Growth and Investment Across Countries:

Are Primitives All That Matter?

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ABSTRACT

This paper examines the channels through which country characteristics affect growth. We investigate whether "primitives," or rates of factor accumulation, are sufficient statistics for economic growth, and whether "ancillary variables," such as political instability, income distribution, and financial development, affect growth by influencing levels of investment in physical and human capital. Our results suggest that financial development is an important determinant of both total factor productivity growth and levels of investment. Political instability is also found to influence levels of physical capital accumulation. However, the impact of many of the ancillary variables on levels of investment are not very robust to the inclusion of country fixed effects.

Key words: Growth, Investment, Human Capital, Financial Development

JEL Classification: N10; N30

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1. Introduction

There now exists a large empirical and theoretical literature which examines the roles of policy variables and political and institutional factors, or "ancillary variables" as they are commonly referred to in the literature, in the determination of economic growth. These include income and wealth inequality, education, political instability, technology diffusion, and imperfect financial markets, among others.[1] This paper is an attempt to systematically explore the role of these variables in accounting for differences growth and investment rates across countries in the light of the theories that suggest their importance, and to subject them to further empirical scrutiny.

One can distinguish between economic growth that follows from the enhancement of a nation's technology, that is from increases of total factor productivity in standard growth accounting exercises, and economic growth that arises from increases in the nation's factor stocks, or "primitives." This latter group would include standard factors of production, such as labor and capital, as well as human capital. The rate of their accumulation would be directly affected by ancillary variables like income distribution or redistributive government programs which can influence tax rates [Persson and Tabellini (1995), Alesina and Rodrik (1994), Perotti (1993)]; political variables like social unrest or rent-seeking activities that dilute rates of return on investment [Veneiris and Gupta (1986), Alesina and Perotti (1996), Benhabib and Rustichini (1996), Tornell and Velasco (1992)]; or imperfect financial markets that limit educational as well as economic opportunities for the talented and constrain their productivity [Galor and Zeira (1993), Banerjee and Newman (1991), Benabou (1996)]. Since a number of underlying theories suggest that such ancillary factors influence growth essentially through their impact on factor accumulation, it would make sense to test their effects directly on investment rates. In such cases, we

[1] See Levine (1997) for an extensive survey of this literature. Sala-i-Martin (1997) provides an exhaustive list of ancillary variables considered in previous studies.

should not expect them to appear in a standard growth accounting exercise that already incorporates rates of factor accumulation as explanatory variables, as also discussed in Benhabib and Spiegel (1994).

To this test of the role of ancillary variables, we must first have a base model that captures the impact of technological progress and technology diffusion on economic growth. We can then ask whether ancillary variables affect growth directly, or whether they affect the growth of factor accumulation. If these ancillary variables directly affect growth, then they will enter into the growth accounting equations even after accounting for disparities in factor accumulation rates.

We can also check whether ancillary variables have a direct impact on investment rates in physical and human capital. In this paper, we take as a "base specification" for levels of investment in physical and human capital, a standard model in which savings are a linear function of income, and where GDP is used directly as a right-hand variable. We then study whether there is any additional role is left for ancillary variables in explaining investment rates in physical and human capital.

Finally, we also examine the robustness of our results. The literature contains a variety of approaches to evaluate the robustness of ancillary variables. Levine and Renelt (1992) conducted the extreme bounds analysis method. Essentially, their method examined whether a right-hand side variable was robust to a large myriad of specifications. An ancillary variable was reported as "non-robust" if it failed to enter significantly in any of these specifications. Sala-i-Martin (1997), on the other hand, suggested that such a test was misleading, since it did not distinguish between ancillary variables which failed to enter in all specifications, and those which had failed in only one of the specifications in the study. In this paper, we utilize the information in our panel data set to examine the robustness of our results to the inclusion and exclusion of country-specific fixed effects. One difficulty with cross country regressions is the possibility of omitting country-specific fixed effects, and thereby attributing explanatory power to other variables which act as proxies for unobservables. It is quite possible, for example, that fixed effects would usurp the role of educational attainment in the regressions, but it is also possible that educational attainment levels, which enter as a set of not too dissimilar numbers in the panel for each country, are nothing but proxies for other omitted country characteristics. Therefore, it seems desirable to check whether our ancillary variables survive the introduction of fixed effects.

Our panel specification also accommodates some response to the issue of simultaneity. As is well known, the potential endogeneity of factor accumulation rates, particularly physical capital accumulation rates, implies that an OLS treatment of the data may yield biased coefficient estimates [for example, see Benhabib and Jovanovic (1990)]. Benhabib and Spiegel (1994) demonstrate that the coefficient estimate bias on physical as well as human capital accumulation is likely to be positive. This is of particular concern to our study here. If our physical capital coefficient estimate is biased, it is likely that some of the coefficient estimates on the ancillary variables in the growth regressions will also be biased.

To diminish such problems of simultaneity bias, we follow a number of recent studies [Barro and Lee (1994), Caselli, et al (1996), and Easterly, et al (1996)] in using lagged values of endogenous variables as instruments in our growth regressions. In particular, we use the generalized method of moments application because this application does not rely on the presence of random individual effects, as the instrumental variables method would.

We first introduce a variety of specifications for "base" growth and investment equations. The theoretical models referred to above suggest that the ancillary variables like capital market imperfections or income or wealth inequality can explain departures of growth rates or of investment rates from their values implied by the base specifications. We therefore proceed to introduce the ancillary variables into these base growth specifications and examine whether they contain any further explanatory power, with and without allowing for country-specific fixed effects. We also study the robustness of the "primitives" to the inclusion of these ancillary variables. Finally, we examine whether the ancillary variables we consider enter directly into the determination of the rates of investment in physical and human capital, again with and without accounting for country fixed effects.

We concentrate on a small set of ancillary variables which have received a large amount of attention in the literature. In particular, we concentrate on indicators of political instability, income distribution, and financial development. There are a variety of explanations as to why each of these might have an impact on growth rates, which we address in detail below.

We find a strong distinction in the channels though which financial and non-financial variables influence growth. Some variables that we use as proxies for financial development influence growth even after accounting for rates of factor accumulation. We also find that financial development directly enhances investment in both physical and human capital in addition to its effect on growth. In contrast, the contribution of non-financial variables appears to influence only levels of investment in physical capital.

Our results concerning initial financial development and total factor productivity complement King and Levine (1993a), which examines the determinants of direct estimates of total factor productivity growth, measured as real per capita GDP growth minus 0.3 times the growth in the capital-labor ratio. They find that all of their indicators are positively correlated with their measure of subsequent total factor productivity growth. Our specification allows the capital coefficient to be relatively unconstrained, and we use a quite different sample, but by and large we confirm their finding of a positive relationship between measures of financial development and subsequent total factor productivity growth. Moreover, our study demonstrates that these total factor productivity growth results are robust to the inclusion of country fixed effects, which King and Levine did not consider.

Among the non-financial ancillary variables that we consider, we find that political instability has an adverse impact on investment in physical capital with fixed effects excluded. However, this result is not robust to the inclusion of country fixed effects. Similarly, we find that the performance of human capital levels in the growth regressions is not robust to the inclusion of country fixed effects. To the extent that fixed effects are important and significant, and that they eliminate the explanatory power of other variables, they reflect a further measure of our ignorance in the process of identifying the broad universal categories that account for economic growth.

The remainder of this paper is divided into four sections. The following section discusses our "base" growth specifications and examines our results for these specifications with and without fixed effects. Section three introduces the ancillary variables into two growth specifications: a standard neoclassical specification, and another specification providing a role for education to increase total factor productivity, as well as to facilitate technology diffusion and adoption. In the following sections, we refer to the latter as an "endogenous" growth specification. Section four examines the determinants of rates of physical and human capital accumulation. Section five concludes.

2. Base Growth and Investment Regressions

2.1 Specification of Growth Regressions

We consider three alternative specifications for growth accounting. The first type would be associated with the standard Solow (1956) neoclassical growth model with human capital added as a factor of production. Under a neoclassical model, the nominal income of country *i* in period *t*, Y_{it}, will be a function of labor, L_{it}, physical capital, K_{it}, and human capital, H_{it}. Adopting a Cobb-Douglas technology, $Y_{it} = A_{it}L^{\alpha}_{it}K^{\beta}_{it}H^{\gamma}_{it}\varepsilon_{it}$, where ε_{it}, represents in i.i.d. disturbance term, and taking log differences, the specification follows:

(1) $$(\log Y_{it} - \log Y_{it-1}) = (\log A_{it} - \log A_{it-1}) + \alpha(\log L_{it} - \log L_{it-1}) + \beta(\log K_{it} - \log K_{it-1}) + \gamma(\log H_{it} - \log H_{it-1}) + e_{it}$$

where $e_{it} = log\ \varepsilon_{it} - log\ \varepsilon_{it-1}$.

Note that the above specification does not include initial income. The textbook neoclassical model only provides a role for initial income as a determinant of growth rates in relation to its distance from the country's steady state. The greater the distance from the steady state, the greater the predicted growth of per capita income through enhanced rates of capital accumulation. Since our specification already incorporates capital accumulation rates and models the production function directly, there is no additional role for initial income levels.

An alternative role for initial income may be found in a model which allows the possibility of "catch-up," or technology diffusion, across countries. Initial income may play a role in determining the rate at which countries can adopt the technologies of leader countries [Nelson and Phelps (1966)]. In particular, the farther behind is a nation's technology, the greater is the amount it can learn from others. Consequently, we would predict a greater rate of growth of 'A" holding all else equal, and hence a greater overall growth rate.

This is the role of initial income in the growth specifications considered by Benhabib and Spiegel (1994). The specification allows the growth of income to be affected by the level of human capital in a nation, rather than by the growth of human capital. Based on the argument that human capital levels facilitate the adoption of technology from abroad, Benhabib and Spiegel (1994) develop a model in which the growth rate of total factor productivity depends upon both the current level of human capital as well as an interactive term with the disparity of technology levels from the "leader country," i.e. that country which has the maximum level of initial total factor productivity. They adopt the Cobb-Douglas technology, $Y_{it} = A_{it}(H_{it})K^{\alpha}_{it}L^{\beta}_{it}v_{it}$ 0, where $A_{H_{it}} > 0$ and v_{it} 0represents an i.i.d. disturbance term and the following structural specification for the rate of total factor productivity growth

(2) $$(\log A_{it} - \log A_{it-1}) = c + g\log H_{it} + m(\log H_{it})\left[\frac{(y_{maxt} - y_{it})}{y_t}\right] + \phi t + \theta i$$

where y_{maxt} 0 represents the total factor productivity of the “leader nation,” approximated in our sample by output per worker in the country with the greatest level of output per worker, and t and i represent time and country-specific fixed effects.

Benhabib and Spiegel then derive the following specification:

(3) $$(\log Y_{it} - \log Y_{it-1}) = c + (g - m)\log H_{it} + m(\log H_{it})\left[\frac{y_{maxt}}{y_{it}}\right]$$
$$+ \alpha(\log L_{it} - \log L_{it-1}) + \beta(\log K_{it} - \log K_{it-1}) + \phi t + \theta i + u_{it}$$

where $u_{it} = \log v_{it} - \log v_{it-1}$ and t and i represent time and country-specific fixed effects respectively.

The coefficient m is predicted to be positive, reflecting the positive interaction between the amount of technology adoption a country can conduct, which is an increasing function of its degree of relative backwardness, and its capacity to adopt technology, which is an increasing function of its human capital stock. However, the coefficient on $\log H_{it}$ 0 is of ambiguous sign, depending on the relative magnitudes of g, which reflects the importance of human capital as a source of technological innovation [Romer (1990)] and m.

We also entertain a less structural growth specification in which human capital enters in levels to explain technological progress, and where initial income is allowed to enter on its own to reflect the potential for technological "catch-up." This "reduced form" specification follows:

$$(4) \qquad \begin{aligned}(\log Y_{it} - \log Y_{it-1}) &= c + a \log H_{it} + b(\log Y_{it-1}) \\ &+ \alpha(\log L_{it} - \log L_{it-1}) + \beta(\log K_{it} - \log K_{it-1}) + \phi t + \theta i + u_{it}\end{aligned}$$

where $u_{it} = \log v_{it} - \log v_{it-1}$.

Due to unobservable country-characteristics which also influence a nation's rate of technological progress, the above specifications are underspecified. Recently, a number of studies have attempted to capitalize on the information available through the full panel of cross-country data by adjusting for country-specific characteristics which are constant across time through the use of fixed-effects [Knight, et al (1993), Islam (1995), and Caselli, et al (1996)]. In particular, fixed effects associated with technological differences that go beyond the choice of technique based on the availability of human or capital resources, could be accounted for with such fixed effects. Alternatively, the presence of fixed effects may reflect some other country-specific factors that we have not yet properly identified. We therefore examine the performance of the three "base regressions," defined by equations (1), (3), and (4), with and without country-specific fixed effects.[2]

Finally, as in Mankiw, Romer and Weil (1992), we also constrain the factor coefficients to levels consistent with constant returns to scale. In the case of the neoclassical model [equation (1)], this

[2] Note that introducing country fixed effects in this form implies that country-specific characteristics influence the growth of a country's total factor productivity rather than its level.

corresponds to the restriction $\alpha+\beta+\gamma=1$. In the endogenous growth specifications [equations (3) and (4)], this corresponds to the restriction $\alpha+\beta=1$.[3]

We estimate our growth regressions using generalized method of moments to account for the endogeneity of physical capital accumulation. This methodology has been used in a number of panel growth regressions, including Caselli, et al (1996) and Easterly, et al (1996), following techniques advanced by Holtz-Eakin, Newey and Rosen (1988) and Arellano and Bond (1991). Essentially, consistency of our estimators under generalized method of moments requires the assumption that all factors except physical capital accumulation are strictly exogenous, while physical capital is only weakly exogenous. For example, for equation (1) we require $E(K_{it}e_{is}) =0$ for all $s>t$.

Nevertheless, even after accounting for the endogeneity of physical capital accumulation, the assumptions required for our estimation method to be consistent are not innocuous. For example, there are a number of studies which have argued that the ancillary variables, such as political instability, will be dependent on rates of income growth [Londregan and Poole (1990), Alesina and Perotti (1996)]. We therefore test the validity of our instruments by first testing for serial correlation in the residuals, and then conducting the Sargan test of the over-identifying restrictions suggested by Arellano and Bond (1991). The results for these specification tests are included below.

2.2 Data

Details concerning the data set are contained in the data appendix. Data for PPP-adjusted income and labor force participation were obtained from the Summers-Heston Data set, version 5.6. Human

[3] We also ran the growth specifications without constraining the coefficients. The results were qualitatively similar, with the exception that the coefficient estimates on factor accumulation rates were implausibly low (summing to about 2/3 and suggesting decreasing returns to scale) and the impact of initial

capital, which is proxied by average years of schooling in the population above 25 years of age, was obtained from the updated version of the Barro-Lee (1993) data set.

Constant dollar estimates of physical capital stocks were calculated by Dhareshwar and Nehru (1993) in local currencies based upon the assumption of a 4 percent decay rate. However, efforts to convert these estimates into common currency capital stocks yielded implausible results due to deviations from purchasing power parity, particularly during the early 1980's period of U.S. dollar appreciation. We used local currency GDP levels, also calculated by Dhareshwar and Nehru, to construct unit-free capital-output ratios. We then used PPP-adjusted estimates of output levels obtained from the Summers-Heston data set to construct "PPP-adjusted" capital stock estimates.

2.3 Growth Regression Results

The results for the base growth regressions obtained through generalized methods of moments estimation are displayed in Table 1.[4] Models 1, 2 and 3 display the results for the neoclassical growth model [equation (1)], the reduced form endogenous growth model [equation (4)], and the more structural endogenous growth model [equation (3)] respectively, without including fixed effects.[5] Models 4,5, and 6 display the same specifications with country fixed effects included. All of the specifications also include time dummies to account for global shocks over time.

Table 1 also includes the test results for serial correlation and the Sargan test of the overidentifying restrictions. The Sargan tests determine the validity of our set of instruments in the

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financial development on total factor productivity growth was not robust to the inclusion of country fixed effects.

[4] We also ran the reported specification under ordinary least squares, without using instruments. Although endogeneity would lead to biased estimates under OLS, these results were quite similar to the GMM results reported here. They are available upon request.

absence of first-order serial correlation.[6] With fixed effects included (Models 4,5, and 6), we fail to reject the absence of serial correlation, which allows us to use the Sargan test. This test fails to reject the validity of our over-identifying restrictions. However, we cannot reject the presence of serial correlation when fixed effects are omitted (Models 1,2, and 3). While our Sargan statistics fail to reject our over-identifying restrictions for the first three models without fixed effects, the presence of serial correlation invalidates this test. This lends some uncertainty to the validity of our results with fixed effects omitted.

Looking over all of the specifications, it can be seen that the significance of rates of accumulation of physical capital and labor are very robust, both with and without the inclusion of fixed effects. In addition, it appears that the model specification does not have a large influence on the estimates of factor shares across these two variables. However, the presence of fixed effects does influence our coefficient values. Without fixed effects, physical capital accumulation yields a coefficient point estimate around 0.54, while with the inclusion of fixed effects, the coefficient rises to 0.69. Of course, our estimate for the labor share exhibits an opposite decline.

It also appears clear that the neoclassical specifications (Models 1 and 4) do most poorly.[7] Labor growth fails to enter significantly and human capital accumulation enters insignificantly with a negative point estimate. This result on human capital , initially pointed out in Benhabib and Spiegel (1994) and confirmed by others [see for example Islam (1995)], does not indicate that education plays no role in

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5 Estimates of the fixed effect coefficients are available upon request.

6 Since Arellano and Bond (1991) difference the data, the validity of their Sargan test requires the absence of second-order serial correlation. However, we do not difference the data to allow comparisons of specifications with and without fixed effects. For our purposes, the reported first-order serial correlation test is valid.

7 We also ran a specification which nests the two endogenous growth specifications with the neoclassical model by adding *GEDUC*. Growth rates of human capital failed to enter significantly in any of the nested specifications. These results are available upon request.

growth. The endogenous growth specifications above allow levels of human capital accumulation to facilitate technological innovation or the adoption of technology from abroad.

However, our results here suggest that the performance of human capital levels in the growth specifications is dependent upon the inclusion or exclusion of fixed effects. In the reduced growth specifications (Models 2 and 5), human capital enters in levels with a positive, but not significant coefficient when fixed effects are excluded, but a negative and significant coefficient estimate with the inclusion of fixed effects. On the other hand, the "catch-up" term in the structural endogenous growth specification enters with a positive and significant coefficient when we include fixed effects, but is insignificant when we exclude them. In any event, the structural model in equation (3) reveals that the predicted coefficient estimate on human capital levels is ambiguous, depending on the relative importance of technological innovation and catch-up.[8]

3. Ancillary variables

3.1 Motivation

We examine three classes of ancillary variables: political instability, income distribution, and initial financial development. In the case of political instability, Alesina, et al (1996) follow a long literature [for example, see Alesina and Perotti (1996), Barro (1996), and Easterly and Rebelo (1993)] in finding a negative relationship between measures of political instability and growth. Other authors, such as Cukierman, Edwards and Tabellini (1992) have identified the influence of political instability on a more focused policy variable, such as inflation.

[8] One may think that one of the shortcomings of using five year panels in growth regressions, is that initial investments in education may take longer than five years to exhibit an effect on growth rates and productivity. However, note that our specification of human capital uses average accumulated years of schooling in the labor force rather than enrollment rates, and therefore should have an immediate impact.

Most of the arguments concerning the channel through which political instability influences growth stress its impact on factor accumulation rates. For example, Alesina, et al (1996) argue that "Political instability affects growth because it increases policy uncertainty, which has negative effects on productive economic decisions such as investment and saving." An alternative channel is stressed by Murphy, Shleifer, and Vishny (1991) and Grossman (1991) in which political instability leads to enhanced rent-seeking, or even revolutionary, activity.

Another ancillary variable which has been introduced into growth equations is income distribution. Perotti (1996) distinguishes between different channels of causation. The first is "endogenous fiscal policy," which would be associated with Alesina and Rodrik (1994), Perotti (1993,1996), and Person and Tabellini (1994), among others. Under this channel, the distribution of income affects growth through its influence on the level of government expenditure and taxation. Holding all else equal, the greater the disparity of income in a society, the greater will be the amount of redistribution which takes place through the levying of distortionary taxation. An alternative channel is the role of income inequality and poverty as a source of political contention and instability. Under this argument, associated with Veneiris and Gupta (1986), Alesina and Perotti (1996), and Benhabib and Rustichini (1996), income disparities and poverty encourages groups to engage in rent-seeking activities which can both discourage investment and disrupt the allocation of factors.

A third set of ancillary variables introduced into the growth equations are variables that can capture the degree of financial development. A number of authors, including Greenwood and Jovanovic (1991), Bencivenga and Smith (1991), Galor and Zeira (1993), Banerjee and Newman (1991), Benabou (1996), Ljungqvist (1993) and King and Levine (1993b) have stressed the effect of market imperfections and borrowing constraints on investment rates of physical and human capital, especially in poor economies or in economies with skewed income distributions. To test such hypotheses we can use the extent of the development of financial markets as a proxy for market imperfections, and interact them with measures of wealth or income distribution to see if they influence either economic growth rates or investment rates in physical or human capital. Levine and Zervos (1993) have found that financial development is a uniquely robust argument in the determination of income growth.

The studies mentioned above suggest that financial backwardness may hinder the ability of agents to engage in investment in capital. This would be particularly true for, but not limited to, an agent's own human capital, as liquidity constraints can preclude such an agent from investing in his own human capital at optimal levels. As a result, this theory would suggest that an interactive term with GDP per worker and financial development levels would enter negatively as a determinants of the rates of physical and human capital accumulation. We add such an interactive term to our measure of financial development below.

Finally, the liquidity arguments concerning the importance of financial development in factor accumulation would seem to be particularly relevant for economies with skewed income distributions. The more skewed the distribution of income, the larger would be the share of the population which would be unable to acquire financing for profitable investments in either physical or their own human capital. This would argue for the possibility of an interactive term with income distribution and the degree of financial development. To investigate this possibility, we introduce a term representing the interaction of income distribution and financial development.

3.2 Ancillary Variable Data

Data for political instability, referred to as *MJCHANGE* below, was obtained from Alesina et al (1996). Alesina et al identify a subset of the total government changes in the Jodice and Taylor (1983) data set which they consider "major changes" in government. They describe this subset as "... all irregular transfers of power such as coups, along with the subset of regular transfers that imply a substantial change in the party or coalition or parties in office." This data is only available up to 1982, so our regressions below including this variable only encompass the four five-year periods from 1960 through 1980.

Income distribution data was obtained from the Deininger and Squire (1996) data set. Deininger and Squire report income quintiles from a wide variety of sources for a large set of countries.[9] We use the standard measure of income distribution, the Gini coefficient, referred to as *GINI* below, because it is available for a larger set of countries.

The indicators of financial development were obtained from King and Levine [(1993a) and (1993b)]. These include *LLY,* a measure of the ratio of liquid liabilities of the financial sector to GDP,[10] *BANK*, the ratio of deposit money bank assets over total assets which emphasizes the risk-sharing services banks are most likely to provide, and the share of credit funneled through the private sector through *PRIVATE,* the ratio of claims on the non-financial private sector to GDP.[11]

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[9] Deininger and Squire (1996) identify a subset of their income distribution data set as "acceptable," based upon meeting a set of criteria. While we report the results for the full sample, we also ran the tests with the sample restricted to the Deininger and Squire "acceptable" sample. These results are very similar to those reported below and are available upon request.

[10] King and Levine (1993a) use M3 as a proxy for liquid liabilities when available, and M2 when M3 was unavailable. We chose to use M2 throughout, which is available for all countries in the sample.

[11] To check robustness, King and Levine also examine the ratio of claims on the nonfinancial private sector to total domestic credit. We also checked this indicator and obtained similar results.

3.3 Ancillary Variable Results in the Growth Regressions

Because of space limitations and the poor performance of the neoclassical specification in the base growth regressions, we only report the results of including the ancillary variables in the reduced form and structural endogenous growth specifications.[12] We include the ancillary variables one at a time to avoid collinearity, with the exception of the interactive terms which whose specifications also included *LLY* on its own. Table 2 reports the results the ancillary variables included in the growth regressions. We do not report the coefficient estimates for the "base regression" terms for all of these specifications, although these terms were similar to those reported in Table 1 for the various specifications.[13]

The results for the reduced form specification [equation (4)] without the inclusion of fixed effects are reported in Column 1. The two non-financial variables, *MJCHANGE* and *GINI*, are insignificant,[14] as is income distribution interacted with financial development, *GINI*LLY*. However, many of the measures of financial development appear to enter with their predicted signs. In particular, *LLY* and *PRIVATE* enter with significantly positive coefficients, while *BANK* does not. *LLY* interacted with initial *GDP* is also insignificant.

Column 2 reports the results for the reduced form specification with fixed effects included. The performance of the ancillary variables is similar. The two non-financial ancillary variables, *MJCHANGE* and *GINI*, are insignificant. Two of the financial variables, *LLY* and *PRIVATE*, again enter with positive

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[12] The qualitative performance of the ancillary variables in the neoclassical specification were similar.

[13] The results for all of the unreported regressions are available upon request from the authors.

[14] We obtained similar results for the alternative political instability indicator of the presence of a coup, the alternative income distribution indicator "MID."

and significant coefficients. *BANK* again enters with the incorrect sign, this time at a significant level. The interactive terms are again either of the wrong sign or insignificant.[15]

The results for the inclusion of the ancillary variables into the structural specification [equation (3)] without fixed effects are reported in Column 1. The results are very similar. The non-financial ancillary variables, *MJCHANGE* and *GINI*, are insignificant. The financial variables *LLY* and *PRIVATE* are again positive and significant, while *BANK* fails to enter. The interactive terms again fail to enter significantly. The results are almost identical with fixed effects included (Column 4).

In summary, the ancillary variables themselves tend to be insignificant as predictors of growth once we account for factor accumulation levels, with the exception of two measures of financial development: *LLY* always enters significantly, and *PRIVATE* consistently enters when fixed effects are excluded, but is robust to the inclusion of fixed effects only in the reduced form specification. We also observe that the interactive terms, whose inclusion would naturally follow from the theoretical considerations, perform quite poorly.

4. Determinants of Physical and Human Capital Accumulation

In this section, we examine the performance of our ancillary variables as determinants of investment. We first examine the base specification for investment levels. If we focus on either infinitely-lived representative agent models or overlapping generations models, standard and usual assumptions imply that investment levels increase with wealth, but additional assumptions and

[15] With the inclusion of fixed effects the point estimates for the factor shares of physical capital and labor are very sensitive to our specification. The labor share varies from 0.891 to 0.065 depending on the ancillary variable included in the specification. The performance of human capital in levels, *LEDUC* is also mixed, with the coefficient entering significantly at a ten percent confidence level in about half of the specifications considered.

simplifications are needed to pin down the behavior of the rates of investment with respect to wealth. In a partial equilibrium framework, saving and investment will depend on wealth and future rates of return of assets, but in a general equilibrium context rates of return are endogenous: they depend on factor stocks and labor. The savings rates may depend positively or negatively on future returns, depending on the magnitude of inter-temporal elasticity of substitution in consumption, which determines impact of the wealth and substitution effects. However, with logarithmic preferences income and substitution effects wash out and it is easy to show that investment becomes a simple fraction of income, both under the OLG and the infinitely lived representative agent specifications. For simplicity, we first adopt such a base specification, and then check whether ancillary variables have any explanatory power for the remaining variance.

We should note that our investment specifications would not be undermined by the existence of multiple steady states in the underlying economy. For example, capital market imperfections and financial constraints could be more binding in poor and unequal economies, and generate an investment and growth trap. Nevertheless an investment function with arguments including income or wealth, together with proxies for financial market imperfections, possibly with interaction terms, would perfectly well defined, and could be estimated. In many models of this type, for example in the model of Galor and Zeira (1993), there are such multiple steady states, but investment is nevertheless uniquely defined at each point in time.[16]

The simplest specification is for investment is

[16] The situation would be different if the underlying economy exhibited indeterminacy, or the existence of a continuum of equilibrium paths. In such situations, initial conditions for state variables like wealth, coupled with ancillary variables, do not uniquely determine investment [Benhabib and Gali, (1995)]. Countries similar in fundamentals can coordinate on different investment rates that give rise to different equilibria. The introduction of fixed effects would capture not country specific characteristics

(5) $$I_{it} = sGDP_{it} - b + \phi t + \theta i + \varepsilon_{it}$$

where *b* is a constant. The *b* term captures the possibility of non-homogeneity in I_{it}/GDP_{it}, due to the poor choosing to dissave at low incomes.

The OLS results for such a specification for physical capital accumulation without the inclusion of fixed effects are displayed in Table 3. The results are very supportive of a positive role for the ancillary variables in the determination of rates of physical capital accumulation. *GDP* enters positively and significantly with a plausible point estimate of approximately 0.21. *MJCHANGE* and the financial variables all enter significantly with their respective predicted signs, including the interactive term *LGDPL*LLY*. However, *GINI* is insignificant, both on its own and interacted with financial development. With the exception of the income distribution variable, then it would appear from these results without fixed effects that the channel through which the ancillary variables affect income growth is through their impact on rates of physical capital accumulation.

The physical capital accumulation results with country fixed effects included, however, which are reported in Table 4, are very different. While *GDP* is still positive and significant, with a point estimate still around 0.21, the performances of the ancillary variables are not as robust. With the exception of the financial development proxy, *LLY,* the ancillary variables fail to enter significantly with their predicted signs after accounting for country fixed effects.

We next turn to investment in human capital. We interpret the investment in human capital as the change in man-years of schooling. Our human capital analog to the physical capital specification in equation (5) then satisfies:

(6) $$IEDUC_{it} = kGDP_{it} - c + \phi t + \theta t + \sigma_{it}$$

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for preferences and technology, but the factors determining the selection of equilibria and investment where *c* is again a constant which here captures the possibility of non-homogeneity in $IEDUC_{it}/GDP_{it}$, due to the poor choosing to reduce investment in human capital at low incomes.

Due to unit problems (the stock of investment in human capital is measured here as person-years of schooling), we do not expect to obtain a coefficient estimate for *k* analogous to a savings rate. However, we still expect a positive coefficient on GDP associated with a positive relationship between income and investment in human capital.

The results for the equation (6) specification with country fixed effects excluded are reported in Table 5. GDP enters significantly with its expected positive sign. The ancillary variables as a group, however, do not perform as well as they did in the determination of physical capital accumulation in the absence of country fixed effects. The non-financial variables, *MJCHANGE* and *GINI* are insignificant, as is GINI interacted with the financial development variable *LLY.* On their own, the indicators of financial development also do poorly. *LLY* and *PRIVATE* are insignificant, while *BANKS* enters insignificantly with the incorrect negative sign.

However, the interactive term LLY*GDP enters significantly positive with its predicted negative sign. In addition, in the presence of this interactive variable LLY also enters significantly with its predicted positive sign. The superior performance of the interactive financial term in the human capital investment specification is intuitive, as the stories above concerning liquidity problems precluding otherwise profitable investments would seem to be particularly appropriate for human capital investments.

Our results for the specification in equation (6) with fixed effects included are reported in Table 6. In this case, the introduction of fixed effects has qualitatively small effects. Gross domestic product again enters positive and significant, as would be expected. Among the ancillary variables, the only one which enters is again the interactive financial specification *LLY*GDP*, which is now significant at a ten percent

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rates.

confidence level. The financial development proxy *LLY* is also significant in this specification at a ten percent level.

5. Interpretations and Conclusion

Our results indicate a disparity between the roles played by financial and non-financial variables in the determination of income growth. Financial development appears to positively influence both levels of investment and total factor productivity growth. Two of the financial variables, the liquidity indicator and the ratio of financial assets of the private sector to GDP, enter into both the rate of income growth after accounting for rates of factor accumulation and the level of investment in physical capital. The other measure, the share of assets intermediated by the commercial banking system, either fails to enter or enters with the incorrect sign in the growth regressions, but enters positively as a determinant of levels of investment in physical capital with fixed effects excluded.

Financial development interacted with initial income levels either fails to enter or enters with the incorrect sign in the growth regressions after accounting for factor accumulation rates. However, this variable enters significantly with its predicted sign in the determination of levels of investment in both physical and human capital. With the inclusion of this variable, the level of liquidity measure also enters significantly as a determinant of investment in human capital.

In contrast, none of the non-financial ancillary variables enter significantly as determinants of income growth after accounting for disparities in rates of factor accumulation. Political instability however has a significant negative impact on investment in physical capital with fixed effects excluded. With fixed effects excluded, however, none of the non-financial ancillary variables has a measurable impact on investment in human capital.

Our results suggest that while financial development positively affects total factor productivity growth, and to some extent investment in human capital, the effect of the remaining ancillary variables is limited. At best, the non-financial ancillary variables that we considered have an impact on rates of investment in physical capital.

We also observe a distinction in the robustness of financial and non-financial variables to the introduction of country fixed effects. The positive results for levels of liquidity on total factor productivity growth and levels of investment in physical capital, as well as the positive results for liquidity in the interactive specification in the determination of investment in human capital, were robust to the inclusion of country fixed effects. However, the impact of the remaining ancillary variables on investment in physical capital accumulation rates were not. The lack of robustness for these other ancillary variables sheds doubt on much of the piecemeal results which have been reported concerning them in the growth literature.

Data Appendix

$GGDP_t$: Average of annual growth rate of GDP from time t+1 to t+5. GDP defined as RGDPW*POP. Source: PWT5.6

$GLAB_t$: Average of annual growth rate of the labor force from time t+1 to t+5.Labor force defined as RGDPW/RGDPCH*POP. Source: PWT5.6

$GCAP_t$: Average of annual growth rates of physical capital stock from time t+1 to t+5.Source: Nehru

$GEDUC_t$: Five year growth rate from t to t+5 of average years of schooling for adults over 25 years of age. Source: Barro-Lee

$LEDUC_t$: Log level of average years of schooling for adults over 25 years of age at time t. Source: Barro-Lee

$LGDPL_t$: Log of GDP per worker (RGDPW). Source: PWT5.6

$LLAB_t$: Log of labor force at time t. Source: PWT5.6

$LCAP_t$: Log of physical capital stock at time t. Source: Nehru

$LEDUC_t$: Log level of average years of schooling for adults over 25 years of age at time t. Source: Barro-Lee

$MJCHANGE_t$: Dummy variable that takes a value of 1 if a coup or major regular government transfer takes place between years t-4 to t, 0 otherwise. Source: Alesina, .et al.

$GINI_t$: 'Best' Gini coefficient from time t-4 to t. Source: Deininger and Squire
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The following criteria order was used to identify the best available income distribution measure among those available in the Deininger Squire data set: 1. Quality (accept, cs, ps, nn); 2. Timeliness (closest to time t); 3. Most recent study; 4. National over rural/urban; 5. Household over person

LLY_t: Average from time t-4 to t of M2/GDP. Source: IFS. lines 34+35/line99b

$BANK_t$: Average from time t-4 to t of deposit money bank domestic assets divided by deposit money bank domestic assets plus central bank domestic assets. Source: IFS. lines 12a-f/(lines12a-f + lines22a-f)

$PRIVATE_t$: Average from time t-4 to t of credit issued to private enterprises divided by GDP. Source: IFS. line 32d/line 99b.

Note: Financial Data for Taiwan is from Financial Statistics Monthly, Taiwan District.

Table 1
Base Growth Regressions[17]

Dependent Variable: GGDP

	Without Fixed Effects			Fixed Effects Included		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.0053** (0.0026)	0.0085 (0.0185)	-0.0030 (0.0073)	0.0092 (0.0088)	0.5281** (0.1112)	0.0651** (0.0262)
GLAB	0.4417** (0.0623)	0.4713** (0.0611)	0.4713** (0.0611)	0.2583 (0.1878)	0.3252** (0.1081)	0.3252** (0.1081)
GCAP	0.5630** (0.0623)	0.5287** (0.0611)	0.5287** (0.0611)	0.7441** (0.1893)	0.6748** (0.1081)	0.6748** (0.1081)
GEDUC	-0.0046 (0.0066)			-0.0024 (0.0152)		
LEDUC		0.0042 (0.0029)	0.0031** (0.0015)		-0.0224** (0.0102)	-0.0666** (0.0152)
LGDPL		-0.0011 (0.0024)			-0.0442** (0.0100)	
LHYMAXY			0.0011 (0.0024)			0.0442** (0.0100)
Durbin-Watson	1.5441	1.5859	1.5859	1.8156	1.7345	1.7345
Sargan	1.2206	0.9293	0.8523	1.7538	0.8222	0.6779
# Observations	397	397	397	397	397	397
Degrees of Freedom	390	389	389	309	308	308

[17] Estimated by generalized method of moments with GGDP and GCAP lagged one period used as instruments. All specifications include time dummies. Models 4, 5, and 6 also include country dummies. Dummy coefficient estimates are available upon request. ** indicates statistical significance at the five percent confidence level while * indicates statistical significance at the ten percent confidence level.

Table 2[18]
Ancillary Variables in Growth Regressions

	"Reduced Form" (Equation)		Structural Specification (Equation)	
	With Fixed Effects	Without Fixed Effects	With Fixed Effects	Without Fixed Effects
MJCHANGE	0.0005	0.0033	0.0005	0.0033
	(0.0043)	(0.0033)	(0.0043)	(0.0032)
GINI	-0.0002	-0.0002	-0.0002	-0.0002
	(0.0003)	(0.0002)	(0.0003)	(0.0002)
LLY	0.0384*	0.0206**	0.1085**	0.0219**
	(0.0226)	(0.0060)	(0.0360)	(0.0062)
BANK	-0.0506**	-0.0003	-0.1748**	-0.0037
	(0.0203)	(0.0091)	(0.0574)	(0.0093)
PRIVATE	0.0430**	0.0133**	0.0170	0.0165**
	(0.0213)	(0.0066)	(0.0362)	(0.0069)
LGDPL*LLY	0.0421**	-0.0055	0.0421**	-0.0055
	(0.0167)	(0.0079)	(0.0167)	(0.0079)
GINI*LLY	-0.0005	-0.0005	-0.0005	-0.0005
	(0.0010)	(0.0005)	(0.0010)	(0.0005)

[18] Estimated by generalized method of moments with GGDP and GCAP lagged one period used as instruments. All specifications include time dummies. Dummy coefficient estimates are available upon request. ** indicates statistical significance at the five percent confidence level while * indicates statistical significance at the ten percent confidence level.

Table 3
Physical Capital Accumulation: Closed Economy Model[19]

Dependent variable: I

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	$4.08x10^9$**	$4.91x10^9$**	$8.79x10^9$	$6.49x10^7$	$-2.70x10^9$	$-3.07x10^9$	$-1.55x10^9$	$-4.29x10^9$
	$(1.70x10^9)$	$(1.34x10^9)$	$(6.69x10^9)$	$(2.34x10^9)$	$(3.10x10^9)$	$(2.20x10^9)$	$(2.46x10^9)$	$(4.64x10^9)$
GDP	0.2180**	0.2202**	0.2158**	0.2151**	0.2131**	0.2128**	0.2163**	0.2118**
	(0.0020)	(0.0022)	(0.0029)	(0.0021)	(0.0020)	(0.0021)	(0.0022)	(0.0030)
MJCHANGE		$-3.08x10^9$**						
		$(1.23x10^9)$						
GINI			$-4.28x10^7$					
			$(1.49x10^8)$					
LLY				$1.06x10^{10}$**			$6.48x10^{10}$**	$1.66x10^{10}$
				$(3.39x10^9)$			$(2.64x10^{10})$	$(1.70x10^{10})$
BANK					$9.95x10^9$**			
					$(3.83x10^9)$			
PRIVATE						$2.30x10^{10}$**		
						$(3.97x10^9)$		
LGDPL*LLY							$-5.48x10^9$**	
							$(2.65x10^9)$	
GINI*LLY								$2.96x10^8$
								$(4.80x10^8)$
# Obs.	542	357	274	450	439	451	450	249
DF	535	351	266	442	431	443	441	240

[19] Estimated by OLS. All specifications include time dummies. Dummy coefficient estimates are available upon request. ** indicates statistical significance at the five percent confidence level while * indicates statistical significance at the ten percent level.

Table 4
Physical Capital Accumulation: Closed Economy Model[20]

Dependent Variable: INVST

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	-7.20×10^{10}**	-5.25×10^{10}**	-2.55×10^{10}	-2.58×10^{10}*	-1.68×10^{10}	-1.51×10^{10}	-2.65×10^{10}*	-0.19×10^{10}
	(1.40×10^{10})	(1.34×10^{10})	(1.99×10^{10})	(1.37×10^{10})	(1.36×10^{10})	(1.32×10^{10})	(1.36×10^{10})	(2.30×10^{10})
GDP	0.2286**	0.2315**	0.2098**	0.2099**	0.2085**	0.0283**	0.2082**	0.2062**
	(0.0046)	(0.0053)	(0.0062)	(0.0042)	(0.0043)	(0.0043)	(0.0043)	(0.0065)
MJCHANGE		-1.00×10^{9}						
		(7.58×10^{8})						
GINI			2.75×10^{8}					
			(1.91×10^{8})					
LLY				1.03×10^{10}*			-6.62×10^{10}*	-4.28×10^{9}
				(6.06×10^{9})			(3.44×10^{10})	(2.53×10^{10})
BANK					3.26×10^{9}			
					(4.76×10^{9})			
PRIVATE						1.86×10^{9}		
						(6.34×10^{9})		
LGDPL*LLY							8.22×10^{9}**	
							(3.64×10^{9})	
GINI*LLY								7.56×10^{8}
								(5.49×10^{8})
# Obs.	542	357	274	450	439	451	450	249
DF	444	262	189	355	347	358	354	165

[20] Estimated by OLS. All specifications include time and country dummies. Dummy coefficient estimates are available upon request. ** indicates statistical significance at the five percent confidence level while * indicates statistical significance at the ten percent confidence level.

Table 5

Human Capital Accumulation: Closed Economy Model

Dependent variable: ΔLAB*EDUC

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	-1.79x10^{7}	5.83x10^{7}*	-9.16x10^{6}	4.05x10^{7}	4.40x10^{7}	4.43x10^{7}	4.42x10^{7}	4.05x10^{7}
	(3.62x10^{7})	(3.36x10^{7})	(5.74x10^{7})	(3.09x10^{7})	(3.01x10^{7})	(2.98x10^{7})	(3.09x10^{7})	(4.93x10^{7})
GDP	5.44x10^{-5}**	2.25x10^{-5}*	5.33x10^{-5}**	3.44x10^{-5}**	3.29x10^{-5}**	3.36x10^{-5}**	3.62x10^{-5}**	3.19x10^{-5}**
	(1.13x10^{-5})	(1.26x10^{-5})	(1.74x10^{-5})	(9.21x10^{-6})	(9.28 x10^{-6})	(9.13 x10^{-6})	(9.24 x10^{-6})	(1.37x10^{-5})
MJCHANGE		-1.25x10^{6}						
		(1.46x10^{6})						
GINI			-1.28x10^{5}					
			(4.85x10^{5})					
LLY				2.78x10^{6}			1.15x10^{8}*	3.13x10^{7}
				(1.14x10^{7})			(6.55x10^{7})	(4.86x10^{7})
BANK					3.57x10^{6}			
					(9.24x10^{6})			
PRIVATE						8.94x10^{5}		
						(1.19x10^{7})		
LGDPL*LLY							-1.22x10^{7}*	
							(6.98x10^{6})	
GINI*LLY								-5.31x10^{5}
								(1.02x10^{6})
#Obs.	400	235	223	360	355	361	360	209
DF	312	151	150	274	271	276	273	136

Table 6
Human Capital Accumulation: Closed Economy Model[21]

Dependent Variable: ΔLAB*EDUC

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	$4.55x10^{6}$	$2.06x10^{6}$	$2.11x10^{7}$	$9.72x10^{6}$**	$8.88x10^{6}$**	$8.79x10^{6}$**	$1.36x10^{6}$	$2.18x10^{7}$**
	($3.38x10^{6}$)	($1.55x10^{6}$)	($1.36x10^{7}$)	($4.61x10^{6}$)	($4.10x10^{6}$)	($4.43x10^{6}$)	($4.60x10^{6}$)	($9.07x10^{6}$)
GDP	$5.99x10^{-5}$**	$4.52x10^{-5}$**	$5.77x10^{-5}$**	$5.94x10^{-5}$**	$5.01x10^{-5}$**	$5.98x10^{-5}$**	$6.62x10^{-5}$**	$5.93x10^{-5}$**
	($3.90x10^{-6}$)	($2.48x10^{-6}$)	($5.55x10^{-6}$)	($4.09x10^{-6}$)	($2.56x10^{-6}$)	($4.23x10^{-6}$)	($4.05x10^{-6}$)	($5.76x10^{-6}$)
MJCHANGE		$-7.81x10^{5}$						
		($1.62x10^{6}$)						
GINI			$-3.43x10^{5}$					
			($3.03x10^{5}$)					
LLY				$-1.07x10^{7}$			$3.04x10^{8}$**	$9.33x10^{6}$
				($6.79x10^{6}$)			($5.23x10^{7}$)	($3.37x10^{7}$)
BANK					$-1.15x10^{7}$**			
					($5.11x10^{6}$)			
PRIVATE						$-1.13x10^{7}$		
						($8.14x10^{6}$)		
LGDPL*LLY							$-3.21x10^{7}$**	
							($5.28x10^{6}$)	
GINI*LLY								$-1.08x10^{6}$
								($9.42x10^{5}$)
# Obs.	400	235	223	360	355	361	360	209
DF	394	230	216	353	348	354	352	201

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[21] Estimated by OLS. All specification include time dummies. Dummy coefficient estimates are available upon request. ** indicates statistical significance at the five percent confidence level while * indicates statistical significance at the ten percent level.

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