5

The Relationship between Debt Levels and Growth

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5.1 Introduction

This chapter empirically investigates a critical policy question of the extent to which large public debts are likely to have an adverse effect on investment, productivity, and growth. From a theoretical point of view, this can occur through a variety of channels including higher long-term interest rates, possibly higher future distortionary taxation, higher inflation, greater uncertainty, vulnerability to crises, and reduced scope for countercyclical fiscal policies. Despite the importance of the issue, there is little systematic evidence in the literature.

The chapter provides empirical evidence on the impact of high public debt on subsequent growth of real per capita GDP in a panel of advanced and emerging market economies during 1970 to 2008. Building on large empirical growth literature (e.g., see Barro and Sala-i-Martin 2003; Aghion and Durlauf 2005), it pays particular attention to a variety of methodological issues, including 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 an adverse effect on growth.

The empirical results of the analysis, 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 over the medium to long run with a slowdown in real per capita GDP growth of around 0.2 percentage points per year, with the impact being somewhat smaller in advanced economies than in emerging market economies. There is some evidence of nonlinearity with higher levels of initial debt having a proportionately larger negative effect on subsequent growth. Moreover, when a country's economic and financial position vis-à-vis the rest of the world is

weak or the share of its foreign-currency denominated debt is large, the adverse impact of initial public debt on subsequent growth tends to be much more pronounced than when these factors are at more moderate levels.

The rest of the chapter is organized as follows: Section 5.2 discusses the channels through which high debt may affect growth, and summarizes related existing studies. Section 5.3 describes data and some stylized facts relating to public debt and growth; Section 5.4 presents the main panel regression results on the relationship between debt and growth, including an analysis of the relationship between international financial integration and the impact of high public debt on growth. Section 5.5 concludes.

5.2 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 increases (reflecting deficit financing) can stimulate aggregate demand and output in the short run but crowds out private capital and reduces output in the long run (see Elmendorf and Mankiw 1999 for a literature survey). This chapter focuses on the long-run effects of public debt.

Standard growth theory predicts that an increase in government debt 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). Building on Barro's (1990) endogenous growth model with public goods externalities, Aizenman et al. (2007) further show that with effective upper bound on tax revenue due to distortions and imperfect tax enforcement, an increase in initial debt lowers productive government spending, which reduces the return to capital and growth subsequently.

There are several channels through which high debt could adversely impact medium- and long-run growth that 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) and lower future public capital spending (Aizenmann et al. 2007), higher inflation (Sargent and Wallace 1981; 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).[1]

Despite these considerations, there has been little systematic analysis of the impact on GDP growth of high public debt in advanced or emerging market economies until very recently—the notable exceptions are Kumar and Woo (2010) for 46 advanced and emerging economies in 1970 to 2007, Checherita and Rother (2010) for 12 euro economies for 1970 to 2008, Cecchetti et al. (2011) for 18 OECD countries for 1980 to 2006, and Balassone et al. (2011) for Italy for 1890 to 2009. Kumar and Woo (2010) was the first study that provided systematic econometric evidence on the negative effects of public debt on long-run growth by employing rigorous statistical techniques that took into account determinants of growth, reverse causality, endogeneity, and other issues. Using long historical data (since the early 1800s), Reinhart and Rogoff (2010) find that the difference in average growth rates of GDP between low debt (below 30 percent of GDP) and high debt (above 90 percent of GDP) groups is 4.2 percentage points in advanced economies (also see Reinhart et al. 2012). Their study, however, only considers correlations between debt and growth and does not take into account other determinants of growth as well as other issues such as reverse causality.[2]

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; Sachs 1989). Imbs and Ranciere (2007) 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 external debt levels (typically over 60 percent of GDP), but an insignificant impact at low debt levels.

5.3 Data and Stylized Facts

Data for the key variables such as GDP, population, and investment are obtained from Penn World Table 7.0 (Heston et al. 2011). Fiscal data including government debt are from the IMF's World Economic Outlook Database, and other variables are from World Bank's World Development Indicators and Barro and Lee (2011). The main econometric analysis is based on a panel of 38 large and medium-sized advanced and emerging economies (defined as an economy with a population of over five million) for the period 1970 to 2008, although we also present the results using the full sample of 79 countries (advanced, emerging, and developing countries) without population size restriction (see the appendix at the end of this chapter for the country list).

First, data on government debt and growth clearly show a negative relationship between *initial* government debt and *subsequent* growth of real per capita

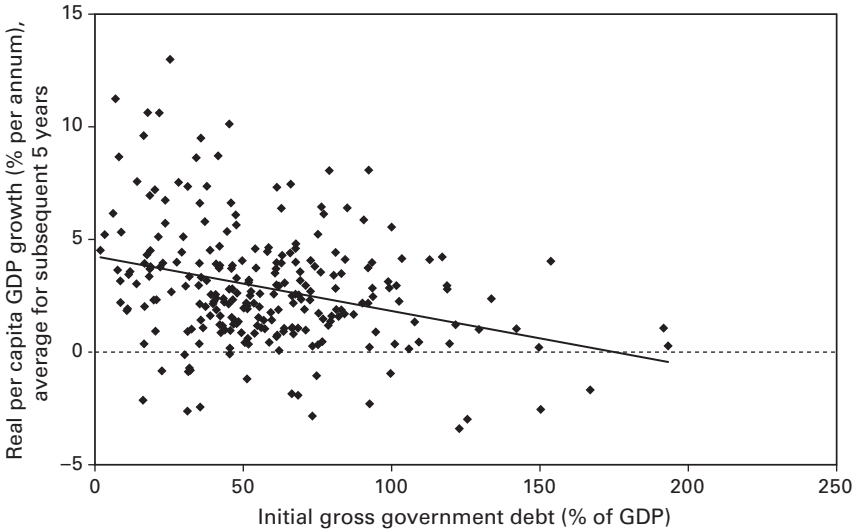

Figure 5.1
Initial government debt and subsequent growth of per capita real GDP over five-year periods
Source: Authors' calculation

GDP. Figure 5.1 shows a scatter plot of initial debt against subsequent growth of real per capita GDP over five-year periods in the sample of countries with population of over five million. According to the OLS fitted line, the coefficient of initial debt is –0.024. 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 slowdown in per capita GDP growth of 0.24 percentage points.[3] At shown below, this magnitude turns out to be surprisingly consistent with that obtained using robust econometric analysis. Similarly *initial* debt is negatively associated with *subsequent* domestic investment over five-year periods (figure 5.2).

Second, the *subsequent* growth rate of per capita GDP over five-year periods following high *initial* debt episodes (above 90 percent of GDP) is on average lower than that following low *initial* debt episodes (below 30 percent of GDP) (figure 5.3). In advanced economies, the difference in the average growth rates between low initial debt and high initial debt episodes is 0.9 percentage points; in emerging economies, it is more than twice that (1.7 percentage points). Similarly the average growth differential in G7 countries between low and high initial debt periods is 1.7 percentage points. In the full sample (including developing countries) the growth differential is 2.8 percentage points.

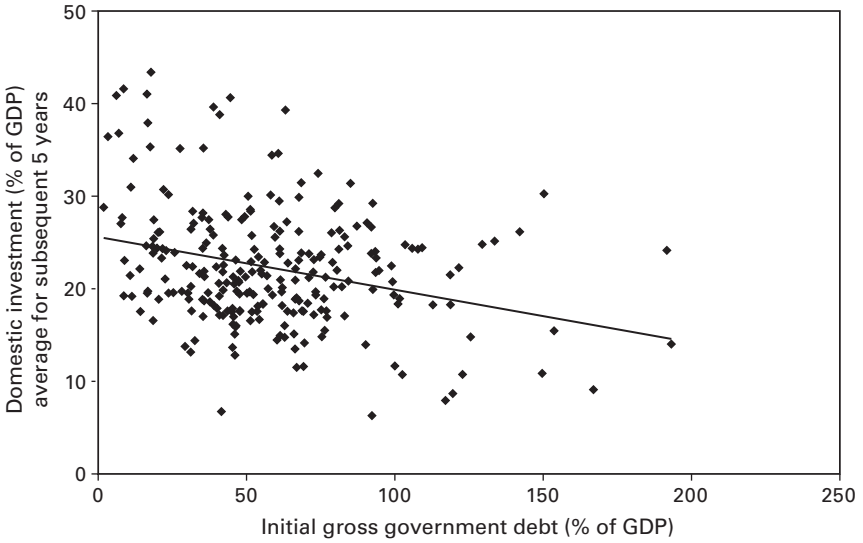

Figure 5.2
Initial government debt and subsequent domestic investment over five-year periods
Source: Authors' calculation

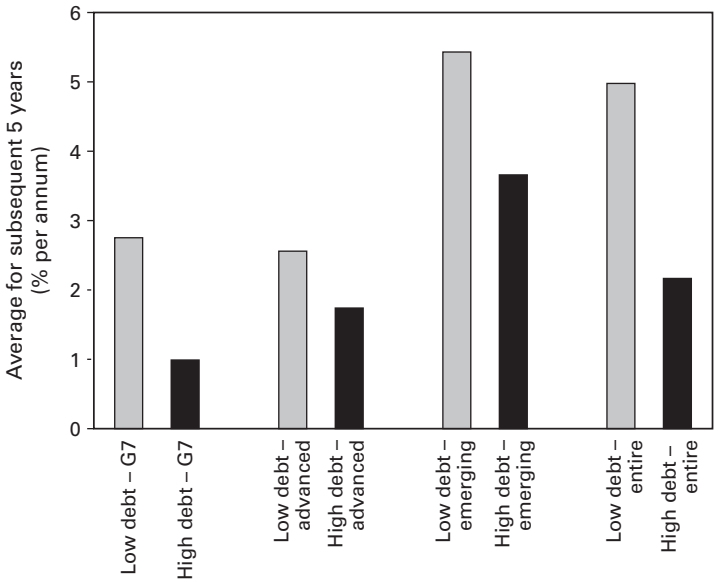

Figure 5.3
Subsequent growth of real GDP per capita and high and low initial government debt (low debt <30 percent of GDP, and high debt >90 percent of GDP)
Source: Authors' calculation

5.4 Econometric Analysis

5.4.1 Model Specification

The econometric analysis focuses on the medium- and long-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 39 years from 1970 to 2008, and comprises eight nonoverlapping five-year periods (1970–1974, 1975–1979, . . ., 2000–2004, 2005–2008), except for the last period spanning four years. Additionally cross-country OLS regressions were estimated for longer time periods (see appendix tables A5.2 and A5.3).

The baseline panel regression specification is as follows:

$$y_{i,t} - y_{i,t-\tau} = \alpha y_{i,t-\tau} + X_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta_t + \nu_i + \varepsilon_{i,t}, \quad (5.1)$$

where a period is a five-year time interval (i.e., $\tau = 4$); t denotes the end of a period and $t - \tau$ 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; $X_{i,t-\tau}$ is a vector of economic and financial variables; $Z_{i,t-\tau}$ is the initial government debt (as percentage of GDP).[4]

We consider a core set of explanatory variables that have been shown to be consistently associated with growth in the empirical literature (e.g., Sala-i-Martin et al., 2004). The variables X in the baseline specification are as follows: (1) initial level of real GDP per capita, to capture the catching-up process; (2) log of average years of secondary schooling in the population over age 15 in the initial year (taken from Barro and Lee 2011); (3) initial government size (as measured by government consumption share of GDP);[5] (4) initial trade openness (sum of export and import as a percentage of GDP); (5) initial financial market depth (liquid liabilities as a percentage of GDP); (6) initial inflation as measured by CPI inflation (to be precise, logarithm of (1+ inflation rate)); (7) terms of trade growth rates (averaged over each time period); (8) banking crisis incidence, since banking crises typically result in slow growth; (9) fiscal deficit , which includes the finding that fiscal deficits are negatively associated with long-run growth (see Fischer 1993; Baldacci et al. 2004).

To check the robustness of results, some prudent specifications were tried and additional variables also considered: these included population (a proxy of country size), age-dependency ratio (a proxy for population aging), investment,[6] fiscal spending volatility, urbanization, private saving, and checks and balances or constraints on executive decision-making (as a proxy for institutionalized constraints; see Glaeser et al. 2004).[7]

5.4.2 Econometric Estimation and Sources of Bias

A number of sources of biases can cause inconsistent estimates of the coefficients in panel growth regressions using differing estimation techniques. The first is the

omitted-variables bias (so-called heterogeneity bias) resulting from possible correlation between country-specific fixed effects (v_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 (fixed effect panel regressions). Specific to dynamic panels, there is a dynamic panel bias that will make FE estimates inconsistent.[8] The third is the classical measurement errors (errors in variable) 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.

Different estimation techniques have their own pros and cons: on the one hand, the BE estimator (which applies the OLS to a single cross section of variables averaged across time periods) tends to reduce the extent of measurement error via time averaging of the regressors but does not deal with the omitted-variables bias. On the other hand, 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. Separately, 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. The 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).[9] 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 such as the omitted-variables bias, endogeneity, and measurement errors (e.g., as long as instruments are uncorrelated with the errors in measurement, if they are white noise as in the classical case), but it may be subject to a weak instruments problem (Roodman 2009; Bazzi and Clemens 2009). While the SGMM (system GMM) that is used in this chapter is generally more robust to weak instruments than the difference GMM, it can still suffer from weak instrument biases.[10] In sum, it is difficult to see a priori which estimator yields the smallest *total bias* in the presence of various sources of bias.

However, an important conclusion from the Monte Carlo study of growth regressions by Hauk and Wacziarg (2009) is that the BE 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.[11] Therefore the BE and SGMM estimators are the preferred estimation techniques in this chapter, although we present results using other techniques also.

5.4.3 Basic Results

The main results for advanced and emerging economies are presented in table 5.1. Columns 1 through 4 show that the coefficients of initial debt are negative and are significant at the 1 to 5 percent levels, with their values ranging from –0.015 to –0.030 across the various estimation techniques.[12] The BE regression in column 1 suggests that a 10 percentage points of GDP increase in initial public debt is associated with a slowdown in subsequent growth in real GDP per capita of around 0.25 percentage points per year. The pooled OLS and FE in columns 2 and 3 yield results similar to those of the BE regression, although 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 (–0.03) 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) have the expected sign and are 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 upward, and FE downward. 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 –1.88, whereas the FE coefficient is –3.92. The SGMM coefficient of the initial income per capita (–2.34) 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 overidentifying restrictions, which tests the overall validity of the instruments by analyzing the sample analogue 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 = 0.65).[13] 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 = 0.24).[14]

The regressions in columns 2 to 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 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-

Table 5.1
Baseline panel regression: Growth and initial government debt, 1970 to 2008 (five-year period panel)

Sample: Advanced and emerging economies (with population of over 5 million);
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 real GDP per capita	–2.123***	–1.877**	–3.924***	–2.336***	–1.707**	–4.744**	–2.229***
	(–5.02)	(–2.54)	(–2.74)	(–3.47)	(–2.14)	(–2.36)	(–2.95)
Initial years of schooling	4.813***	3.143**	3.388	4.508*	3.136**	2.394	3.161
	(3.94)	(2.57)	(1.64)	(1.93)	(2.55)	(1.07)	(1.55)
Initial inflation rate	2.151	–2.100***	–2.630***	–2.666**	–2.457***	–2.454***	–2.678**
	(0.82)	(–3.32)	(–5.38)	(–2.49)	(–3.21)	(–5.81)	(–2.05)
Initial government size	0.109**	0.109**	0.147	0.162	0.111**	0.055	0.138
	(2.06)	(2.43)	(1.68)	(1.36)	(2.38)	(0.70)	(1.23)
Initial trade openness	–0.002	–0.004	0.023*	–0.013**	–0.005	0.023	–0.004
	(–0.43)	(–0.78)	(1.73)	(–2.03)	(–1.11)	(1.57)	(–0.57)
Initial financial depth	0.022**	0.020**	0.001	0.035***	0.023**	0.006	0.027**
	(2.15)	(2.13)	(0.07)	(3.18)	(2.50)	(0.64)	(2.31)
Terms of trade growth	0.204**	–0.013	0.009	–0.032	–0.017	–0.003	–0.044*
	(2.33)	(–0.52)	(0.33)	(–1.14)	(–0.70)	(–0.13)	(–1.97)
Banking crisis	–1.077	–0.617	–0.638***	–1.033	–0.612*	–0.513*	–1.838
	(–0.61)	(–1.58)	(–2.96)	(–1.55)	(–1.75)	(–1.98)	(–1.24)
Fiscal deficit	0.028	–0.044***	–0.047***	–0.046***	–0.045***	–0.035***	–0.062***
	(0.80)	(–4.27)	(–4.07)	(–2.96)	(–4.72)	(–3.50)	(–3.10)
Initial government debt	–0.025**	–0.022***	–0.015**	–0.030***	–0.018**	–0.004	–0.019*
	(–2.28)	(–3.29)	(–2.17)	(–4.14)	(–2.34)	(–0.67)	(–1.89)
Arellano–Bond AR(2) test *p*-value[a]				0.65			0.45
Hansen *J*-statistics (*p*-value)[b]				0.24			0.29
Number of observations	166	166	166	166	166	166	166
R^2	0.68	0.51	0.39		0.58	0.51	
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.

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

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

fixed effects may understate the estimated effects of these variables. Columns 5 to 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 5 to 10 percent, and the size of those coefficients is reduced as expected. The estimates 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.

In contrast, the FE results on initial debt turn out to be 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.[15] Moreover the measurement error bias can also be exacerbated under FE. With these caveats, time-fixed effects are included in the remaining regressions.

5.4.5 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. 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 to 4 in table 5.2 repeat the same sets of regressions (BE, pooled OLS, FE, and SGMM) for the period 1990 to 2008. 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 –0.020 to –0.024, 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 to 0.24 percent per year.

Second, columns 5 to 8 and 9 to 12 of table 5.2 replicate the regression exercises for 46 advanced and emerging economies and the full sample of 79 countries (which includes 33 developing countries in addition to the 46). Again, the results are broadly similar to those in table 5.1, although the size of the debt coefficients becomes slightly smaller.

Third, 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 results are remarkably similar to the panel regression results in table 5.2 (appendix tables A5.2 and A5.3).

Table 5.2
Baseline panel regression: Robustness checks on time periods and sample

Dependent variable: Real per capita GDP growth (%)												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM
Explanatory variables	Period: 1990–2008 sample: OECD and emerging economies				Period: 1970–2008 sample: OECD and emerging economies without population size restriction				Period: 1970–2008 sample: Full sample (including developing countries) without popullzation size restriction			
Initial real GDP per capita	−1.794***	−1.711**	−3.325*	−2.376**	−1.796***	−1.074*	−5.843***	−2.072*	−0.962***	−1.021**	−4.495**	−1.566**
	(−4.67)	(−2.22)	(−1.99)	(−2.21)	(−4.37)	(−1.80)	(−3.09)	(−1.96)	(−2.79)	(−2.09)	(−2.13)	(−2.12)
Initial years of schooling	3.815***	3.491***	−0.784	3.903	3.768***	1.809*	4.629**	2.956	1.550*	0.887	2.624	2.346*
	(3.35)	(2.78)	(-0.17)	(0.92)	(3.10)	(1.68)	(2.56)	(0.87)	(1.79)	(0.98)	(1.11)	(1.79)
Initial inflation rate	1.258	−2.918***	−2.308***	−1.717	2.227	−1.201**	−2.262***	−1.112	2.727	0.324	−0.899	−0.251
	(0.51)	(−3.19)	(−4.33)	(−1.14)	(0.92)	(−2.14)	(−5.37)	(−0.93)	(1.14)	(0.46)	(−1.12)	(−0.33)
Initial government size	0.120**	0.119**	0.074	0.205*	0.030	−0.018	−0.039	−0.180*	−0.020	−0.026	−0.023	−0.092
	(2.41)	(2.45)	(0.68)	(1.73)	(0.77)	(−0.44)	(−0.56)	(−1.75)	(−0.63)	(−1.00)	(−0.41)	(−1.23)
Initial trade openness	0.001	−0.007	0.030*	−0.006	0.009**	0.003	0.015	0.003	0.003	0.004	0.002	0.000
	(0.19)	(−1.55)	(1.76)	(−0.72)	(2.38)	(0.78)	(1.63)	(0.24)	(0.83)	(1.29)	(0.15)	(0.03)
Initial financial depth	0.016*	0.027**	0.002	0.032	0.002	0.001	0.007	−0.001	−0.000	−0.004	−0.006	0.006
	(1.71)	(2.68)	(0.13)	(1.66)	(0.27)	(0.07)	(0.76)	(−0.06)	(−0.05)	(−0.60)	(−0.54)	(0.39)
Terms of trade growth	0.223***	−0.016	−0.018	−0.049	0.187**	−0.001	0.008	−0.046	−0.033	0.028	0.062**	0.024
	(2.79)	(−0.29)	(−0.36)	(-0.94)	(2.14)	(−0.04)	(0.31)	(−1.03)	(−0.64)	(0.92)	(2.05)	(0.74)

(*continued*)

Table 5.2
(*continued*)

Dependent variable: Real per capita GDP growth (%)												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM
Explanatory variables	Period: 1990–2008 sample: OECD and emerging economies				Period: 1970–2008 sample: OECD and emerging economies without population size restriction				Period: 1970–2008 sample: Full sample (including developing countries) without popullzation size restriction			
Banking crisis	0.632	−0.358	−0.576	−1.233	−1.445	−0.867**	−0.837***	−1.003	−3.566**	−1.357***	−1.026***	−1.861***
	(0.38)	(−0.68)	(−1.15)	(−0.90)	(−0.80)	(−2.23)	(−2.80)	(−1.16)	(−2.32)	(−3.85)	(−3.53)	(−3.21)
Fiscal deficit	0.009	−0.055***	−0.046***	−0.057*	0.050*	−0.037***	−0.045***	−0.045**	−0.028**	−0.034***	−0.041***	−0.035**
	(0.27)	(−4.18)	(−2.92)	(−1.71)	(1.72)	(−3.40)	(−4.25)	(−2.46)	(−2.17)	(−3.80)	(−5.50)	(−2.13)
Initial government debt	−0.024***	−0.020**	−0.008	−0.023*	−0.019*	−0.020**	−0.011*	−0.021*	−0.021***	−0.017***	−0.011*	−0.016*
	(−2.85)	(−2.26)	(−0.65)	(−2.02)	(−1.94)	(−2.62)	(−1.78)	(−1.74)	(−3.22)	(−3.31)	(−1.66)	(−1.83)
Arellano–Bond AR(2) test *p*-value[a]				0.42				0.59				0.59
Hansen *J*-statistics (*p*-value)[b]				0.13				0.98				0.36
Number of observations	124	124	124	124	208	208	208	208	297	297	297	297
R^2	0.72	0.61	0.44		0.56	0.44	0.51		0.37	0.36	0.43	
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.

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

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

5.4.6 Nonlinearities and Differences between Advanced and Emerging Economies

To explore potential nonlinearities, table 5.3 (columns 1–4) shows regressions that include the interaction terms between initial debt and dummy variables for three ranges of initial debt ratio: 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 all insignificant and of the positive sign, which seems to suggest that relatively low levels of public debt are not significantly harmful to growth. 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 –0.028. 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 at 1 percent under OLS, and SGMM.

Interestingly, the negative effect of initial debt on growth in advanced economies tends to be smaller than that in emerging economies. Columns 5 to 8 in table 5.3 use the interaction terms between initial debt and dummy variables for advanced and emerging economies.[16] The coefficients of both interaction terms are negative and significant at various levels, except for the FE results and the coefficient of the initial debt*Dum_advanced term in BE. Under BE, OLS, and SGMM, the coefficients of initial debt in advanced economies range from –0.012 to –0.017, whose absolute size is smaller than that of emerging economies (–0.038 to –0.044): a 10 percentage point increase in initial debt-to-GDP ratio is associated with growth slowdown around 0.12 to 0.17 percent in advanced economies, compared to 0.38 to 0.4 percent in emerging economies. This may reflect limited borrowing capacity of emerging economies due to less-developed domestic financial markets, and/or inadequate access to international capital markets, with both factors leading to greater adverse effect on private investment and growth compared to the advanced economies.

5.4.7 International Financial Integration and Impact on Growth

An important question that arises is whether and to what extent the impact on growth of initial public debt is conditional on a country's economic and financial position vis-à-vis the rest of the world. For example, does the NFA (net foreign asset) position of a country or aggregate foreign liabilities matter for the magnitude of the relationship between public debt and growth?[17] Is it the case that the adverse impact of high debt on growth would be low if at the same time the aggregate foreign liabilities of a country are relatively low? This could be related to the fact that high public debt is being financed by private domestic savings rather than from abroad. Conversely, excessive foreign liabilities may compound the fiscal vulnerability arising from public debt per se, to the extent that foreign creditors may be more sensitive to changes in global risk appetite, or they may have shorter time horizons. Another

Table 5.3
Panel regression: Different levels of initial debt and advanced versus 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 real GDP per capita	–2.014***	–1.875***	–4.912**	–2.227***	–2.796***	–2.539***	–4.705**	–2.897***
	(–5.13)	(–2.79)	(–2.65)	(–3.14)	(–4.51)	(–2.96)	(–2.35)	(–4.07)
Initial years of schooling	4.377***	3.185***	2.260	3.988	4.691***	3.127***	2.232	2.074
	(3.77)	(3.10)	(1.00)	(1.42)	(3.91)	(2.79)	(1.03)	(1.06)
Initial inflation rate	1.551	–2.773***	–2.329***	–2.352**	0.503	–3.213***	–2.390***	–9.852**
	(0.59)	(–3.67)	(–5.06)	(–2.65)	(0.18)	(–3.17)	(–5.17)	(–2.31)
Initial government size	0.135**	0.127***	0.033	0.199**	0.096*	0.086*	0.056	0.293**
	(2.65)	(3.06)	(0.40)	(2.03)	(1.82)	(2.02)	(0.70)	(2.65)
Initial trade openness	–0.003	–0.005	0.026*	–0.007	–0.002	–0.005	0.023	–0.005
	(–0.65)	(–1.37)	(1.77)	(–1.02)	(–0.30)	(–1.18)	(1.56)	(–0.76)
Initial financial depth	0.023**	0.023***	0.006	0.026***	0.022**	0.024***	0.005	0.032***
	(2.18)	(3.02)	(0.68)	(2.84)	(2.24)	(2.87)	(0.57)	(3.06)
Terms of trade growth	0.183*	–0.018	–0.003	–0.038	0.235**	–0.008	–0.002	–0.050**
	(1.93)	(–0.65)	(–0.18)	(–1.23)	(2.66)	(–0.32)	(–0.10)	(–2.26)
Fiscal deficit	0.011	–0.046***	–0.033***	–0.045**	0.019	–0.050***	–0.034***	–0.059***
	(0.32)	(–4.75)	(–3.14)	(–2.23)	(0.53)	(–4.94)	(–3.24)	(–3.69)
Banking crisis	–1.270	–0.563	–0.468	–0.612	–0.992	–0.588*	–0.506*	–1.163
	(–0.72)	(–1.60)	(–1.61)	(–0.83)	(–0.57)	(–1.75)	(–1.94)	(–1.13)

Initial debt*Dum_below30	0.016	0.0002	0.017	0.030				
	(0.17)	(0.01)	(0.65)	(1.25)				
Initial debt*Dum_30_90	–0.037	–0.028**	0.007	–0.015				
	(–1.43)	(–2.66)	(0.79)	(–1.26)				
Initial debt*Dum_above90	–0.010	–0.015***	–0.001	–0.015***				
	(–0.79)	(–2.79)	(–0.08)	(–2.91)				
Initial debt*Dum_ advanced					–0.017	–0.012**	–0.005	–0.014*
					(–1.35)	(–2.19)	(–0.75)	(–1.95)
Initial debt*Dum_emerging					–0.044**	–0.042***	0.001	–0.038*
					(–2.62)	(–2.97)	(0.08)	(–1.95)
Arellano–Bond AR(2) test *p*-value[a]				0.34				0.14
Hansen *J*-statistics (*p*-value)[b]				0.86				0.85
Number of observations	166	166	166	166	166	166	166	166
R^2	0.75	0.62	0.52		0.7	0.61	0.51	
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.

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

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

channel could be in terms of signaling: high public debt when foreign liabilities are also high may indicate that the imbalances facing a country are broader than just the public sector and hence there are greater underlying vulnerabilities. Similar arguments could be used with regard to the NFA, rather than only foreign liabilities per se.

In order to investigate this issue, we considered the NFA and foreign liabilities (as a percentage of GDP) as an additional variable, as well as an interactive term. The empirical analysis indicates that the bilateral correlation between government debt and the NFA or foreign liabilities is low (correlation coefficients are –0.10 and 0.11, respectively), and neither the NFA nor foreign liabilities are significant in growth regressions, as shown in columns 1 to 4 of table 5.4 (the results on foreign liabilities are not reported). However, the logic of the above argument would suggest that the interaction of initial public debt with NFA or liabilities might be more important than the simple correlations. This was assessed by examining the interaction of debt with a dummy that took a value of 1 if the NFA exceeded the sample median value (–17 percent of GDP), or if foreign liabilities were greater than the 75th percentile (89 percent of GDP), and 0 otherwise. The results are shown in columns 5 to 8 and 8 to 12 of table 5.4, respectively. The results appear to bear out the basic hypothesis: when foreign liabilities are high or NFA low, the adverse impact of public debt on growth is about *one and a half to two* times as large as is the case otherwise. These results are striking from an economic perspective, and statistically significant. Perhaps what they are really alluding to is the notion that if the economy as a whole is operating essentially outside its means, the impact of high public debt on growth is substantially worse than when it is operating within it.

Next, we turn to the question of whether the currency composition of public debt also matters. The larger the portion of foreign-currency denominated debt as a share of total public debt, the larger the extent of exposure to foreign currency risk. This is related to the "Original Sin" problem highlighted by Eichengreen and Hausmann (1999), whereby the debt is denominated in foreign currency, which could have adverse macroeconomic consequences. If a country affected by "Original Sin" has net foreign debt, then it is likely to have a currency mismatch in its national balance sheet. Large swings in the real exchange rate will thus likely have an effect on aggregate wealth and on the country's ability to service its debt. As a consequence "Original Sin" tends to make debt riskier, increase volatility, and affect a country's ability to conduct an independent monetary policy. Table 5.5 shows the results when we included the interaction of debt with a dummy that took a value of 1 if the domestic-currency portion exceeded the sample median value (89 percent of total debt), or if it is greater than the 25th percentile (59 percent of total debt), and 0 otherwise. The regression coefficients of the interaction terms are mostly significant and of the expected sign. *Importantly, they suggest that when the foreign-currency debt*

Table 5.4
Panel regression: Different levels of initial NFA and foreign liabilities

Dependent variable: Real per capita GDP growth (%)												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Explanatory variables	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM
Initial real GDP per capita	–2.127***	–1.698**	–4.772**	–1.852**	–2.273***	–1.863**	-4.754**	-2.182***	-1.909***	-1.816**	-4.949**	-1.881***
	(–4.95)	(–2.23)	(–2.29)	(–2.51)	(–5.43)	(–2.66)	(-2.38)	(-3.86)	(-4.40)	(-2.35)	(-2.46)	(-2.78)
Initial years of schooling	4.760***	3.044**	2.345	2.580	4.458***	3.076***	2.396	3.749***	5.066***	3.308***	2.250	1.592
	(3.81)	(2.51)	(1.04)	(1.11)	(3.72)	(2.92)	(1.08)	(2.77)	(4.22)	(2.76)	(1.04)	(0.67)
Initial inflation rate	2.019	–2.397***	–2.483***	–1.402	2.874	–2.098***	-2.418***	-1.905	-0.277	-2.621***	-2.527***	-2.514**
	(0.75)	(–3.20)	(–5.82)	(–1.21)	(1.12)	(–3.06)	(-5.53)	(-1.58)	(-0.09)	(-3.57)	(-5.84)	(-2.15)
Initial government size	0.108*	0.115**	0.057	0.142	0.096*	0.115**	0.059	0.114	0.117**	0.117**	0.053	0.111
	(2.00)	(2.44)	(0.73)	(1.50)	(1.86)	(2.70)	(0.74)	(0.68)	(2.26)	(2.61)	(0.67)	(1.32)
Initial trade openness	–0.003	–0.006	0.023	0.008	0.0003	–0.004	0.024	-0.007	-0.001	-0.002	0.026*	0.003
	(–0.50)	(–1.28)	(1.51)	(1.07)	(0.06)	(–1.17)	(1.58)	(-1.40)	(-0.13)	(-0.39)	(1.90)	(0.28)
Initial financial depth	0.019	0.021**	0.006	0.018	0.014	0.021**	0.006	0.027**	0.020*	0.022**	0.006	0.021*
	(1.47)	(2.18)	(0.66)	(1.24)	(1.29)	(2.62)	(0.66)	(2.33)	(1.98)	(2.26)	(0.64)	(1.66)
Terms of trade growth	0.199**	–0.016	–0.003	–0.034	0.167*	–0.021	-0.004	-0.034	0.161*	-0.022	-0.007	-0.051***
	(2.22)	(–0.62)	(–0.13)	(–0.77)	(1.92)	(–0.90)	(-0.17)	(-0.99)	(1.81)	(-0.95)	(-0.28)	(-2.75)
Fiscal deficit	0.028	–0.044***	–0.035***	–0.034	0.021	–0.045***	-0.035***	-0.044	-2E-04	-0.050***	-0.039***	-0.067***
	(0.79)	(–4.80)	(–3.59)	(–1.44)	(0.62)	(–5.40)	(-3.52)	(-1.59)	(-0.00)	(-5.03)	(-3.55)	(-2.78)
Banking crisis	–0.943	–0.570	–0.525*	–2.219*	–1.468	–0.510	-0.489*	-1.077	-0.672	-0.550	-0.485*	-0.427
	(–0.52)	(–1.66)	(–1.88)	(–1.96)	(–0.85)	(–1.46)	(-1.83)	(-1.19)	(-0.38)	(-1.56)	(-1.81)	(-0.54)
Initial government debt	–0.024**	–0.017**	–0.004	–0.015*								
	(–2.14)	(–2.40)	(–0.72)	(–1.81)								
Initial NFA (net foreign assets)	0.003	0.005	–0.002	–0.013								
	(0.39)	(0.84)	(–0.21)	(–1.26)								

(*continued*)

Table 5.4
(*continued*)

Dependent variable: Real per capita GDP growth (%)												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Explanatory variables	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM	BE	Pooled OLS	FE	SGMM
Initial debt*Dum_NFA_above_median[a]					–0.020*	–0.015**	-0.004	-0.023*				
					(–1.80)	(–2.64)	(-0.60)	(-1.84)				
Initial debt*Dum_NFA_below_median					–0.042***	–0.029***	-0.006	-0.029*				
					(–2.88)	(–3.17)	(-0.70)	(-1.95)				
Initial debt*Dum_Foreign_Liabilities_below_75percentile[b]									-0.013	-0.015*	-0.003	-0.017*
									(-0.99)	(-1.98)	(-0.38)	(-1.85)
Initial debt*Dum_Foreign_Liabilities_above_75percentile									-0.036***	-0.025***	-0.010	-0.025*
									(-2.81)	(-2.74)	(-1.19)	(-1.71)
Arellano–Bond AR(2) test *p*-value[c]				0.16				0.28				0.36
Hansen *J*-statistics (*p*-value)[d]				0.47				0.16				0.90
Number of observations	166	166	166	166	166	166	166	166	166	166	166	166
R^2	0.68	0.59	0.51		0.71	0.61	0.51		0.7	0.59	0.52	
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.

a. The median value of NFA in the sample of 36 advanced and emerging economies is –17 percent of GDP.

b. The 75 percentile level of foreign liabilities in the sample of 36 advanced and emerging economies is 89 percent of GDP.

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

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

Table 5.5
Panel regression: Domestic versus foreign currency-denominated portion of public debt

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 real GDP per capita	–2.531***	–2.092***	–4.927**	–2.337**	–2.178***	–1.856**	–4.818**	-2.688**
	(–4.79)	(–2.96)	(–2.32)	(–2.29)	(–4.40)	(–2.44)	(–2.35)	(-2.37)
Initial years of schooling	5.311***	3.293***	3.195	4.209	5.054***	3.110**	3.030	2.578
	(4.01)	(3.10)	(1.32)	(1.54)	(3.63)	(2.52)	(1.22)	(0.74)
Initial inflation rate	0.946	–2.471***	–2.393***	–3.002**	2.136	–2.652***	–2.401***	-2.521*
	(0.30)	(–3.53)	(–5.90)	(–2.28)	(0.69)	(–2.98)	(–4.73)	(-1.67)
Initial government size	0.081	0.091*	0.086	0.182	0.111*	0.112**	0.095	0.118
	(1.30)	(2.01)	(1.19)	(1.64)	(1.80)	(2.32)	(1.24)	(1.05)
Initial trade openness	–0.002	–0.005	0.025	–0.012*	–0.001	–0.004	0.026	0.001
	(–0.32)	(–0.93)	(1.51)	(–1.72)	(–0.18)	(–0.90)	(1.48)	(0.12)
Initial financial depth	0.018	0.017**	0.005	0.026*	0.022	0.023**	0.004	0.024*
	(1.40)	(2.08)	(0.50)	(1.84)	(1.54)	(2.36)	(0.41)	(1.97)
Terms of trade growth	0.211**	0.004	0.003	–0.032	0.212**	–0.018	–0.000	-0.040*
	(2.27)	(0.14)	(0.10)	(–0.99)	(2.18)	(–0.72)	(–0.00)	(-1.70)
Banking crisis	–1.613	–0.832*	–0.588*	–0.501	–0.547	–0.612	–0.577*	-2.577
	(–0.67)	(–2.03)	(–2.00)	(–0.34)	(–0.23)	(–1.33)	(–1.98)	(-1.48)
Fiscal deficit	0.008	–0.051***	–0.036***	–0.074***	0.028	–0.047***	–0.035***	-0.063***
	(0.19)	(–4.36)	(–3.24)	(–4.01)	(0.66)	(–4.61)	(–3.11)	(-4.43)
Initial debt*Dum_ domdebt_below25pctile[a]	–0.047**	–0.054***	–0.039***	–0.060*				
	(–2.35)	(–2.86)	(–2.79)	(–1.94)				

(*continued*)

Table 5.5
(*continued*)

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 debt*Dum_ domdebt_above25pctile	–0.021*	–0.017**	–0.004	–0.023*				
	(–1.72)	(–2.50)	(–0.77)	(–1.74)				
Initial debt*Dum_ domdebt_belowMedian[b]					–0.025	–0.028**	–0.011	-0.033**
					(–1.63)	(–2.71)	(–1.04)	(-2.24)
Initial debt*Dum_ domdebt_aboveMedian					–0.025*	–0.018**	–0.006	-0.019**
					(–1.90)	(–2.40)	(–0.87)	(-2.20)
Arellano–Bond AR(2) test *p*-value[c]				0.68				0.89
Hansen *J*-statistics (*p*-value)[d]				0.41				0.55
Number of observations	151	151	151	151	151	151	151	151
R^2	0.7	0.63	0.51		0.67	0.6	0.51	
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.

a. The 25 percentile level of domestic currency-denominated public debt portion in the sample 36 advanced and emerging economies is 59 percent of total public debt.

b. The median level of domestic currency-denominated public debt portion in the sample 36 advanced and emerging economies is 89 percent of total public debt.

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

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

portion is large, the negative impact of public debt on growth can be more than twice as large as is the case otherwise.

5.5 Summary and Concluding Remarks

This chapter has provided systematic empirical evidence on the impact of high initial debt on subsequent growth for a panel of advanced and emerging market economies over nearly four decades. The chapter 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 chapter 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 results, based on a range of econometric techniques, suggest an inverse relationship between *initial* public 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 real per capita GDP growth of around 0.2 percentage points per year, with the impact being smaller (around 0.15) in advanced economies and larger when (net) foreign liabilities are relatively high. There is some evidence of nonlinearity, with only high (above 90 percent of GDP) levels of debt having a significant negative effect on growth. As shown in Kumar and Woo (2010), 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 ratio is associated with a decline of investment by about 0.4 percentage points of GDP, with a larger impact in emerging economies. The analysis also suggests that when foreign liabilities are high or NFA low, or the share of foreign currency denominated debt is large, the adverse impact of public debt on growth is substantially greater. Various robustness checks yield largely similar results. The results underline the need to take measures that would over the medium- to long-term not just stabilize public debts but place them on a downward trajectory to avoid adverse effects on growth.

Appendixes: 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 baseline panel regressions.

Table A5.1

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

Note: 1. Eight additional countries are also available in the panel regressions for all available 46 advanced and emerging economies without the over five-million population size restriction: Finland, Iceland, Ireland, Israel, Jordan, Norway, New Zealand, and Singapore.
2. Thirty-three developing countries that are included in the full sample of 79 countries are Barbados, Bolivia, Bulgaria, Costa Rica, Croatia, Cyprus, Ecuador, Gambia, Guinea-Bissau, Guyana, Honduras, Iran, Jamaica, Kuwait, Lesotho, Mauritania, Mauritius, Mozambique, Nicaragua, Panama, Romania, Rwanda, Senegal, Slovenia, Sri Lanka, Sudan, Swaziland, Syria, Togo, Trinidad and Tobago, Tunisia, Uganda, and Uruguay.
3. The list of advanced economies includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States, which were the OECD member nations as of 1990, except for Turkey, which is classified as an emerging market economy.

Table A5.2
Cross-country regression: Government debt and long-term growth of advanced and emerging economies (without restriction on population size)

Dependent variable: Real per capita GDP growth (%)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	1975–	1985–	1990–	1995–	2000–	1990–	1995–	2000–
Explanatory variables	2008	2008	2008	2008	2008	2008	2008	2008
Initial real GDP per capita	1.862	–2.928*	–2.464***	–1.726**	–0.480	–1.353	–1.121*	–0.494
	(1.91)	(–2.00)	(–4.44)	(–2.37)	(–0.58)	(–1.63)	(–1.84)	(–0.61)
Initial years of schooling	0.393	0.576	2.462**	2.944**	1.021	1.419	2.204**	1.286
	(0.38)	(0.50)	(2.66)	(2.08)	(0.63)	(1.15)	(2.09)	(0.82)
Initial inflation rate	8.395**	–1.578	0.400	8.932**	1.628	–0.059	2.831**	1.300
	(4.37)	(–0.77)	(0.99)	(2.12)	(0.43)	(–0.38)	(2.19)	(0.38)
Initial government size	–0.127*	–0.024	–0.027	0.021	0.114**	–0.020	0.020	0.101*
	(–2.86)	(–0.40)	(–0.85)	(0.58)	(2.25)	(–0.72)	(0.57)	(1.96)
Initial trade openness	0.012*	0.016	0.010**	0.014***	0.001	0.008	0.004	–0.0002
	(3.93)	(1.39)	(2.18)	(3.04)	(0.21)	(1.43)	(0.81)	(–0.04)
Terms of trade growth	0.039	–0.036	–0.192	–0.189*	0.071	–0.195	–0.124	0.049
	(0.54)	(–0.20)	(–1.13)	(–1.97)	(0.78)	(–1.31)	(–1.60)	(0.61)
Banking crisis			–0.428	–0.728	0.061	0.082	–0.825	–0.044
			(–1.26)	(–1.33)	(0.11)	(0.22)	(–1.60)	(–0.08)
Initial government debt	–0.020**	–0.009	–0.018***	–0.029***	–0.020			
	(–4.49)	(–1.07)	(–3.29)	(–3.73)	(–1.65)			
Government debt, average						–0.021**	–0.022**	–0.018*
						(–2.21)	(–2.68)	(–1.83)
Number of observations	10	20	30	37	44	42	46	46
R^2	0.99	0.60	0.85	0.67	0.63	0.53	0.51	0.62

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, except for column 1 in which the number of observations is small relative to the number of covariates (not reported to save space).

Table A5.3
Growth accounting and cross-country growth regression: Advanced and emerging economies (without restriction on population size)

Explanatory variables	(1) OLS 1990–2008	(2) OLS 1995–2008	(3) OLS 1990–2008	(4) OLS 1995–2008	(5) OLS 1990–2008	(6) OLS 1995–2008	(7) OLS 1990–2008	(8) OLS 1995–2008	(9) OLS 1990–2008	(10) OLS 1995–2008	(11) OLS 1990–2008	(12) OLS 1995–2008
	Dependent variable: Growth of real output per worker				Dependent variable: Growth of TFP				Dependent variable: Growth of capital stock per worker			
Initial real GDP per capita	−2.278***	−1.490**	−1.219	−1.033	−1.810***	−1.070**	−1.276**	−1.001***	−1.438*	-1.080	-0.041	-0.119
	(−4.35)	(−2.19)	(−1.44)	(−1.68)	(−5.14)	(−2.57)	(−2.52)	(−2.87)	(−1.89)	(-1.21)	(-0.04)	(-0.16)
Initial years of schooling	2.653***	3.076**	1.692	2.620**	2.972***	2.810***	2.352***	2.790***	1.350	2.387	0.004	1.300
	(2.90)	(2.10)	(1.40)	(2.17)	(4.37)	(3.04)	(3.12)	(3.79)	(0.86)	(1.24)	(0.00)	(0.85)
Initial inflation rate	0.739*	11.195**	0.079	3.680*	0.762**	7.907***	0.239	2.529**	0.029	8.876	-0.440	2.710
	(1.89)	(2.54)	(0.33)	(1.91)	(2.84)	(3.08)	(1.41)	(2.04)	(0.05)	(1.23)	(-1.39)	(0.98)
Initial government size	−0.030	0.038	−0.033	0.015	−0.026	0.038*	−0.026	0.019	−0.037	0.006	-0.038	-0.012
	(−0.87)	(1.10)	(−1.01)	(0.40)	(−1.51)	(1.86)	(−1.24)	(0.84)	(−0.68)	(0.13)	(-0.99)	(-0.25)
Initial trade openness	0.010**	0.013**	0.007	0.002	0.011***	0.011***	0.009**	0.005	−0.002	0.004	-0.006	-0.008
	(2.35)	(2.64)	(1.14)	(0.35)	(3.47)	(4.05)	(2.30)	(1.54)	(−0.32)	(0.60)	(-0.94)	(-1.27)
Terms of trade growth	−0.063	−0.187*	−0.089	−0.171**	−0.054	−0.165**	−0.031	−0.138**	−0.082	-0.071	-0.176	-0.098
	(−0.43)	(−1.80)	(−0.64)	(−2.29)	(−0.59)	(−2.64)	(−0.38)	(−2.66)	(−0.33)	(-0.44)	(-1.07)	(-1.00)
Banking crisis	−0.014	−0.628	0.432	−0.837	0.030	−0.467	0.372	−0.299	−0.345	-0.204	0.092	-1.295*
	(−0.04)	(−1.01)	(1.15)	(−1.55)	(0.14)	(−1.28)	(1.59)	(−0.93)	(−0.62)	(-0.23)	(0.18)	(-1.75)
Initial government debt	−0.021***	−0.029***			−0.012***	−0.018***			−0.020*	-0.027*		
	(−3.33)	(−2.86)			(−3.93)	(−3.21)			(−1.77)	(-1.80)		
Government debt, average			−0.020**	−0.017**			−0.010	−0.008			-0.026**	
			(−2.08)	(−2.20)			(−1.68)	(−1.68)			(-2.33)	
												-0.026**
												(-2.69)
Number of observations	30	36	44	45	30	36	44	45	30	36	44	45
R^2	0.85	0.64	0.48	0.46	0.87	0.69	0.56	0.51	0.65	0.42	0.45	0.38

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).

Notes

This chapter heavily draws on Kumar and Woo (2010, 2012).

1. There is some evidence that high initial debt is associated with weaker recovery strength during the recovery phase in 54 advanced and emerging economies during 1970 to 2009 (Woo et al., 2013).

2. Herdon, Ash, and Pollin (2013) show that some of Reinhart and Rogoff (2010)'s "average" result when debt is above the 90 percent debt threshold was incorrect due to a coding error. Yet they also obtain the similar result that high debt is associated with lower growth, although the corrected growth rate (2.2 percent) when debt is above 90 percent is higher than that (–0.1 percent) originally reported in Reinhart and Rogoff (2010). Then again, Panizza and Presbitero (2012) suggest that there is no a causal relationship from high debt to slow growth using an IV regression, while confirming a negative relationship between debt and subsequent growth in the OLS regression, in a sample of OECD countries. However, significant caution is needed in interpreting their result, as their instrumental variable (IV), valuation effects (product of foreign currency debt portion of public debt and exchange rates), seems problematic and invalid. There is no convincing economic rationale as to why such an IV could satisfy the exclusion restriction condition (a key condition required of an acceptable IV) nor support the empirical test.

3. Also there is evidence that high *initial* debt at the start of recession is associated with weaker strength of recovery as well as longer duration from trough to end of the recession-recovery cycle for the advanced and emerging economies during 1970 to 2009. See Woo et al. (2013).

4. To be precise, the average growth rate of real per capita GDP per year over the period $t\text{-}\tau$ and t is $(y_{i,t} - y_{i,t-\tau})/\tau$, which is actually used in the empirical application of **equation (5.1).** All the explanatory variables in $\boldsymbol{X}_{i,t-\tau}$ 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 $t - \tau$ and t.

5. 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.

6. 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.

7. Results are not shown here to save space. See Kumar and Woo (2010).

8. To see this more clearly, rewrite **equation (5.1)** as $y_{i,t} = (1 + \alpha)y_{i,t-\tau} + X_{i,t-\tau}\beta + \gamma Z_{i,t-\tau} + \eta_t + \nu_i + \varepsilon_{i,t}$. 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.

9. 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 1987; Hauk and Wacziarg 2009).

10. 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.

11. The BE estimator applies the OLS to perform estimating of the following equation: $\overline{y_{i,} - y_{i,-1}} = \alpha\overline{y_{i,-1}} + \overline{X_{i,-1}}\beta + \gamma\overline{Z_{i,-1}} + \nu_i + \bar{\varepsilon}_i$, 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 the dependent and explanatory variables are averaged, say, over 1970 to 2008, 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.

12. 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.

13. 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 being used as instruments in levels are uncorrelated with the errors. This is the additional restriction that needs to be satisfied for the SGMM estimator.

14. 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. The reported SGMM results in our chapter are obtained by combining the "collapsed" instrument matrix with lag limits.

15. 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 chapter.

16. See Table A5.1 for the list of advanced and emerging economies.

17. Recent sovereign debt crisis in Europe suggests that there is a strong correlation between the NFA positions and sovereign yields, indicating the market perceptions of fiscal risks (e.g.,

debt default and fiscal unsustainability) stemming from high debt may depend on the NFA position.

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