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Inflation, Financial Development and Endogenous Growth

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November 2004

Working Paper 24/04

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November 16, 2004

Abstract

The paper extends the literature on financial development, inflation, and growth by using the idea that both the rates of return on physical and human capital affect growth. This leads to the introduction of the investment rate into the model, as a proxy for the return to physical capital, along with the inflation rate as a variable affecting the return to human capital. As a result financial development plays a different role from the typical growth-enhancing effect found pervasively in the literature. Instead the results suggest a new hypothesis linking financial development to the nature of the effect of inflation on growth.

JEL: C23, E44, O16, O42

Keywords: investment rate, return on capital, panel data, fixed effects

*We would like to thank Toni Braun, Michal Kejak, Szilard Benk, Krisztina Molnar, Laszlo Matyas. Financial support from a Monash University Faculty Research Grant (Business and Economics 2004) no. B02002/1752095 is kindly acknowledged; and the first author also thanks Central European University for additional grant support.

1. Introduction

Rousseau and Wachtel (2001) observe that while much research focuses on the three separate strands of financial development and economic growth, inflation and economic growth, and inflation and financial development, less understood is how inflation and financial development jointly affect economic growth. Inflation has been found typically to have a negative effect on growth, at least for an inflation rate above a threshold level (see for example Ghosh and Phillips 1998, Khan and Senhadji 2001, Gillman, Harris, and Matyas 2004). Financial development has been found to increase economic growth, as in the seminal paper of King and Levine (1993). Levine (1997) reviews such financial development evidence, and Levine, Loayza, and Beck (2000) extend these results with robustness across further measures of financial development.

Levine, Loayza, and Beck (2000) present a large model with various conditioning variables. They find a robustly positive effect of financial development on growth, but also find both a positive and negative effect of inflation on growth, depending on which financial development variable is used. Rousseau and Wachtel (2001) use a parsimonious model, present the regression results of a large panel data set, and focus on the effects of the inflation rate and of financial development on growth. They discuss how Andres and Lopez-Salido (1999) use a smaller panel data set and find that the effect of financial development is weak while there is a robustly negative effect of inflation. Here it is noted that Khan and Senhadji (2000) also find insignificance for some of their financial development variables in a panel study as based on a Mankiw, Romer, and Weil (1992) framework that excludes the inflation rate.¹ However Rousseau and Wachtel (2001) find that their financial development variables significantly affect growth in a positive, robust, fashion, thereby re-establishing the result of the traditional literature. Their inflation effect is negative and significant, to a lesser degree than the financial de-

¹Their more standard variable, of domestic private credit as a share of GDP, showed significance however.

velopment variable.

As an extension to the literature, the study here re-postulates the inflation and financial development variables within the framework of endogenous growth models. As in Gillman, Harris, and Matyas (2004), the approach is to view the growth rate as depending primarily on the rate of return to capital, partly as in a standard Euler equation. Further, along the balanced-growth path equilibrium the return to physical capital and to human capital is equal, and so the growth model should focus on both of these returns.

The paper presents an econometric model that starts broadly as in Levine, Loayza, and Beck (2000), and ends with a model almost as parsimonious as in Rousseau and Wachtel (2001). As in Levine, Loayza, and Beck (2000), the paper includes the dynamic panel estimation as part of the investigation. Very robust results are found for both financial development and inflation effects, but not as in the traditional literature. Instead the results suggest a new hypothesis contrary to conventional wisdom to some degree but still apparently plausible.

1.1. Variables in the Model Specification

The return on physical capital that would ideally enter the model is the real rate of interest. However including this directly is problematic in terms of data. Using the nominal interest rate and subtracting the ex post inflation rate often leads to negative real interest rate computations during periods of accelerating inflation. An alternative is to proxy this real return by a variable that depends positively on it. Gillman, Harris, and Matyas (2004) show that the savings rate within a representative agent endogenous growth monetary economy depends positively on the real interest rate to real wage rate ratio, the input price ratio; and with a representative agent economy the savings rate equals the investment rate, which is readily available in data. Therefore as well as factors affecting the return to human capital, the model of this paper includes the investment rate, as do Kormendi and Meguire (1985) in the older Solow-Tobin growth literature that studied the effect of inflation on growth, and as do Ghosh and Phillips (1998) more recently.

Including the investment rate as a proxy of the return on physical capital, the paper also uses a representative agent strategy for considering the return on human capital. In the endogenous growth monetary models of Gomme (1993) and Gillman and Kejak (2005), the return on human capital is significantly decreased by inflation rate increases. This decreased human capital return pushes down the return to all capital and hence the growth rate. This happens because inflation induces substitution from exchange goods to leisure; the increased leisure usage causes a lesser utilization rate of human capital; the return to human capital and the growth rate falls. This occurs to the extent that calibrations find a magnitude of the negative inflation-growth effect consistent with empirical evidence. Therefore the paper includes the inflation rate as a major factor that affects the return to human capital. Theoretically the negative inflation-growth effect is nonlinear, being monotonically stronger at lower levels of the inflation rate. This has been identified empirically, as in Ghosh and Phillips (1998), Khan and Senhadji (2001) and Gillman, Harris, and Matyas (2004), and theoretically as in Gillman and Kejak (2005). It is allowed for in the model here by entering the inflation rate in log-form.

Two other factors considered as significant are those affecting the return on physical and human capital along the transitional dynamic paths. For this the initial human capital level and the initial level of income are considered; however only the initial level of income is robustly significant and so constitutes a third major variable of the base model. To this parsimonious base the level of financial development is added as a factor that may increase the return to either physical or human capital. This addition is also based on a representative agent endogenous growth economy such as in Gillman and Kejak (2005), in which a credit sector is explicitly modeled and the credit technology parameters can affect the growth rate. Other standard factors are also considered by using the various conditioning sets of Levine, Loayza, and Beck (2000). Some of these other variables are significant in certain specifications, as the results section describes.

2. The Econometric Model

The econometric model is an extension of the framework in Levine, Loayza, and Beck (2000). In its static form their model is specified as

$$g_{it} = \alpha_i + \lambda_t + \beta_k F_{it}^k + [CONDITIONING SET]_{it}' \gamma + \varepsilon_{it}, \quad (2.1)$$

where g_{it} is the real per capita annual rate of growth of GDP of country i in period t ; α_i is an *unobservable effect* (also known as an *individual effect*) for country i ; λ_t is an *unobservable effect* for time period t ; and F_{it}^k is the level of financial intermediary development. Financial development is proxied by $k = 3$ variables: the log of the level of liquid liabilities to GDP, denoted by *lly*; the log of the level of private assets to GDP, denoted by *private*; and the ratio of commercial assets to total banking assets (results not reported). These have unknown weights β_k . The $CONDITIONING SET_{it}$ is a vector of controls generally associated with economic growth, with unknown weights, γ . Finally there is a disturbance term ε_{it} .

Levine, Loayza, and Beck (2000) consider three *CONDITIONING SETS*:

1. A Simple Conditioning Information Set, consisting of the logarithm of initial per capita GDP and the initial level of educational attainment;
2. a Policy Conditioning Information Set, consisting of the Simple Conditioning Set plus measures of government size, inflation, the black market exchange premium and openness to international trade; and
3. a Full Conditioning Information Set, consisting of the Policy Conditioning Information Set plus measures of political stability.

As with Levine, Loayza, and Beck (2000) the focus here is on the first two of these. However, as in Gillman, Harris, and Matyas (2004), the investment to output ratio and the inflation rate are included in the simple conditioning set. Further, an interaction term is hypothesized between inflation and financial development.

2.1. Financial Intermediation and Inflation Effects on Growth

The model proposes that the financial intermediary effect, β_k , is a function of the inflation rate effect. A simple way to allow for such an effect is to write β_k as

$$\beta_k = \phi + \xi \dot{p}_{it}, \quad (2.2)$$

where ϕ and ξ are parameters. With this effect, and for presentation purposes taking the inflation term out of the conditioning set, equation (2.1) becomes

$$\begin{aligned} g_{it} &= \alpha_i + \lambda_t + \beta_k F_{it}^k + \gamma_p \dot{p}_{it} + [\text{CONDITIONING SET}^*]_{it}' \boldsymbol{\gamma}^* + \varepsilon_{it}; \quad (2.3) \\ &= \alpha_i + \lambda_t + (\phi + \xi \dot{p}_{it}) F_{it}^k + \gamma_p \dot{p}_{it} + [\text{CONDITIONING SET}^*]_{it}' \boldsymbol{\gamma}^* + \varepsilon_{it}; \\ &= \alpha_i + \lambda_t + \phi F_{it}^k + \xi \dot{p}_{it} F_{it}^k + \gamma_p \dot{p}_{it} + [\text{CONDITIONING SET}^*]_{it}' \boldsymbol{\gamma}^* + \varepsilon_{it}. \end{aligned}$$

The specification includes the financial development and inflation variables both individually and in product, as an *interaction* term, along with the remainder of the conditioning set.

2.2. Unobserved Heterogeneity

Following Levine, Loayza, and Beck (2000) and Rousseau and Wachtel (2001), we take a panel data approach that follows the large cross-country growth literature by considering blocks of five-yearly averages as our observational unit. In this way the model accounts for both unobserved country and time effects with a reduced influence from short run variations. Unobserved country heterogeneity, captured by the α_i in equation (2.3), can arise for example from differing domestic and foreign trade policies that are not reflected in those observed variables identified in equation (2.3). Country invariant *time effects*, captured by the λ_t of equation (2.3), are designed to pick up effects for example from business cycle variations.

Equation (2.3) is generally known as a two-factor model. The issue of how to treat the unobserved effects α_i and λ_t in the estimation procedure, is generally one of the likely extent of correlation between the α_i and the included explanatory

variables, and between the λ_t and the included explanatory variables. In all of the subsequent estimations the Hausman specification test indicates the existence of such correlation. This implies that both a simple OLS, as in traditional growth literature, as well as a panel approach that conditions on unobserved heterogeneity but ignores such correlation, is likely to yield biased parameter estimates.

With the existence of the correlation either a two-way *fixed effects* or a *random effects* specification can be consistent. In the fixed effects approach, the effects can be treated as constants so as to remove any potential correlations. This requires including one set of dummy variables for each country and another set for each year.

2.3. Simultaneity Bias and Robustness Checks

The possibility of an endogeneity bias arising from simultaneity among growth, inflation, and financial development is investigated, following for example Ghosh and Phillips (1998), Levine, Loayza, and Beck (2000), Rousseau and Wachtel (2001), and Gillman, Harris, and Matyas (2004). Using panel data methods and experimenting with instruments from Levine, Loayza, and Beck (2000), primarily national legal origin, little evidence of endogeneity is found for the level of financial development.²

For the possible endogeneity of inflation, in contrast to most previous studies, current and lagged values of the money supply are tested as instruments. The money supply is chosen because standard monetary general equilibrium models assume that the money supply growth rate is exogenous and is what “causes” the inflation rate along the balanced-growth path in such models (see for example Lucas 1980, Gillman and Kejak 2005). Crowder (1998) provides evidence of Granger causality from money to inflation for the US; and Gillman and Nakov (2004) provide similar evidence for two transition countries. With this money supply instrument, the results are consistent across different specifications. How-

²The time-invariant instruments that are used predominantly in Levine, Loayza, and Beck (2000) cannot be used within a fixed effects framework.

ever, experimenting with different instruments found that the results are sensitive to the instrument across the different specifications. This can result when the instrument is either not strictly exogenous itself and/or is unrelated to the inflation rate.

The results suggest on the whole that, as with the level of financial development, the null-hypothesis could not be rejected that the inflation rate as entered into equation (2.3) is exogenous. The reported results reflect this by treating these variables as exogenous. But while not finding significant endogeneity of financial development and inflation, the Hausman specification tests nonetheless suggest the existence of correlation between the observed and unobserved effects. After proceeding with a fixed effects approach initially in Sections 4.1 and 4.2, an attempt to account for the correlation within the random effects framework is reported in Section 4.3.1.

The other important robustness check is to investigate model stability through estimation of a dynamic panel in Section 4.3.2. Given the literature suggesting a significant amount of persistence in growth rates, for example Lee, Longmire, Mátyás, and Harris (1998), we follow Levine, Loayza, and Beck (2000) by augmenting the conditioning set variables with the previous year's growth rate.

3. The Data

The data primarily comes from the set in Levine, Loayza, and Beck (2000), for which they cite the sources.³ The original sample consists of 74 countries over the period 1961-1995. Supplementing this data with the investment to output ratio (*EconData*) and the money supply (*IFS*) from Gillman, Harris, and Matyas (2004) results in omitting many countries from the sample mainly because of a lack of investment data. This reduces the sample to 27 countries with full information on all required variables for at least two periods. These countries are Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Greece, Ireland,

³We are very grateful to those authors for kindly supplying their data.

Italy, Japan, the Republic of Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Portugal, Spain, Sweden, Switzerland, Thailand, the United Kingdom, and the United States.⁴

Following Levine, Loayza, and Beck (2000) five-yearly, non-overlapping, data averages are used unless otherwise noted, such that are six observations per country. The variables are defined as in Levine, Loayza, and Beck (2000) and denoted, with the i and t subscripts omitted, as

- g : real per capita growth in GDP.
- \dot{p} : $\ln(1 + \dot{p})$, where \dot{p} is the domestic rate of inflation;
- I : I/GDP , the ratio of gross domestic investment to GDP;
- y_0 : $\ln(y_0)$, where y_0 is real per capita GDP, initial period;
- gov : $\ln(gov)$, where gov is the share of government expenditure in GDP;
- $trade$: $\ln(trade)$, where $trade$ is the share of total international trade in GDP;
- bmp : $\ln(1 + bmp)$, where bmp is a black market premium;
- $private$: $\ln(private)$, where $private$ is the ratio of the value of credits by financial intermediaries to the private sector to GDP - Levine, Loayza, and Beck's (2000) *PRIVATE CREDIT*;
- lly : $\ln(lly)$, where lly is the ratio of liquid liabilities of the financial system to GDP - Levine, Loayza, and Beck's (2000) *LIQUID LIABILITIES*;
- $pprivate$: $\ln(pprivate)$, where $pprivate$ is the product of \dot{p} and $private$ (interaction term);

⁴Note that for the inflation rate data, 4 data points of the 186 are above 50%, three for Peru and one for Mexico, and there are no negative rates of inflation.

- $plly$: $\ln(plly)$, where $plly$ is the product of \dot{p} and lly (alternative interaction term).

Note that only “liquid liabilities” and “private credit” enter as the financial intermediary controls, representing two of the three variables in Levine, Loayza, and Beck (2000). The third one, the *COMMERCIAL – CENTRAL BANK* proxy, is found to be insignificant in the specifications. Also, the only elements of the conditioning sets retained are those indicated as significant by Wald tests.

4. Results

The results presented in Table 4.1 represent a selection of the specifications, following experiments with different configurations of all of the potential conditioning sets combined with all the various proxies of financial development. Note that education level proxies were not found to be robustly significant.

4.1. Model Specification: Explanatory Variables

In terms of the conditioning set variables, those considered in our Simple Conditioning Set (inflation, the investment rate and initial GDP) are all strongly significant in each of the different model specifications, suggesting that studies which exclude one or more of these variables could potentially yield misspecified inference. Moreover, the magnitudes of these coefficients appear to remain stable across specifications. Additional variables included in Levine, Loayza, and Beck’s (2000) Policy Conditioning Set were generally insignificant apart from the specifications presented in Table 4.1.

The most striking result is that the level of financial development is consistently statistically insignificant. This suggests that $\phi = 0$ in equation (2.3). Other results include a consistent, positive, significant effect of the investment rate, a consistent, negative, significant effect of the inflation rate, and for the *pprivate* and *plly* variables a negative, significant, effect of the interaction term.

Table 4.1: Growth Regression Results

	Model 1	Model 2	Model 3	Model 4
Constant	0.425 (0.05)**	0.458 (0.06)**	0.388 (0.06)**	0.446 (0.06)**
\dot{p}	-0.250 (0.05)**	-0.187 (0.04)**	-0.189 (0.04)**	-0.206 (0.04)**
I	0.003 (0.00)**	0.002 (0.00)**	0.002 (0.00)**	0.002 (0.00)**
y_0	-0.052 (0.01)**	-0.056 (0.01)**	-0.053 (0.01)**	-0.054 (0.01)**
gov	-	-	-0.020 (0.01)**	-
$trade$	-	-	-0.016 (0.01)**	-
bmp	-	-	-	-0.028 (0.02)*
$pprivate$	-	-0.043 (0.02)**	-0.043 (0.01)**	-0.058 (0.02)**
$plly$	-0.088 (0.02)**	-	-	-
\overline{R}^2	0.735	0.722	0.737	0.727
$LR \sim \chi_{33}^2$	169.697	163.91	169.244	167.578
$Hausman \sim \chi_{df}^2$	47.34 (4)	50.19 (4)	56.83 (7)	49.03 (5)
$Endogeneity \sim N(0, 1)$	0.224	1.723	1.056	2.173
NT	186	186	186	186

**Significant at 5% size; *Significant at 10% size.

LR refers to Likelihood Ratio tests of $\alpha_i = \lambda_t = 0, \forall i, t$.

$Hausman$ tests are of fixed *versus* random specifications.

$Endogeneity$ tests the null-hypothesis that the inflation variable is exogenous.

4.2. Some Model Predictions

Using the equation given by Model (1) in Table 4.1, the predicted relationship between inflation, financial development, and growth can be visualized. For $\dot{p} \in (-0.02, 0.5)$ and $F \in (0.12, 1.9)$, approximately the limit values in the sample, and with growth on the vertical axis, inflation on the X -axis, and financial intermediary development on the Z -axis a three-dimensional graph, Figure 4.1 shows that for a given level of financial intermediary development, growth decreases as the inflation rate increases. This effect is stronger the higher is the level of financial development. Also note that the negative inflation-growth effect for a given level of financial development is slightly non-linear, getting somewhat stronger as the inflation rate increases. In the other dimension, for a given positive level of inflation, growth decreases nonlinearly as the level of financial intermediary development increases. This effect is much more pronounced at higher levels of inflation. And while there are no negative inflation rate data points in the sample, it is noted that the simulation shows that at negative levels of the inflation rate the growth rate increases negligibly as financial development increases.

Figure 4.2 represents a cross-section of the 3-dimensional graph (Figure 4.1), corresponding to a fixed value of F (0.25). It illustrates the negative, marginally non-linear, relationship between inflation and growth (plotting inflation on the X -axis and growth on the Y), and shows that the growth rate turns negative at an inflation rate close to 50%.

4.3. Model Specification: Statistical Tests and Extensions

4.3.1. A Consistent Random Effects Approach

This section extends the random effects framework by explicitly taking the potential observed-unobserved correlation into account in order to obtain consistent parameter estimates. Consider the generic model of

$$g_{it} = \mathbf{w}'_{it}\boldsymbol{\beta} + \alpha_i + \lambda_t + u_{it}, \quad (4.1)$$

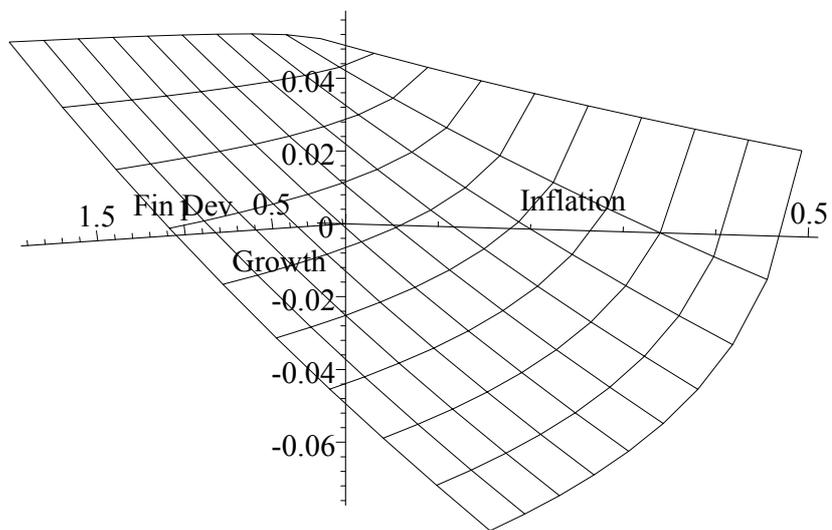


Figure 4.1: Inflation, Financial Development, and Growth

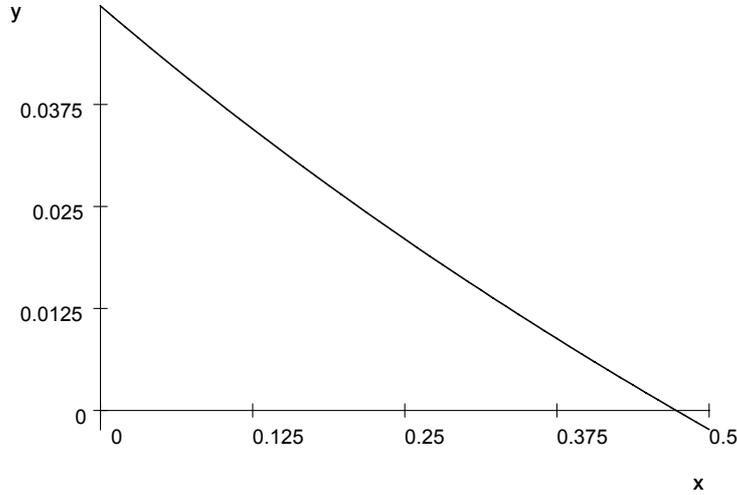


Figure 4.2: The Negative Inflation-Growth Effect

where \mathbf{w}_{it} contains both time varying variables, \mathbf{x}_{it} , and time invariant ones, \mathbf{f}_i . Following Hausman and Taylor (1981), it is possible to decompose \mathbf{w}_{it} into $\mathbf{w}_{it} = (\mathbf{w}'_{1it}, \mathbf{w}'_{2it})'$, where \mathbf{w}_{1it} is a subset of \mathbf{w}_{it} that is independent of the unobserved effect. Generalized Method of Moments (GMM) estimation can be based upon the orthogonality conditions

$$E(\mathbf{z}'_{it}\alpha_i) = \mathbf{0},$$

where \mathbf{z}_{it} is based upon \mathbf{w}_{1it} . Note that the λ_t are still treated as constants.

Using different approaches concerning the partitions for \mathbf{w}_{it} , Table 4.2 reports two different versions of the GMM estimator. First, the Hausman and Taylor (1981) (HT) estimator postulates $\mathbf{z}_i = (\mathbf{f}'_{1i}, \bar{\mathbf{x}}'_i)'$. Second, the Amemiya and MaCurdy (1986) (AM) estimator postulates $\mathbf{z}_i = (\mathbf{f}'_{1i}, \mathbf{x}'_{1i0}, \mathbf{x}'_{1i1}, \dots, \mathbf{x}'_{1iT})'$.⁵ The

⁵Another approach is that, given constant correlation between \mathbf{w}_{2it} and α_i over time, there exists an orthogonality condition concerning the deviations from the means of the time effects that also yields a valid instrument (Breusch, Mizon, and Schmidt 1989). Because this approach is found here to yield an estimator that is not well-defined, its results are not reported.

results of the HT and AM estimators as based on two alternative sets of candidates for \mathbf{w}_{1it} . One set includes only the investment rate, I_{it} , while the other set also includes the initial income, y_{i0} .

Table 4.2: Growth Results: A Consistent Random Effects Approach

	Base Model	$\mathbf{w}_{1it} = I_{it}$		$\mathbf{w}_{1it} = (I_{it}, y_{i0})$	
		HT	AM	HT	AM
Constant	0.425 (0.05)**	0.101 (0.04)**	0.022 (0.01)	0.016 (0.01)	0.028 (0.01)**
\dot{p}	-0.250 (0.05)**	-0.189 (0.08)**	-0.233 (0.05)**	-0.251 (0.06)**	-0.130 (0.04)**
I	0.003 (0.00)**	0.001 (0.00)**	0.002 (0.00)**	0.002 (0.00)**	0.002 (0.00)**
y_0	-0.052 (0.01)**	-0.011 (0.01)*	-0.001 (0.00)	0.000 (0.00)	-0.002 (0.00)
$plly$	-0.088 (0.02)**	-0.062 (0.04)	-0.082 (0.03)**	-0.090 (0.03)**	-0.034 (0.02)*
lly	- -	-0.034 (0.01)**	-0.021 (0.01)**	-0.027 (0.01)**	-0.012 (0.01)**
NT	186	186	186	186	186
\overline{R}^2	0.73	- ^a	0.38	0.33	0.466
$Sargan$	-	24.81 (1)	20.26 (7)	19.97 (2)	26.24 (14)

**Significant at 5% size; *Significant at 10% size.

^aNot well-defined.

$Sargan$ refers to Sargan (see Sargan 1958, Sargan 1988) χ^2 tests for over-identifying restrictions, degrees of freedom in parentheses.

The major difference here from Model 1 is that the level of financial intermediation is significant. However, controlling for the investment rate, the level of financial development appears to exert a *negative* effect on growth. The significance and the magnitude of the interaction term between inflation and financial intermediation remains unaffected, except the HT case with $\mathbf{w}_{1it} = I_{it}$ in which the product term is insignificant. The range of the coefficient of the estimated effect of the interaction term is (-0.034, -0.09) in comparison to -0.088 in Model

1.

The investigation of the correlation between the observed and unobserved variables appear to indicate robustness in the base model's results, with the discrepancy in particular with respect to financial development. The financial development effect goes in the opposite direction to that typically found in the literature. However, an important qualification to these results is that all of these specifications significantly reject the null hypothesis of valid instruments using the Sargan criteria. The Sargan test indicates that the estimated parameters may be inconsistent.

4.3.2. Dynamic Growth Equations

Following Levine, Loayza, and Beck (2000), the final robustness check is to consider the dynamic growth equations. Here the basic model is extended by including lagged growth, $g_{i,t-1}$. For the dynamic panel model the usual estimation techniques are inconsistent. To allow for growth to follow an autoregressive process while removing the unobserved effects, it is common to write equation (4.1) in terms of first differences with a lagged dependent variable:

$$\Delta y_{it} = \delta \Delta y_{i,t-1} + \Delta \mathbf{x}'_{it} \boldsymbol{\beta} + \Delta \varepsilon_{it}. \quad (4.2)$$

This model now contains only time-varying explanatory variables. Following Arellano and Bond (1991) it is possible to consistently estimate the model by GMM estimation based upon the moment conditions,

$$E(\Delta \varepsilon_{it} g_{i,t-j}) = 0, \quad j = 2, \dots, t-1; \quad t = 3, \dots, T. \quad (4.3)$$

The moment conditions implies that the $\Delta \varepsilon_{it}$ do not follow a second-order serial correlation process, a condition that is tested here.

Table 4.3 presents the results along with those of the Model 1 for comparison. Note that estimation of a dynamic model is facilitated by use of a balanced panel. Therefore two further countries are dropped from the sample, Korea and the Philippines, and one year is dropped due to the dynamic nature of the model.

Table 4.3: Dynamic Growth Results

	Base Model	Model D1	Model D2	Model D3	Model D4
Constant	0.425 (0.05)**	0.008 (0.00)**	0.008 (0.00)**	- -	- -
$g_{i,t-1}$	- -	-0.312 (0.06)**	-0.311 (0.06)**	-0.481 (0.06)**	-0.482 (0.06)**
\dot{p}	-0.250 (0.05)**	-0.177 (0.04)**	-0.177 (0.04)**	-0.222 (0.03)**	-0.222 (0.03)**
I	0.003 (0.00)**	0.003 (0.00)**	0.003 (0.00)**	0.002 (0.00)**	0.002 (0.00)**
y_0	-0.052 (0.01)**	-0.081 (0.01)**	-0.081 (0.01)**	-0.039 (0.01)**	-0.039 (0.00)**
$plly$	-0.088 (0.02)**	-0.052 (0.02)**	-0.052 (0.02)**	-0.072 (0.02)**	-0.072 (0.02)**
lly	- -	0.001 (0.01)	- -	-0.001 (0.01)	- -
NT	186	125	125	125	125
\overline{R}^2	0.73	0.67	0.67	0.66	0.66
$Sargan$	-	22.01 (14)	21.77 (14)	22.51 (14)	22.44 (14)
m_2		-1.61	-1.57	-2.23	-2.23

**Significant at 5% size; *Significant at 10% size.

$Sargan$ refers to Sargan χ^2 tests for over-identifying restrictions, degrees of freedom in parentheses.

m_2 tests for second-order serial correlation and is $\tilde{a}N(0, 1)$ under the null hypothesis.

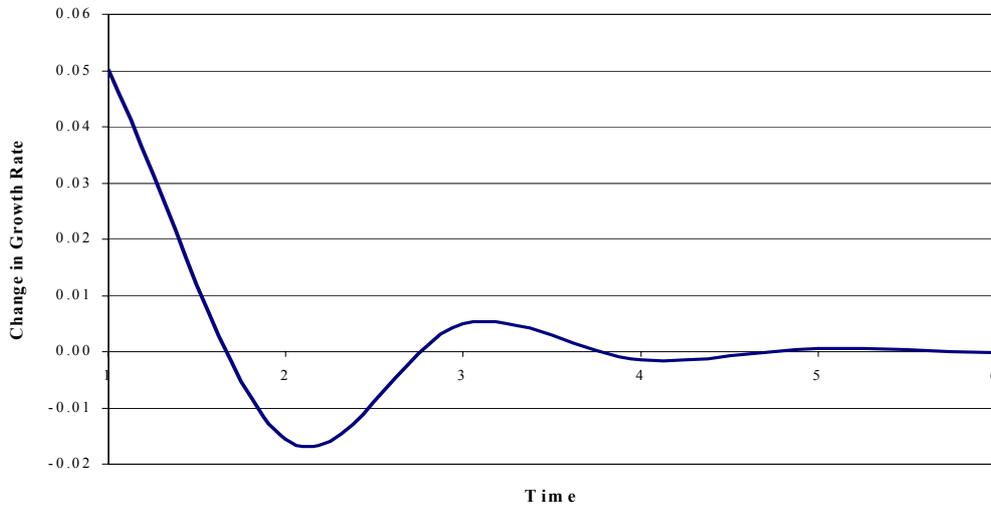


Figure 4.3: Implied Convergence to an Exogenous Shock

When modelling the *change* in the rate of growth, a constant term in this equation implies that there is a constant rate of change in the growth rate, or a trend in the rate of growth. Table 4.3 presents four specifications, Models D1-D4. A trend in the rate of growth is included in D1 and D2, but not in D3 and D4. The inflation rate parameter, ϕ in equation (2.2), is allowed to be non-zero by including the level of financial development, as is found in D1 and D3, with and without a trend. Since the results indicates that the level of financial development is insignificant, the re-estimation excludes this variable in D2 and D4, with and without a trend.

The growth process emerges as autoregressive with the lagged dependent variable being strongly significant. This variable's negative sign indicates, as illustrated in Figure 4.3, that the return to the equilibrium growth path following a shock is cyclical. With $\hat{\delta} = -0.312$ in Figure 4.3, an exogenous shock of five percentage points leads to a relatively quick convergence with most adjustment complete within four time periods.

Although lagged growth is strongly significant, the remaining coefficients remain substantively unchanged across the base model and dynamic specifications. This suggests that any potential omitted variable bias in Model 1 arising from exclusion of $g_{i,t-1}$ is minimal. In both base and dynamic specifications the level of financial intermediation insignificant and all the other variables are strongly significant. For example, in Model 1 the coefficients on \dot{p} and $plly$ are (-0.250, -0.088) compared to (-0.222, -0.072) and (-0.177, -0.052), in Models D2 and D4 of the dynamic specification.

The dynamic specifications all pass the Sargan test for over-identifying restrictions. However for Models D3 and D4 with the constant excluded, there is some evidence of second-order serial correlation. These tests suggest that Model D2 performs well as a robustness check on Model 1. The coefficient of the investment rate term is the same in Models 1 and D2; the coefficients for the inflation rate and the interaction term are somewhat lower in D2; and the initial income term has a somewhat higher coefficient in D2.

5. Discussion

Specifications differ from those in Levine, Loayza, and Beck (2000) and Rousseau and Wachtel (2001) by including the investment rate, as suggested by the endogenous growth theory for example in Gillman, Harris, and Matyas (2004). In all specifications, this variable significantly, robustly, and positively affects the growth rate. A positive correlation between the investment rate and financial development (in the sample the correlation is $\hat{\rho} = 0.27$) combined with a “large” investment rate effect, could result in a positive financial development effect if the investment rate is erroneously omitted from the model.

The panel results of Levine, Loayza, and Beck (2000) find a positive, significant, association between financial development and growth that comfortably passes the robustness checks including a dynamic specification. If an important variable is erroneously omitted, such testing procedures would be within a biased

framework. As the results of the paper here show similar robustness without such a positive effect from financial development, the investment rate in particular emerges as a candidate for such an omitted variable in previous work.

It is possible that the paper's non-standard results on financial development are due to using a reduced sample size, as necessitated by excluding countries for which the investment rate data is unavailable. This explanation may appear to have credence from certain experiments. For example using Model 1 without the inflation/financial-development product term and the investment term, while including the Liquid Liabilities variable, results in finding that financial development still is statistically insignificant. However, the standard results of a positive financial development effect can nonetheless be replicated with the paper's data set. With the same experiment, but using the Levine, Loayza, and Beck (2000) Private Credit variable instead of their Liquid Liabilities variable, and including their Black Market Premium variable, the results find that the financial development variable is significant at the 1% level (two-sided); the negative inflation effect is also replicated at a 5% level of significance (one-sided).

Another replication of standard results occurs when only the investment rate only is excluded from Model 1, while Liquid Liabilities is included. The interaction effect is still negative and the effect of the level of financial development is positive. However both of these variables have weak levels of significance with t -statistics respectively of -1.182 and 1.296.

Also note that a negative inflation-financial-development interaction term is consistent with the results in Gillman, Harris, and Matyas (2004). There a milder inflation-growth effect is found for an APEC sub-sample, and a stronger one is found for an OECD sub-sample. This is consistent with taking two cross-section slices of the Figure 4.1, one at a lower level of financial development for APEC, and one at a higher level of financial development for the OECD. But in contrast to Gillman, Harris, and Matyas (2004), now the results enable a full profile across the continuum of levels of financial development.

6. Conclusions and Extensions

Combining the older Solow-type approach with endogenous growth variables concerning human capital gives a basis for reexamining the robustness of the effects of inflation and financial development. Using similar data, Levine, Loayza, and Beck (2000) find strong evidence of relationship between the level of financial intermediation development and long-run growth in a cross-section setting. When five-yearly averages are used, and a dynamic panel model estimated, these results still hold. Rousseau and Wachtel (2001) focus on the interaction of inflation and financial development and again confirm the results of Levine, Loayza, and Beck (2000).

The new results presented in this paper show that when including the investment rate as in the Solow-growth literature, the level of financial development no longer can be said to positively affect growth. Instead the level of financial development enhances the negative inflation-growth relationship. Financial development is not robustly significant by itself in this model, although a negative stand-alone effect on growth was found in some specifications. This suggests that in previous results a positive effect of financial development may have been found spuriously because financial development is proxying the rate of return to physical capital. Including a proxy for this rate of return through the investment rate, the level of financial development is found no longer to play that role.

This paper focuses on the effect of inflation on growth and of financial development on growth. Its results allow for a new interpretation of the role of financial development on growth by using the third related strand of literature: that of the relation between inflation and financial development. Khan and Smith (2001) and Boyd and Smith (2001) find that, at least for levels of inflation above a threshold amount, an increase in the inflation rate causes a decrease in financial depth, or financial lending to the private sector. This builds upon the findings of Aiyagari, Braun, and Eckstein (1998), who present evidence of a scale effect of inflation on the size of the banking sector in high inflation countries. They find confir-

mation of their theory that an increase in the inflation rate induces an increased supply of exchange credit that is used to avoid the inflation tax and that causes an expansion of the bank sector. Together these findings suggest the possibility of an inflation-induced substitution within the bank sector from intertemporal, or investment, types of credit towards inflation-tax avoiding types of exchange credit.

The evidence of possible credit substitution combined with our results suggests the following interpretation: countries with more developed financial sectors may be able to substitute more readily from investment credit to exchange credit in seeking to avoid the inflation tax. This would cause a bigger decrease in investment credit than would occur in the countries with the less developed bank sector because investment credit may be substituted to a greater degree with exchange credit in the more developed bank sectors. The bigger decrease in the investment credit in turn could cause the bigger negative effect of inflation on growth. While this conjecture may be plausible, its supposition is offered here only as a possible direction for future research.

As far as the paper goes, it puts forth an endogenous growth type of model that builds upon older Solow-growth type approaches. Bringing the investment rate into the model in order to proxy the return on physical capital, as well as including factors that affect the return to human capital, the level of financial development plays a different role. The hypothesis that the paper presents is that the level of financial development enables a stronger negative inflation-growth effect, perhaps because exchange credit is substituted in for growth-enhancing investment credit more strongly, the more developed is the financial sector.

The results do not rule out that financial development may be found to affect growth positively once data refinements progress. It may be possible for example that the inclusion of a more exact measure of the real return to physical capital would enable a separate influence of financial development to re-emerge. This might yield once again support for Schumpeter's interesting hypothesis, (see King and Levine (1993)), of the benefits of financial development.

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