Three Lectures on Economic Efficiency and Growth

CESifo

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Outline and aims

Present a policy-oriented overview of the theory and empirical evidence of economic growth

Trace linkages between economic growth and its main determinants: saving, investment, and economic efficiency

- ✓ Exogenous vs. endogenous growth
- ✓ Liberalization, stabilization, privatization
- ✓ Education, institutions, natural resources

Outline and aims

Lecture I

Saving, efficiency, and economic growth

Lecture II

Economic policy and growth

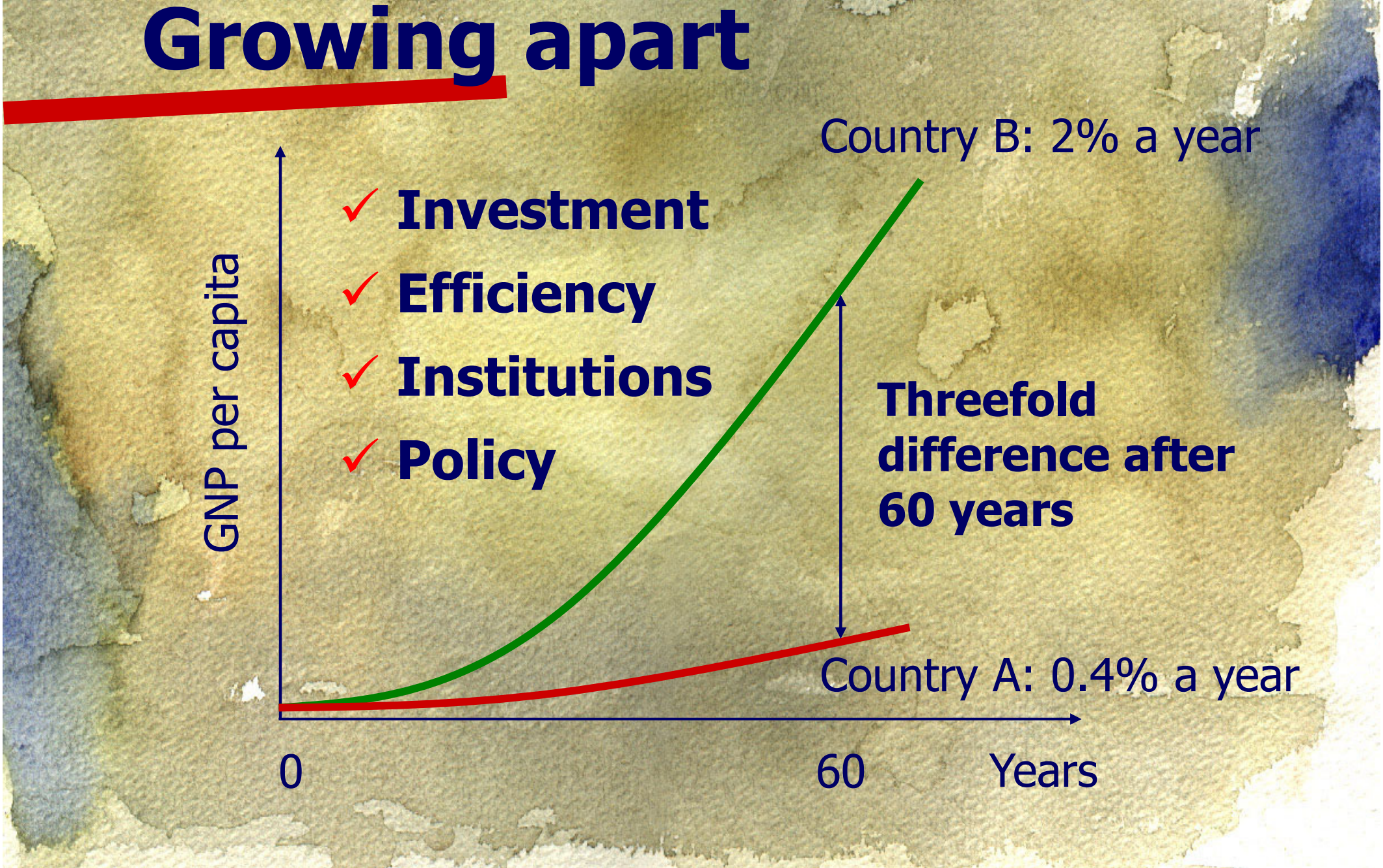
Lecture III

Education, natural resources, institutions, and empirical evidence

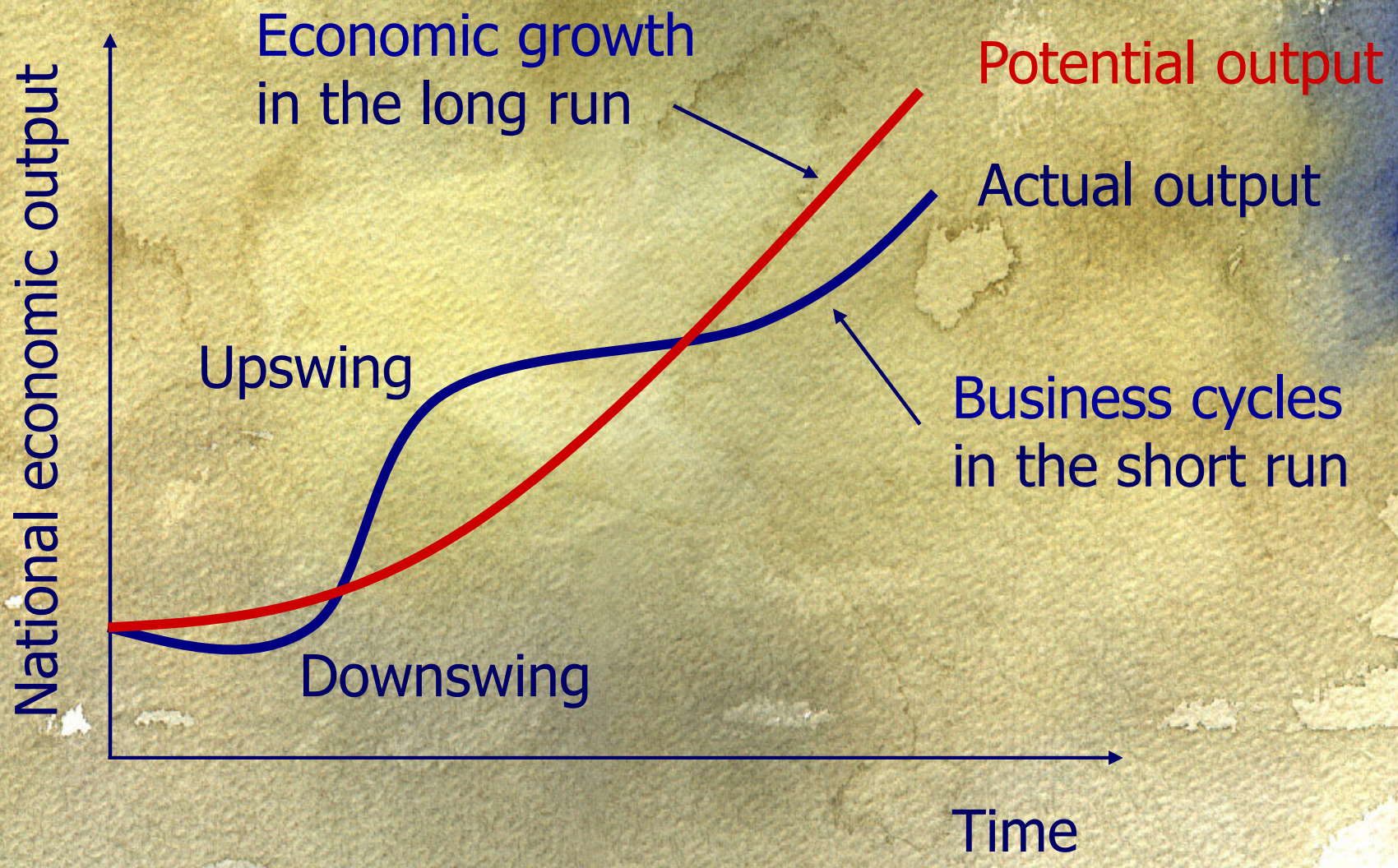
1 Introduction

- Growth theory
  - As old as economics itself
  - Smith, Marshall, Schumpeter, Keynes
  - Explicit growth theory started with Harrod and Domar in 1940s
- Why important?
  - Unfashionable in 1960s and 1970s
  - Limits to growth, etc.
  - Growth and development

Growing apart



Economic growth:
The short run vs. the long run



Other comparisons

1) West-Germany vs. East-Germany
2) Austria vs. Czech Republic
3) US vs. USSR
4) South Korea vs. North Korea
5) Taiwan vs. China
6) Finland vs. Estonia

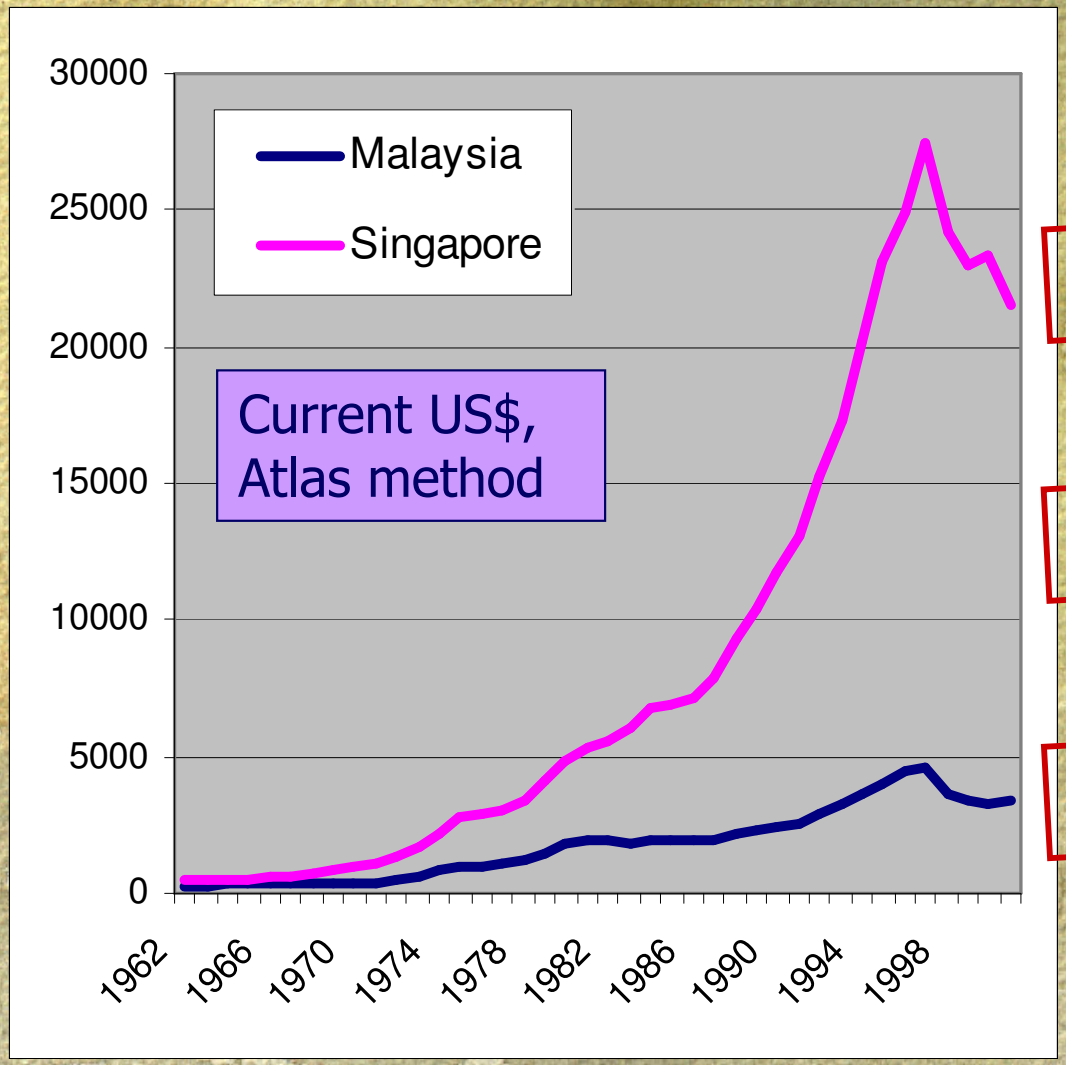
China vs. Europe:
1:1 in 1400
1:20 in 1989

- ✓ See my *Pictures of Growth*
- ✓ www.hi.is/~gylfason/pictures2.htm

Further comparisons

1) Thailand vs. Burma
2) Mauritius vs. Madagascar
3) Botswana vs. Nigeria
4) Tunisia vs. Morocco
5) Spain vs. Argentina
6) Dominican Republic vs. Haiti

Singapore and Malaysia: GNP per capita 1962-2001

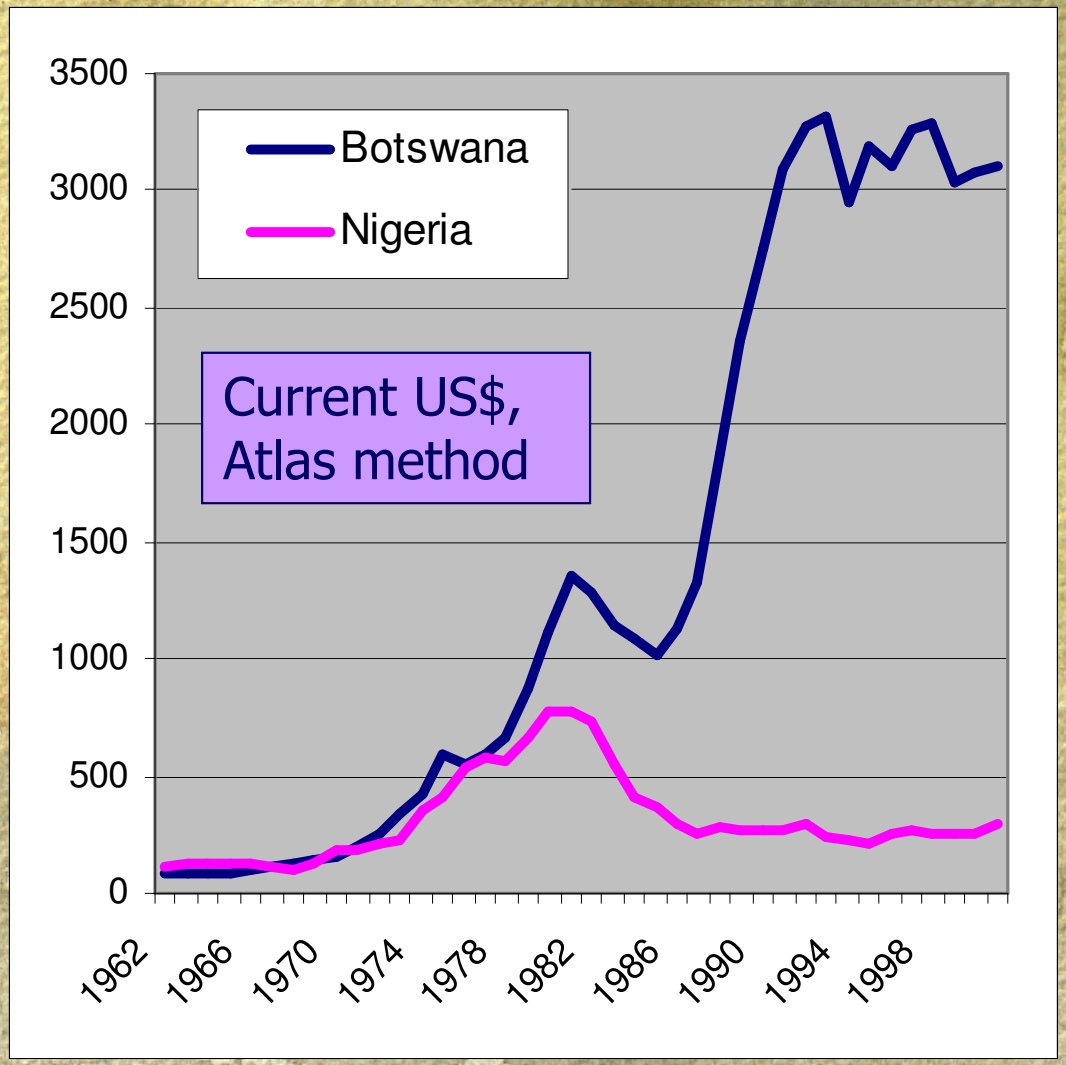


6.1%

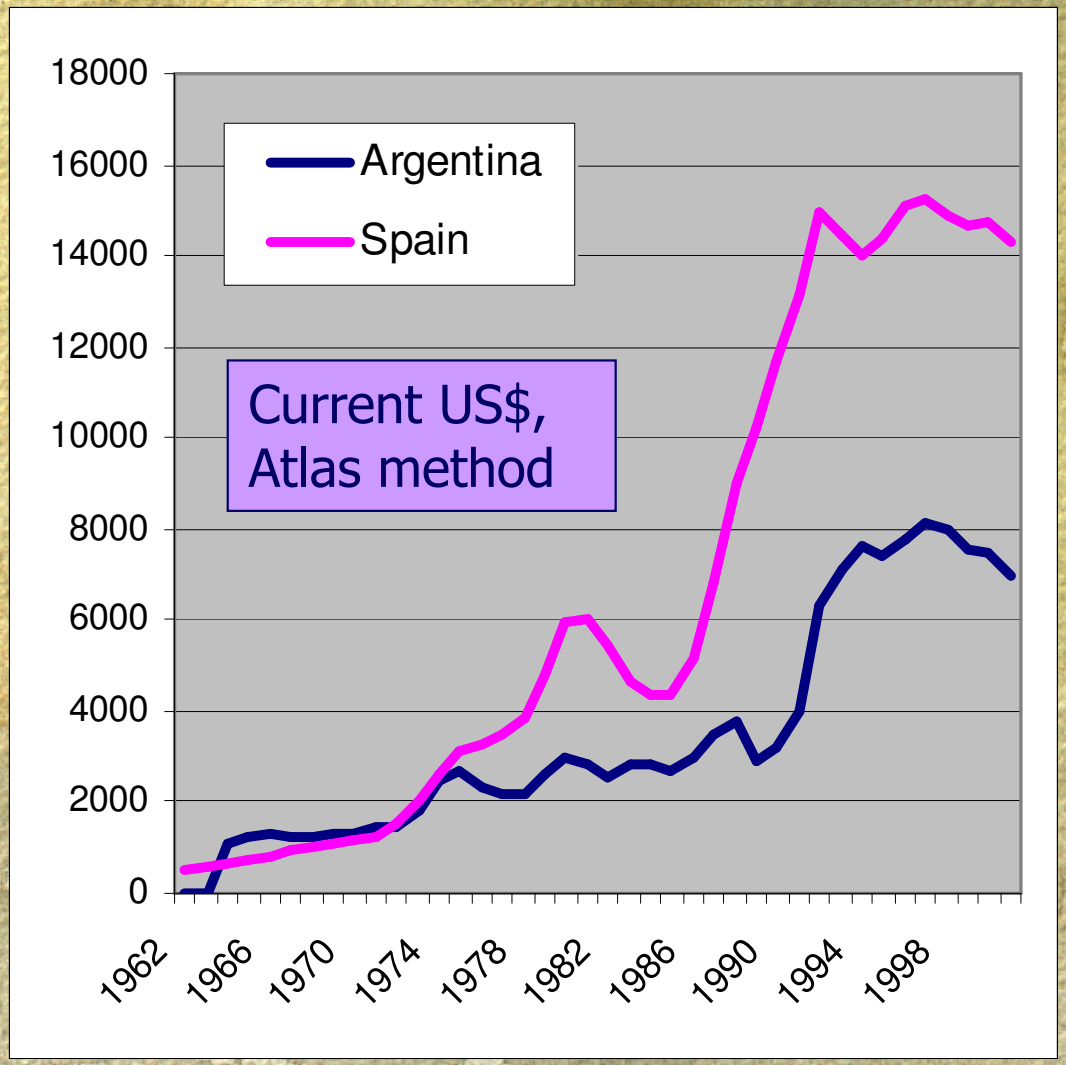
$(1.02)^{40} = 2.2$

4.1%

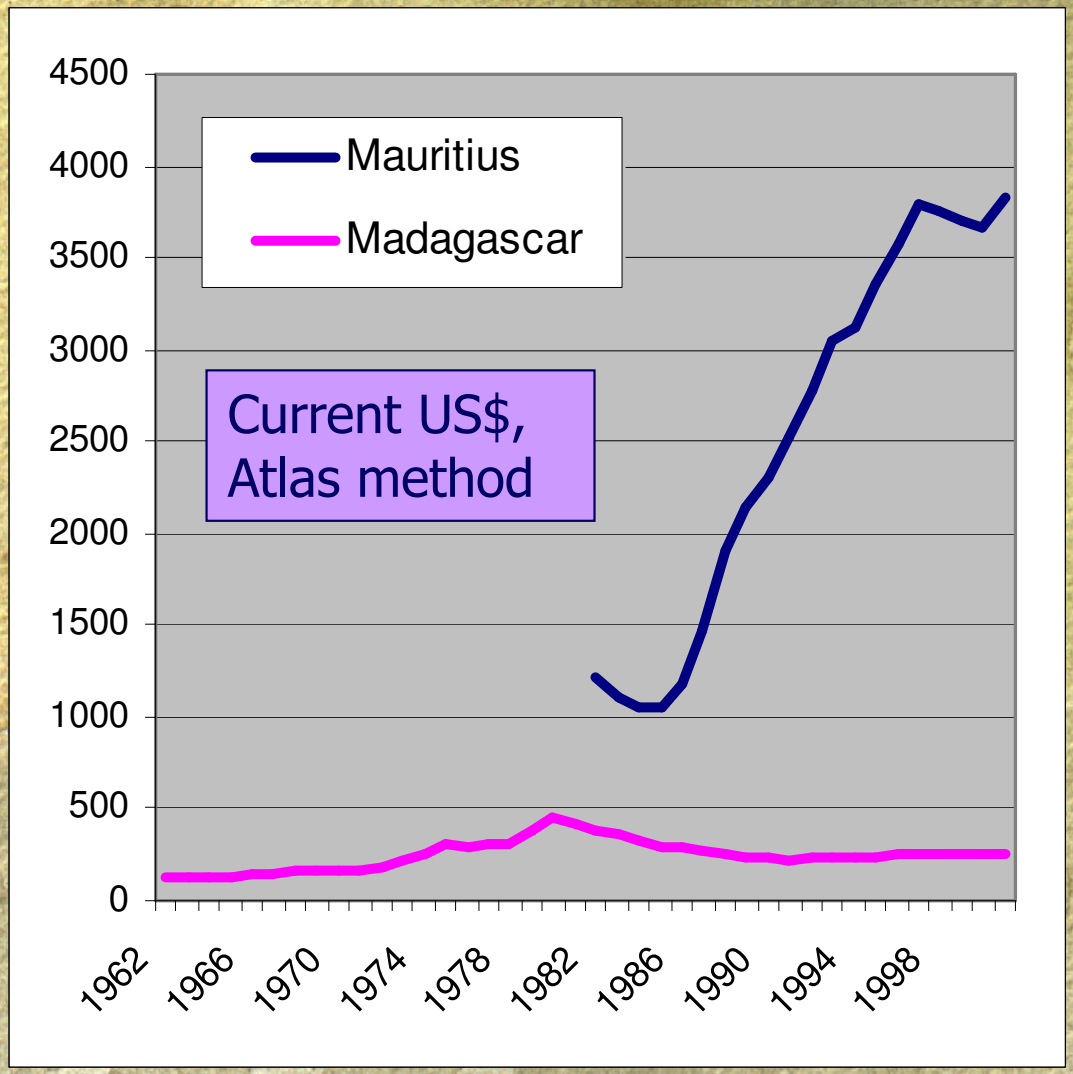
Botswana and Nigeria: GNP per capita 1962-2001



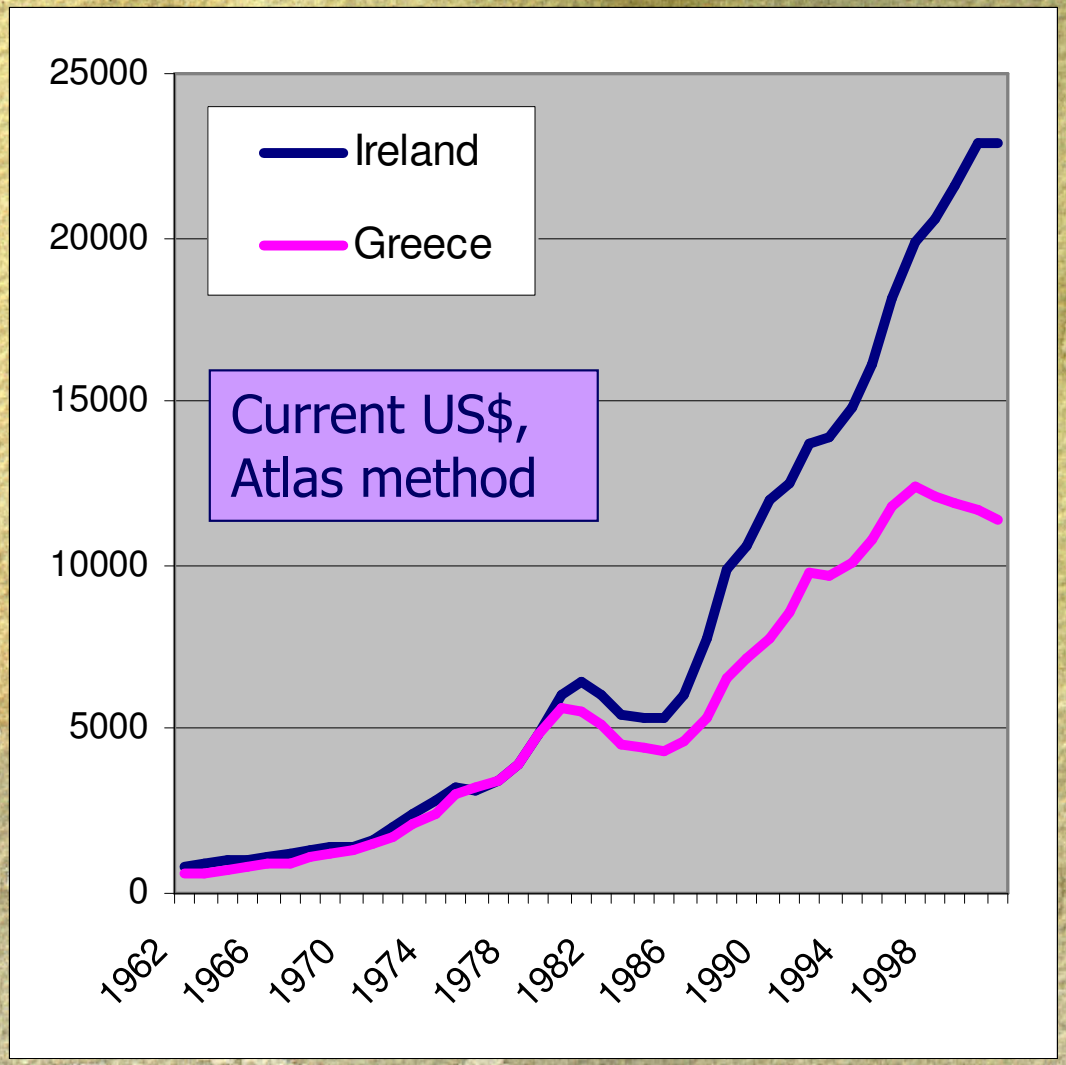
Spain and Argentina : GNP per capita 1962-2001



Mauritius and Madagascar: GNP per capita 1962-2001



Ireland and Greece: GNP per capita 1962-2001



Basic growth theory

A. Harrod-Domar model
B. Solow model
C. Endogenous growth model

Let's do the algebra

Harrod-Domar model

Two assumptions

$S = sY$ Fixed saving rate

$K = vY$ Fixed capital/output ratio

$$g = \frac{s}{v} - \delta$$

Implications for growth

$$g = \frac{0.21}{3} - 0.04 = 0.03$$

$S = I$

gross net replacement

$$S = sY = I = \Delta K + \delta K$$

$$sY = v\Delta Y + \delta vY$$

$$(s - \delta v)Y = v\Delta Y$$

$$\frac{\Delta Y}{Y} = \frac{s}{v} - \delta$$

Harrod-Domar model

Three propositions about growth

$$g = \frac{s}{v} - \delta$$

$$\frac{dg}{ds} > 0$$

Saving increases growth

v = K/Y

1/v = Y/K

$$\frac{dg}{dv} < 0$$

Efficiency increases growth

$$\frac{dg}{d\delta} < 0$$

Depreciation reduces growth

Solow model

Output growth equals labor force growth

$$g = n$$

Four assumptions

$$Y = Y^F$$ Full employment

$$L = L_0 e^{nt}$$ Constant growth of labor force

$$A = const.$$

$$Y = (AL)^a K^{1-a}$$ Constant returns to scale

$$S = sY = I = \Delta K + \delta K$$ Saving equals investment

$$g = an + (1-a)\left[s\frac{Y}{K} - \delta \right] = an + (1-a)g$$

Solow model

Endogenous output/capital ratio

$$g = an + (1-a)\left[s\frac{y}{k} - \delta \right]$$

Exogenous

Exogenous

Endogenous

$$Y = (AL)^a K^{1-a}$$

$$y = Ak^{1-a}$$

$$\frac{y}{k} = Ak^{-a}$$

Need to determine k and hence y/k

Solow model

Dynamic stability of output/capital ratio

$$k = \frac{K}{L}$$

$$\dot{k} = 0 \Rightarrow \frac{y}{k} = \frac{n+\delta}{s}$$

$$\dot{k} = \dot{K} - \dot{L}$$

$$\dot{k} = \dot{K} - \dot{L} = s\frac{y}{k} - \delta - n = sAk^{-a} - \delta - n$$

$$\frac{d\dot{k}}{dk} = -asAk^{-(1+a)} < 0$$

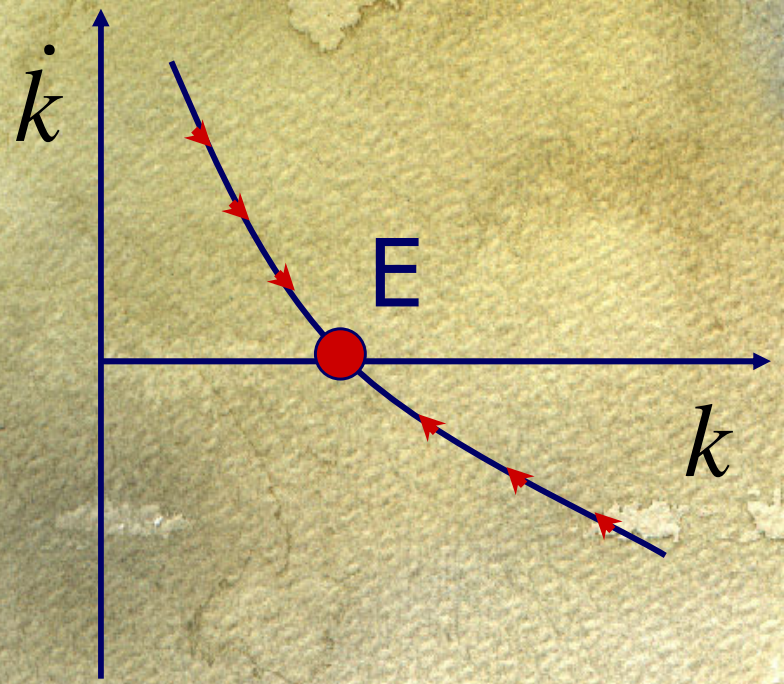
Stable equilibrium

Solow model

Dynamic stability of output/capital ratio

$$\frac{d\dot{k}}{dk} = -asAk^{-(1+a)} < 0$$

Stable equilibrium



Solow model

Two equations in two unknowns, y and k

$$y = Ak^{1-a}$$

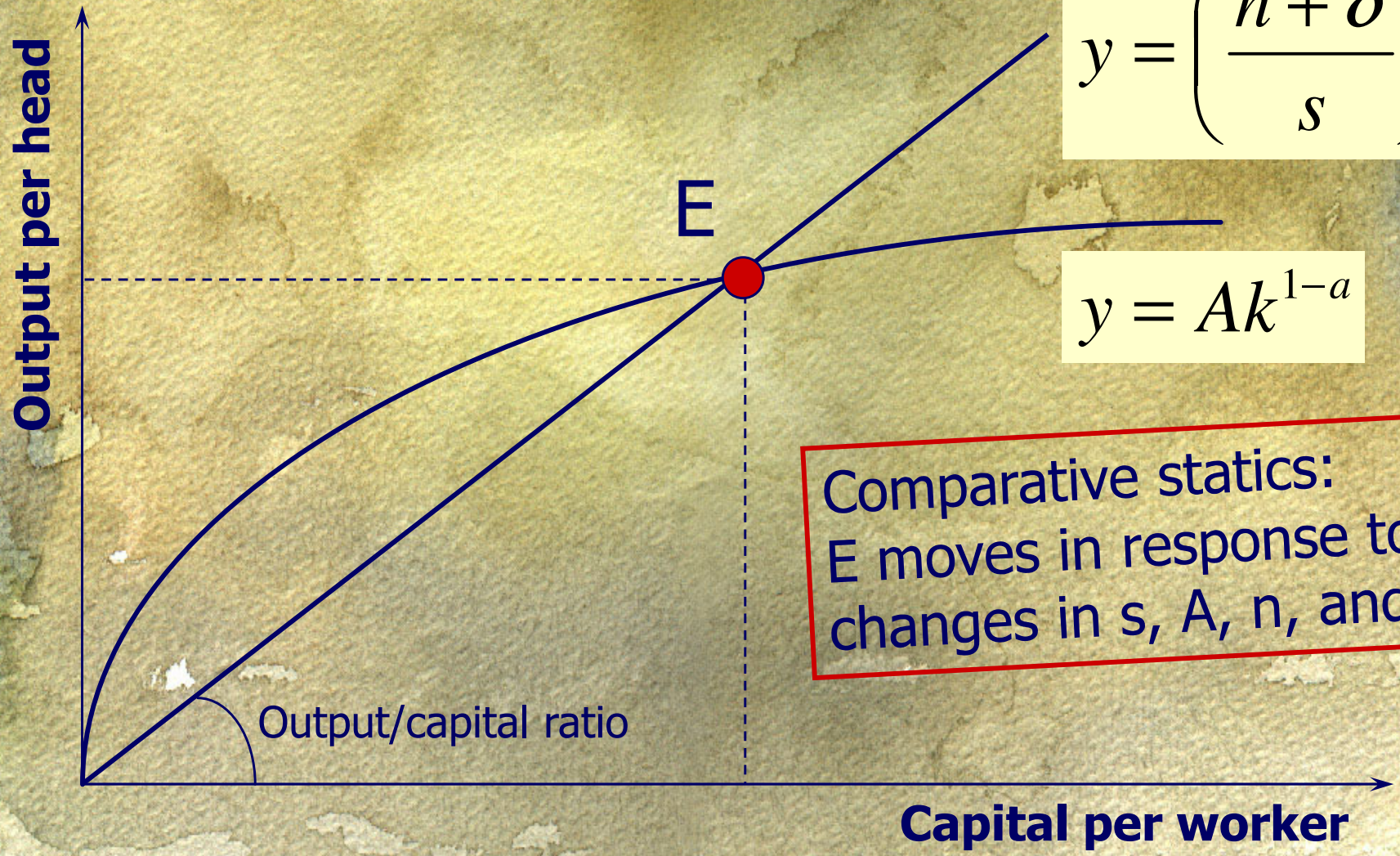
$$y = \left(\frac{n+\delta}{s}\right)k$$

$$k = \left(\frac{sA}{n+\delta}\right)^{\frac{1}{a}}$$

$$y = \left(\frac{s}{n+\delta}\right)^{\frac{1-a}{a}} A^{\frac{1}{a}}$$

Long-run equilibrium

Solow model



$$y = \left(\frac{n + \delta}{s} \right) k$$

$$y = Ak^{1-a}$$

Comparative statics:
E moves in response to changes in s, A, n, and δ

Solow model

$$y = \left(\frac{s}{n+\delta} \right)^{\frac{1-a}{a}} A^{\frac{1}{a}}$$

Four propositions about long-run growth

$\frac{dy}{ds} > 0$ Increased saving increases income per capita

$\frac{dy}{dA} > 0$ Increased efficiency increases income per capita

$\frac{dy}{dn} < 0$ Increased population growth reduces income per capita

$\frac{dy}{d\delta} < 0$ Increased depreciation reduces income per capita

Closed-form solution to Solow model

$$L = L_0 e^{nt}$$

$$Y = (AL)^a K^{1-a}$$

Labor-augmenting technological progress

$$A = A_0 e^{qt}$$

$$\hat{y} = Y / AL$$

$$AL = A_0 L_0 e^{(n+q)t}$$

$$\hat{k} = K / AL$$

$$\hat{y} = \hat{k}^{1-a}$$

$$\Delta K = I - \delta K = sY - \delta K$$

$$\frac{\Delta K}{AL} = s\hat{y} - \delta\hat{k}$$

Closed-form solution to Solow model

$$\Delta\hat{k} = \Delta\left(\frac{K}{AL}\right) = \frac{\Delta K}{AL} - \left(\frac{K}{A^2L^2}\right)\Delta(AL) = s\hat{y} - \delta\hat{k} - n\hat{k} - q\hat{k}$$

$$g_{\hat{k}} = \frac{\Delta\hat{k}}{\hat{k}} = s\left(\frac{\hat{y}}{\hat{k}}\right) - \delta - n - q = s\hat{k}^{-a} - \delta - n - q$$

$$\left[\frac{\Delta\hat{k}}{\hat{k}} + (\delta + n + q)\right]\hat{k}^{a} = s$$

$$\Delta\hat{k}\cdot\hat{k}^{-(1-a)} + (\delta + n + q)\hat{k}^{a} = s$$

$$\hat{k} = \left(\frac{s}{\delta + n + q}\right)^{\frac{1}{a}}$$

Closed-form solution to Solow model

$$v = \hat{k}^a$$

$$\frac{\Delta v}{v} = a\left(\frac{\Delta \hat{k}}{\hat{k}}\right)$$

$$\frac{\Delta v}{a} = \left(\frac{\Delta \hat{k}}{\hat{k}}\right) \cdot v$$

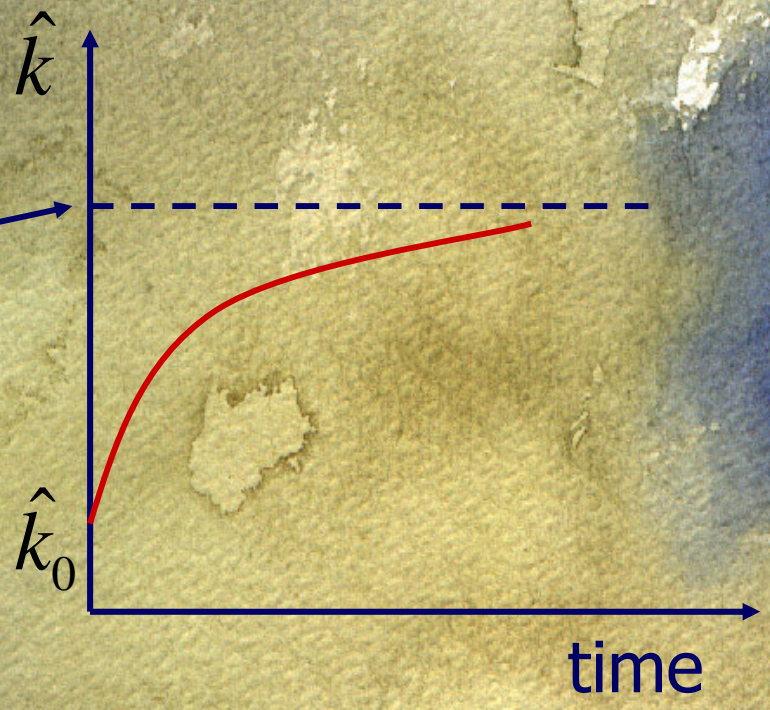
$$v = \hat{k}^a \Rightarrow \left(\frac{1}{a}\right)\Delta v + (\delta + n + q)v = s$$

$$v = \hat{k}^a = \frac{s}{\delta + n + q} + \left\{\hat{k}_0^a - \left(\frac{s}{\delta + n + q}\right)\right\} e^{-[a(\delta+n+q)]t}$$

a(δ+n+q) is the speed of convergence

Closed-form solution to Solow model

$$\lim_{t\to\infty}\hat{k} = \left(\frac{s}{\delta+n+q}\right)^{\frac{1}{a}}$$



$$\lim_{t\to\infty}\hat{y} = \left(\frac{s}{\delta+n+q}\right)^{\frac{1-a}{a}}$$

$$\lim_{t\to\infty} y = \lim_{t\to\infty}\left(\frac{Y}{L}\right) = A\left(\frac{s}{\delta+n+q}\right)^{\frac{1-a}{a}} = A_0 e^{qt}\left(\frac{s}{\delta+n+q}\right)^{\frac{1-a}{a}}$$

Solow model: Convergence

$$\Delta\hat{k} \approx -a(n+q+\delta)\hat{k}$$

$$\Delta\hat{k} \approx -0.7(0.01+0.01+0.04)\hat{k} = -0.7 \cdot 0.06 \cdot k = -0.04\hat{k}$$

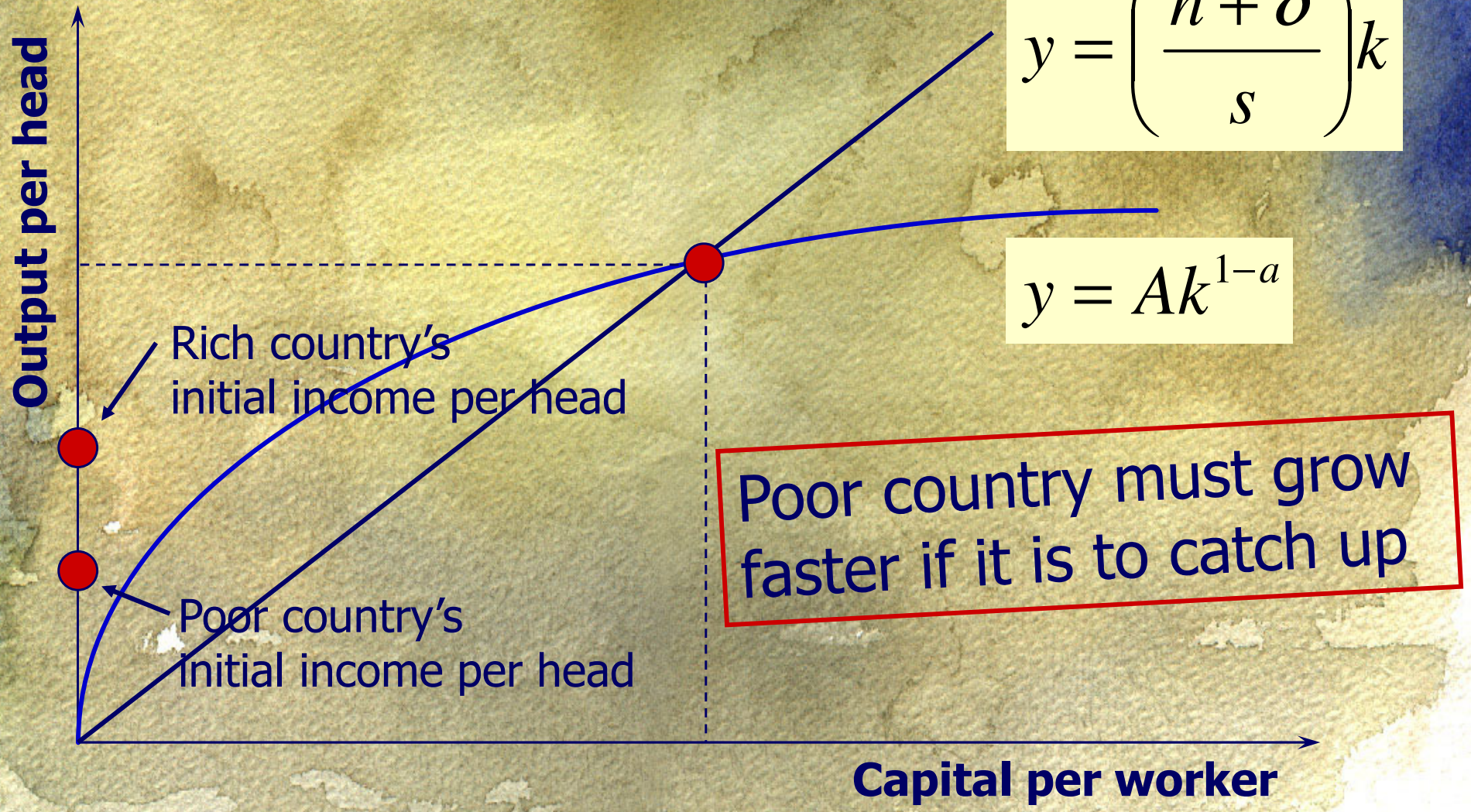
$$e^{-0.04t} = 0.5 \Rightarrow t = 17$$

Takes 17 years to close half the gap

$$e^{-0.04t} = 0.8 \Rightarrow t = 40$$

Takes 40 years to close 80% of the gap

Solow model: Convergence

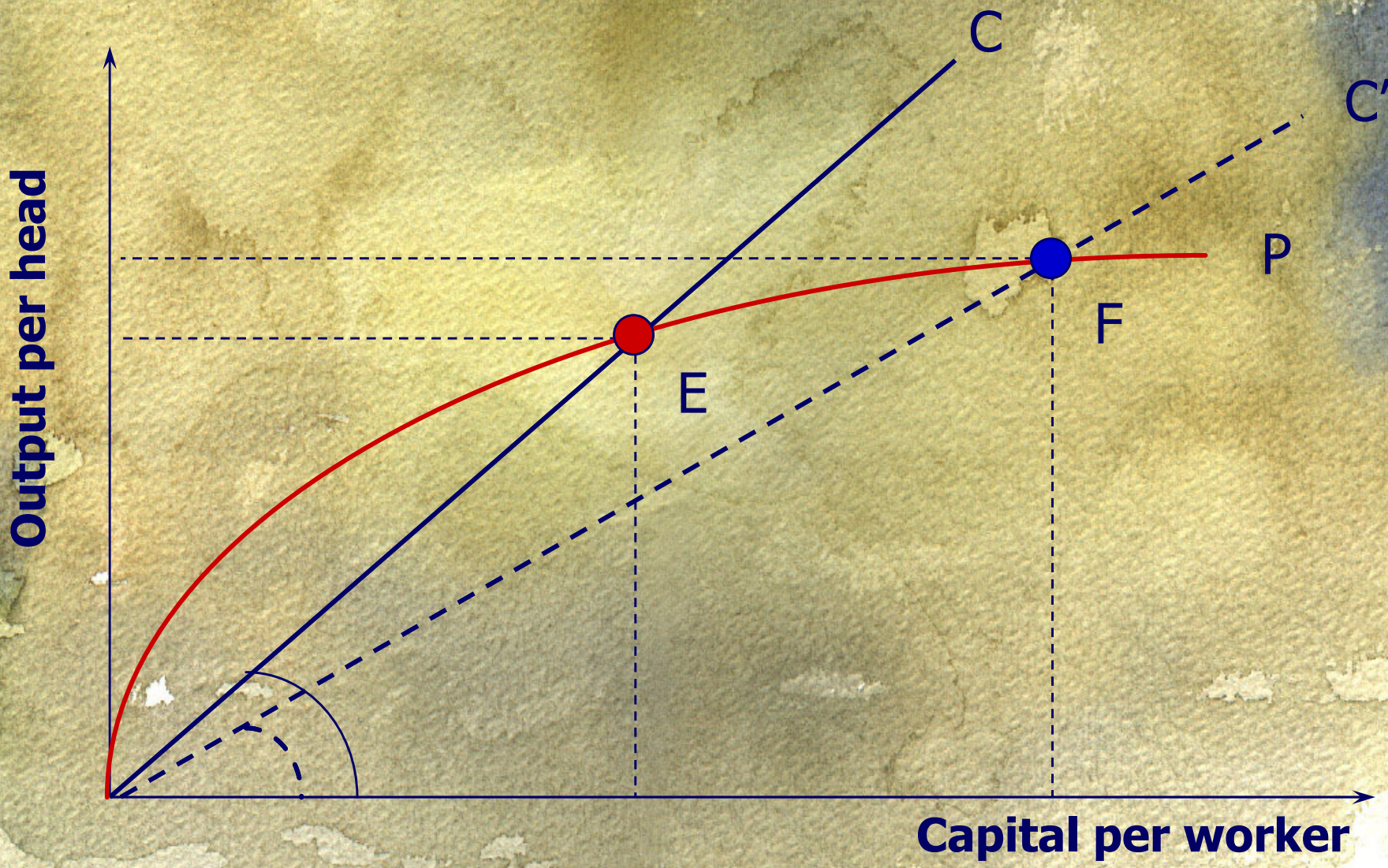


$$y = \left(\frac{n + \delta}{s} \right) k$$

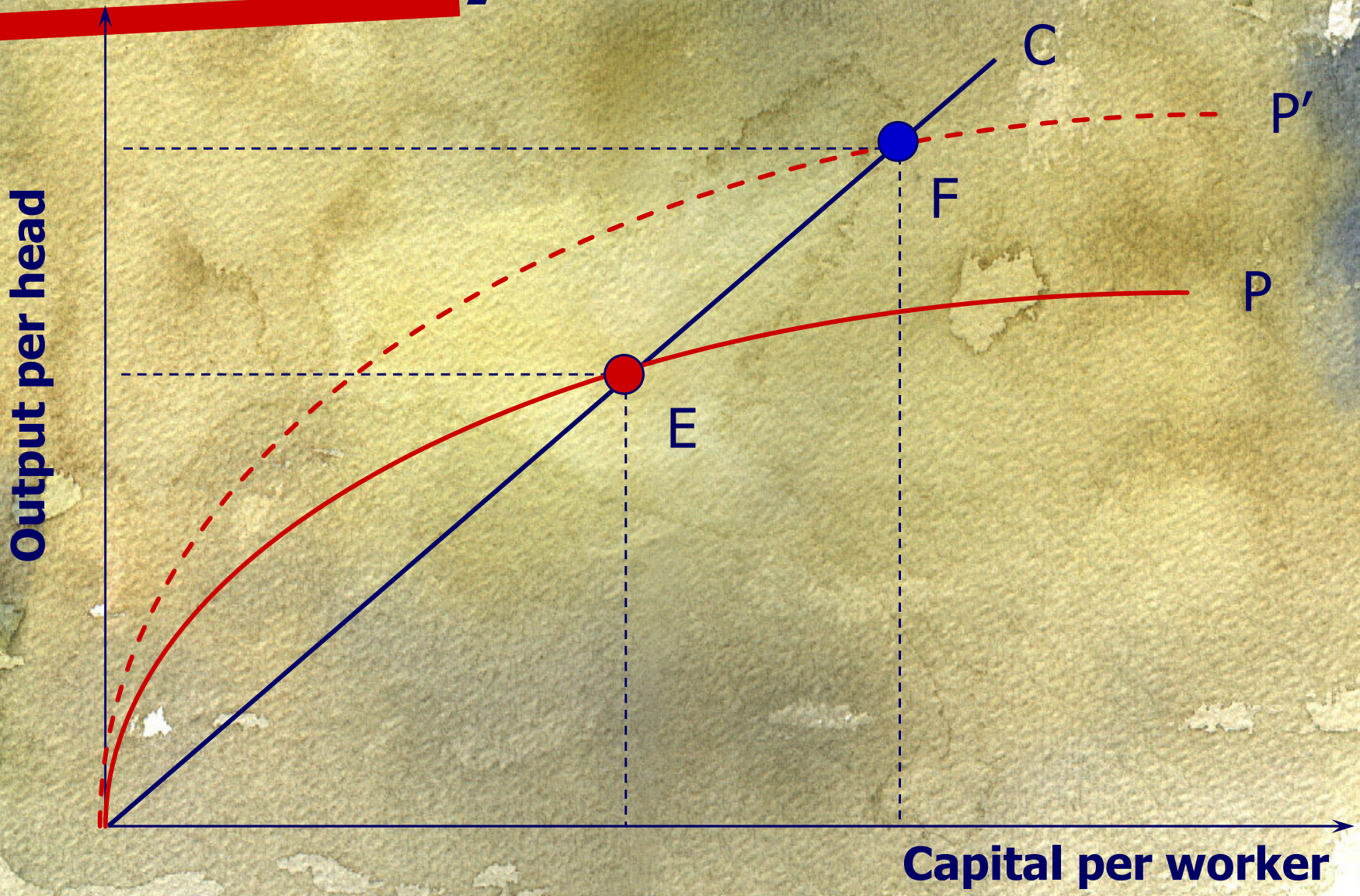
$$y = Ak^{1-a}$$

Poor country must grow faster if it is to catch up

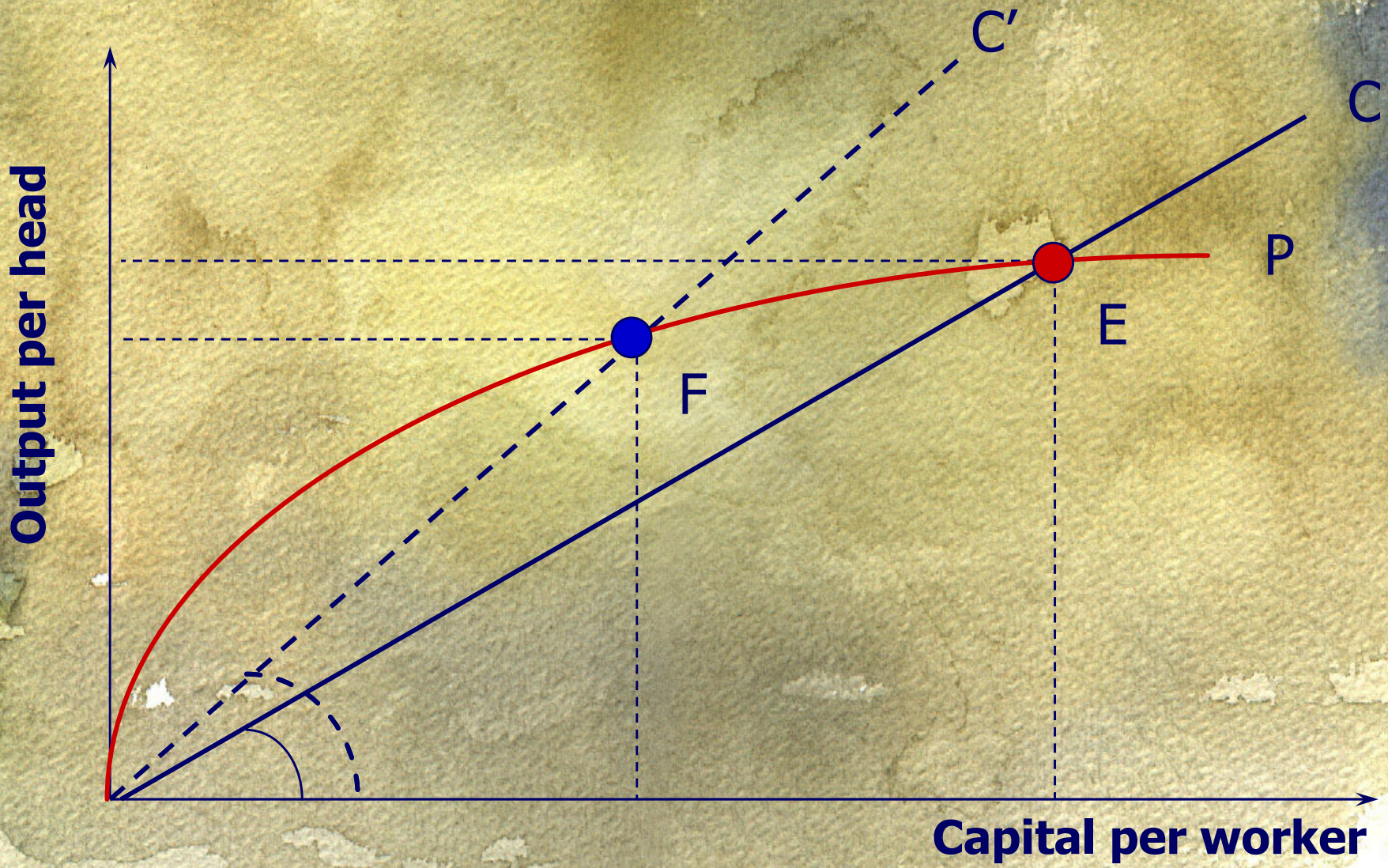
An Increase in the Saving Rate



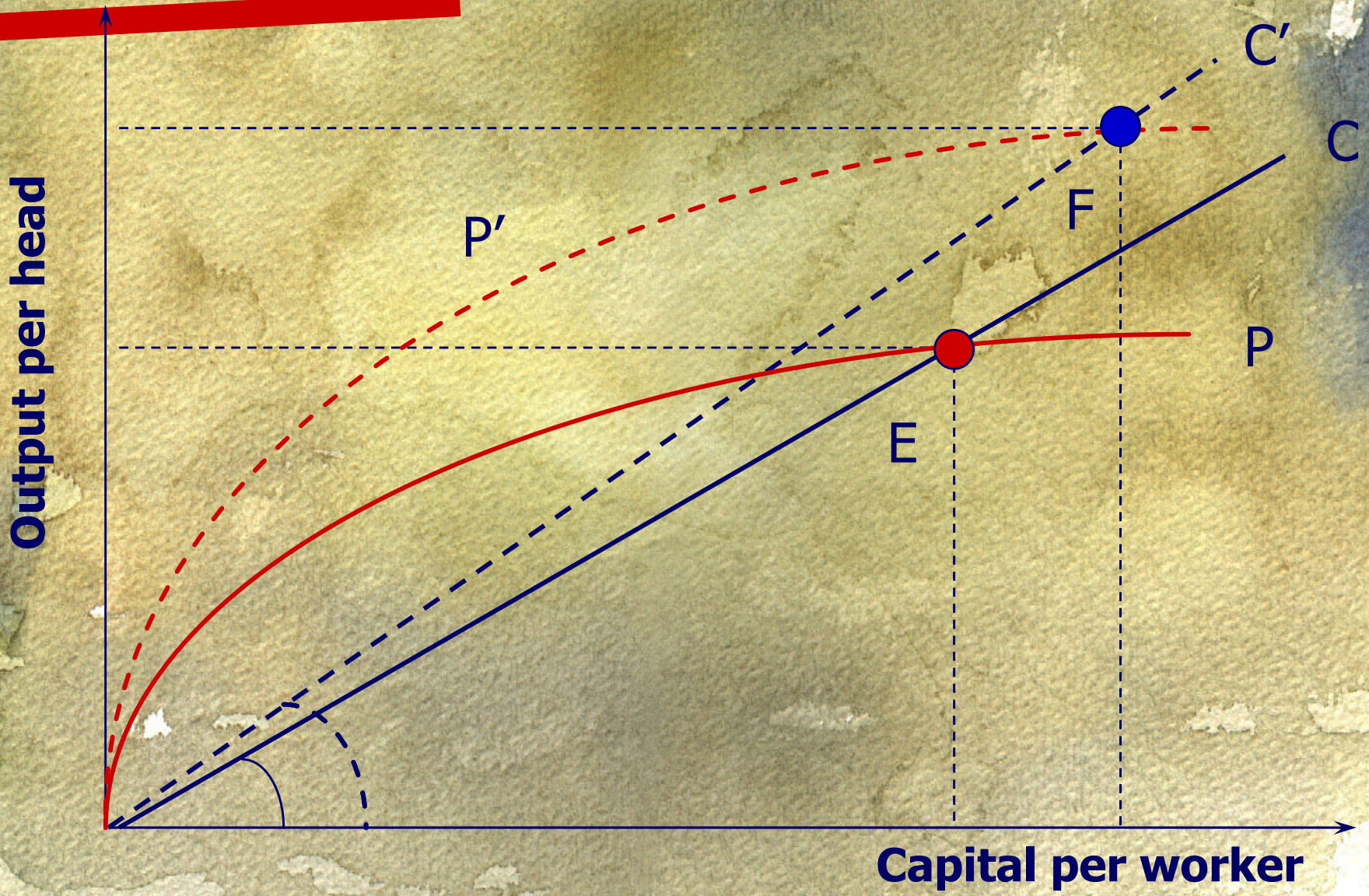
An Increase in Static Efficiency



An Increase in Population Growth or Depreciation



An Increase in Dynamic Efficiency (Technical Progress)



Solow model: Conclusion

- Three main points to note
  - Long-run growth is exogenous: $g = n + q$
    - ✓ No role for economic forces, policy or institutions, just technology
    - ✓ But education is good for growth
  - Model implies convergence
    - ✓ Poor countries grow more rapidly than rich
  - The medium term can be quite long
    - ✓ Growth is endogenous for a long while

Solow model with education

$$Y = (AH)^a K^{1-a}$$

H = skilled labor

$$H = Le^{bt}$$

L = raw labor, b = years of schooling

AH grows at n + q + b

$$g = n + q + b$$

$$\frac{dg}{ds} = 0$$

Education stimulates long-run growth

Endogenous growth

$$Y = AL^a K^{1-a}$$

$$A = E(K/L)^a$$

E = efficiency

$$Y = EK$$

E = 1/v in Harrod-Domar

$$g = sE - \delta$$

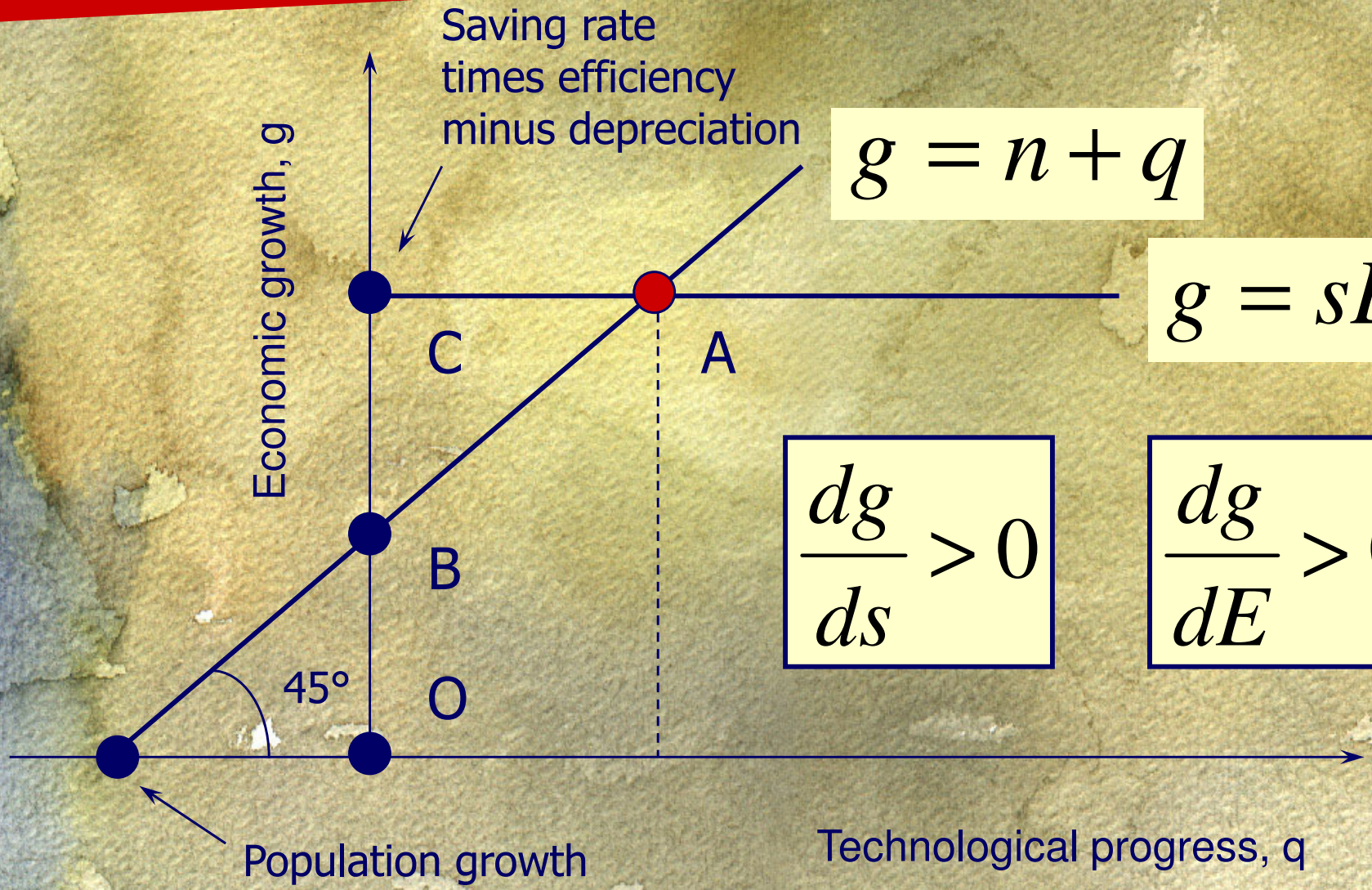
Harrod-Domar, again, without the drawbacks

$$g = n + q$$

Two equations in two unknowns, g and q

Let's take four examples

Endogenous growth



$$g = n + q$$

$$g = sE - \delta$$

$$\frac{dg}{ds} > 0$$

$$\frac{dg}{dE} > 0$$

A tax on education and endogenous growth

1

$$Y = \sqrt{AGK}$$

G = government spending on education

$$G = tK$$

G is financed by tax on capital

$$Y = \sqrt{At}K = EK$$

Constant returns to capital

$$E = \sqrt{At}$$

$$g = s\sqrt{At} - \delta$$

A tax to finance education is good for growth

Inflation, money, and endogenous growth

2

$$Y = \sqrt{\left(\frac{M}{P}\right)}K$$

Output is made by financial and real capital

Inflation reduces the use of financial capital

$$Y = \sqrt{\left(\frac{M}{PK}\right)}K$$

$$E = \sqrt{\left(\frac{M}{PK}\right)}$$

$$\frac{M}{PK} = \frac{1}{1+\pi}$$

$$g = s\sqrt{\left(\frac{1}{1+\pi}\right)} - \delta$$

Inflation impedes growth

Education and endogenous growth, again

3

R&D model (Romer)

$$Y = A(1-b)L$$

b = fraction of labor force engaged in R&D

$$\Delta A = BbLA$$

bL = number of workers engaged in R&D

$$\frac{\Delta A}{A} = BbL$$

A = stock of existing knowledge

$$g = BbL + n$$

Growth depends on R&D

$$\frac{dg}{ds} = 0$$

$$\frac{dg}{db} > 0$$

Education and endogenous growth, once more

4

Human capital model (Lucas)

$$Y = AL^a K^{1-a}$$

$$A = c^a$$

c = human capital

$$Y = (cL)^a K^{1-a}$$

$$\frac{\Delta c}{c} = 1 - h$$

h = fraction of time spent on work

$$g = n + 1 - h$$

Less education means less growth

$$\frac{dg}{ds} = 0$$

Let's look at some evidence, but first ...

How growth becomes endogenous

Solow model: when s rises, E = Y/K falls due to decreasing returns to capital, so g stays put

$$Y = (AL)^{a} K^{1-a} \qquad y = Ak^{1-a} \qquad \frac{y}{k} = Ak^{-a}$$

Endogenous growth: when s rises, E stays put due to constant returns to capital, so g rises

$$Y = EK \qquad \frac{Y}{K} = \frac{y}{k} = E \neq f(k)$$

Empirical growth research

1) Cross-country regressions
   - ✓ Large samples, beginning in 1960 or 1970
2) Cross sections vs. panels
3) Averages vs. initial values of independent variables
   - ✓ Cost of simultaneity bias vs. cost of discarding available data
4) Recursive modeling vs. instruments
5) Levels of income vs. rates of growth

Recursive modeling

Growth regression

$$g = a_0 - a_1 y_0 + a_2 x + a_3 z \qquad (1)$$

where x is exogenous and z is endogenous

$$z = b_0 + b_1 y_0 - b_2 x \qquad (2)$$

where z is, say, education and x is natural resource reliance

Eq. (2) makes z exogenous, so (1) and (2) can be estimated by OLS

TSLS calls for instruments that help explain z without being correlated with g: Not easy

Levels of income vs. rates of growth

$$g = a - by_0 + cx$$

Levels of income vs. rates of growth

$$g = a - by_0 + cx$$

$$y = y_0 + T\ln(1 + \frac{g}{100}) \approx y_0 + T(\frac{g}{100})$$

Levels of income vs. rates of growth

$$g = a - by_0 + cx$$

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$$y = y_0 + \frac{T}{100}(a - by_0 + cx)$$

Levels of income vs. rates of growth

$$g = a - by_0 + cx$$

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$$y = y_0 + \frac{T}{100}(a - by_0 + cx)$$

$$y = \alpha + \beta y_0 + \gamma x \qquad \alpha = a\frac{T}{100} \qquad \gamma = c\frac{T}{100}$$

Levels of income vs. rates of growth

Conditional convergence requires b > 0 ⟹ β < 1

$$g = a - by_0 + cx$$

$$y = y_0 + T\ln(1 + \frac{g}{100}) \approx y_0 + T(\frac{g}{100})$$

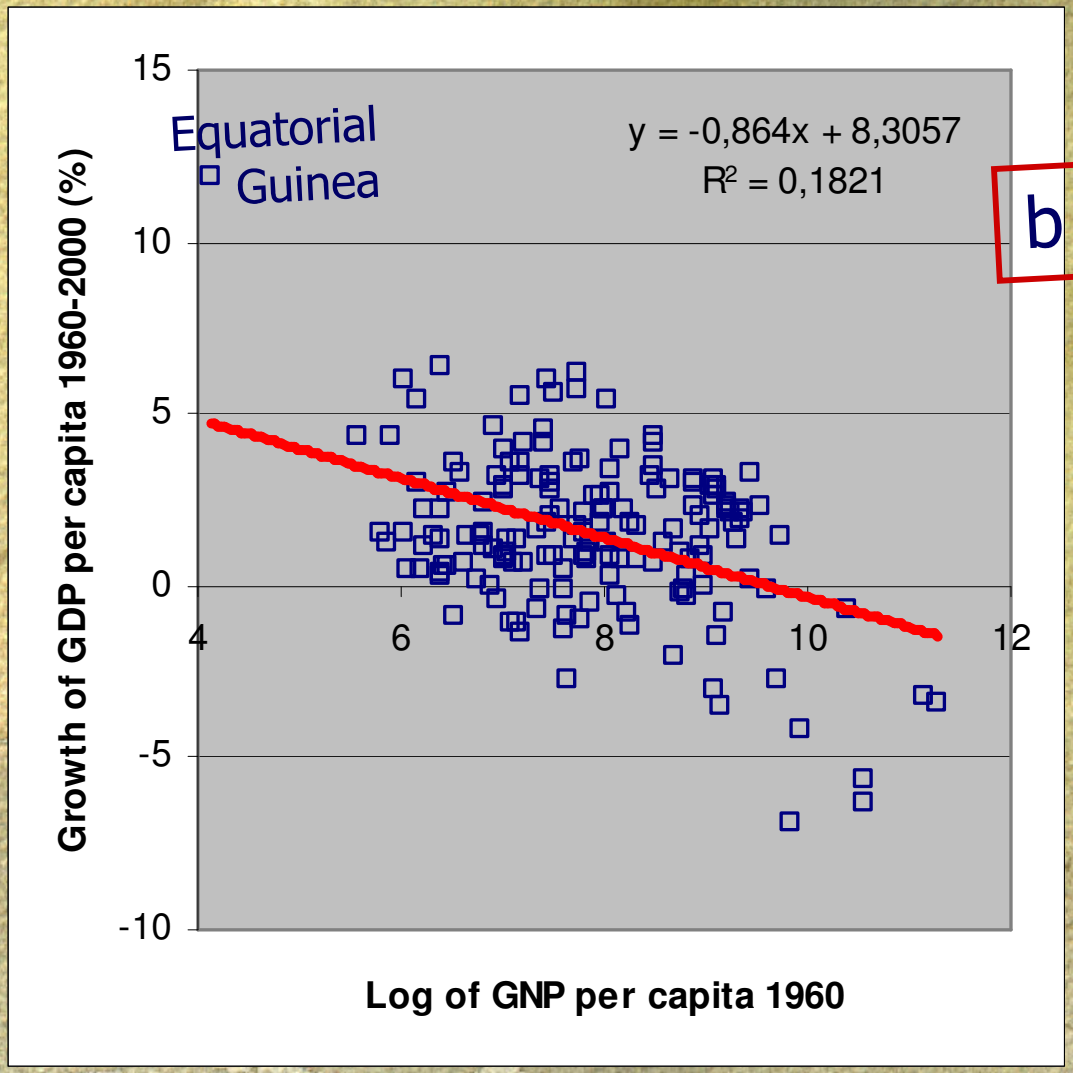
$$y = y_0 + \frac{T}{100}(a - by_0 + cx)$$

$$y = \alpha + \beta y_0 + \gamma x \qquad \alpha = a\frac{T}{100} \qquad \gamma = c\frac{T}{100}$$

One-to-one correspondence between parameters

$$\beta = 1 - b\frac{T}{100}$$

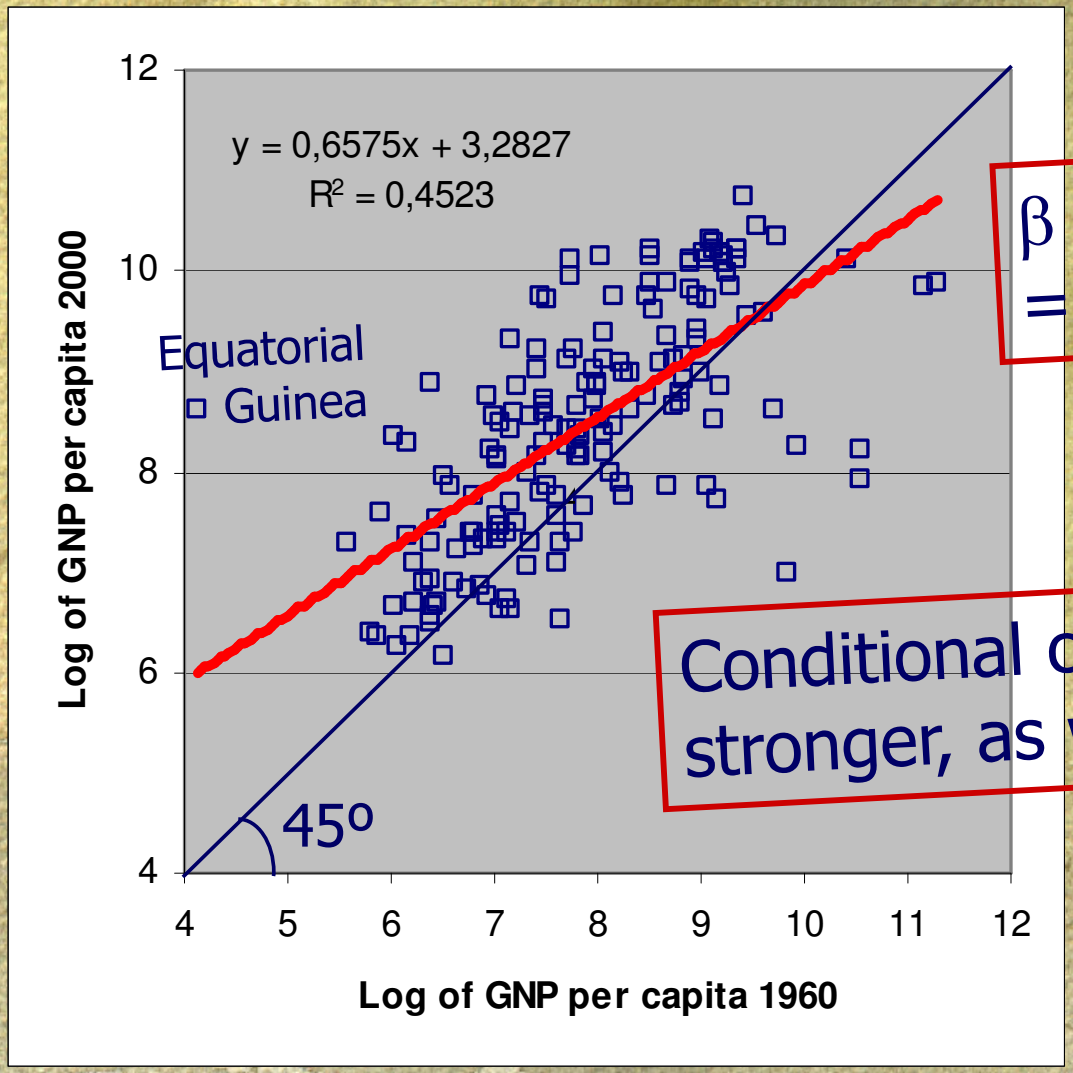
Absolute convergence: Growth rates



b = 0.864

165 countries

Absolute convergence: Levels of income



$\beta = 0.658$
$= 1 - 0.4 \cdot 0.864$

Conditional convergence is stronger, as we will see

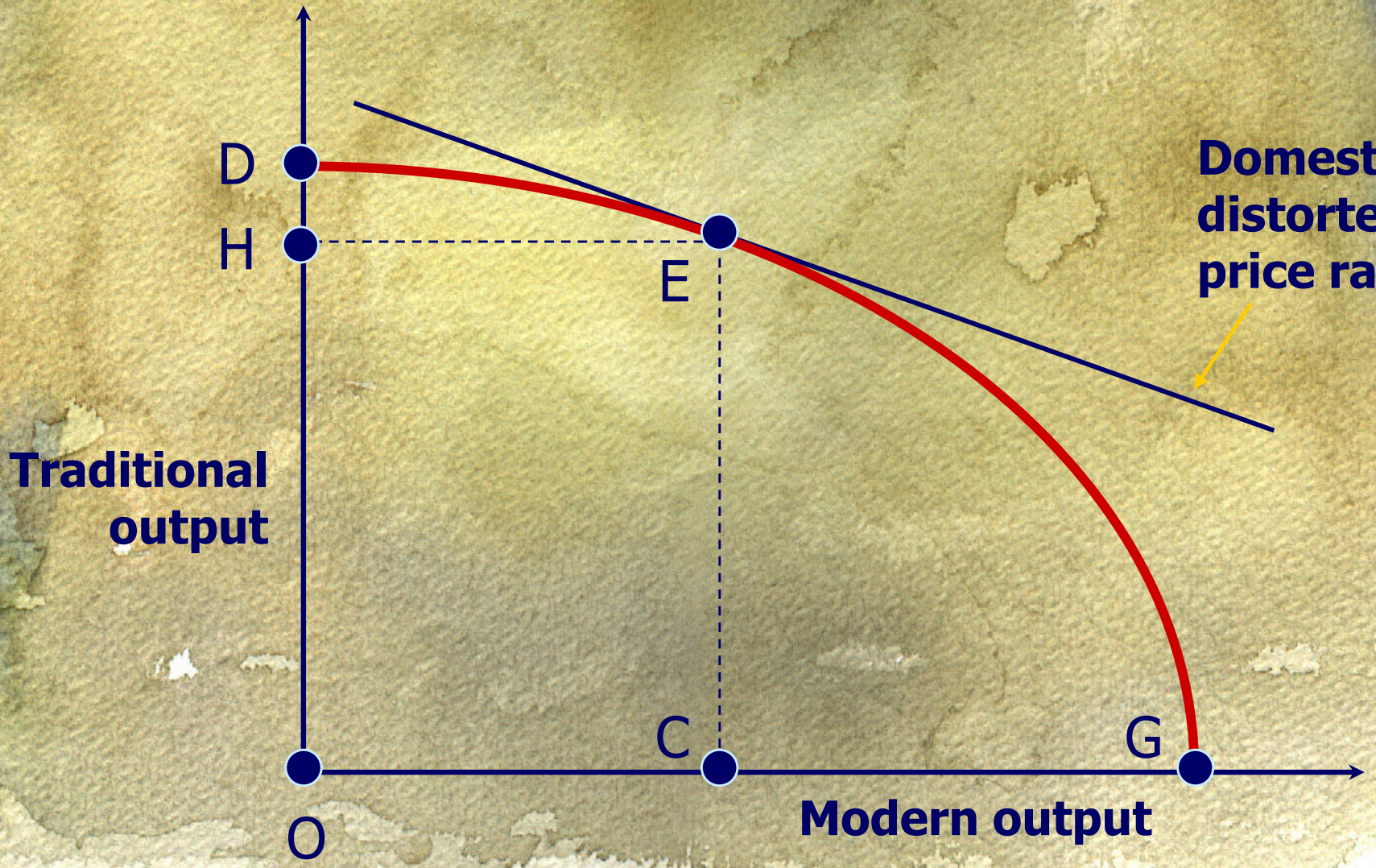
165 countries

From efficiency to growth

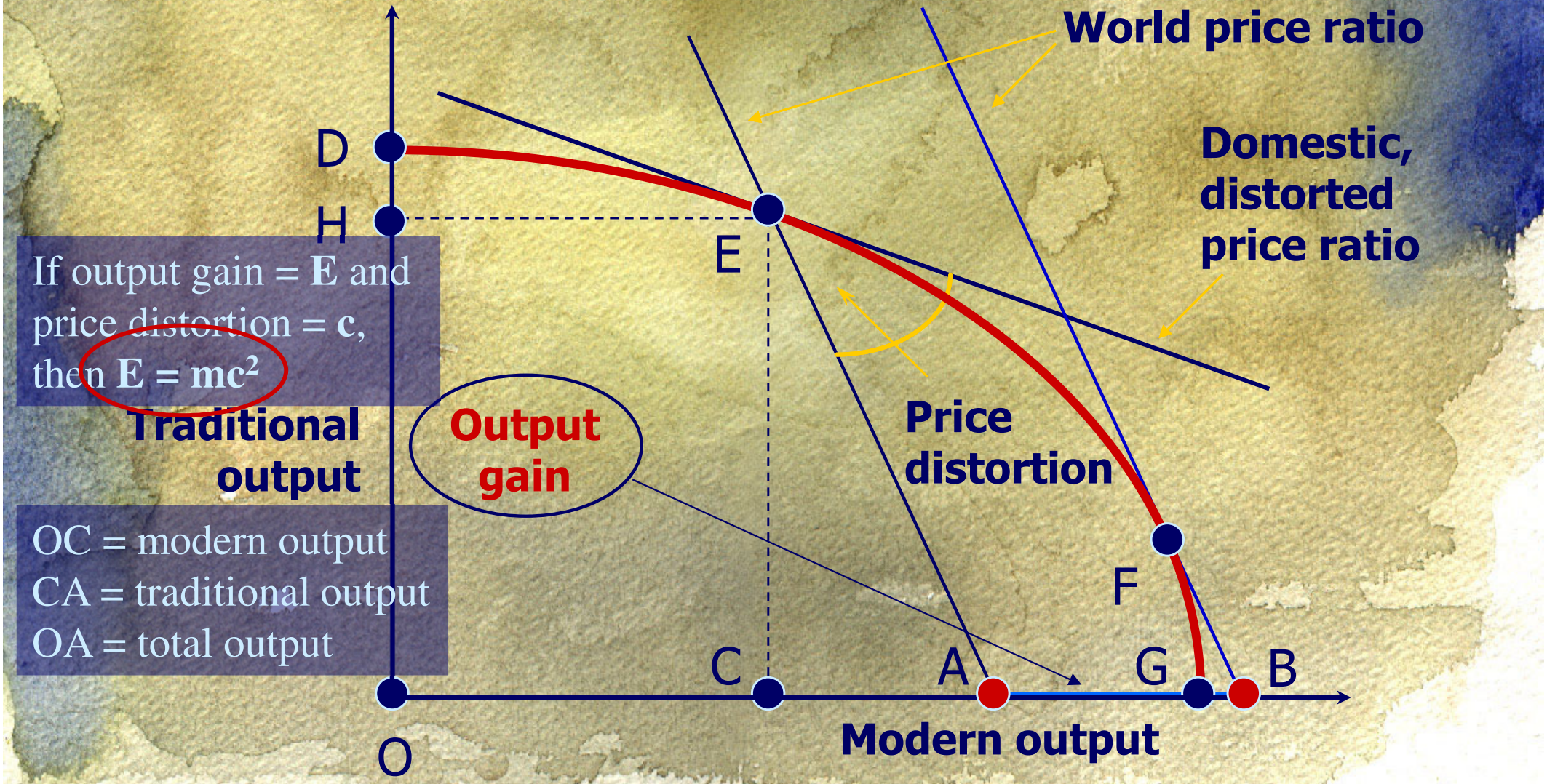
Basic result

- If it – anything! – increases economic efficiency, it is also good for growth
- Follows from Harrod-Domar model as well as from endogenous-growth theory and also, as a proposition about the medium run, from the Solow model
- In practice, Solow model and endogenous growth are hard to distinguish
- So, let's look more closely at efficiency

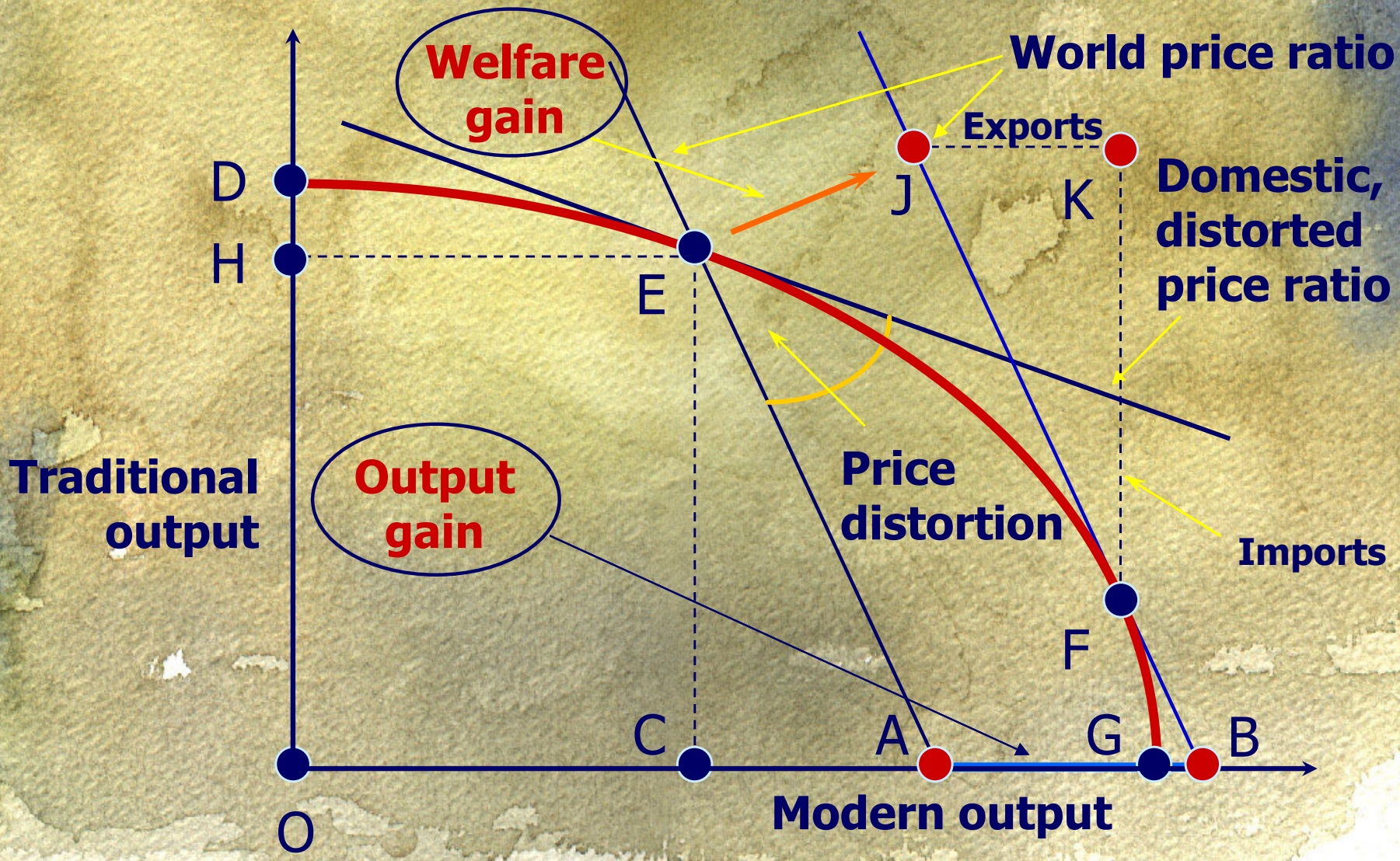
Liberalization Increases Economic Efficiency



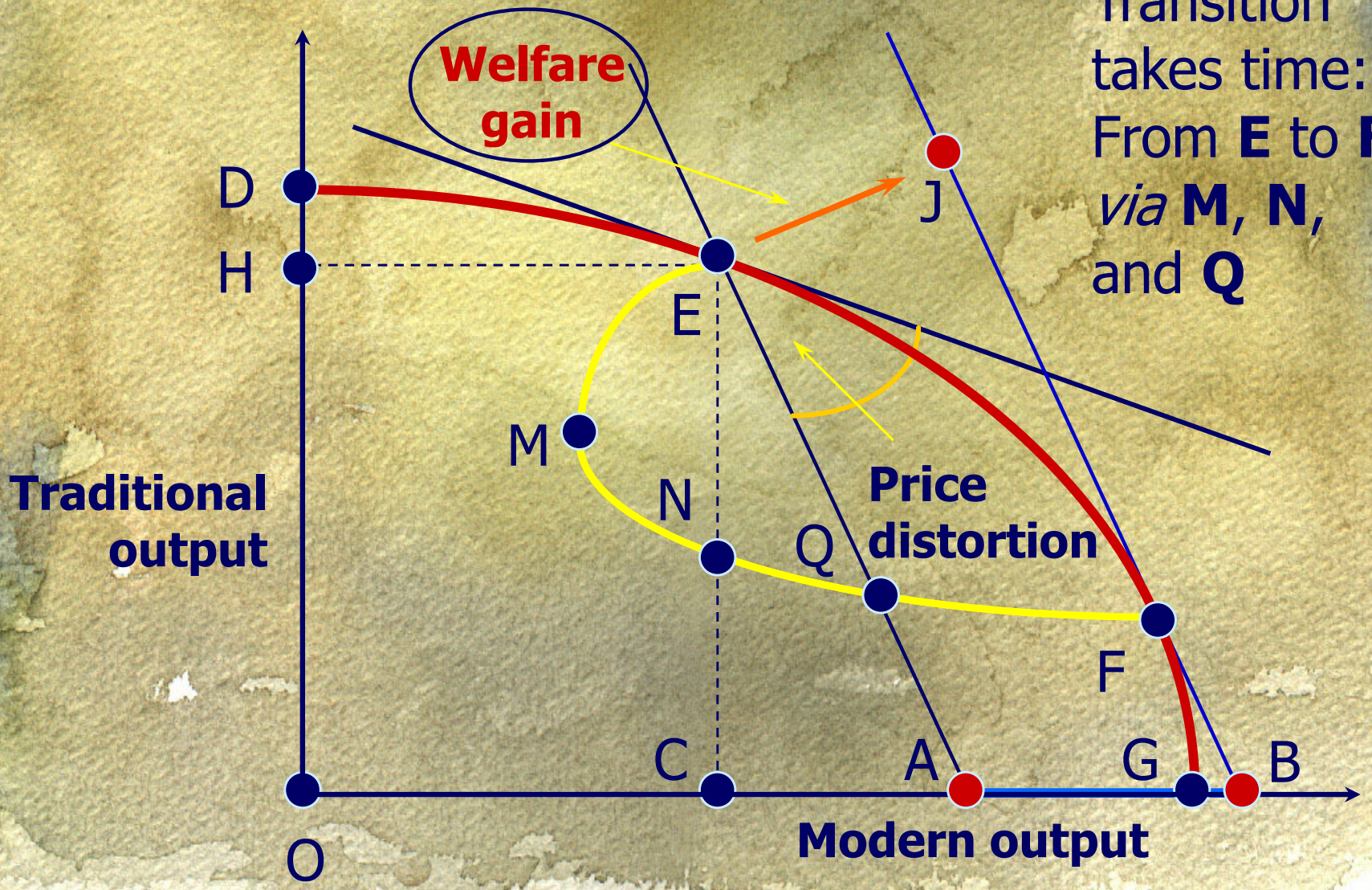
Liberalization Increases Economic Efficiency



Liberalization Increases Economic Efficiency

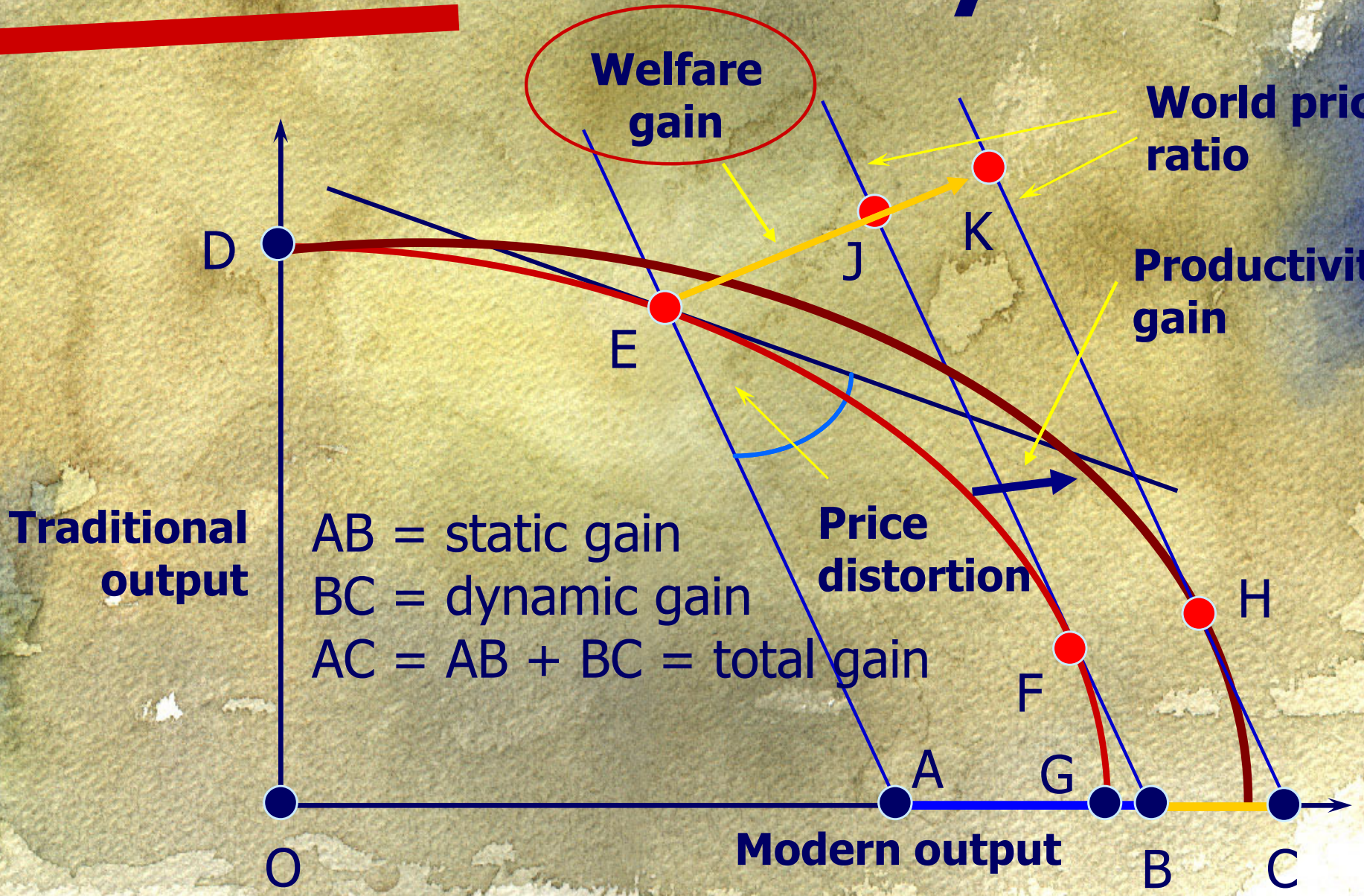


Liberalization Increases Economic Efficiency

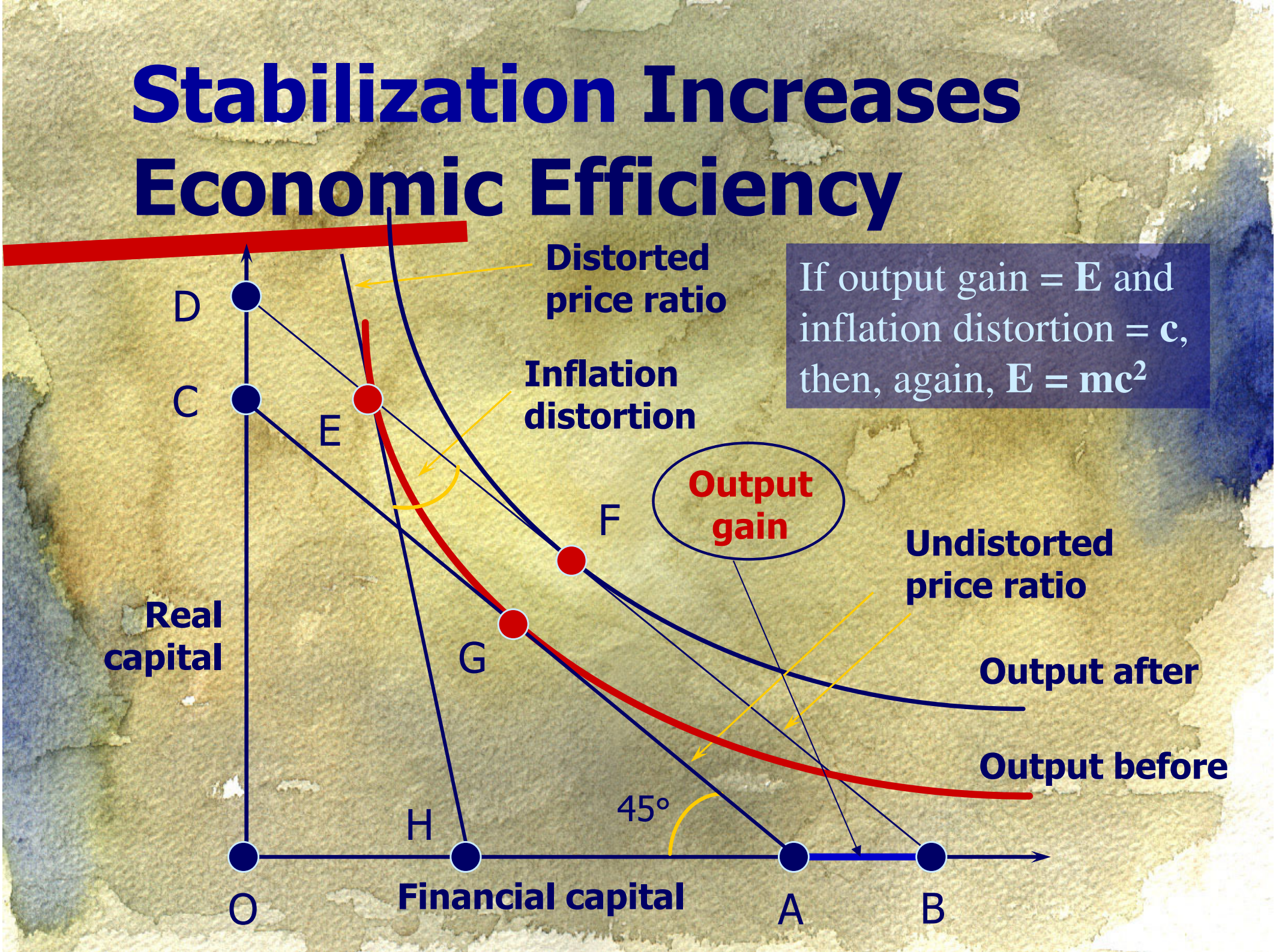


Transition takes time: From **E** to **F** *via* **M**, **N**, and **Q**

Liberalization Increases Economic Efficiency

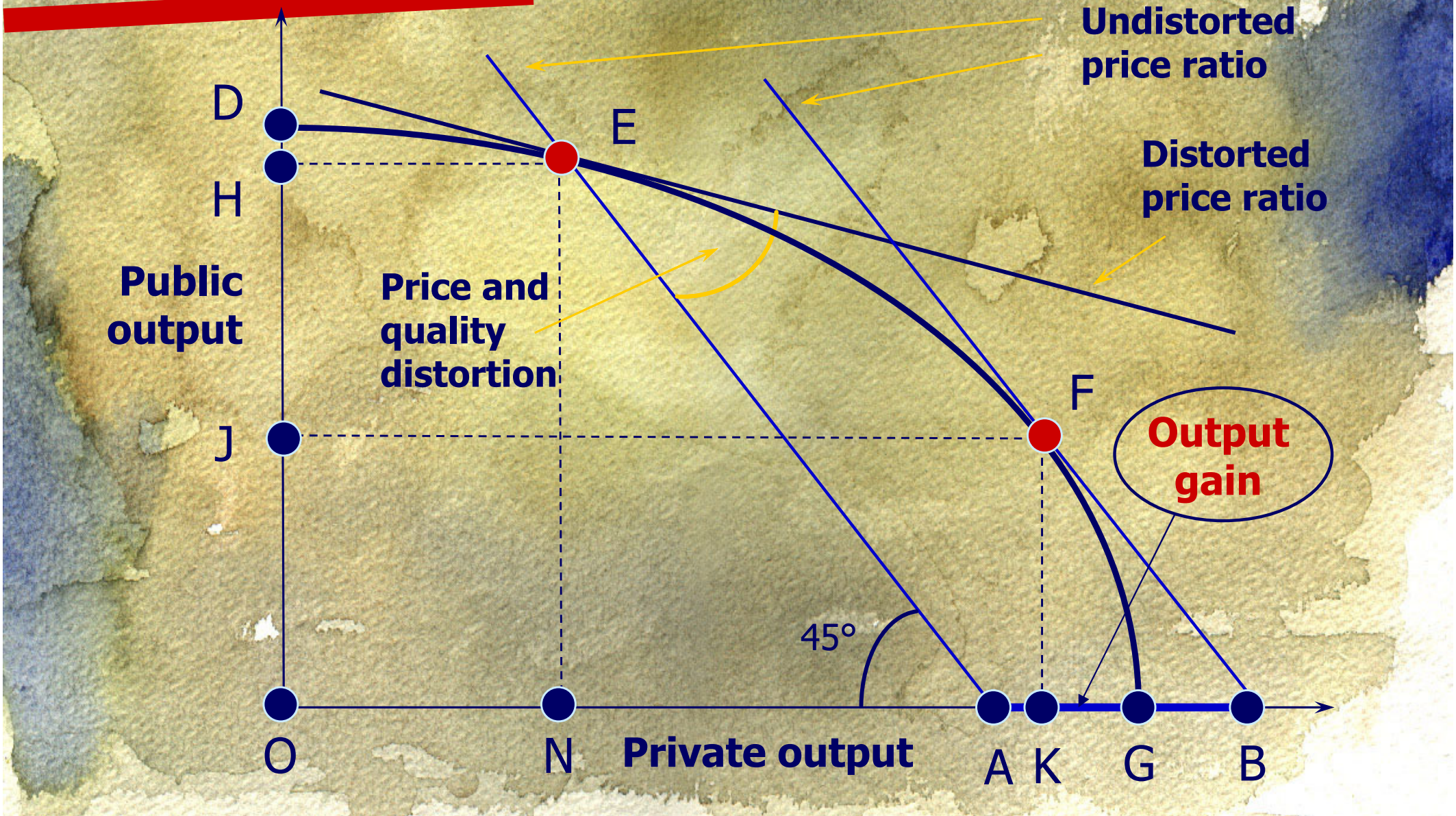


Stabilization Increases Economic Efficiency



If output gain = **E** and inflation distortion = **c**, then, again, $\mathbf{E = mc^2}$

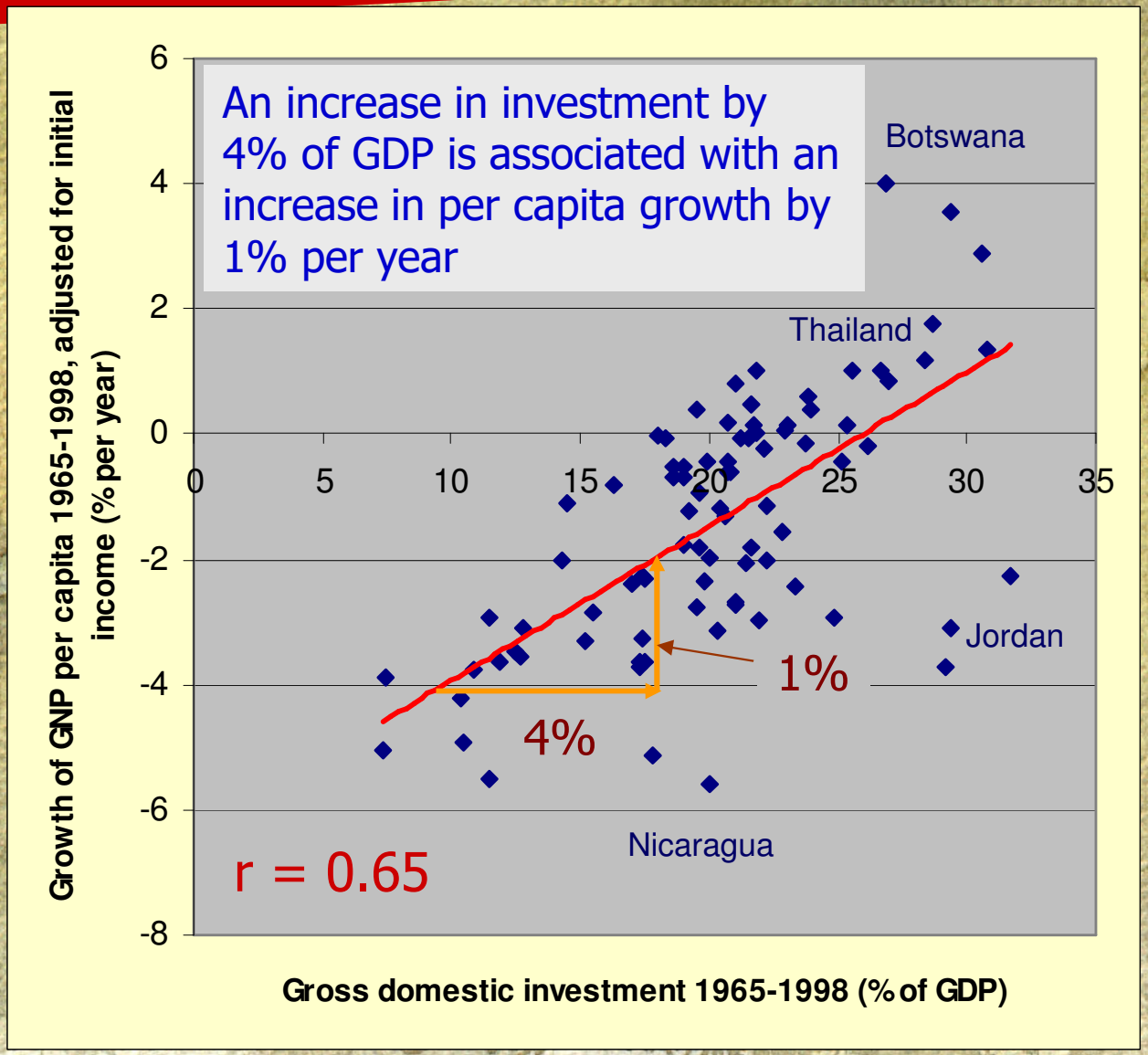
Privatization Increases Economic Efficiency



From efficiency to growth: Same story time and again

- **Free trade** is good for growth
  - Reduces the inefficiency that results from restrictions on trade
- **Price stability** is good for growth
  - Reduces inefficiency resulting from inflation
- **Privatization** is good for growth
  - Reduces inefficiency resulting from SOEs
- **Education** is good for growth
  - Reduces the inefficiency that results from inadequate education

Investment and growth, 1965-1998

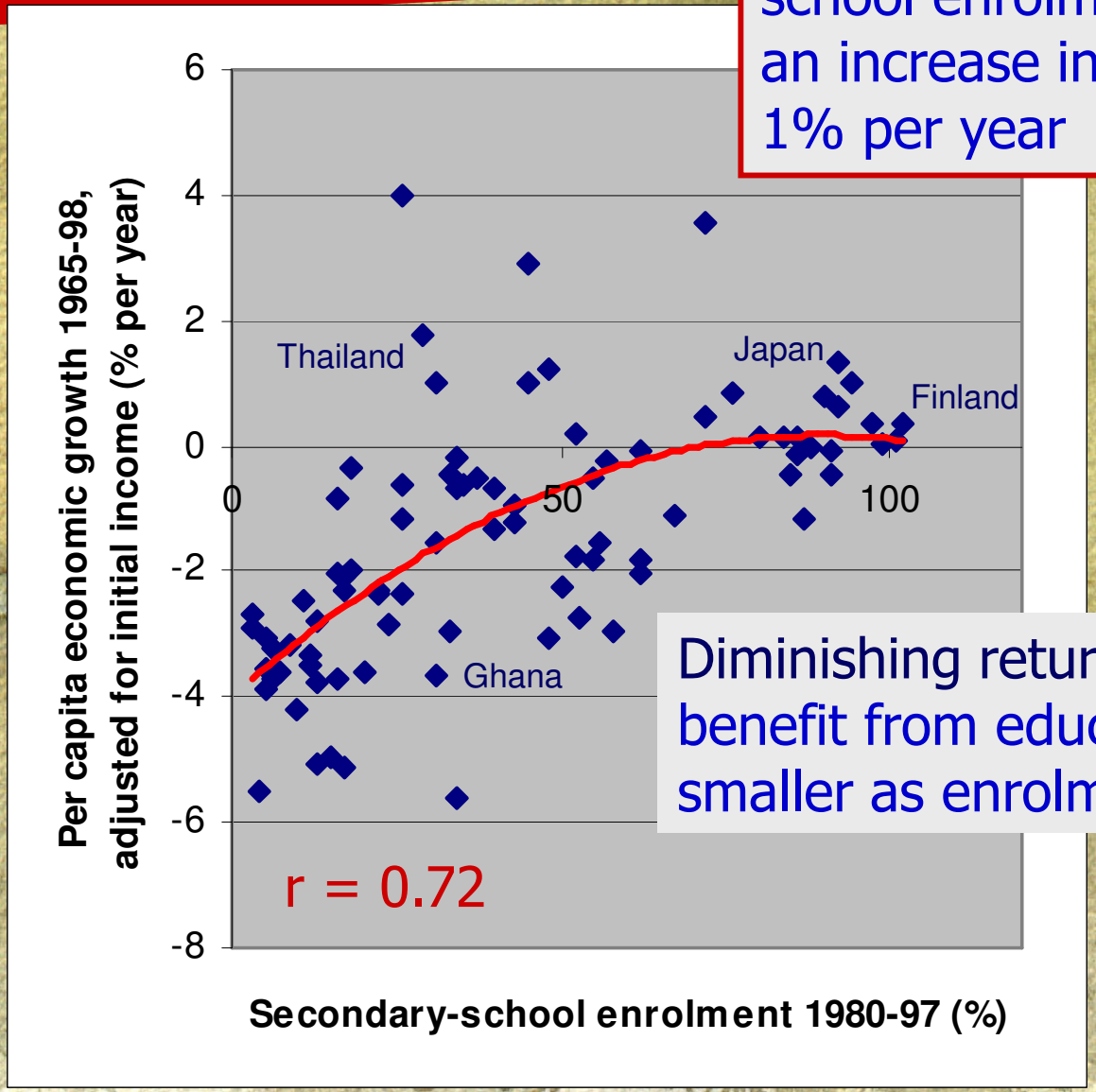


r = rank correlation

85 countries

Education and growth, 1965-1998

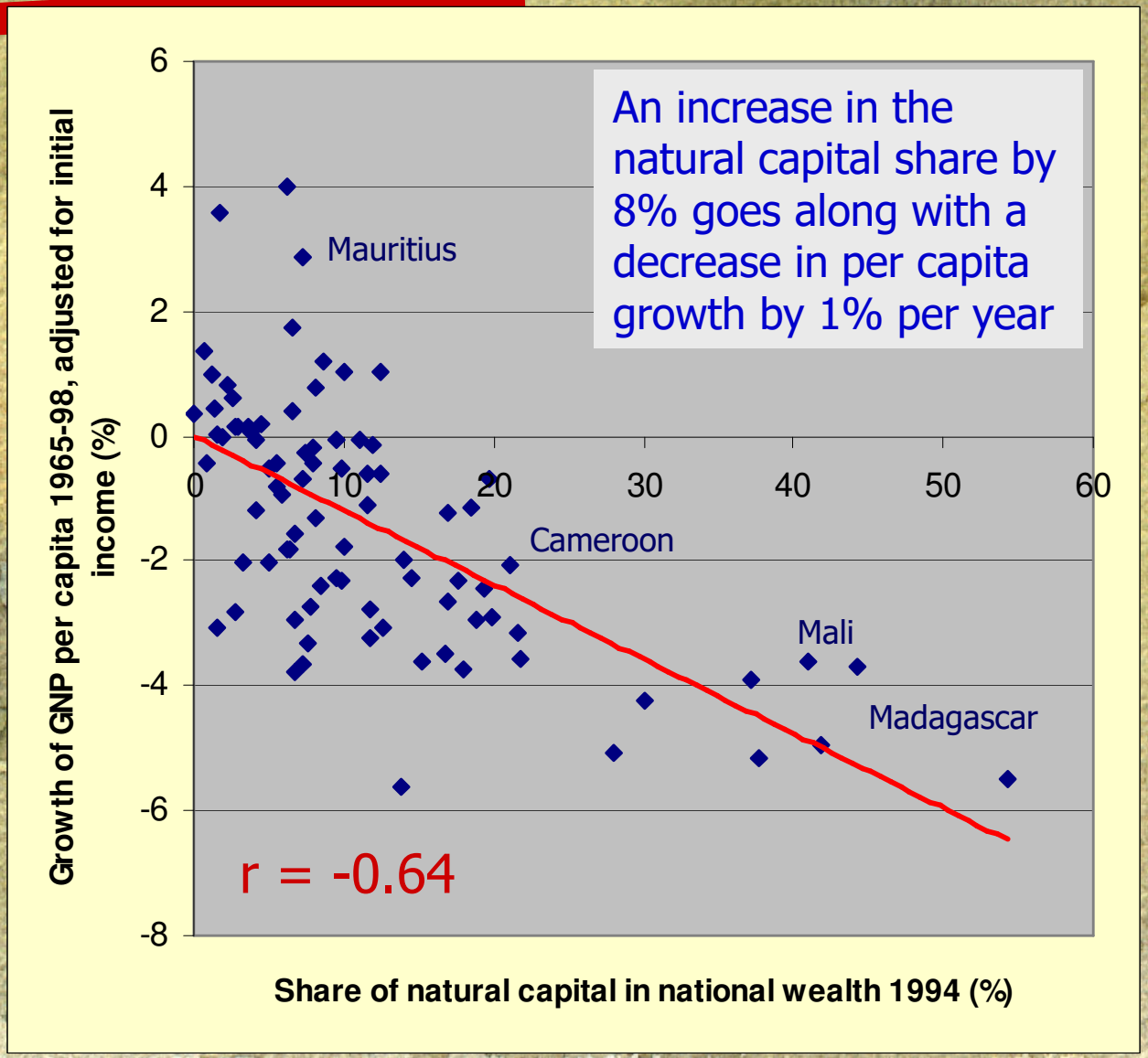
A 25 point increase in secondary-school enrolment goes along with an increase in per capita growth by 1% per year



Diminishing returns: The additional benefit from education becomes smaller as enrolment increases

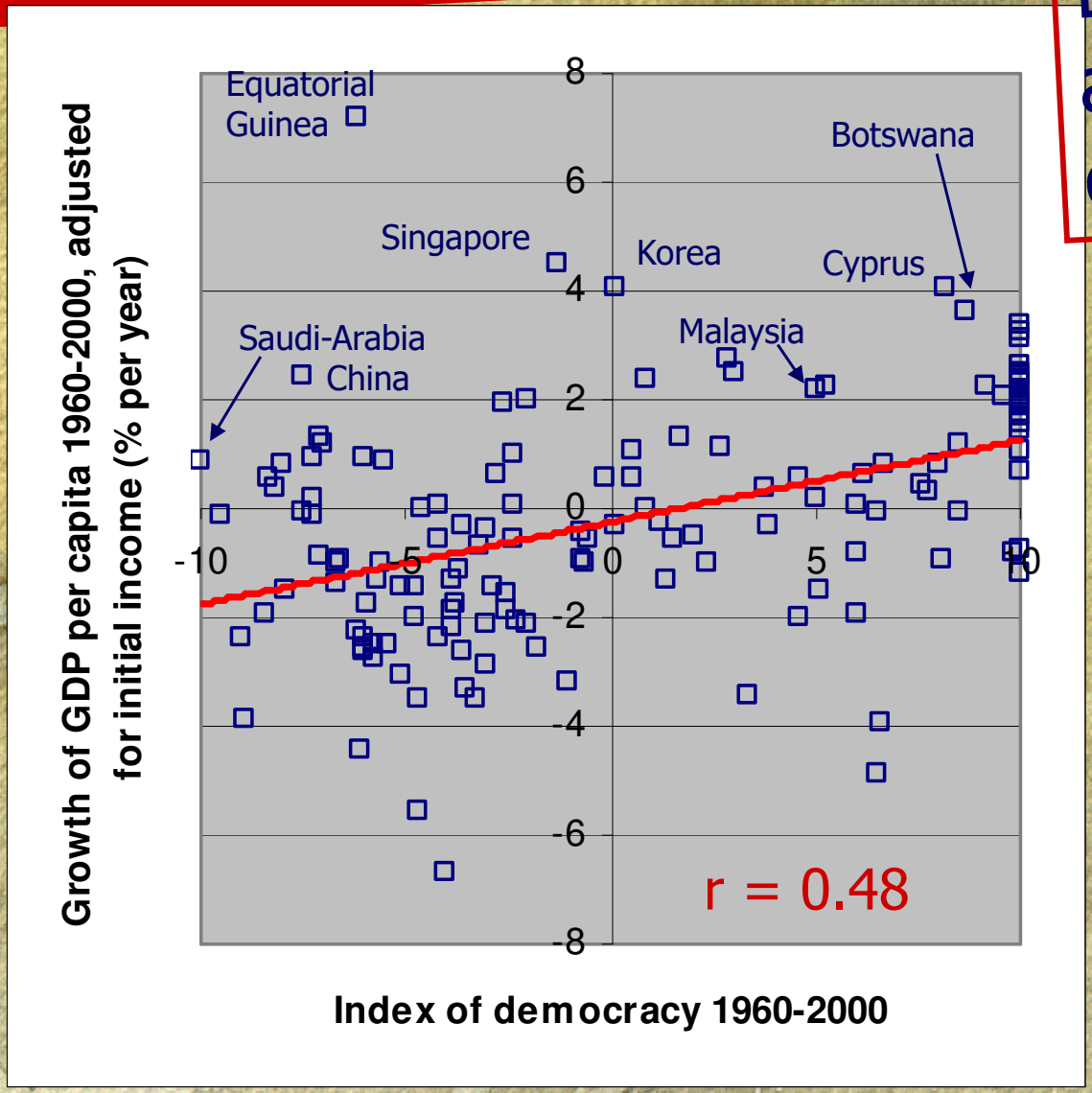
87 countries

Natural resources and growth, 1965-1998



85 countries

Democracy and growth, 1965-1998



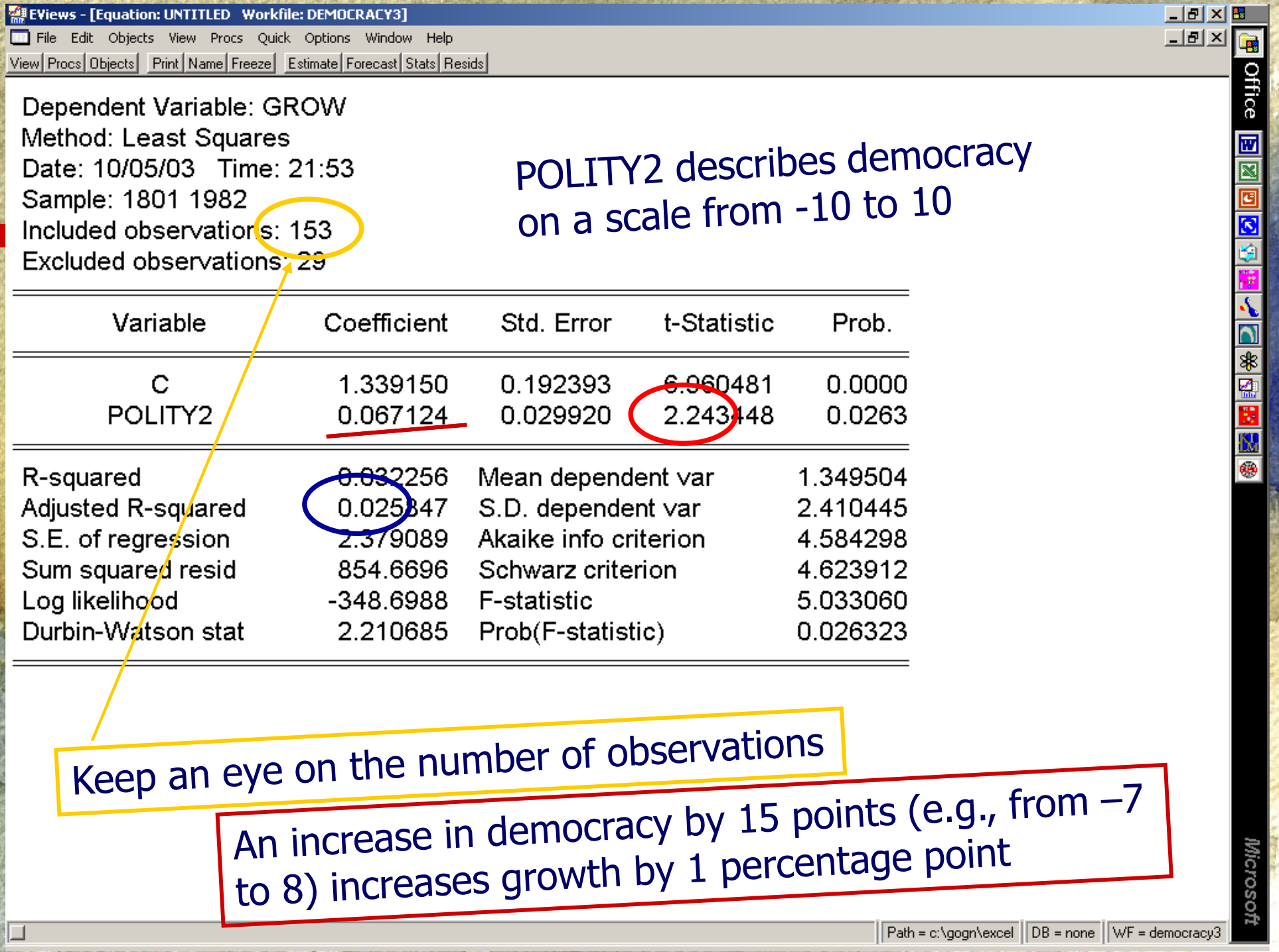
Democracy and growth go together

Now, let's run some regressions

144 countries

Growth regressions

- Based on World Bank data
  - World Development Indicators, published each year on CD
  - Wide coverage: 208 countries, 42 years
  - Could also use Penn data (compiled by Summers and Heston), but they cover fewer countries
  - Here, we report cross-sectional evidence, representing each country by a single observation for each variable


EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]
File Edit Objects View Procs Quick Options Window Help
View Procs Objects Print Name Freeze Estimate Forecast Stats Resids
Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 21:53
Sample: 1801 1982
Included observations: 153
Excluded observations: 29
Variable Coefficient Std. Error t-Statistic Prob.
C 1.339150 0.192393 6.960481 0.0000
POLITY2 0.067124 0.029920 2.243448 0.0263
R-squared 0.032256 Mean dependent var 1.349504
Adjusted R-squared 0.025847 S.D. dependent var 2.410445
S.E. of regression 2.379089 Akaike info criterion 4.584298
Sum squared resid 854.6696 Schwarz criterion 4.623912
Log likelihood -348.6988 F-statistic 5.033060
Durbin-Watson stat 2.210685 Prob(F-statistic) 0.026323
POLITY2 describes democracy on a scale from -10 to 10
Keep an eye on the number of observations
An increase in democracy by 15 points (e.g., from –7 to 8) increases growth by 1 percentage point
Path = c:\gogn\excel
DB = none
WF = democracy3
Office
Microsoft

EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View Procs Objects Print Name Freeze Estimate Forecast Stats Resids

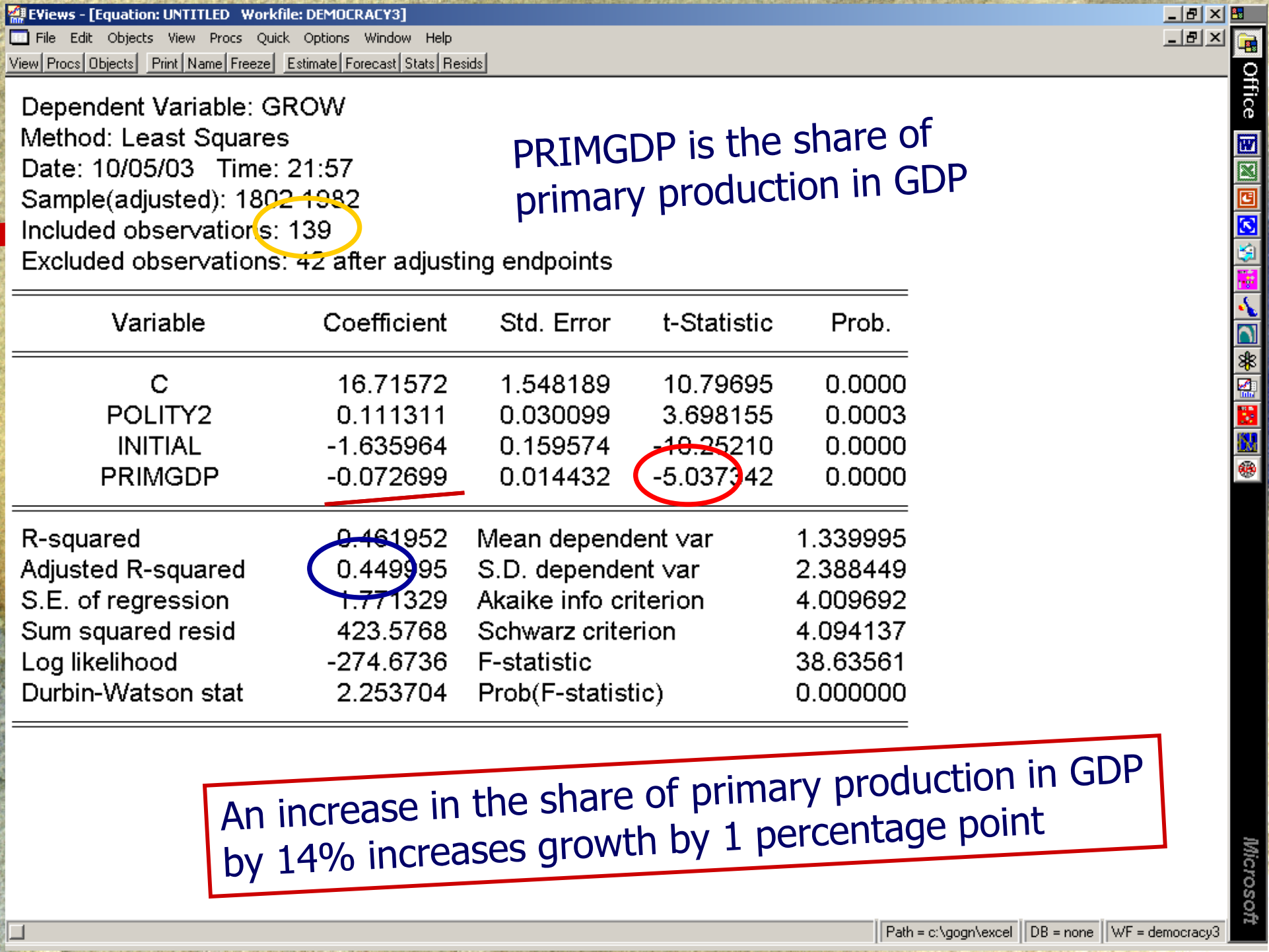
Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 21:55
Sample(adjusted): 1802 1982
Included observations: 144
Excluded observations: 37 after adjusting endpoints

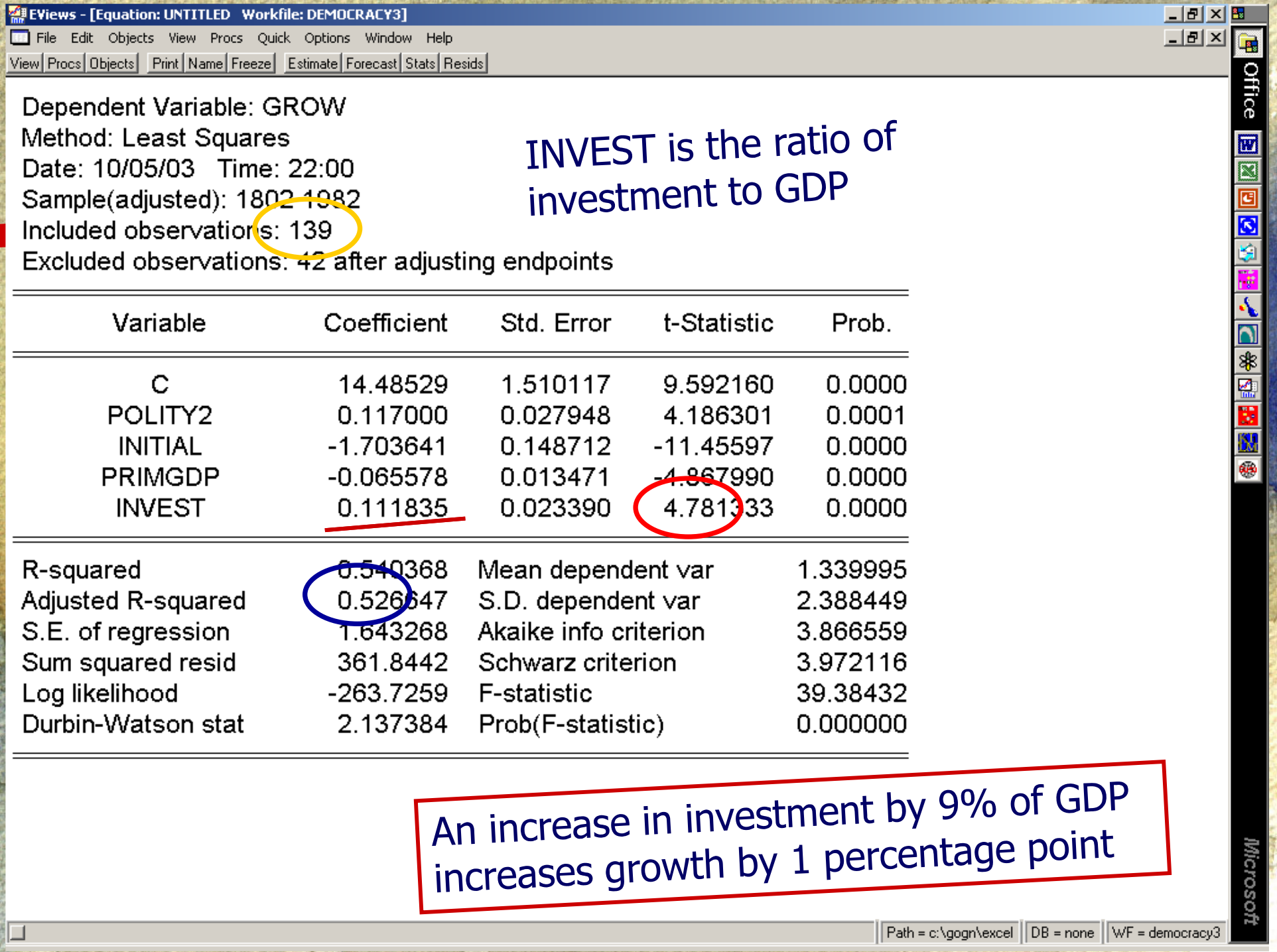
INITIAL is the log of per capita GNP in 1960, so the coefficient describes the speed of convergence

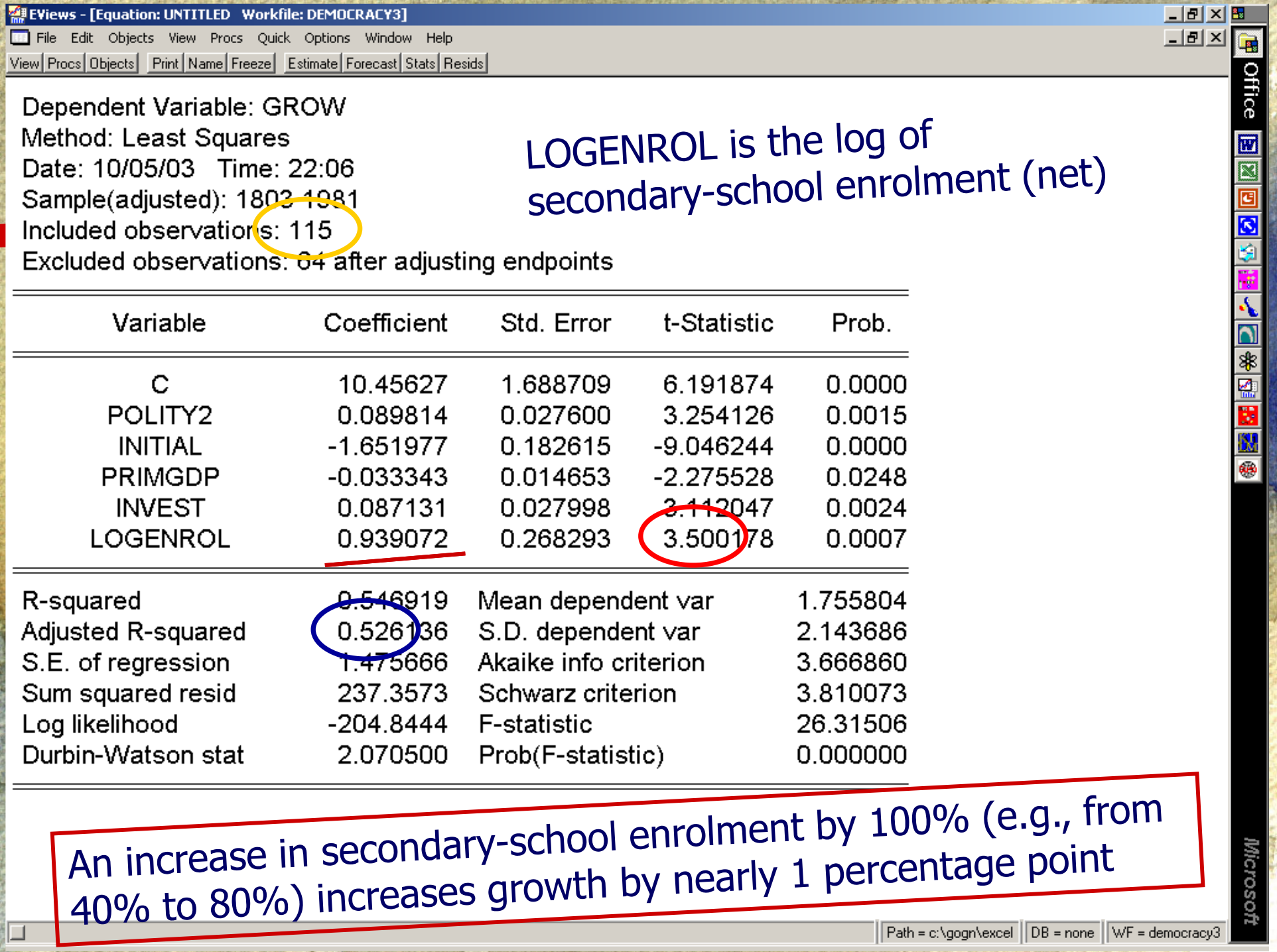
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.20680	1.202970	9.315946	0.0000
POLITY2	0.185116	0.027973	6.617587	0.0000
INITIAL	-1.266962	0.152676	-8.298396	0.0000

R-squared	0.357498	Mean dependent var	1.353713
Adjusted R-squared	0.348384	S.D. dependent var	2.354045
S.E. of regression	1.900249	Akaike info criterion	4.142460
Sum squared resid	509.1435	Schwarz criterion	4.204331
Log likelihood	-295.2571	F-statistic	39.22724
Durbin-Watson stat	2.134033	Prob(F-statistic)	0.000000

Path = c:\gogn\excel DB = none WF = democracy3


EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]
File Edit Objects View Procs Quick Options Window Help
View Procs Objects Print Name Freeze Estimate Forecast Stats Resids
Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 21:57
Sample(adjusted): 1802 1982
Included observations: 139
Excluded observations: 42 after adjusting endpoints
PRIMGDP is the share of primary production in GDP
Variable Coefficient Std. Error t-Statistic Prob.
C 16.71572 1.548189 10.79695 0.0000
POLITY2 0.111311 0.030099 3.698155 0.0003
INITIAL -1.635964 0.159574 -10.25210 0.0000
PRIMGDP -0.072699 0.014432 -5.037342 0.0000
R-squared 0.461952 Mean dependent var 1.339995
Adjusted R-squared 0.449995 S.D. dependent var 2.388449
S.E. of regression 1.771329 Akaike info criterion 4.009692
Sum squared resid 423.5768 Schwarz criterion 4.094137
Log likelihood -274.6736 F-statistic 38.63561
Durbin-Watson stat 2.253704 Prob(F-statistic) 0.000000
An increase in the share of primary production in GDP by 14% increases growth by 1 percentage point
Path = c:\gogn\excel
DB = none
WF = democracy3
Office
Microsoft


EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]
File Edit Objects View Procs Quick Options Window Help
View Procs Objects Print Name Freeze Estimate Forecast Stats Resids
Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 22:00
Sample(adjusted): 1802 1982
Included observations: 139
Excluded observations: 42 after adjusting endpoints
INVEST is the ratio of investment to GDP
Variable Coefficient Std. Error t-Statistic Prob.
C 14.48529 1.510117 9.592160 0.0000
POLITY2 0.117000 0.027948 4.186301 0.0001
INITIAL -1.703641 0.148712 -11.45597 0.0000
PRIMGDP -0.065578 0.013471 -4.867990 0.0000
INVEST 0.111835 0.023390 4.781333 0.0000
R-squared 0.540368 Mean dependent var 1.339995
Adjusted R-squared 0.526647 S.D. dependent var 2.388449
S.E. of regression 1.643268 Akaike info criterion 3.866559
Sum squared resid 361.8442 Schwarz criterion 3.972116
Log likelihood -263.7259 F-statistic 39.38432
Durbin-Watson stat 2.137384 Prob(F-statistic) 0.000000
An increase in investment by 9% of GDP increases growth by 1 percentage point
Path = c:\gogn\excel
DB = none
WF = democracy3
Office
Microsoft



LOGENROL is the log of secondary-school enrolment (net)

An increase in secondary-school enrolment by 100% (e.g., from 40% to 80%) increases growth by nearly 1 percentage point

EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 22:03
Sample(adjusted): 1803 1981
Included observations: 115
Excluded observations: 64 after adjusting endpoints

$$DISTORT = \pi/(1+\pi)$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.08850	1.552197	6.499496	0.0000
POLITY2	0.066783	0.025821	2.586361	0.0110
INITIAL	-1.551798	0.169028	-9.180730	0.0000
PRIMGDP	-0.031080	0.013460	-2.309149	0.0228
INVEST	0.069217	0.025992	2.663073	0.0089
LOGENROL	1.070840	0.247925	4.319206	0.0000
DISTORT	-2.752835	0.595696	-4.621209	0.0000

R-squared	0.621719	Mean dependent var	1.755804
Adjusted R-squared	0.600704	S.D. dependent var	2.143686
S.E. of regression	1.354593	Akaike info criterion	3.503817
Sum squared resid	198.1715	Schwarz criterion	3.670900
Log likelihood	-194.4695	F-statistic	29.58373
Durbin-Watson stat	2.264302	Prob(F-statistic)	0.000000

A decrease in inflation from 50% to zero increases growth by nearly 1 percentage point

Path = c:\gegn\excel | DB = none | WF = democracy3

EViews - [Equation: UNTITLED Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: GROW
Method: Least Squares
Date: 10/05/03 Time: 22:08
Sample(adjusted): 1803 1981
Included observations: 115
Excluded observations: 64 after adjusting endpoints

DUMMYAFR is a dummy for sub-Saharan Africa

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.56470	1.685289	6.862145	0.0000
POLITY2	0.067523	0.025434	2.654822	0.0091
INITIAL	-1.593635	0.167688	-9.503576	0.0000
PRIMGDP	-0.029696	0.013273	-2.237247	0.0273
INVEST	0.063342	0.025755	2.459432	0.0155
LOGENROL	0.837612	0.268669	3.117641	0.0023
DISTORT	-2.905384	0.591273	-4.913778	0.0000
DUMMYAFR	-0.864473	0.415327	-2.081429	0.0398

R-squared	0.636440	Mean dependent var	1.755804
Adjusted R-squared	0.612655	S.D. dependent var	2.143686
S.E. of regression	1.334166	Akaike info criterion	3.481517
Sum squared resid	190.4600	Schwarz criterion	3.672469
Log likelihood	-192.1872	F-statistic	26.75879
Durbin-Watson stat	2.291853	Prob(F-statistic)	0.000000

Path = c:\gogn\excel | DB = none | WF = democracy3

EViews - [Equation: EQ31 Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: LOG(GNP)
Method: Least Squares
Date: 10/06/03 Time: 12:26
Sample(adjusted): 1803 1981
Included observations: 115
Excluded observations: 64 after adjusting endpoints

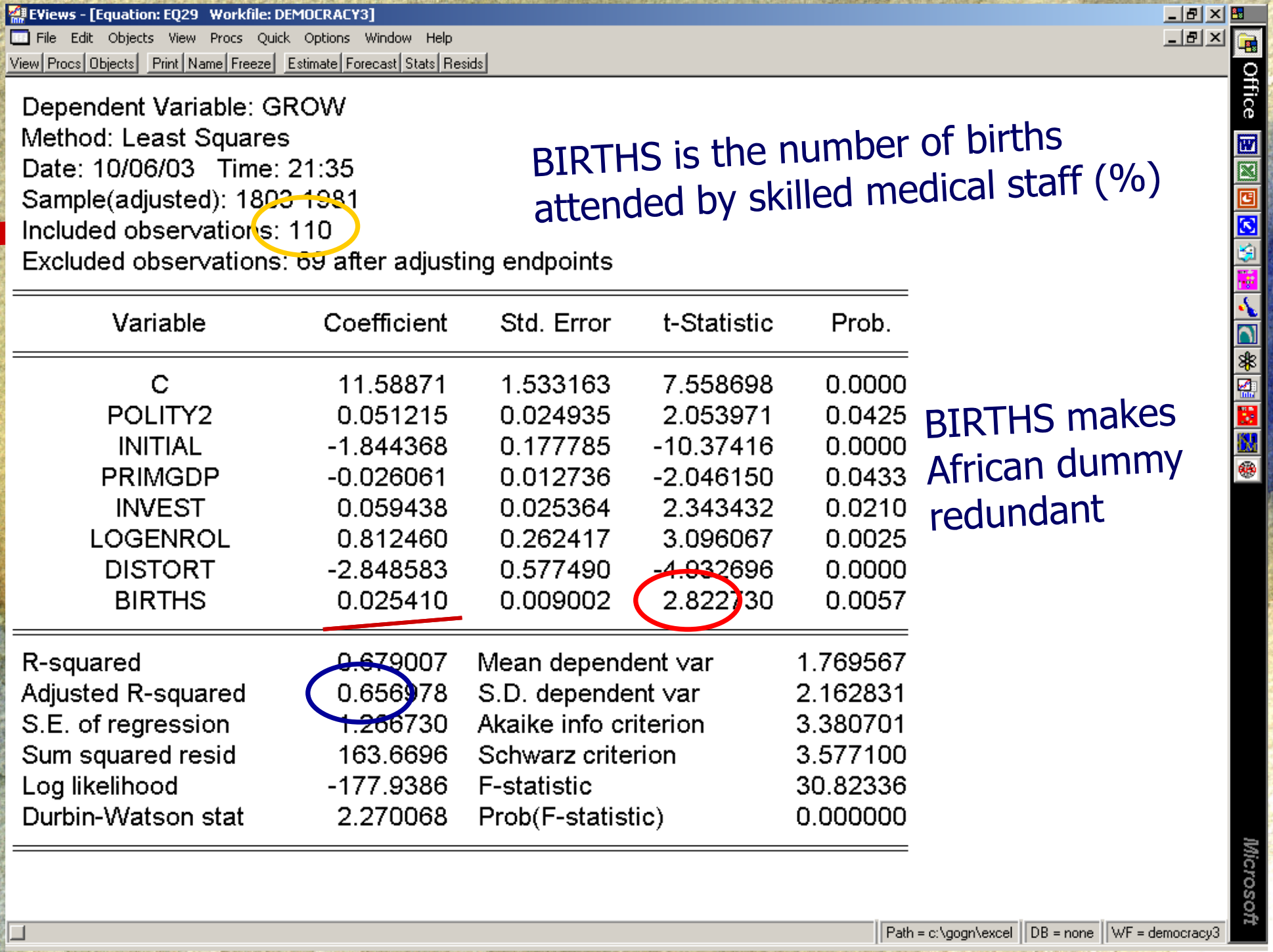
Dependent variable is now the level of per capita GNP: same story

Conditional convergence, as before

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.657236	0.653850	7.122790	0.0000
POLITY2	0.026690	0.009868	2.704774	0.0080
INITIAL	0.371939	0.065059	5.716969	0.0000
PRIMGDP	-0.012494	0.005150	-2.426172	0.0169
INVEST	0.023980	0.009992	2.399885	0.0181
LOGENROL	0.316652	0.104237	3.037821	0.0030
DISTORT	-1.163443	0.229399	-5.071697	0.0000
DUMMYAFR	-0.357443	0.161136	-2.218262	0.0286

R-squared	0.823025	Mean dependent var	8.466503
Adjusted R-squared	0.811447	S.D. dependent var	1.192057
S.E. of regression	0.517623	Akaike info criterion	1.587889
Sum squared resid	28.66892	Schwarz criterion	1.778841
Log likelihood	-83.30361	F-statistic	71.08636
Durbin-Watson stat	2.261577	Prob(F-statistic)	0.000000

Path = c:\gogn\excel | DB = none | WF = democracy3



BIRTHS is the number of births attended by skilled medical staff (%)

BIRTHS makes African dummy redundant

Grand finale

EViews - [System: SYS03 Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View | Procs | Objects | Print | Name | Freeze | MergeText | Estimate | Spec | Stats | Resids

System: SYS03
Estimation Method: Seemingly Unrelated Regression
Date: 10/07/03 Time: 18:37
Sample: 1801 1982
Included observations: 153
Total system (unbalanced) observations 650
Linear estimation after one-step weighting matrix

Effects of democracy

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	11.58871	1.476359	7.849523	0.0000
C(2)	0.051215	0.024011	2.132999	0.0333
C(3)	-1.644368	0.171198	-10.77331	0.0000
C(4)	-0.026061	0.012265	-2.124877	0.0340
C(5)	0.059438	0.024424	2.433597	0.0152
C(6)	0.812460	0.252694	3.215189	0.0014
C(7)	-2.848583	0.556094	-5.122484	0.0000
C(8)	0.025410	0.008668	2.931336	0.0035
C(11)	22.05419	0.484963	45.47605	0.0000
C(14)	0.222350	0.075010	2.964292	0.0031
C(21)	1.403888	0.558277	2.514680	0.0122
C(22)	0.024009	0.010280	2.335495	0.0198
C(23)	0.340197	0.057659	5.900158	0.0000
C(24)	-0.017155	0.005112	-3.355633	0.0008
C(31)	-23.75710	14.34675	-1.655922	0.0982
C(32)	0.789133	0.292741	2.695667	0.0072
C(33)	13.80748	1.476646	9.350570	0.0000
C(34)	-0.401443	0.132942	-3.019691	0.0026
C(41)	1.364558	4.320161	0.315858	0.7522
C(42)	0.924296	0.439470	2.103207	0.0358
C(43)	-0.226565	0.035544	-6.374173	0.0000

Determinant residual covariance 97081.89

Path = c:\gogn\excel | DB = none | WF = democracy3

Dependent variable: per capita growth 1960-2000, $R^2 = 0.68$

If Panama became like Costa Rica, growth would rise by 1%

Growth equation

Total effect of democracy on growth is 0.051 + 0.013 + 0.019 + 0.020 = 0.103

Investment equation

Education equation

Health equation

Democracy equation

Grand finale

EViews - [System: SYS03 Workfile: DEMOCRACY3]

File Edit Objects View Procs Quick Options Window Help

View | Procs | Objects | Print | Name | Freeze | MergeText | Estimate | Spec | Stats | Resids

System: SYS03
Estimation Method: Seemingly Unrelated Regression
Date: 10/07/03 Time: 18:37
Sample: 1801 1982
Included observations: 153
Total system (unbalanced) observations 650
Linear estimation after one-step weighting matrix

Dependent variable: per capita growth 1960-2000, $R^2 = 0.68$

Effect of primary production on growth

Effects of natural resources

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	11.58871	1.476359	7.849523	0.0000
C(2)	0.051215	0.024011	2.132999	0.0333
C(3)	-1.844368	0.171198	-10.77331	0.0000
C(4)	-0.026061	0.012265	-2.124877	0.0340
C(5)	0.059438	0.024424	2.433597	0.0152
C(6)	0.812460	0.252694	3.215189	0.0014
C(7)	-2.848583	0.556094	-5.122484	0.0000
C(8)	0.025410	0.008668	2.931336	0.0035
C(11)	22.05419	0.484963	45.47605	0.0000
C(14)	0.222350	0.075010	2.964292	0.0031
C(21)	1.403888	0.558277	2.514680	0.0122
C(22)	0.024009	0.010280	2.335495	0.0198
C(23)	0.340197	0.057659	5.900158	0.0000
C(24)	-0.017155	0.005112	-3.355633	0.0008
C(31)	-23.75710	14.34675	-1.655922	0.0982
C(32)	0.789133	0.292741	2.695667	0.0072
C(33)	13.80748	1.476646	9.350570	0.0000
C(34)	-0.401443	0.132942	-3.019691	0.0026
C(41)	1.364558	4.320161	0.315858	0.7522
C(42)	0.924296	0.439470	2.103207	0.0358
C(43)	-0.226565	0.035544	-6.374173	0.0000

Determinant residual covariance 97081.89

Growth equation

Total effect of primary share on growth is 0.026 + 0.014 + 0.010 + 0.012 = 0.062

Investment equation

Education equation

Health equation

Democracy equation

Path = c:\gogn\excel | DB = none | WF = democracy3

Conclusion

Saving and efficiency are good for growth

Efficiency gains take many different forms

The End

Liberalization, stabilization, privatization

Conversion of inputs into output is not solely a matter of technology, but also efficiency, so **economic policy matters**


Classroom discussion