.64)	(-0.58)	(0.46)	(1.59)	(0.26)	(-0.29)	(1.93)	(0.21)
Initial government size	-0.241***	-0.066	-0.043	-0.003	0.075	-0.027	-0.0004	0.067
	(-8.82)	(-0.79)	(-1.05)	(-0.07)	(1.57)	(-0.93)	(-0.01)	(1.46)
Initial trade openness	0.015***	0.011	0.009	0.014**	0.004	0.008*	0.005	0.003
	(4.97)	(0.83)	(1.97)	(2.48)	(0.76)	(1.83)	(1.03)	(0.56)
Terms of trade growth	0.199***	-0.045	-0.168	-0.075	0.078	-0.132	-0.076	0.053
	(4.84)	(-0.19)	(-0.72)	(-0.73)	(0.80)	(-0.87)	(-0.91)	(0.61)
Banking crisis			-0.534	-0.417	0.008	-0.049	-0.971*	-0.059
			(-1.23)	(-0.89)	(0.02)	(-0.16)	(-1.97)	(-0.12)
Government debt, initial	-0.026***	-0.004	-0.017**	-0.024***	-0.019*			
	(-5.98)	(-0.34)	(-2.60)	(-3.22)	(-1.73)			
Government debt, average						-0.02**	-0.022**	-0.018**
						(-2.52)	(-2.81)	(-2.11)
Number of Observations	10	20	30	37	44	42	46	46
R^2	0.99	0.56	0.74	0.56	0.56	0.53	0.48	0.57

Note: Heteroskedasticity consistent *t-statistics* are in parentheses. Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. An intercept term and dummies for OECD, Asia, Latin America, and sub-Saharan Africa are included in each regression (not reported to save space).

Appendix Table 3. Growth Accounting and Cross-Country Growth Regression: Advanced and Emerging Economies (without restriction on population size)

Explanatory Variables	(1) OLS 1990-2007	(2) OLS 1995-2007	(3) OLS 1990-2007	(4) OLS 1995-2007	(5) OLS 1990-2007	(6) OLS 1995-2007	(7) OLS 1990-2007	(8) OLS 1995-2007	(9) OLS 1990-2007	(10) OLS 1995-2007	(11) OLS 1990-2007	(12) OLS 1995-2007
	Dependent variable: Growth of real output per worker				**Dependent variable: Growth of TFP**				**Dependent variable: Growth of capital stock per worker**			
Initial per capita real GDP	-2.387***	-1.419*	-1.446	-0.985	-1.982***	-1.161*	-1.435**	-1.037**	-1.183	-0.699	0.166	0.294
	(-3.16)	(-1.67)	(-1.56)	(-1.64)	(-3.69)	(-1.92)	(-2.25)	(-2.61)	(-1.26)	(-0.70)	(0.16)	(0.40)
Initial years of schooling	2.564**	2.334*	1.974*	2.343**	3.041***	2.317**	2.490***	2.535***	0.832	1.342	-0.185	0.731
	(2.31)	(1.68)	(1.68)	(2.49)	(3.54)	(2.19)	(3.13)	(3.89)	(0.54)	(0.80)	(-0.12)	(0.58)
Initial inflation rate	0.611	9.619	-0.04	2.198	0.588*	8.304**	0.115	1.751	-0.065	6.178	-0.518	1.607
	(1.22)	(1.56)	(-0.12)	(1.35)	(1.81)	(2.29)	(0.45)	(1.59)	(-0.10)	(0.79)	(-1.42)	(0.61)
Initial government size	-0.041	0.025	-0.036	0.006	-0.03	0.0192	-0.026	0.009	-0.034	0.009	-0.032	-0.01
	(-0.98)	(0.67)	(-1.01)	(0.15)	(-1.12)	(0.71)	(-0.99)	(0.36)	(-0.59)	(0.18)	(-0.84)	(-0.23)
Initial trade openness	0.01*	0.012**	0.008	0.002	0.010***	0.010***	0.009**	0.004	-0.004	0.002	-0.007	-0.009
	(2.09)	(2.37)	(1.53)	(0.41)	(3.62)	(3.23)	(2.29)	(1.28)	(-0.61)	(0.24)	(-1.14)	(-1.56)
Terms of trade growth	-0.001	-0.083	-0.008	-0.129	-0.012	-0.045	0.068	-0.075	-0.050	-0.024	-0.15	-0.102
	(-0.01)	(-0.79)	(-0.05)	(-1.52)	(-0.07)	(-0.70)	(0.62)	(-1.03)	(-0.17)	(-0.15)	(-0.92)	(-1.07)
Banking crisis	-0.101	-0.385	0.373	-0.928	-0.002	-0.459	0.234	-0.563	-0.420	0.157	0.012	-1.312*
	(-0.25)	(-0.66)	(1.09)	(-1.60)	(-0.01)	(-1.27)	(1.16)	(-1.62)	(-0.66)	(0.20)	(0.03)	(-1.68)
Government debt, initial	-0.019**	-0.024**			-0.013***	-0.015***			-0.016	-0.023		
	(-2.59)	(-2.56)			(-3.24)	(-2.79)			(-1.40)	(-1.49)		
Government debt, average			-0.019**	-0.017**			-0.009*	-0.008			-0.024**	-0.025**
			(-2.29)	(-2.17)			(-1.67)	(-1.55)			(-2.39)	(-2.60)
Number of Observations	30	36	44	45	30	36	44	45	30	36	44	45
R^2	0.72	0.54	0.48	0.45	0.78	0.64	0.52	0.5	0.53	0.32	0.48	0.39

Note: Heteroskedasticity consistent *t-statistics* are in parentheses. Levels of significance: *** 1 percent, ** 5 percent, * 10 percent. An intercept term and dummies for OECD, Asia, Latin America, and sub-Saharan Africa are included in each regression (not reported to save space).

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