Financial Development, Volatility, and Growth

Philippe Aghion
Harvard and NBER

George-Marios Angeletos
MIT and NBER

Abhijit Banerjee
MIT and NBER

Kalina Manova
Harvard and NBER

MOTIVATION

- early RBC theory

  → dichotomy between long-run growth and business cycle

- data (e.g. Ramey and Ramey, 1995)

  → volatility has a negative effect on growth

Table 1a. Ramey-Ramey revisited

Dependent variable: Growth 1960-1995

	Whole sample				OECD countries			
Independent variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
initial income		-0.0019	-0.0129	-0.0158		-0.0110	-0.0230	-0.0258
		(-0.69)	(-4.02)***	(-4.76)***		(-3.49)***	(-8.00)***	(-8.65)***
volatility	-0.2465	-0.2796	-0.2286	-0.3205	0.2712	0.0370	-0.2561	-0.2303
	(-2.60)***	(-2.63)***	(-2.48)**	(-2.91)***	(1.41)	(0.22)	(-2.08)*	(-1.42)
pop growth			-0.0087	-0.0094			0.0022	-0.0003
			(-3.25)***	(-3.39)***			(0.92)	(-0.12)
sec school enrollment			0.0281	0.0201			0.0095	0.0046
			(2.09)**	(1.49)			(1.98)*	(1.08)
government size				0.00004				-0.00011
				(0.10)				(-0.42)
inflation				0.0001				-0.0011
				(1.05)				(-2.39)**
black market premium				-0.0203				-0.0317
				(-2.28)**				(-0.41)
trade openness				0.00011				-0.00006
				(1.88)*				(-1.88)*
R-squared	0.0904	0.0969	0.3734	0.5445	0.0829	0.4194	0.8397	0.9324
N	70	70	69	62	24	24	21	20

Note:Dependent variable is average growth over the 1960-1995 period. t-statistics in parenthesis. Constant term not shown. 1960 1995 sample period.
****,**,*,^ significant at the 1%, 5%, 10% and 11% respectively.*

MOTIVATION

- early RBC theory

  → dichotomy between long-run growth and business cycle

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  → volatility has a negative effect on growth

- endogenous growth theory (*AK*, precautionary savings, investment risk)

  → ambiguous effect of volatility on growth, via savings/investment

Table 1b. Ramey-Ramey revisited

(controlling for average investment/GDP)

	Whole Sample		OECD	
Independent variable	**(1)**	**(2)**	**(3)**	**(4)**
initial income	-0.0094	-0.0161	-0.0123	-0.0258
	(-3.89)***	(-5.63)***	(-4.25)***	(-8.23)***
volatility	-0.1829	-0.2589	0.0142	-0.2295
	(-2.14)**	(-2.70)***	(0.09)	(-1.35)
investment/GDP	0.1742	0.1159	0.0662	0.0036
	(6.47)***	(4.42)***	(2.43)**	(0.18)
pop growth		-0.0076		-0.0001
		(-3.16)***		(-0.06)
sec school enrollment		0.0074		0.0047
		(0.62)		(1.04)
government size		-0.00013		-0.00010
		(-0.37)		(-0.35)
inflation		0.0001		-0.0011
		(0.80)		(-2.02)*
black market premium		-0.0178		-0.0333
		(-2.32)**		(-0.41)
trade openness		0.00010		-0.00006
		(1.86)*		(-1.70)
R-squared	0.4472	0.6687	0.5515	0.9326
N	70	62	24	20

Note: Dependent variable is average growth over the 1960-1995 period. All regressors are averages
****,**,*,^ significant at the 1%, 5%, 10% and 11% respectively.*

MOTIVATION

- early RBC theory

  → dichotomy between long-run growth and business cycle

- data (e.g. Ramey and Ramey, 1995)

  → volatility has a negative effect on growth

- endogenous growth theory (*AK*, precautionary savings, investment risk)

  → ambiguous effect of volatility on growth, via savings/investment

- data (e.g. Ramey and Ramey, 1995)

  → most of the effect via a different channel, not savings/investment

THIS PAPER

transmission channel:

cyclical composition of investment

exogenous shocks

⇓ ⇓

productivity-enhancing investments

⇓ ⇓

TFP, growth, and volatility

differential effects depending on credit markets

a theory for the Solow residual

RESULTS

- **complete markets** ⇒
  - ▸ productivity-enhancing investment **countercyclical**
  - ▸ mitigates business cycle
  - ▸ likely positive relation between growth and volatility

- **tight borrowing constraints** ⇒
  - ▸ productivity-enhancing investment **procyclical**
  - ▸ amplifies business cycle
  - ▸ likely negative relation between growth and volatility

EMPIRICAL FINDINGS

- cross-section and panel
  - ▸ 46 countries/OECD
  - ▸ 1960-2000/1973-1999

- tighter credit constraints ⇒
  - ▸ lower growth and more volatility
  - ▸ stronger effect of volatility on growth
  - ▸ not via total investment
  - ▸ higher sensitivity of growth to shocks
  - ▸ more countercyclical R&D

LAYOUT

1. Introduction

2. Model

3. Investment in Capital and R&D

4. Growth and Volatility

5. Empirical Findings: Cross-Section

6. Empirical Findings: Panel

THE MODEL

- two types of investment

- type 1: **"working capital"**

  ▸ short horizon: little time-to-build, low adjustment costs

- type 2: **"productivity-enhancing investment (R&D, technology adoption, etc.)"**

  ▸ long horizon: more time-to-build, high adjustment costs

- **cyclical variation in**

  ▸ cost/return vs ▸ liquidity risk

PRODUCTIVITY GROWTH

- aggregate TFP A_t (Solow residual)

$$\ln A_t = \ln T_t + \ln a_t$$

T_t : level of technology

a_t : exogenous shock

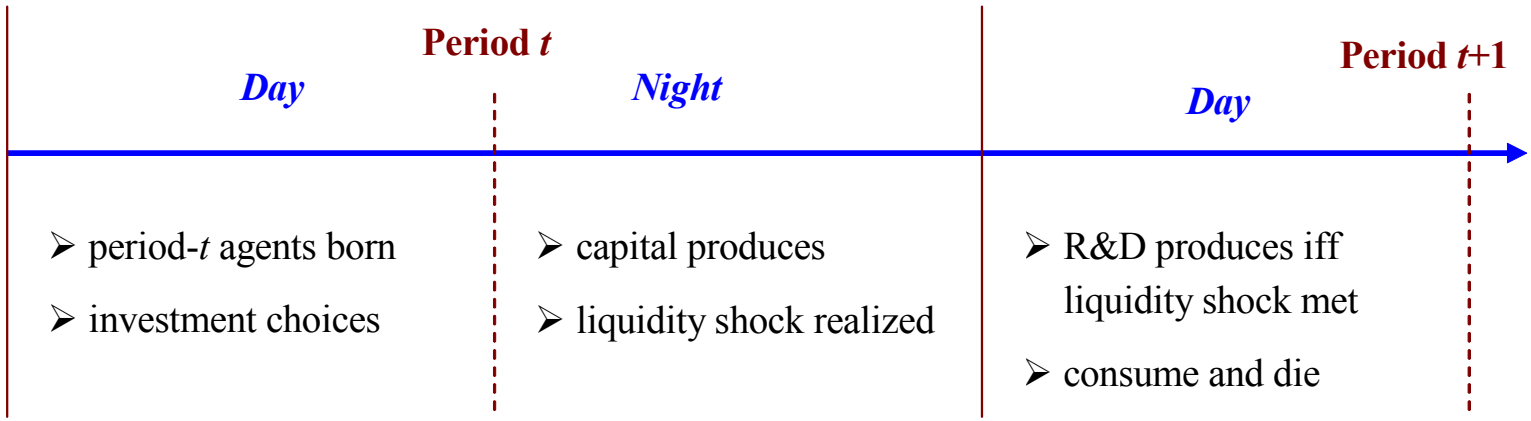
- the shock follows an $AR(1)$

$$\ln a_t = \rho \ln a_{t-1} + \varepsilon_t$$

$$\varepsilon_t \sim \mathcal{N}(-\tfrac{1}{2}\sigma^2, \sigma^2) \quad \rho \in [0,1) \quad \sigma > 0$$

INDIVIDUAL ENTREPRENEUR

- a mass one of agents (entrepreneurs) is born in each period t
- agents leave for two periods



- credit markets $\rightsquigarrow$ investment choices $\rightsquigarrow$ TFP growth and volatility

INDIVIDUAL ENTREPRENEUR

day of period *t*

- agent *i* born with

$$W_t^i = w\, T_t$$

- trade in "day" credit market and make **investment choices**

- budget constraint

$$K_t^i + Z_t^i + B_t^i \leq W_t^i$$

- equivalently

$$k_t^i + z_t^i + b_t^i \leq w$$

$$\left(k_t^i , z_t^i , b_t^i \right) = \left(\frac{K_t^i}{T_t} , \frac{Z_t^i}{T_t} , \frac{B_t^i}{T_t} \right)$$

night of period t

- **capital** produces

$$\Pi_t^i = A_t \, \pi(k_t^i)$$

- **liquidity** shock is realized

$$C_t^i = c_t^i \, T_t$$

where c_t^i i.i.d. with c.d.f. $F(c)$

- trade in "overnight" credit market

day of period $t + 1$

- **R&D** produces

$$\Pi_{t+1}^i + C_t^i \quad \text{if liquidity shock met,} \quad 0 \quad \text{otherwise}$$

where

$$\Pi_{t+1}^i = V_{t+1} \, q(z_t^i) \, , \qquad V_{t+1} = v_{t+1} \, T_t$$

CREDIT MARKETS

- **day market**

$$k_t^i + z_t^i \leq \mu w$$

- **overnight market**

$$c_t^i \leq \mu x_t^i$$
$$x_t^i \equiv a_t \pi(k_t^i) + (1 + r_t) b_t^i$$

- $\mu \geq 1$ parametrizes tightness of borrowing constraints

CREDIT MARKETS

- **day market**

$$k_t^i + z_t^i \leq \mu w$$

- **overnight market**

$$\begin{aligned} c_t^i &\leq \mu x_t^i \\ x_t^i &\equiv a_t \pi(k_t^i) + (1 + r_t) b_t^i \end{aligned}$$

- $\mu \geq 1$ parametrizes tightness of borrowing constraints

- storage available at night and $\int_i \left[c_t^i \mathbf{I}_t^i - a_t \pi(k_t^i) \right] \leq 0$

  $\Rightarrow$ zero overnight interest rate

- day interest rate r_t adjust so that $\int_i \left[k_t^i + z_t^i \right] = w$

ENTREPRENEUR'S PAYOFF

- consume end of life, risk neutral

- utility = expected end-of-life wealth

$$\mathbb{E}_t w^i_{t+1} \quad = \quad a_t \, \pi(k^i_t) \quad + \quad \mathbb{E}_t v_{t+1} \, q(z^i_t) \, F(\mu x^i_t) \quad + \quad (1 + r_t) \, b^i_t$$

where

$F(\mu x^i_t)$ = probability liquidity shock has been met

VALUE OF INNOVATION

$$\ln v_{t+1} \;=\; \theta \, \ln a_t \;+\; \xi_{t+1}$$

$$\theta \;=\; \theta(\rho, h) \;\leq\; \rho$$

TECHNOLOGICAL GROWTH

$$\ln T_{t+1} \;-\; \ln T_t \;=\; \gamma \int q(z_t^i)\mathbf{I}_t^i$$

EQUILIBRIUM : COMPLETE MARKETS

- agents solve

$$\max_{k,z}\{\ a_t\,\pi(k)\ +\ \mathbb{E}_t v_{t+1}\,q(z)\ +\ (1+r_t)b\ \}$$

- FOCs

$$a_t\,\pi'(k_t)\ =\ \mathbb{E}_t v_{t+1}\,q'(z_t)\ =\ 1+r_t$$

- equilibrium

$$\frac{q'(z_t)}{\pi'(k_t)}\ =\ \frac{a_t}{\mathbb{E}_t v_{t+1}}\ =\ a_t^{1-\theta}$$

$$k_t\ +\ z_t\ =\ w$$

Proposition *Under complete markets, capital investment k_t is procyclical, whereas productivity-enhancing investment z_t is countercyclical – and the more so the less persistent the productivity shock or the longer the horizon of the productivity-enhancing investment.*

EQUILIBRIUM : INCOMPLETE MARKETS

- agents solve

$$\max_{k,z,b} \left\{ \; a_t \, \pi(k) \; + \; \mathbb{E}_t v_{t+1} \, q(z) \, F(\bullet) \; + \; (1 + r_t) b \; \right\}$$

- FOCs reduce to

$$a_t \, \pi'(k_t) \; = \; 1 + r_t$$

$$\mathbb{E}_t v_{t+1} \, q'(z_t) \; = \; (1 + r_t) \left[\frac{1 \; + \; \mathbb{E}_t v_{t+1} \, q(z_t) \, f(\bullet) \, \mu}{F(\bullet)} \right]$$

Proposition *For any realization a_t, incomplete markets lead to a lower interest rate r_t, a higher capital investment k_t, and a lower productivity-enhancing investment z_t.*

CYCLICAL BEHAVIOR OF P.E.I.

- assume approximately constant elasticity for probability of meeting liquidity shock

$$\ln F(c) \approx \phi \ln c$$

- in equilibrium

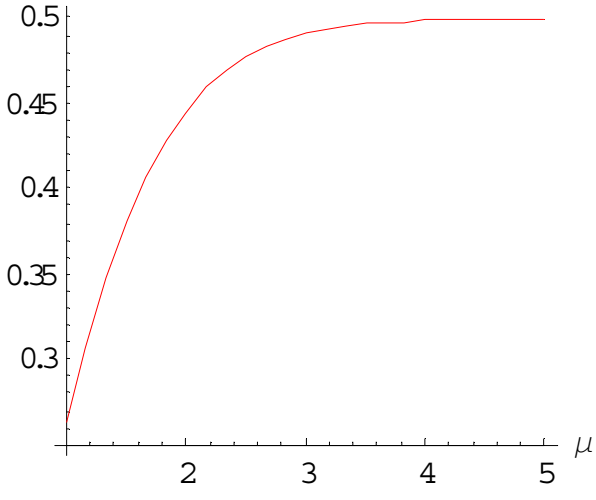
$$\frac{q'(z_t)}{\pi'(k_t)} \approx \frac{a_t^{1-\theta-\phi}}{[\mu\pi(k_t)]^{\phi}} + \phi\frac{q(z_t)}{\pi(k_t)}$$

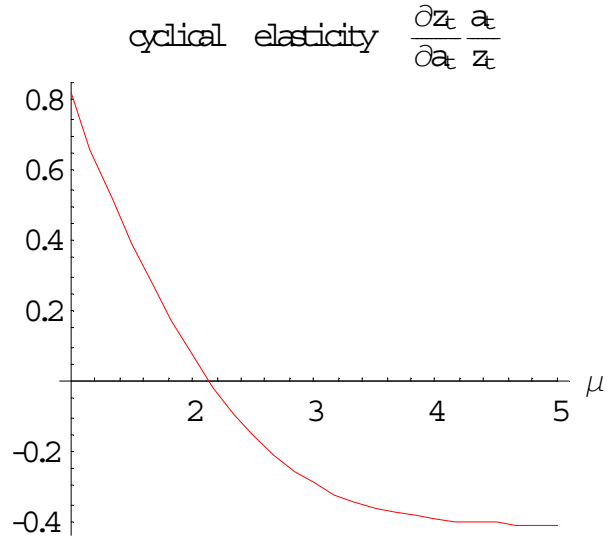
- *definition.* tigther constraints = lower μ and/or higher ϕ

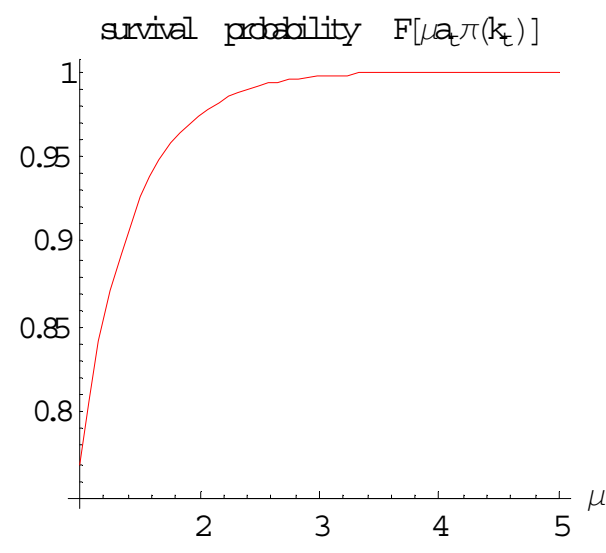
Proposition *Under sufficiently incomplete markets, k_t becomes countercyclical and z_t becomes procyclical – the more so the tighter credit constraints.*

NUMERICAL EXAMPLE

$$\pi(k) = k^{\alpha} \qquad q(z) = z^{\alpha} \qquad \text{log-normal } c$$







VOLATILITY AND GROWTH : COMPLETE MARKETS

- technological growth

$$\ln T_{t+1} - \ln T_t \quad = \quad \gamma \, q\big(\, z(a_t) \, \big)$$

- $z(a)$ decreasing in a

Proposition *Under complete markets, technological growth is countercyclical and therefore mitigates the business cycle.*

VOLATILITY AND GROWTH : COMPLETE MARKETS

- technological growth

$$\ln T_{t+1} - \ln T_t \quad = \quad \gamma \, q\big(\, z(a_t) \, \big)$$

- $z(a)$ decreasing in a

Proposition *Under complete markets, technological growth is countercyclical and therefore mitigates the business cycle.*

- $z(a)$ decreasing in a and bounded in $[0, w] \Rightarrow z(a)$ convex

Proposition *Under complete markets, the relation between volatility and growth is generally ambiguous, possibly positive.*

VOLATILITY AND GROWTH : INCOMPLETE MARKETS

- technological growth

$$\ln T_{t+1} - \ln T_t \quad = \quad \gamma \, q\big(\, z(a_t) \, \big) \, \delta(a_t)$$

$$\delta(a_t) \quad = \quad F\big(\, \mu \, a_t \, \pi\big(\, w - z(a_t) \, \big) \, \big)$$

- low μ or high $\phi \Rightarrow$ both $z(a)$ and $\delta(a)$ decreasing in a

Proposition *Under tight credit constraints, technological growth is procyclical and therefore amplifies the business cycle.*

VOLATILITY AND GROWTH : INCOMPLETE MARKETS

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- low μ or high $\phi \Rightarrow$ both $z(a)$ and $\delta(a)$ decreasing in a

Proposition *Under tight credit constraints, technological growth is procyclical and therefore amplifies the business cycle.*

- $z(a)$ and $\delta(a)$ decreasing in a and bounded $\Rightarrow$ concave

  $\hookrightarrow$ *causal relation*

- tigther constraints $\Rightarrow$ less growth, higher volatility

  $\hookrightarrow$ *spurious relation*

Proposition *Under tight credit constraints, higher volatility is likely to be associated with lower mean growth – the more so the tighter the credit constraints.*

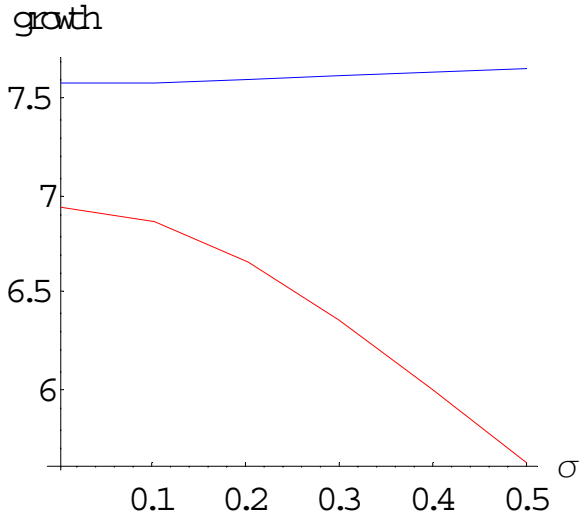
EXAMPLE 1

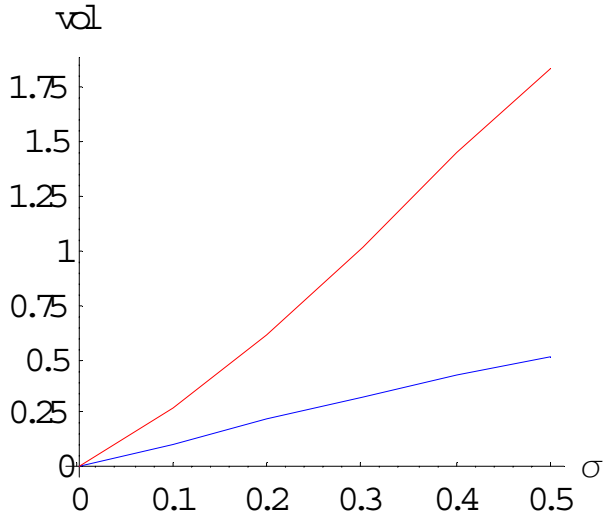
$\pi(k) = k \qquad q(z) = z \qquad \varphi = 1$

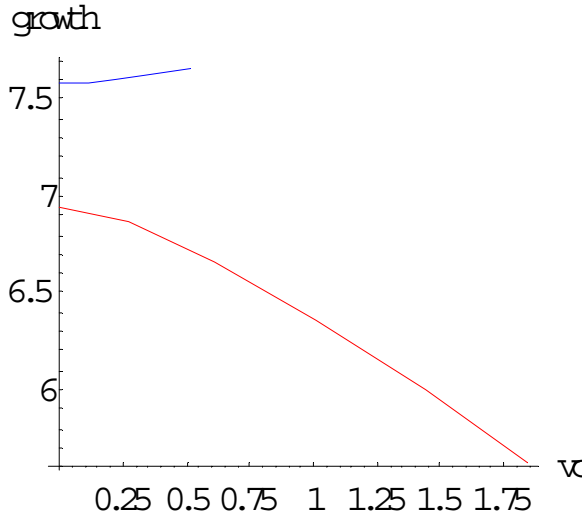
analytical solution

EXAMPLE 2

$\pi(k) = k^{\alpha} \qquad q(z) = z^{\alpha} \qquad$ log-normal c







SPILLOVERS

- production/demand/learning externalities
- value of innovation proportional to T_{t+1} rather than T_t

$$\ln v_{t+1} \quad = \quad \gamma\, z(a_t) \;+\; \theta\, \ln a_t \;+\; \xi_{t+1}$$

Proposition *Externalities increase the countercyclicality of technological growth and further mitigate the business cycle when markets are complete, whereas they increase the procyclicality of technological growth and further amplify the business cycle when markets are sufficiently incomplete.*

EMPIRICAL IMPLICATIONS

- lower credit ⇒ lower growth and higher volatility
- lower credit ⇒ stronger impact of volatility on growth
- lower credit ⇒ higher sensitivity of growth to shocks (especially lagged)
- lower credit ⇒ less procyclical (or more countercyclical) R&D

EMPIRICAL FINDINGS

Table 2. Growth, volatility and credit constraints: basic specification

Dependent variable: avg. growth, 1960-1995

	No investment				With investment			
	Whole sample		OECD countries		Whole sample		OECD countries	
Independent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
initial income	-0.0071	-0.0174	-0.0177	-0.0256	-0.0103	-0.0159	-0.0173	-0.0256
	(-2.56)**	(-5.77)***	(-6.69)***	(-6.32)***	(-4.10)***	(-5.70)***	(-6.55)***	(6.01)***
volatility	-0.4129	-0.5098	-0.5165	-0.5196	-0.3012	-0.4245	-0.5446	-0.5607
	(-3.06)***	(-3.33)***	(-1.73)*	(-1.14)	(-2.52)**	(-2.98)***	(-1.83)*	(-1.16)
private credit	-0.00005	-0.00016	-0.00019	-0.00006	-0.00008	-0.00020	-0.00021	-0.00008
	(-0.29)	(-0.98)	(-1.26)	(-0.29)	(-0.60)	(-1.34)	(-1.39)	(-0.37)
*volatility*private credit*	0.0113	0.0090	0.0080	0.0040	0.0069	0.0069	0.0083	0.0049
	(2.59)**	(2.15)**	(1.67)^	(0.63)	(1.76)*	(1.78)*	(1.73)^	(0.72)
investment/GDP					0.1420	0.0857	0.0270	0.0218
					(4.68)***	(3.20)***	(1.13)	(0.63)
pop growth		-0.0081		0.0005		-0.0076		0.0018
		(-3.55)***		(0.17)		(-3.64)***		(0.48)
sec school enrollment		0.0037		0.0064		-0.0040		0.0056
		(0.28)		(1.15)		(-0.33)		(0.92)
government size		-0.00001		0.00006		-0.00013		0.00027
		(-0.04)		(0.14)		(-0.43)		(0.51)
inflation		0.0003		-0.0004		0.0002		0.0001
		(2.78)***		(-0.52)		(1.91)*		(0.11)
black market premium		-0.0072		-0.0380		-0.0082		-0.0218
		(0.91)		(-0.34)		(-1.14)		(-0.18)
trade openness		0.00011		-0.00004		0.00009		-0.00003
		(2.06)**		(-0.62)		(1.98)*		(-0.36)
intell property rights		0.0013		-0.0015		0.0018		-0.0007
		(0.50)		(-0.50)		(0.76)		(-0.22)
property rights		0.0023		0.0003		0.0018		0.0009
		(1.94)*		(0.23)		(1.64)^		(0.57)
F-test (volatility terms)	0.0103	0.0051	0.2462	0.4122	0.0489	0.0105	0.2157	0.4580
F-test (credit terms)	0.0001	0.0310	0.0690	0.3993	0.0814	0.2120	0.1125	0.3875
R-squared	0.3141	0.6576	0.7894	0.9534	0.4889	0.7212	0.8049	0.9569
N	70	59	22	19	70	59	22	19

Table 3. Growth, volatility and credit constraints: sensitivity analysis

Dependent variable: avg. growth, 1960-1995								
Credit constraints var.:	private credit		liquid liabilities		bank assets		private credit$_{1960}$	
Independent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
initial income	-0.0071	-0.0174	-0.0062	-0.0166	-0.0076	-0.0173	-0.0042	-0.0146
	(-2.56)**	(-5.77)***	(-2.93)***	(-5.90)***	(-2.95)***	(-5.59)***	(-1.36)	(-5.46)***
volatility	-0.4129	-0.5098	-0.6781	-0.5554	-0.6441	-0.4981	-0.5722	-0.1904
	(-3.06)***	(-3.33)***	(-3.72)***	(-2.97)***	(-4.03)***	(-2.78)***	(-3.71)***	(-1.52)
credit	-0.00005	-0.00016	0.00000	-0.00004	-0.00016	-0.00021	-0.00048	-0.00023
	(-0.29)	(-0.98)	(-0.03)	(-0.22)	(-0.88)	(-0.96)	(-1.97)**	(-1.27)
*volatility*credit*	0.0113	0.0090	0.0122	0.0077	0.0162	0.0085	0.0204	0.0083
	(2.59)**	(2.15)**	(2.96)***	(1.90)*	(3.41)***	(1.61)^	(3.07)***	(1.74)*
Controls:								
pop growth, sec enroll	no	yes	no	yes	no	yes	no	yes
Levine et al controls	no	yes	no	yes	no	yes	no	yes
property rights	no	yes	no	yes	no	yes	no	yes
R-squared	0.3141	0.6576	0.5058	0.6864	0.3924	0.6328	0.2263	0.7232
N	70	59	70	59	70	59	60	52

*Note: Dependent variable is average growth over the 1960-1995 period. All regressors are averages over the 1960-1995 period, except for intellectual and property rights which are for 1970-1995 and 1970-1990 respectively. Initial income and secondary school enrollment are taken for 1960. In columns (7) and (8) the initial 1960 value of private credit is used. Private credit is defined as the value of credits by financial intermediaries to the private sector, divided by GDP. Liquid liabilities represents currency plus demand and interest-bearing liabilities of banks and non-bank financial intermediaries, dividided by GDP. Bank assets is the value of all credits by banks (but not other financial intermediaries). The Levine et al. controls include the share of government in GDP, inflation, trade openness, and the black market premium. Property rights refer to both intellectural and overall property rights. Constant term not shown. t-statistics in parenthesis. ***,**,*,^ significant at the 1%, 5%, 10% and 11% respectively.*

Table 4. The response of growth to terms of trade and commodity price shocks: 5-year averages

Dependent variable: 5-year avg. growth	Terms of trade shocks				Price commodity shocks			
	private credit$_t$		initial credit	lagged credit	private credit$_t$		initial credit	lagged credit
	OLS	FE	FE	FE	OLS	FE	FE	FE
Independent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
initial income	-0.0063	-0.0757	-0.0670	-0.0899	-0.0076	-0.0701	-0.0592	-0.0751
	(-2.02)**	(-8.06)***	(-7.22)***	(-7.12)***	(-2.68)***	(-8.34)***	(-6.92)***	(-7.00)***
shock	0.1402	0.1383	0.1062	0.1640	0.1297	0.1243	0.1462	0.1234
	(3.07)***	(3.60)***	(2.31)**	(3.65)***	(2.43)**	(2.68)***	(2.45)**	(2.36)**
private credit	0.0143	0.0177		0.0145	0.0264	0.0387		0.0325
	(1.71)*	(1.09)		(0.64)	(3.61)***	(3.21)***		(1.99)**
*private credit*shock*	-0.3226	-0.3509	-0.0539	-0.3599	-0.2263	-0.2119	-0.4207	-0.2065
	(-1.89)*	(-2.24)**	(-0.23)	(-1.78)*	(-1.22)	(-1.33)	(-1.44)	(-0.99)
Controls:								
pop growth, sec enroll	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.0696				0.0867			
R-squared within		0.3296	0.3418	0.3608		0.2723	0.2650	0.2519
R-squared between		0.0419	0.0287	0.0320		0.0403	0.0322	0.0516
# countries (groups)		73	57	70		72	57	72
N	323	323	277	255	388	388	331	321

*Note: Dependent variable is average growth over 5-year intervals in the 1960-1985 period. Terms of trade shock is defined as the growth of export prices less the growth of import prices. Commodity price shocks are export-weighted changes in the price of 42 commodities. Both shocks are averaged over the corresponding 5-year interval. Private credit is concurrent 5-year average, initial 1960-1964 average or lagged (t-5,t-1) average as indicated in the column heading. Constant term not shown. t-statistics in parenthesis. ***,**,*,^ significant at the 1%, 5%, 10% and 11% respectively.*

Table 5. The response of growth to commodity price shocks: annual panel data, fixed effects

Dependent variable: annual growth				
	private credit$_{1960}$	(t-5,t-1) avg credit	(t-10,t-6) avg credit	1960-2000 avg credit
Independent variable:	(1)	(2)	(3)	(4)
shock$_t$	0.0390	0.0356	0.0427	0.0449
	(1.87)*	(1.87)*	(2.19)**	(2.03)**
shock$_{t-1}$	0.0610	0.0508	0.0612	0.0959
	(2.84)***	(2.58)***	(3.02)***	(4.25)***
shock$_{t-2}$	0.0664	0.0772	0.0789	0.0701
	(3.04)***	(3.86)***	(3.77)***	(3.06)***
priv credit		0.0038	0.0092	
		(0.45)	(0.83)	
*priv credit*shock$_t$*	-0.1291	-0.0699	-0.0929	-0.1011
	(-1.14)	(-1.06)	(-1.27)	(-1.30)
*priv credit*shock$_{t-1}$*	-0.2314	-0.1039	-0.1326	-0.2845
	(-1.97)**	(-1.53)	(-1.71)*	(-3.57)***
*priv credit*shock$_{t-2}$*	-0.2446	-0.1915	-0.1929	-0.1671
	(-2.05)**	(-2.81)***	(-2.39)**	(-2.07)**
Controls:				
initial income	yes	yes	yes	yes
linear trend	yes	yes	yes	yes
R-squared within	0.0403	0.0395	0.0374	0.0457
R-squared between	0.0298	0.0182	0.0086	0.0316
# countries (groups)	44	44	44	44
N	1653	1516	1306	1653

*Note: Dependent variable is annual growth. Annual 1960-2000 data, except where lost due to lags. Panel fixed effects estimation. Shock$_t$, shock$_{t-1}$, shock$_{t-2}$ refer to the contemporaneous, 1-year and 2-year lagged commodity price shock, as defined in the text. All regressions include a constant term and a linear trend, and control for initial income. Initial 1960 or lagged average value used for private credit, as indicated in the column heading. Columns (2)-(4) limit the sample to countries for which we have initial credit values. t-statistics in parenthesis. ***,**,* significant at the 1%, 5% and 10% respectively.*

Table 7. The response of investment to commodity price shocks: annual panel data, fixed effects

Dependent variable:	Investment/GDP				R&D/investment			
Credit and prop rights:	(t-5,t-1) avg			(t-10,t-6) avg	(t-5,t-1) avg			(t-10,t-6) avg
Independent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$shock_t$	-2.56	-9.19	-27.60	-9.14	0.2629	0.7217	0.5945	0.2863
	(-0.21)	(-0.20)	(-0.59)	(-0.85)	(0.65)	(0.52)	(0.58)	(0.79)
$shock_{t-1}$	10.06	22.58	47.85	12.61	0.0547	1.0157	0.4940	0.0642
	(0.82)	(0.47)	(1.00)	(1.16)	(0.14)	(0.70)	(0.48)	(0.18)
$shock_{t-2}$	-7.56	111.51	148.02	-13.19	0.7429	-1.0500	0.0350	0.8298
	(-0.65)	(3.09)***	(3.89)***	(-1.20)	(1.94)*	(-0.97)	(0.04)	(2.24)**
priv credit	1.83	-0.17	-1.71	5.93	-0.0583	0.0078	-0.0685	-0.0735
	(1.32)	(-0.11)	(-0.77)	(3.72)***	(-1.29)	(0.17)	(-1.41)	(-1.37)
priv credit$*shock_t$	11.54	9.81	8.43	23.25	-0.3734	-0.2190	-0.2459	-0.4368
	(0.62)	(0.39)	(0.34)	(1.40)	(-0.61)	(-0.29)	(-0.45)	(-0.78)
*priv credit**$shock_{t-1}$	-2.23	0.14	-16.62	-3.42	-0.0871	-0.0220	0.0518	-0.1722
	(-0.12)	(0.01)	(-0.69)	(-0.20)	(-0.14)	(-0.03)	(0.10)	(-0.30)
*priv credit**$shock_{t-2}$	26.09	40.46	2.85	38.12	-1.2544	-1.2025	-1.1847	-1.5159
	(1.46)	(2.06)**	(0.14)	(2.08)**	(-2.12)**	(-2.04)**	(-2.75)***	(-2.45)**
intell rights		-3.35	-4.27			0.2276	0.1233	
		(-2.70)***	(-2.91)***			(6.11)***	(3.87)***	
*intell rights**$shock_t$		1.35	5.05			-0.1462	0.1216	
		(0.09)	(0.28)			(-0.32)	(0.31)	
*intell rights**$shock_{t-1}$		-5.27	-13.09			-0.3558	-0.2452	
		(-0.34)	(-0.71)			(-0.76)	(-0.61)	
*intell rights**$shock_{t-2}$		-40.58	-26.12			0.5785	0.0894	
		(-3.25)***	(-1.91)*			(1.54)	(0.30)	
prop rights			0.39				-0.0037	
			(1.54)				(-0.68)	
*prop rights**$shock_t$			1.02				-0.1037	
			(0.19)				(-0.87)	
*prop rights**$shock_{t-1}$			0.62				0.0141	
			(0.12)				(0.13)	
*prop rights**$shock_{t-2}$			-8.14				0.0478	
			(-2.00)**				(0.54)	
Controls:								
linear trend	yes	yes	yes	yes	yes	yes	yes	yes
R-squared within	0.2535	0.2581	0.2295	0.2848	0.5053	0.5804	0.6228	0.5084
R-squared between	0.0519	0.1470	0.1016	0.0635	0.2292	0.1518	0.2325	0.2227
# countries (groups)	14	14	13	14	14	14	13	14
N	337	291	221	331	338	291	221	332

*Note: Dependent variable is investment as a share of GDP or R&D as a share of investment. Annual 1973-1997 data, except where lost due to lags. Panel fixed effects estimation. Shockt, shockt-1, shockt-2 refer to the contemporaneous, 1-year and 2-year lagged commodity price shock, as defined in the text. Lagged (t-10,t-6) or (t-5,t-1) average used for private credit, as indicated in the column heading. All regressions include a constant term and a linear trend. t-statistics in parenthesis. ***,**,* significant at the 1%, 5% and 10% respectively.*

CONCLUDING REMARKS

- anticipatory effects of credit risk (forward vs backward propagation)
- cyclical variation in idiosyncratic risk
- cyclical behavior of TFP/endogenous Solow residual
- cross-country differences in impulse responses