

# *Capitalism and Society*

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*Volume 1, Issue 1*

2006

*Article 2*

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## Interaction Effects in the Relationship Between Growth and Finance

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## Abstract

This paper analyzes how interacting financial development with initial income, macroeconomic volatility and policy variables, can improve our understanding of convergence and divergence across countries, and also restore the significance of correlations between growth and volatility and therefore between growth and macropolicy, even when controlling for country fixed effects or when eliminating countries with extreme policies or bad institutions.

**KEYWORDS:** financial development, convergence, volatility, interaction effects, countercyclical policy

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\*The author is very grateful to Edmund Phelps for his advice and encouragements, and to the Center on Capitalism and Society at Columbia University and the Kauffman Foundation, for providing generous financial support to this project.

# 1 Introduction

In his excellent survey article on Finance and Growth for the forthcoming Handbook of Economic Growth, Ross Levine summarizes as follows the existing research on this topic: "Taken as a whole, the bulk of existing research suggests that (1) countries with better functioning banks and markets grow faster; (2) simultaneity bias does not seem to drive these conclusions, and (3) better functioning financial systems ease the external financing constraints that impede firm and industrial expansion, suggesting that this is one mechanism through which financial development matters for growth".

In fact, most of the existing literature on the subject, has been concerned with cross-country or panel regressions of the form

$$g_i = \alpha_0 + \alpha_1 F_i + \alpha_2 X + \varepsilon,$$

where  $g_i$  is the average growth rate in country  $i$  during the period or subperiod,  $F_i$  is the country's level of financial development (either at the beginning of the period, or averaged over the period),  $X$  is a vector of controls (policy variables, education, political stability, initial income per capita, etc) and  $\varepsilon$  is a noise term.

As well explained in Levine's survey which we briefly summarize in the next section, empirical papers on finance and growth differ in terms of: (i) whether they look at cross country data (like King and Levine (1993) and subsequent work by Levine and coauthors) or at cross industry data like Rajan and Zingales (1998) or at cross regional data like Guiso, Sapienza and Zingales (2002) or at firm level data like Demircuc-Kunt and Maksimovic (1998); (ii) how is  $F_i$  measured: by the ratio of bank credit to GDP, or by indicators of stock market development, or if it is also interacted like in Rajan and Zingales (1998) with a measure of external financial dependence of the industry; (iii) whether one looks at cross section or at panel data; (iv) whether or not one instruments for financial development.

In this paper we add to this literature by introducing interaction effects between financial development and technological or macroeconomic variables. In particular, following a very brief summary of Levine's survey of the main existing empirical contributions on finance and growth in Section 2, in Section 3 we look at the interaction between financial development and initial income relative to the current frontier (that is, the country's initial distance to the technological frontier), and argue that: (i) countries that are either initially close the technological frontier or with a sufficiently high level of financial development, will converge to the frontier in growth rates and in per capita GDP, whereas: (ii) countries that are too far below the frontier and with a low level of financial development will diverge from it. In particular, the interaction between financial development and income generates a twin-peak distribution of income and growth rates in the long run. In Section 4, we consider

the interaction between financial development and macroeconomic volatility, and argue that: (i) volatility is more detrimental to growth in less financially developed countries; (ii) a more countercyclical budgetary policy is more growth-enhancing in countries with lower level of financial development; (iii) countries with lower levels of financial development are more likely to benefit from a fixed exchange rate regime, if, as we seem to observe, exchange rate risk is the main source of macroeconomic volatility. Finally, Section 5 concludes.

## **2 Levine's empirical survey in a nutshell**

This section presents a very brief summary of Levine (2005)'s survey of the empirical literature on finance and growth. We also refer the readers to his equally exhaustive theoretical survey in Section 2 of that same chapter. One reference which had to be missing in Levine's chapter<sup>1</sup> as it was just produced as another chapter for the same Handbook of Economics Growth, is Banerjee and Duflo (2005). In this chapter, Banerjee and Duflo revisit, a within-country level, Lucas's "no-convergence" puzzle, namely: why is it that poorer countries or sectors where capital is scarce and therefore the marginal productivity of capital is high, do not attract investments that would make them converge towards the frontier countries or sectors? In particular they argue that the most natural way to account for the observed cross-sectoral differences in returns and investment rates in a country like India, is to introduce both, credit market imperfections and increasing returns at the firm level<sup>2</sup>. We will come back to this at the end of this section when we talk about cross-firm regressions.

### **2.1 Cross-country and cross-region**

Levine (2005) attributes the first empirical analysis on finance and growth to Goldsmith (1969). Goldsmith uses cross-country data over the period 1860-1963 to regress average growth on financial development as measured by the size of the financial intermediary sector (measured by the value of its assets) over GDP, and finds a positive correlation between financial development and output growth. As well explained by Levine, this study has its limits: no controls in the regression, no instrumentation to address potential causality issues, the left hand side variable is output growth instead of productivity growth, and the sample consists of 35 coun-

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<sup>1</sup>We also expand a little on Guiso, Sapienza, and Zingales (2005).

<sup>2</sup>One possible way of doing might be to simply adapt the model in Section 3 below into a model of cross-sectoral convergence and divergence within a country.

tries only. It is these limitations that King and Levine address in their seminal work in 1993.

King and Levine (1993) consider a broader sample of 77 countries over the period 1960 to 1989. They regress average growth of per capita GDP or average growth in TFP over financial development and a number of control variables on the right hand side of the regression equation. The controls include: initial income per capita, education measures, indexes of political stability, and policy indicators. Financial development is measured in three possible ways: (i) the ratio between the liquid liabilities of the financial system -not its assets as in Goldsmith (1969)- and GDP; (ii) the ratio of commercial bank credit to bank credit plus central bank's domestic assets (this measure performs generally more poorly than the others); (iii) the ratio of credit to private enterprises to GDP. Each of these measures is averaged over the period 1960-1989. The cross-country regression shows a large and significant correlation between productivity growth and financial development measured as specified above. To make sure they capture the causal relationship from finance to growth and not the reverse, King and Levine repeat the same regression exercise but using initial 1960 values of the financial development measures instead of their average over the whole period. This regression also shows a positive and significant correlation between financial development and growth, which now suggests that "financial development in 1960 is a good predictor of economic growth over the next 30 years".

Subsequently, Levine and Zervos (1998) concentrate on the nature of financial sectors, and in particular the importance of stock market development and stock market "liquidity". In particular, Levine and Zervos consider what they call the "turnover ratio", namely the total value of currently traded shares over the total value of listed shares, and based on a cross-country regression involving 42 countries over the period 1976-1993, they find that both, the initial level of bank credit *and* the initial level of this turnover ratio in 1976, show a positive and significant correlation with average productivity growth over the period 1976-1993.

One may object to the measures of financial development used by Levine and his coauthors, however this is the best that can be done while remaining at cross-country level.

A more serious objection is causality: what tells us that these positive correlations do not reflect, either the fact that financial development occurs in prediction of forthcoming growth, or the fact that a third variable, call it institutional development (e.g, measured by property rights protection), causes both, higher growth and higher financial development. To address this endogeneity problem, Levine (1998, 1999) and Levine, Loayza and Beck (2000) use the legal origins indicators of La Porta et al (1998) as instruments for financial development. Thus the regression exercise now involves a first stage where financial development is regressed over dummy

variables for Anglo-Saxon, French and German legal origins (against Scandinavian legal origins) respectively, and a second stage regression where average productivity growth is regressed over predicted financial development as derived from the first stage regression and the same control variables as before. In particular, Levine et al (2000) obtain a strongly positive and significant correlation between predicted financial development and average productivity growth over the period 1960-1995.

Levine et al (2000) go even further by performing panel cross-country regressions in which the period 1960-1995 is subdivided in five year subperiods, and where, for each five-year subperiod, average productivity growth over the subperiod is regressed over current and past financial development, controlling for country fixed effects. And again, they find positive and significant correlations between (current and lagged) financial development and average productivity growth during the subperiod.

Because they move from cross-country to cross-regional analysis within a country (Italy), Guiso, Sapienza and Zingales (2002) can construct more precise measures of financial development and show that financial development as they measure it is an important determinant of cross-regional convergence. More specifically, GSZ construct their measure of regional financial development by estimating a linear probability model in which they regress the probability that individuals be denied access to credit (they obtain information about individual access to credit from the Survey of Households Income and Wealth, which also provides information on the region to which each individual belongs) over regional dummies and a set of control variables. The coefficients on the regional dummies are the measures of regional financial development, which GSZ instrument using the regional composition of banking branches in 1936.<sup>3</sup>

## **2.2 Cross-industry**

The pioneering attempt at getting at a more microeconomic level by looking at cross-industry comparisons across countries, is by Rajan and Zingales (1998). Their insight is that growth in industries that rely more heavily on external finance, should benefit more from higher financial development than growth in industries that do not rely so much on external finance. The problem is to identify those industries that are more prone to rely on external finance than other industries.

Rajan and Zingales regress average growth of value added of industry  $k$  in country  $i$  over: (i) country and industry dummies; (ii) the share of industry  $k$  in total manufacturing in country  $i$ ; (iii) the interaction between financial develop-

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<sup>3</sup>The year 1936 corresponds to the enactment of a law restricting subsequent entry into the banking sector.

ment (measured by stock market capitalization plus domestic credit over GDP) in country  $i$  and industry  $k$ 's dependence upon external finance (measured by the fraction of capital costs not financed internally in that same industry in the US). The underlying idea is that firms are not financially constrained in the US, so that this measure of external dependence can be thought of as being independent from financial development and to depend instead upon technological factors only. Rajan and Zingales do not include financial development independently, as this would create collinearity with the country dummies.

Using a sample of 36 industries in 42 countries, Rajan and Zingales find an interaction coefficient between external dependence and their measure of financial development, which is positive and highly significant at the one percent level), thereby providing strong evidence to the effect that higher financial development enhances growth in those industries that rely more heavily on external finance.

Building upon the Rajan-Zingales methodology, Beck, Demirguc-Kunt, Laeven and Levine (2004) use cross-country/cross-industry data to look at the effect on productivity growth of the interaction between financial development and the average size of firms in the corresponding industry in the US (again relying on the implicit assumption that only technological factors, not financial market frictions, determine this average size in the US). They find that higher financial development enhances growth in those industries that comprise a higher fraction of small firms. This result is consistent with previous work by Bernanke, Gertler and Gilchrist (1989) suggesting that smaller firms face tighter credit constraints than large firms.

### 2.3 Cross-firm

Demirguc-Kunt and Maksimovic (1998), henceforth DM, analyze the extent to which long-term debt and outside equity financing can foster firm growth. To this end, they first compute the growth rate of firms that would not have access to long-term debt or outside equity (that is, the growth rate of firms that only rely on retained earnings and short-term debt); then they calculate the fraction of firms that grow faster than the no-outside-finance rate; this they interpret as being the fraction of firms that rely on outside finance, and DM compute this fraction  $f_i$  for each country.

Then, using a sample comprising all large publicly traded manufacturing firms in each of 26 countries, DM regress the fraction  $f_i$  of firms that grow faster than the no-outside-finance rate, over financial development (measured either by the ratio of market capitalization to GDP, or by the turnover ratio of Levine and Zervos to capture the liquidity of stock market, or by the ratio of bank assets to GDP to capture the size of the banking sector) and control variables. The main finding in DM is that the turnover ratio and the bank assets to GDP ratio are both positively

and significantly correlated with  $f_i$ .

Another important piece of work on credit constraints at firm level, is the innovative paper by Banerjee and Duflo (2004), which uses firms' investment response to an exogenous policy change affecting the amount of subsidized directed credit, to assess the importance of credit constraints faced by firms. The underlying idea is that an unconstrained firm would respond to such a policy change by simply substituting directed credit for (unsubsidized) market credit, but without changing capital investment (which in that case would only be determined by rate of return considerations). The policy change is that the limit on total capital investment for a firm to belong to the so-called priority sector eligible for subsidized credit, was raised substantially in 1998 and then lowered back in 2000. Banerjee and Duflo then show that bank lending and firm revenues increased for the newly targeted firms immediately after 1998, and then decreased in the years after the 2000 policy change, thereby providing evidence to the effect that those firms were indeed credit constrained.

### **3 Interacting financial constraints with technological development**

In this section, which summarizes Aghion-Howitt-Mayer (2005), we use Schumpeterian growth theory to investigate the interaction between financial development and initial income per capita (or equivalently the initial distance to the technological frontier, which we typically measure by the ratio of a country's average productivity to the frontier country's productivity). Our theory embodies two opposite effects of technological backwardness: on the one hand, a far-from-frontier country makes bigger leaps with innovations that allows its sectors to catch up with the current frontier technology, and this advantage of backwardness pushes towards convergence. On the other hand, a far-from-frontier country has fewer initial resources to pledge into innovation, and in the absence of perfect capital markets this will limit its ability to innovate and thereby catch up with the technology frontier: this disadvantage of backwardness pushes towards divergence. In particular, tighter financial constraints will reinforce the negative effect of a low initial income per capita in lowering the innovation rate of a country and its ability to converge in growth rate or in per capita GDP towards the world technology frontier. In the first part of the section we spell out the theory. In the second part of the section we briefly show that the predictions of the model are confirmed by cross-country regressions where growth is regressed over financial development and its interaction with initial income per capita.



### 3.1 Theory

#### 3.1.1 The economic environment

We consider a multi-country world with  $m$  countries. Each country has a fixed population  $L$ , which we normalize to unity. Everyone lives for two periods, being endowed with one unit of labor services in the first period and none in the second, with a utility function linear in consumption:  $U = c_1 + c_2$ .

There is one final good, produced by labor and a continuum of intermediate inputs according to:

$$Z_t = L^{1-\alpha} \int_0^1 A_t(i) x_t(i)^\alpha di, \quad 0 < \alpha < 1$$

where  $x_t(i)$  is the input of the latest version of intermediate good  $i$  and  $A_t(i)$  is the productivity parameter associated with it. The final good is used for consumption, as an input to R&D, and also as an input to the production of intermediate goods.

The final good, which we take as the numeraire, is produced under perfect competition, so the price of each intermediate good equals its marginal product:

$$p_t(i) = \alpha A_t(i) x_t(i)^{\alpha-1} \quad (1)$$

Each intermediate good  $i$  is produced by an individual born each period  $t-1$  and who can potentially innovate at time  $t$ . Let  $\mu_t(i)$  be the probability that innovation in sector  $i$  succeeds at time  $t$ . A successful innovation allows the sector to catch up with current frontier productivity, so that we have:

$$A_t(i) = \left\{ \begin{array}{ll} \bar{A}_t & \text{with probability } \mu_t(i) \\ A_{t-1}(i) & \text{with probability } 1 - \mu_t(i) \end{array} \right\}$$

where  $\bar{A}_t$  is the world technology frontier, which grows at the constant rate  $g$ , taken as given.

In each intermediate sector where an innovation has just occurred, the incumbent is able to produce any amount of the intermediate good using as input  $\bar{A}_t$  units of the general good per unit of intermediate good. In addition, in every intermediate sector there is an unlimited number of firms, the competitive fringe, that can produce the same quality of that intermediate good at a unit cost of  $\chi A_t(i)$ , with  $\chi \in (1, \alpha^{-1})$ .

In sectors where an innovation has just occurred, the incumbent will be the only producer, at a price equal to the unit cost of the competitive fringe, whereas in non-innovating sectors where the most recent incumbent is dead, production will take place under perfect competition with a price equal to the unit cost of each producer.

In either event the price will be  $\chi A_t(i)$ , and according to the demand function (1) the quantity demanded will be  $(\alpha/\chi)^{\frac{1}{1-\alpha}}$ .

Thus an unsuccessful innovator will earn zero profits next period, whereas the profit of an incumbent will be  $\pi_t(i) = \pi \bar{A}_t$ , where  $\pi = (\chi - 1) (\alpha/\chi)^{\frac{1}{1-\alpha}}$ .

From the above, gross output of the final good will be:

$$Z_t = \zeta A_t$$

where  $\zeta = (\alpha/\chi)^{\frac{\alpha}{1-\alpha}}$  and  $A_t = \int_0^1 A_t(i) di$  is the average productivity parameter across all intermediate sectors.

### 3.1.2 Innovation and productivity growth

In equilibrium the probability of innovation will be the same in each sector:  $\mu_t(i) = \mu_t$  for all  $i$ ; therefore average productivity evolves according to:

$$A_t = \mu_t \bar{A}_t + (1 - \mu_t) A_{t-1}$$

Let:

$$a_t = A_t / \bar{A}_t.$$

This ratio measures the country's proximity to the technological frontier, and its inverse measures the country's distance to the frontier. Dividing the above equation through by  $\bar{A}_t$ , we immediately get:

$$a_t = \mu_t + \frac{(1 - \mu_t)}{1 + g} a_{t-1} \quad (2)$$

We now proceed to determining the equilibrium innovation rate  $\mu_t$ . As we shall see below,  $\mu_t$  increases with both, a country's proximity to the frontier and its level of financial development, which in turn generates the positive interaction effect between financial development and initial income which we find also in the data.

Suppose a quadratic R&D cost of the form:

$$\tilde{n}(\mu_t) \bar{A}_{t+1} = (\eta \mu_t + \delta \mu_t^2 / 2) \bar{A}_{t+1} \quad \eta, \delta > 0$$

where this cost is incurred in units of the final good. The multiplicative term  $\bar{A}_{t+1}$  reflects the fact that the further ahead the frontier technology is, the more costly it is to catch up with it.

In equilibrium  $\mu_t$  will be chosen so as to maximize the expected net payoff:

$$\mu_t \pi \bar{A}_{t+1} - \tilde{n}(\mu_t) \bar{A}_{t+1} \quad (3)$$

in each sector, subject to credit constraints.

**Equilibrium innovation under perfect credit markets** In this section we show that if innovators had unlimited access to outside finance all economies would converge to the same growth rate.

Suppose that each innovator can borrow (from other young people) unlimited quantities at the going rate of interest subject to a binding commitment to repay. Then  $\mu_t$  will be chosen so as to maximize (3) with no constraint. This implies that  $\mu_t = \mu^*$ , where:

$$\tilde{n}'(\mu^*) = \pi$$

that is:

$$\mu^* = (\pi - \eta) / \delta$$

The equilibrium R&D expenditure will be:

$$n^* \bar{A}_t \equiv \tilde{n}(\mu^*) \bar{A}_t$$

It follows from this and equation (2) that the country's technology gap evolves according to:

$$a_{t+1} = \mu^* + \frac{(1 - \mu^*)}{1 + g} a_t \equiv F_1(a_t) \quad (4)$$

which converges in the long run to the steady-state value:

$$a^* = \frac{(1 + g) \mu^*}{g + \mu^*} \in (0, 1)$$

Per capita income (the sum of wage and profit income) in the steady state is:

$$Y_t^* = [(1 - \alpha) \zeta a^* + \mu^* \pi] \bar{A}_t \quad (5)$$

which grows at the same rate  $g$  as the technology frontier, as claimed.

**Credit constraints** Now suppose that credit markets are imperfect. Each innovator is a young person with access to the wage income  $w_t$ . Thus to invest  $N_t$  in an R&D project she must borrow  $L = N_t - w_t$ . Following Aghion, Banerjee and Piketty (1999) suppose that a borrower with initial wealth  $w_t$  cannot invest more than

$$\omega w_t$$

in innovation costs, where  $\omega$  is a (productivity-adjusted) "finance multiplier", and  $w_t$  is proportional to the country's average productivity  $A_t$ , equal to

$$w_t = \lambda A_t$$

Whenever the credit constraint is binding so that

$$N_t = \omega w_t, \tag{6}$$

each entrepreneur will spend the maximum possible  $N_t = \frac{\lambda}{1+g} \omega a_t \bar{A}_{t+1}$  on technology investment at time  $t$ , resulting in  $\mu_{t+1} = \tilde{\mu}(\omega a_t)$ , and  $a_{t+1}$  will be determined according to:

$$a_{t+1} = \tilde{\mu}(\omega a_t) + \frac{(1 - \tilde{\mu}(\omega a_t))}{1 + g} a_t \equiv F_2(a_t) \tag{7}$$

for as long as (6) holds.

### 3.1.3 Empirical Implications

**Three cases** The country's technology gap  $a_t$  will evolve according to the unconstrained dynamic system (4) when  $a_t \geq \underline{a}(\omega)$  and according to the constrained system (7) when  $a_t < \underline{a}(\omega)$ . Thus:

$$a_{t+t} = F(a_t) \equiv \min \{F_1(a_t), F_2(a_t)\} \tag{8}$$

$F_1$  is a linear function with positive vertical intercept and a slope between 0 and 1. Also,  $F_2$  is an increasing concave function when  $a_t \leq \min \{\underline{a}(\omega), 1\}$ , with  $F_2(0) = 0$  and  $F_2'(0) = \frac{\omega}{\eta} + \frac{1}{1+g}$ .

Countries will fall into three groups, defined by the value of their credit multiplier  $\omega$ . The evolution of the technology gap is illustrated for each case in Figures 1 ~ 3 below.

1. *Convergence in growth rate, no marginal effect of financial development.*

When:

$$\frac{n^*}{a^*} \leq \omega$$

then (since  $a^* \geq \underline{a}(\omega)$ )  $F(a^*) = F_1(a^*)$ . As shown in Figure 1,  $a_t$  will converge to the unconstrained steady state  $a^*$  which implies that per-capita income will grow at the same rate  $g$  as the technology frontier in the long run. Increases in financial development will have no marginal effect on either the steady state growth rate or the steady state technology gap; these converge respectively to the values  $g$  and  $a^*$  which are independent of  $\omega$  conditional on the country remaining within the group.

2. *Convergence in growth rate with a level effect of financial development.*

When:

$$\frac{\eta g}{1 + g} \leq \omega < \frac{n^*}{a^*}$$

then  $F(a^*) < F_1(a^*)$ , so  $a_t$  cannot converge to the unconstrained steady state  $a^*$ . Since  $F'(0) \geq 1$ , as shown in Figure 2,  $a_t$  will converge to a limit  $\hat{a}$  that is strictly positive but less than  $a^*$ . In the long run, per capita income will be less than that of countries in group 1:

$$\hat{Y}_t = [(1 - \alpha) \zeta \hat{a} + \tilde{\mu} (\omega \hat{a}) \pi] \bar{A}_t < Y_t^*$$

However this country will also grow at the rate  $g$  in the long run, because  $\hat{Y}_t$  is proportional to  $\bar{A}_t$ . Financial development will have no marginal effect on the steady state growth rate but they will have a positive marginal effect on the steady state technology gap  $\hat{a}$ .

3. *Divergence in growth rate, with a growth effect of financial development.*

When:

$$\omega < \frac{\eta g}{1 + g}$$

then  $F(a^*) < F_1(a^*)$  and  $F'(0) < 1$ , so  $a_t$  will converge to zero, as shown in Figure 3, with an asymptotic growth rate equal to

$$\lim_{t \rightarrow \infty} G_t = (1 + g) \lim_{t \rightarrow \infty} (a_{t+1}/a_t) - 1 = (1 + g) / \eta \in (0, g).$$

Thus increases in financial development will have a positive marginal effect on the country's steady state growth rate.

Figure 1: A country with the highest level of financial development

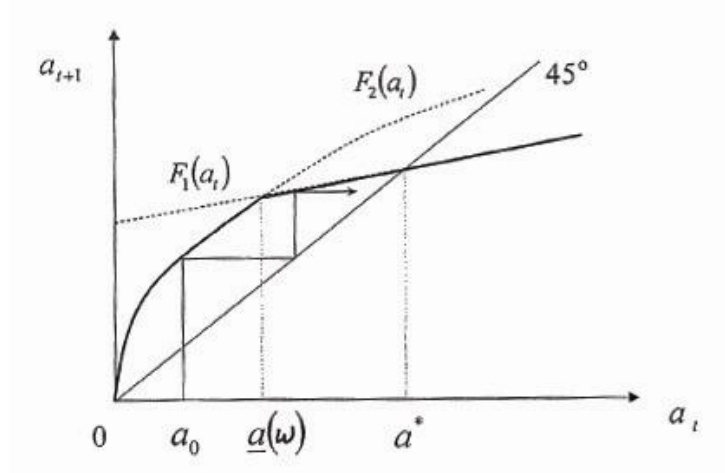


Figure 2: A country with a medium level of financial development

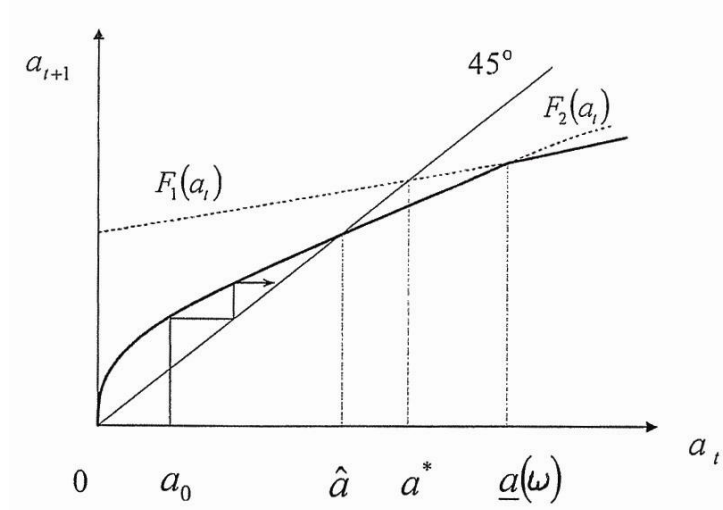
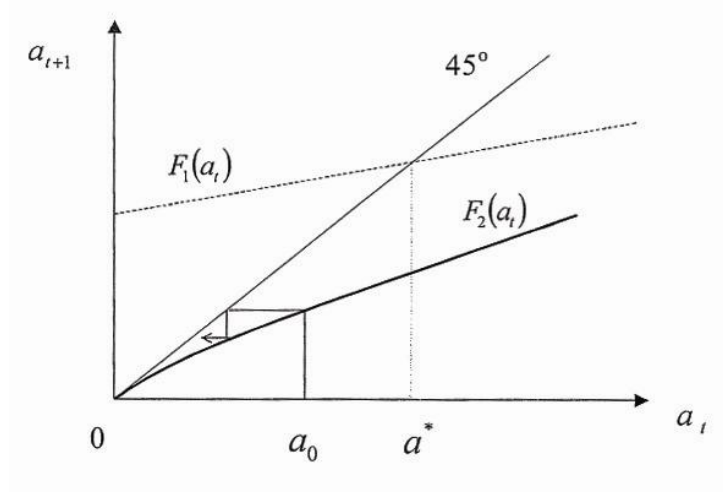


Figure 3: A country with the lowest level of financial development



### 3.1.4 Main theoretical predictions and what the data say

The above analysis can be summarized as follows. First, in a country in which  $\omega$  is initially large enough that credit constraints are not binding. For this country a further increase in financial development, as already noted, has no steady-state effect on normalized productivity or on innovation, and hence no effect on steady-state relative per-capita GDP.

Second, in a country in which  $\omega$  is small enough that credit constraints are binding, an increase in financial development will raise the curve  $F_2(a)$  in Figure 2 above, because, according to (7) it will raise the innovation rate for any given initial value of  $a$  by relaxing the credit constraints faced by entrepreneurs. This upward shift will raise the steady-state relative productivity  $\hat{a}$ , which will amplify the impact effect on innovation  $\tilde{\mu}(\omega a)$  thereby raising the steady-state innovation rate  $\hat{\mu}$ .

Aghion-Howitt-Mayer (2005) thus derive three main implications:

1. the likelihood that a country will converge to the frontier growth rate increases with its level of financial development, and
2. in a country that converges to the frontier growth rate, financial development has a positive but eventually diminishing effect on steady state per-capita GDP, relative to the frontier, and
3. the steady-state growth rate of a country that fails to converge to the frontier growth rate increases with its level of financial development.

Aghion-Howitt-Mayer (2005) confront these predictions to cross-country data on financial development and growth/convergence. They test the effect of financial development on convergence by running the following cross-country growth regression:

$$g_i - g_1 = \beta_0 + \beta_f F_i + \beta_y \cdot (y_i - y_1) + \beta_{fy} \cdot F_i \cdot (y_i - y_1) + \beta_x X_i + \varepsilon_i \quad (9)$$

where  $g_i$  denotes the average growth rate of per-capita GDP in country  $i$  over the period 1960 - 1995,  $F_i$  the country's average level of financial development,  $y_i$  the initial (1960) log of per-capita GDP,  $X_i$  a set of other regressors and  $\varepsilon_i$  a disturbance term with mean zero. Country 1 is the technology leader, which they take to be the United States.

Define  $\hat{y}_i \equiv y_i - y_1$ , country  $i$ 's initial relative per-capita GDP. Under the assumption that  $\beta_y + \beta_{fy} F_i \neq 0$  we can rewrite (9) as:

$$g_i - g_1 = \lambda_i \cdot (\hat{y}_i - \hat{y}_i^*)$$

where the steady-state value  $\hat{y}_i^*$  is defined by setting the RHS of (9) to zero:

$$\hat{y}_i^* = -\frac{\beta_0 + \beta_f F_i + \beta_x X_i + \varepsilon_i}{\beta_y + \beta_{fy} F_i} \quad (10)$$

and  $\lambda_i$  is a country-specific convergence parameter:

$$\lambda_i = \beta_y + \beta_{fy} F_i \quad (11)$$

that depends on financial development.

A country can converge to the frontier growth rate if and only if the growth rate of its relative per-capita GDP depends negatively on the initial value  $\hat{y}_i$ ; that is if and only if the convergence parameter  $\lambda_i$  is negative. Thus the likelihood of convergence will increase with financial development, as implied by the above theory, if and only if:

$$\beta_{fy} < 0. \quad (12)$$

The results of running this regression using a sample of 71 countries are shown in Table 1, which indicates that the interaction coefficient  $\beta_{fy}$  is indeed significantly negative for a variety of different measures of financial development and a variety of different conditioning sets  $X$ . The estimation is by instrumental variables, using a country's legal origins, and its legal origins<sup>4</sup> interacted with the initial GDP gap  $(y_i - y_1)$  as instruments for  $F_i$  and  $F_i (y_i - y_1)$ . The data, estimation methods and choice of conditioning sets  $X$  are all taken directly from Levine, Loayza and Beck (2000) who found a strongly positive and robust effect of financial intermediation on short-run growth in a regression identical to (9) but without the crucial interaction term  $F_i (y_i - y_1)$  that allows convergence to depend upon the level of financial development.

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<sup>4</sup>See LaPorta et al. (1998) for a detailed explanation of legal origins and its relevance as an instrument for financial development.



**Table 1: Growth, Financial Development, and Initial GDP Gap**

Estimation of equation:  $g - g_1 = \beta_0 + \beta_f F + \beta_y (y - y_1) + \beta_{fy} F(y - y_1) + \beta_x X$

Financial development ( $F$ ) Conditioning set ( $X$ )	Private Credit			Liquid Liabilities			Bank Assets		
	Empty	Policy <sup>a</sup>	Full <sup>b</sup>	Empty	Policy <sup>a</sup>	Full <sup>b</sup>	Empty	Policy <sup>a</sup>	Full <sup>b</sup>
<b>Coefficient estimates</b>									
$\beta_f$	-0.015 (-0.93)	-0.013 (-0.68)	-0.016 (-0.78)	-0.029 (-1.04)	-0.030 (-0.99)	-0.027 (-0.90)	-0.019 (-1.07)	-0.020 (-1.03)	-0.022 (-1.12)
$\beta_y$	1.507*** (3.14)	1.193* (1.86)	1.131 (1.49)	2.648*** (3.12)	2.388** (2.39)	2.384** (2.11)	1.891*** (3.57)	1.335* (1.93)	1.365 (1.66)
$\beta_{fy}$	-0.061*** (-5.35)	-0.063*** (-5.10)	-0.063*** (-4.62)	-0.076*** (-3.68)	-0.077*** (-3.81)	-0.073*** (-3.55)	-0.081*** (-5.07)	-0.081*** (-4.85)	-0.081*** (-4.46)
sample size	71	63	63	71	63	63	71	63	63

**Notes:** The dependent variable  $g - g_1$  is the average growth rate of per-capita real GDP relative to the US, 1960-95.  $F$  is average Financial Development 1960-95 using 3 alternative measures: Private Credit is the value of credits by financial intermediaries to the private sector, divided by GDP, Liquid Liabilities is currency plus demand and interest-bearing liabilities of banks and non-bank financial intermediaries, divided by GDP, and Bank Assets is the ratio of all credits by banks to GDP.  $y - y_1$  is the log of per-capita GDP in 1960 relative to the United States. <sup>a</sup>The Policy conditioning set includes average years of schooling in 1960, government size, inflation, the black market premium and openness to trade. <sup>b</sup>The Full conditioning set includes the policy set plus indicators of revolutions and coups, political assassinations and ethnic diversity. Estimation is by IV using  $L$  (legal origins) and  $L(y - y_1)$  as instruments for  $F$  and  $F(y - y_1)$ . The numbers in parentheses are t-statistics. Significance at the 1%, 5% and 10% levels is denoted by \*\*\*, \*\* and \* respectively.

AHM show that the results of Table 1 are surprisingly robust to different estimation techniques, to discarding outliers, and to including possible interaction effects between the initial GDP gap and other right-hand-side variables.

## 4 Interacting financial development and macroeconomic volatility

In this section we consider the interaction between financial development and macroeconomic volatility and policy in the growth process. The common view in macroeconomics, is that there should not be such an interaction as macroeconomic policy (budget deficit, taxation, money supply) are considered to affect primarily the short-run whereas financial development and other structural characteristics of an economy is all what matters for its long run growth rate.

Here again, Schumpeterian growth theory provides hints as to the nature and direction of the interaction effect we are looking for. The Schumpeterian view on volatility and growth, is that recessions provide a cleansing mechanism for correcting organizational inefficiencies and for encouraging firms to reorganize, innovate or reallocate to new markets. The cleansing effect of recessions is also to eliminate those firms that are unable to reorganize or innovate. Schumpeter himself would summarize that view as follows; “[Recessions] are but temporary. They are means

to reconstruct each time the economic system on a more efficient plan". Now, if firms could always borrow enough funds to either reorganize their activities or move to new activities and markets, and the same was true for workers trying to relocate from one job to another, the best would be to recommend that governments do not intervene over the business cycle, and instead let markets operate.

However, credit market imperfections may prevent firms from innovating and reorganizing in recessions. In particular, suppose that firms can choose between short-run capital investment and long-term R&D investment (this choice amounts to a research arbitrage condition). Innovating requires that firms survive short-run liquidity shocks (R&D is a long-term investment) and that to cover liquidity costs firms can rely only on their short-run earnings plus borrowing. Suppose in addition that growth is driven by innovations, with the growth rate of knowledge (or average productivity) being proportional to the flow of innovating firms in the economy. Absent credit constraints, and provided the value of innovation is sufficiently high, volatility will not affect innovation and growth as firms can always borrow up to the net present value of their future earnings in order to cover the short-run liquidity costs. But, now, suppose that the borrowing capacity of firms is proportional to their current earnings (the factor of proportionality is what we refer to as the credit multiplier, with a higher multiplier reflecting a higher degree of financial development in the economy). In a recession, current earnings are reduced, and therefore so is the firms' ability to borrow in order to innovate. This, in turn implies that the lower financial development, the more the anticipation of recessions will discourage R&D investments if those are decided before firms know the realization of the aggregate shock (since firms anticipate that with higher probability, their R&D investment will not pay out in the long-run as it will not survive the liquidity shock).

More formally, suppose that the liquidity shock  $\tilde{c}$  is idiosyncratic across firms, but independently and identically distributed with cumulative distribution function  $F$ , and that the aggregate shock  $a_t$  over time is distributed according to

$$a_t = \bar{a} + \varepsilon_t,$$

where  $\rho < 1$  and  $\varepsilon_t$  is i.i.d over time and normally distributed with mean zero and variance  $\sigma^2$ .

Firms live for two periods; at the beginning of the first period, say period  $t$ , they decide about how to allocate their initial wealth between: (i) short-run capital investment  $k_t$ , which yields short run profit  $a(k_t)^\alpha$  at the end of the first period, and; (ii) long-term R&D investment  $z_t$ , which yields an innovation value  $v_{t+1}$  equal to the expected productivity  $E(a_{t+1})$  in period  $(t + 1)$  with probability  $q(z_t) = z_t^\alpha$  in the second period provided the firm overcomes potential liquidity shocks that may occur at the end of their first period. The investment decision is made before the

realization of the aggregate shock  $a_t$ . Credit market imperfections prevent a firm with short-run profit flow  $a(k_t)^\alpha$  to invest more than  $\mu a(k_t)^\alpha$  for the purpose of covering its idiosyncratic liquidity cost  $\tilde{c}$ .

Since firms choose the allocation of investment before they learn the realization of  $a_t$ , they choose  $k$  and  $z$  to

$$\begin{aligned} \max_{k,z} \{ & \mathbb{E}_t(a_t)(k_t)^\alpha + \mathbb{E}_t(a_{t+1})(z_t)^\alpha \mathbb{E}_t(F(\mu a_t(k_t)^\alpha)) \} \\ \text{s.t. } & k_t + z_t \leq \mu w, \end{aligned}$$

where  $\mathbb{E}_t$  refers to the expected value at date  $t$ , and where we assume that:

$$\mathbb{E}_t(a_t) = \mathbb{E}_t(a_{t+1}) = \bar{a}.$$

Assuming that the cumulative distribution function (c.d.f) for the liquidity shock,  $F$ , is concave, it is immediate to see that a mean-preserving spread of  $a_t$  will reduce the firm's incentive to invest in R&D and it will also reduce the expected probability of overcoming the liquidity shock,  $\mathbb{E}_t(F(\mu a_t(k_t)^\alpha))$ . It will thus reduce even more the expected growth rate equal to

$$g_t = (z_t)^\alpha \mathbb{E}_t(F(\mu a_t(k_t)^\alpha)).$$

Based on cross-country panel data over the period 1960-2000, Aghion, Angelos, Banerjee and Manova (2005) show that the interaction term between financial development and volatility is indeed significantly positive. In theory, one could imagine a counteracting effect of volatility on growth, namely that higher volatility also means higher profits in booms, and therefore a possibly higher ability for firms to innovate during booms; however the regressions in AABM, Ramey and Ramey (1995), or below, all suggest that this latter effect is of second order.

#### 4.1 The effects of countercyclical macropolicies on growth

Having shown that macroeconomic volatility tends to be more harmful to growth the lower the level of financial development, a natural conjecture is that the tighter the credit constraints faced by firms, the greater the scope for appropriate government intervention in particular to reduce the costs that negative liquidity shocks impose on credit-constrained firms. That government intervention might increase aggregate efficiency in an economy subject to credit constraints and aggregate shocks, has already been pointed for example by Holmstrom and Tirole (1998). However this point has never been formally made in the context of a growth model, nor have its potential empirical and policy implications been explored so far. This subsection reports a first attempt<sup>5</sup> at filling this gap, more precisely by analyzing the interplay

<sup>5</sup>The material in this subsection is drawn from current work by Aghion, Barro and Marinescu on cyclical budgetary policies and productivity growth.

between financial development and the growth effects of different types of cyclical macropolicies.

To the extent that, in an economy with tight credit constraints, the occurrence of a recession forces a number of firms to cut on innovative investments in order to survive idiosyncratic liquidity shocks, a natural idea is that a countercyclical budgetary may foster innovation and growth by reducing the negative consequences of a recession (or a bad aggregate shock) on firms' innovative investments. For example, the government may decide to increase the volume of its public investments, thereby fostering the demand for private firms' products. Or the government may choose to directly increase its subsidies to private enterprises, thereby increasing their liquidity holdings and thus making it easier for them to face idiosyncratic liquidity shocks without having to sacrifice R&D or other types of longer-term growth-enhancing investments. From our analysis in the previous subsection, a natural prediction is that the lower the level of financial development, that is, the tighter the credit constraints faced by firms, the more growth-enhancing such countercyclical policies should be.

Current work by Aghion, Barro and Marinescu (2005) [ABM], analyzes the effects of (counter)cyclical budgetary policies on growth, using annual panel data on 17 OECD countries over the period 1965-2001; in particular, they restrict their analysis to a subset of "reasonable" countries for which Easterly (2005) would predict no effect of policy! Then, ABM perform two-stage least-square regressions where:

1. The first stage regressions estimate, for each year, the correlations between: (i) on the left-hand side of the first-stage equation, variables such as: government debt, primary budget deficit, government investment, government consumption, defense spending, social security spending, direct subsidies to private enterprises; (ii) on the right-hand side of the first-stage equation: (a) the current output gap (measured by the difference between the real GDP and the maximum potential GDP, that is the GDP at minimum level of non-inflationary employment for given capital stock; (b) the current gap in government expenditures (measured by the deviation of government expenditure to its trend); and the lagged public debt to GDP ratio (which reflects the share of public spending used to meet the outstanding public debt obligations).

Figure 4 below summarizes the results from the first-stage regressions with the primary budget deficit as the left-hand-side variable for Australia; on average over the period, Australia shows a negative and significant correlation between the primary budget deficit and the output gap (the cyclicity coefficient which we denote by *cycl*), equal to -0.16: thus, on average over the period, Australia has followed a countercyclical policy.

Figure 4A: Procyclicality by year, France

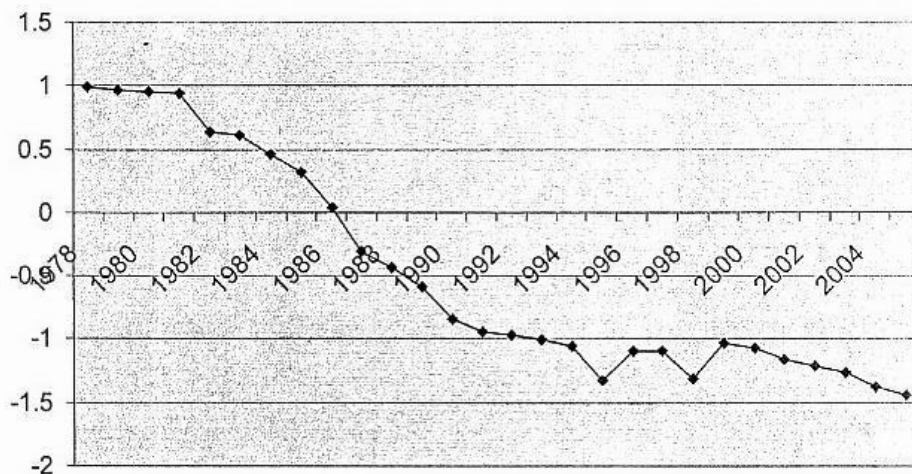
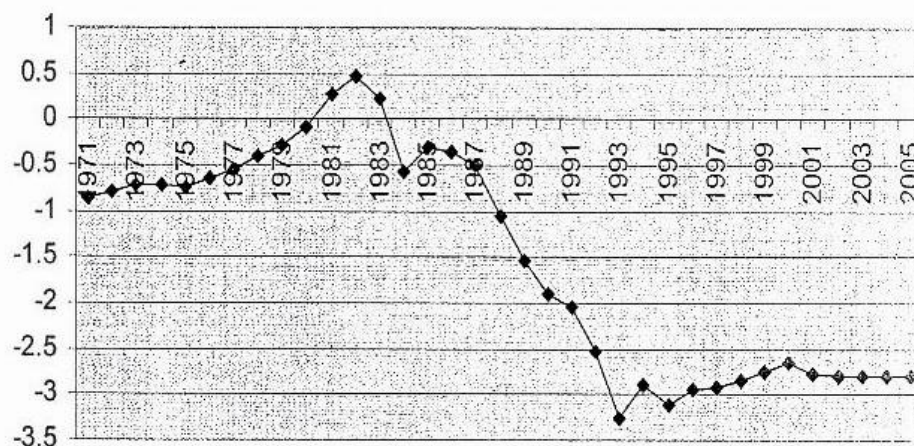


Figure 4B: Procyclicality by year, United Kingdom



2. The second stage regressions estimate, the annual growth rate of per capita GDP (left-hand side variable) as a function of: (i) the lagged value of the cyclicality coefficient obtained from the first stage regression, which we denote by *lcycl*; (ii) lagged financial development, *lpc*, which we measure once again by the ratio of private credit to GDP; (iii) the interaction *lcycl.lpc* between these two variables. Our prediction is that the coefficient on *lcycl* should be negative (a procyclical budgetary policy is bad for growth in a country with no credit at all) whereas the interaction coefficient on *lcycl.lpc* should

be positive (a procyclical budgetary policy is less detrimental to growth, the higher the level of financial development).

The second-stage results with regard to the primary deficit show that a more procyclical primary deficit is detrimental to growth (the coefficient on *lcycl* is negative equal to -0.008 if we consider the whole sample of countries, and to -0.015 if we restrict the analysis to countries where the variance in the *cycl* coefficient in a VC estimation for the first-stage, is non-zero.

Having shown that countercyclical budget deficits can be growth-enhancing, the next step is to look at the composition of public spending. ABM consider the following categories of spending: (i) public investment; (ii) defense spending, which is part of (i); (iii) direct subsidies to private enterprises; (iv) government consumption; (v) social security. For each category, ABM perform first-stage regressions of the corresponding variable on the output gap for each country, which yields the corresponding cyclicity coefficient; then in the second-stage regression, productivity growth is regressed over that coefficient, financial development, and the interaction between the two, controlling for country, or year fixed effects, or both.

Here we shall only show the tables for public investment and government consumption, as the difference between the two is striking. On the one hand, as shown in Table 2, countercyclical public investments are highly growth-enhancing at low levels of financial development with highly negative and significant correlations between productivity growth and the lagged cyclicity of public investment (negative coefficients which are significant at the 5% both, in the regression controlling for the linear time trend or that controlling for year fixed effects), whereas the interaction coefficients are positive and significant at the 5% or 1% when controlling for year fixed effects.

**Table 2: Public Investment**

	No year effects	Linear time trend	Year fixed effects
	Growth of GDP per capita	Growth of GDP per capita	Growth of GDP per capita
Lag(procyclicality of public investment)	-0.082 (0.054)	-0.077 (0.054)	-0.072 (0.035)**
Lag(private credit / GDP)	-0.013 (0.007)*	-0.015 (0.007)**	-0.012 (0.005)**
Lag(procyclicality of public investment*private credit / GDP)	0.071 (0.034)**	0.080 (0.034)**	0.082 (0.025)***
Relative GDP per capita	0.001 (0.004)	0.032 (0.013)**	0.038 (0.021)*
Year		0.001 (0.001)**	
Constant	0.039 (0.017)**	-2.441 (0.973)**	0.225 (0.115)*
Observations	453	453	453
R-squared	0.06	0.07	0.42

All regressions include country fixed effects

Robust standard errors in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

On the other hand, when we turn to government consumption in Table 3, everything becomes insignificant.

**Table 3: Government Consumption**

	No year effects	Linear time trend	Year fixed effects
	Growth of GDP per capita	Growth of GDP per capita	Growth of GDP per capita
Lag(procyclicality of government consumption)	-0.005 (0.028)	-0.005 (0.027)	0.007 (0.021)
Lag(private credit / GDP)	-0.006 (0.008)	-0.008 (0.008)	-0.006 (0.006)
Lag(procyclicality of government consumption * private credit / GDP)	-0.008 (0.032)	-0.007 (0.032)	-0.004 (0.023)
Relative GDP per capita	0.002 (0.004)	0.028 (0.013)**	0.028 (0.022)
year		0.001 (0.001)**	
Constant	0.037 (0.017)**	-2.101 (1.000)**	0.168 (0.116)
Observations	453	453	453
R-squared	0.05	0.06	0.41

All regressions include country fixed effects

Robust standard errors in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Looking at the other components of government spending, ABM find: (a) that countercyclical defense spending is growth-enhancing at low levels of financial development (negative significant direct coefficient with or without year fixed effect or linear time trends) but the interaction coefficient is never significant; (b) that the coefficients for social security are insignificant (apart from the interaction coefficient in the regression with year fixed effects, which is significant at the 10%); that the direct and interaction coefficients for direct subsidies to private enterprises are highly significant in the regression controlling for year fixed effects, still significant in the regression not controlling for year fixed effects or linear time trend, but not significant in the regression controlling for linear time trend only. All these regressions control for country fixed effects.

So far, we have concentrated on budgetary policy. But one could as well perform similar exercises with variables such as the M2/GDP ratio also used by Easterly (2005) or short-term real interest rates which are also linked to monetary policy. For the purpose of this lecture, we have looked at the former, and the second-stage regression is summarized in Table 4 below.

**Table 4: Money Supply (M2/GDP)**

	Country fixed effects	Year fixed effects	Country and year fixed effects
	Growth of GDP per capita	Growth of GDP per capita	Growth of GDP per capita
Lag(procyclicality of M2/GDP)	0.001 (0.004)	-0.005 (0.003)*	-0.003 (0.004)
Lag(private credit / GDP)	-0.006 (0.007)	-0.002 (0.002)	-0.008 (0.006)
Lag(procyclicality of M2/GDP *private credit / GDP)	0.001 (0.004)	0.007 (0.002)***	0.005 (0.003)
Relative GDP per capita	0.003 (0.005)	0.001 (0.001)	0.029 (0.019)
Constant	0.038 (0.019)**	0.028 (0.004)***	0.172 (0.099)*
Observations	458	458	458
R-squared	0.06	0.37	0.41

Robust standard errors in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Unlike for budgetary variables, the coefficients are not very significant except in the regression where one controls for linear time trends; the regression where one controls for year fixed effects shows an interaction coefficient which is significant at the 15%. Thus there is something to having a countercyclical M2/GDP ratio at lower levels of financial development, but nothing as significant as the effect of countercyclical government investment for example.

Finally, what can we say about the interplay between countercyclical budgetary policies and structural reforms such as product or labor market liberalization? Table 5<sup>6</sup> shows that the two are complementary: namely, a higher degree of product or labor market liberalization increases the positive growth impact of countercyclical budgetary policy. A plausible explanation for such complementarity is that government support during a recession, is useful only to the extent that it helps firms maintain long-term innovative investments aimed at entering a new market or a new activity or at improving management methods. However, high entry costs or high labor mobility costs will reduce firms' ability to enter those new activities or to hire

<sup>6</sup>Product market liberalization is captured by the OECD index *pmin3* which, for each OECD country, corresponds to the average degree of deregulation of entry over all sectors in that country. This variable is constructed from data compiled by Giuseppe Nicoletti and Stefano Scarpetta, and it is used in their (2003) paper. The dependent variable *dlngdp* is just the growth rate of per capita GDP, and the *iga* variable is the value of government fixed investment, for which annual data for all OECD countries are available from 1960 to 2005. The cyclicity calculations for *iga* were done as in the previous tables through a time-varying coefficients estimation in first stage regressions of government investment over the output gap for each country separately. The first column controls for country fixed effects only. The second column controls for country fixed effects and year fixed effects.



employees for the new tasks, with or without government support. This finding goes counter to a common view whereby the implementation of structural reforms would reduce the need for pro-active macroeconomic policies to enhance growth.

**Table 5: Product Market Liberalization**

	Year fixed effects	Country and year fixed effects
	Growth of GDP per capita	Growth of GDP per capita
Procyclicality of public investment	-0.048 (0.025)*	-0.033 (0.047)
Product market liberalization	-0.011 (0.008)	0.002 (0.019)
Procyclicality of public investment *product market liberalization	0.126 (0.057)**	0.134 (0.077)*
Constant	0.024 (0.003)***	0.035 (0.008)***
Observations	352	352
R-squared	0.33	0.39

Robust standard errors in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

## 4.2 Exchange rate regimes

The existing theoretical literature on exchange rates and open macroeconomics does not look at long-run growth. Based on the intuition that growth in countries with lower financial development benefits more for macroeconomic stability, and that exchange rate fluctuations represent a major component of aggregate macroeconomic volatility, Aghion, Bacchetta, Ranciere and Rogoff (2005), henceforth ABRR, predict that in economies with lower level of financial development, a flexible exchange rate regime will tend to generate excessive currency appreciations which in turn will make all firms (including the most performing ones) become more vulnerable to other shocks, e.g. on the liquidity needs of long-term (productivity-enhancing) investments. This, in turn, will tend to discourage innovative investments.

Thus the lower financial development, the more growth-enhancing it is for a country to have a fixed exchange rate regime. On the other hand, in economies with

high levels of financial development, exchange rate flexibility may enhance average growth by weeding out the less innovative firms while promoting the more innovative. This prediction turns out to be fully vindicated by the data. In particular, using a GMM panel data system estimator for 83 countries over a sequence of five-year subperiods between 1961 and 2000, ABRR regress the growth rate of output per worker on exchange rate flexibility (computed from the same classification as in Rogoff et al (2003)) and its interaction with financial development. The results are summarized in Table 6 below. We see that the direct effect of exchange rate flexibility on growth is negative and significant, while the interaction term between financial development and exchange rate flexibility has a positive and significant coefficient. Thus, as predicted by ABRR, the higher the degree of financial development, the less negative the effect of exchange rate flexibility on growth.

**Table 6**

**Growth effects of the flexibility of exchange rate regime: the role of financial development**

Dependent Variable: Growth Rate of Output per Worker

Estimation: 2-step system GMM estimation with Windmeijer (2003) Small Sample Robust Correction and Time Effects

(Standard errors are presented below the corresponding coefficient)

Period: 1961-2000

Unit of observation: Non-overlapping 5-year averages

Estimation Technique: System GMM

	[2.1]	[2.2]	
Degree of the Exchange Flexibility (Reinhart and Rogoff classification)	-0.1912 <i>0.3493</i>	-1.1352 <i>0.5794</i>	*
Financial Development (private domestic credit/GDP, in logs)	0.6843 <i>0.3471</i>	** 0.1845 <i>0.1597</i>	
Initial Output per Worker (log(Initial Output per Worker))	-0.1498 <i>0.4181</i>	-0.1170 <i>0.4473</i>	
Flexibility * Financial Development		0.3029 <i>0.1459</i>	**

This result may have interesting policy implications. For example, it may raise further questions for those European countries that are contemplating joining the EMU system. Given their level of financial development, should they tie their hands by adopting the Euro rather than maintaining a fully flexible exchange rate regime? The above result may also call for further organizational changes within the Euro zone, so that it would look more like one country with a flexible exchange rate vis-a-vis the rest of the world.

## 5 Conclusion

In this paper we have shown that interacting financial development with macroeconomic variables such as average productivity or output volatility in growth and finance regressions, generates a rich set of new empirical predictions, e.g on convergence and divergence, and on the growth effect of countercyclical macroeconomic policies.

One next step we are currently exploring, in joint work with Peter Howitt, is to look at finance and growth in the context of an open economy. Our focus is on the extent to which the relationship between domestic savings and growth remains significant once we allow for free capital movements across countries, and whether or not the significance of the correlation between domestic savings and growth depends upon a country's distance to the technological frontier and/or its level of financial development. This and other extensions of the analyses surveyed in this paper, should generate further exciting research on finance and growth.

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