

# Panel Data Models

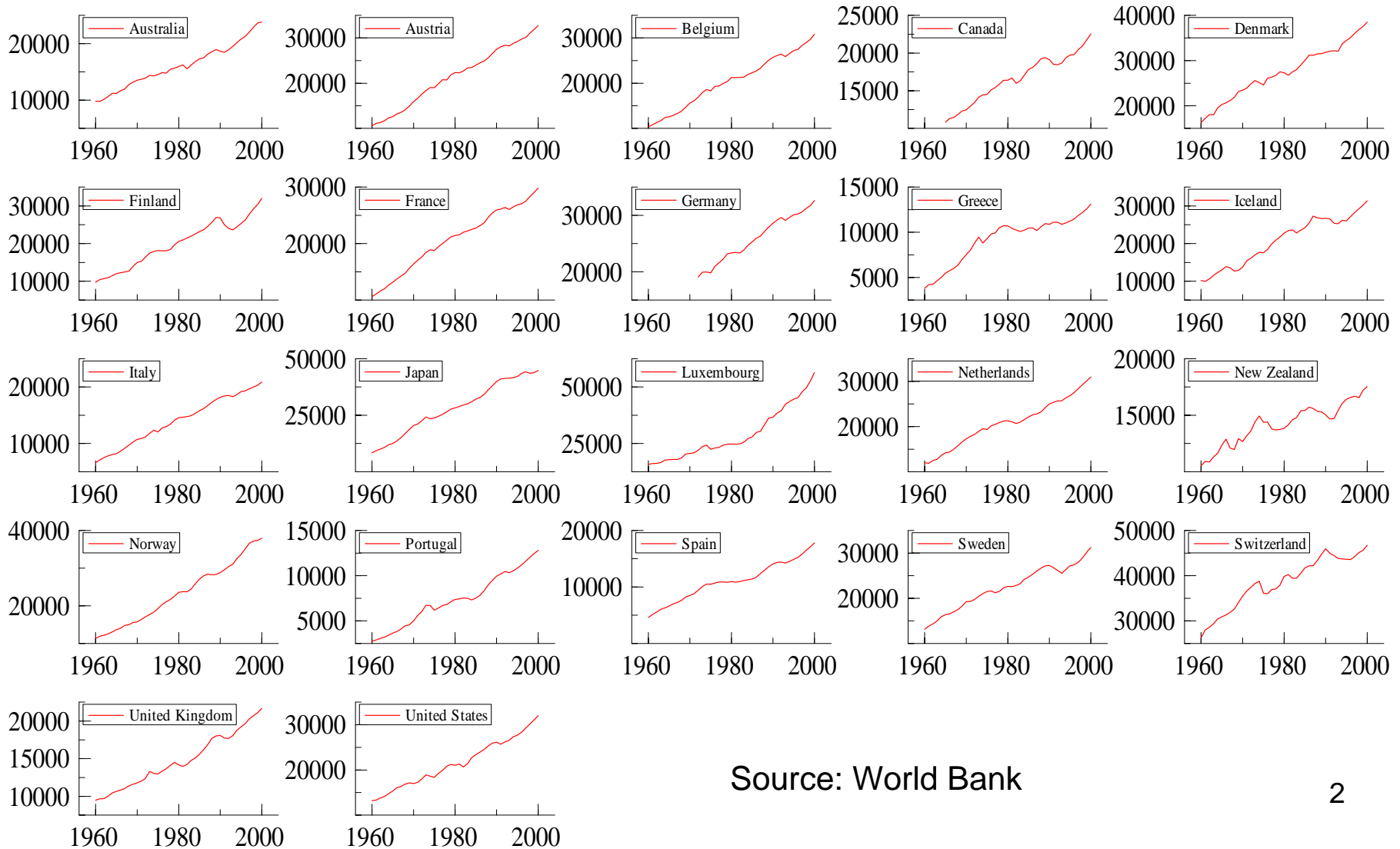
Keshab R. Bhattarai

Business School



# Evidence on Economic Growth-1

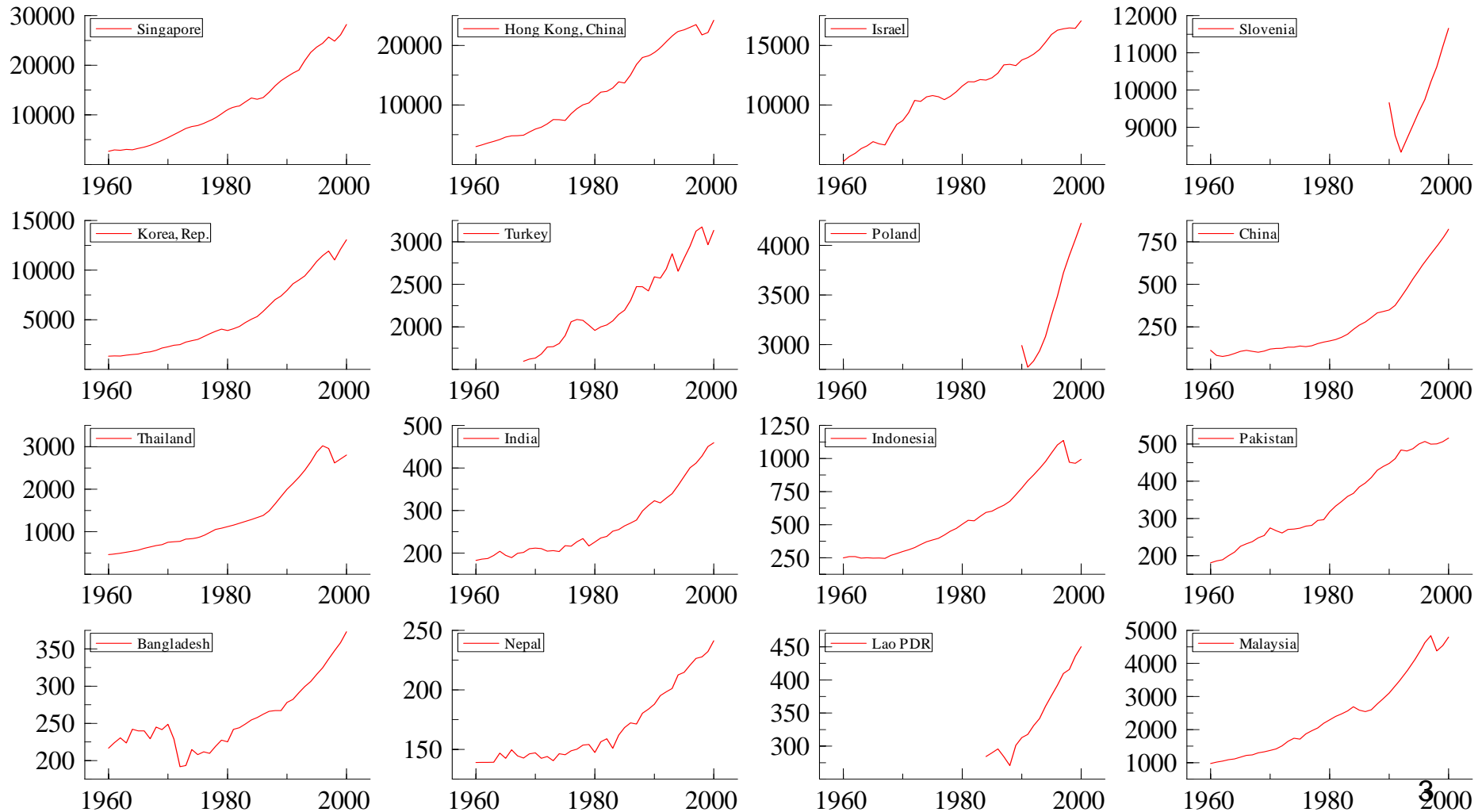
## Per Capita GDP in OECD Economies (1960-2000)



Source: World Bank

# Evidence on Economic Growth -2

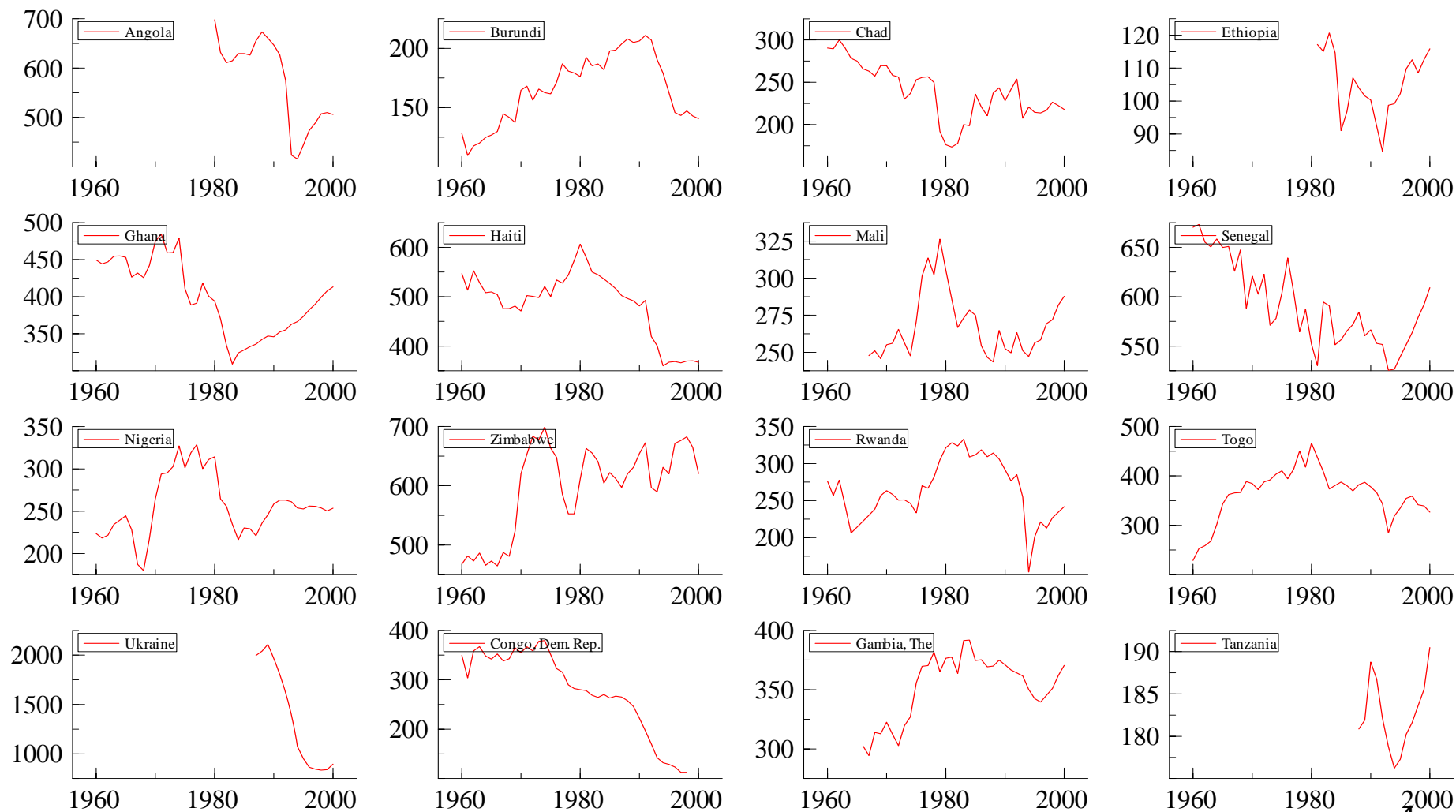
## Per capita income in growth miracle countries 1960-2000



Source: World Bank

# Evidence on Economic Growth -3

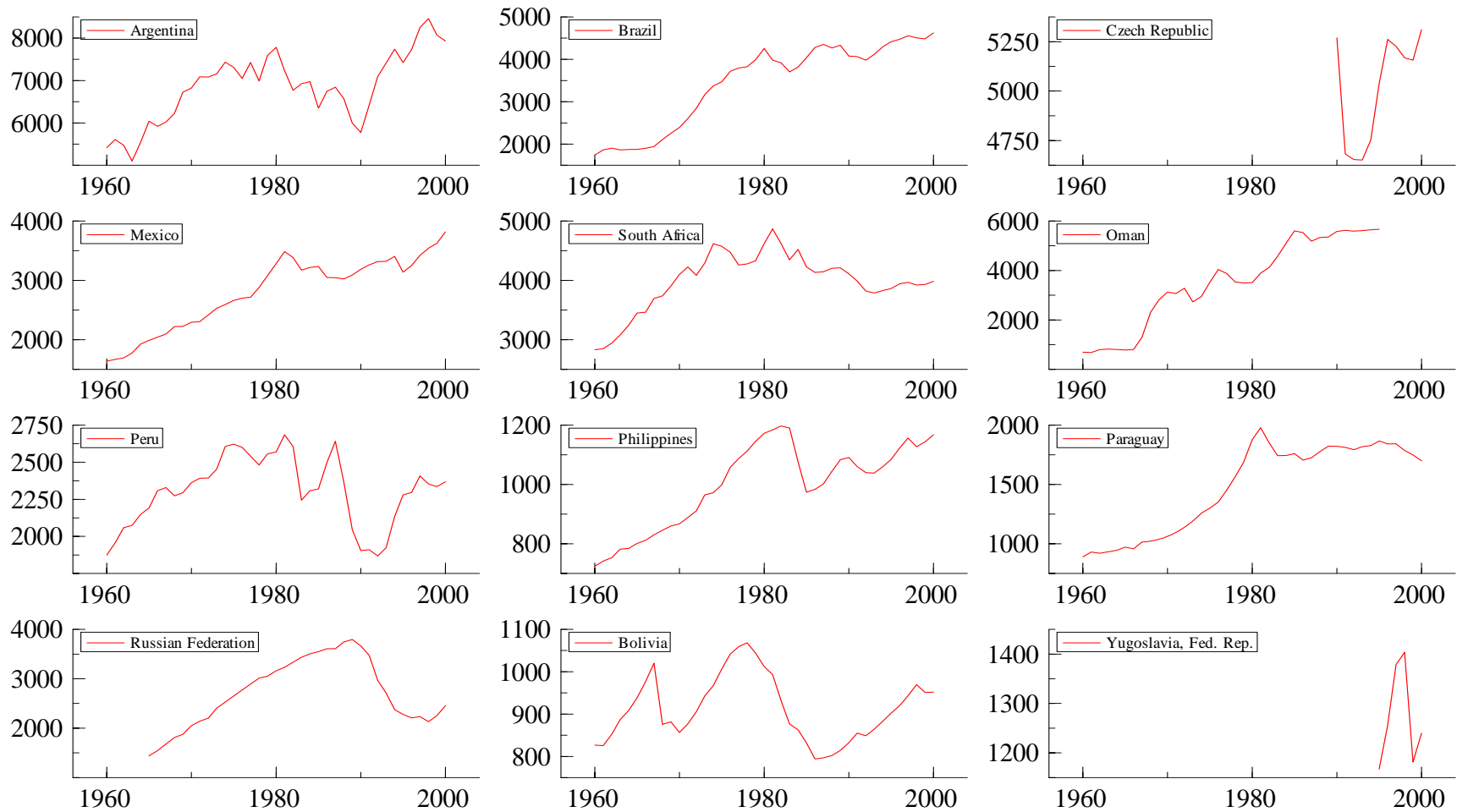
## Per Capita GDP in Growth Disaster Economies 1960-2000



Source: World Bank

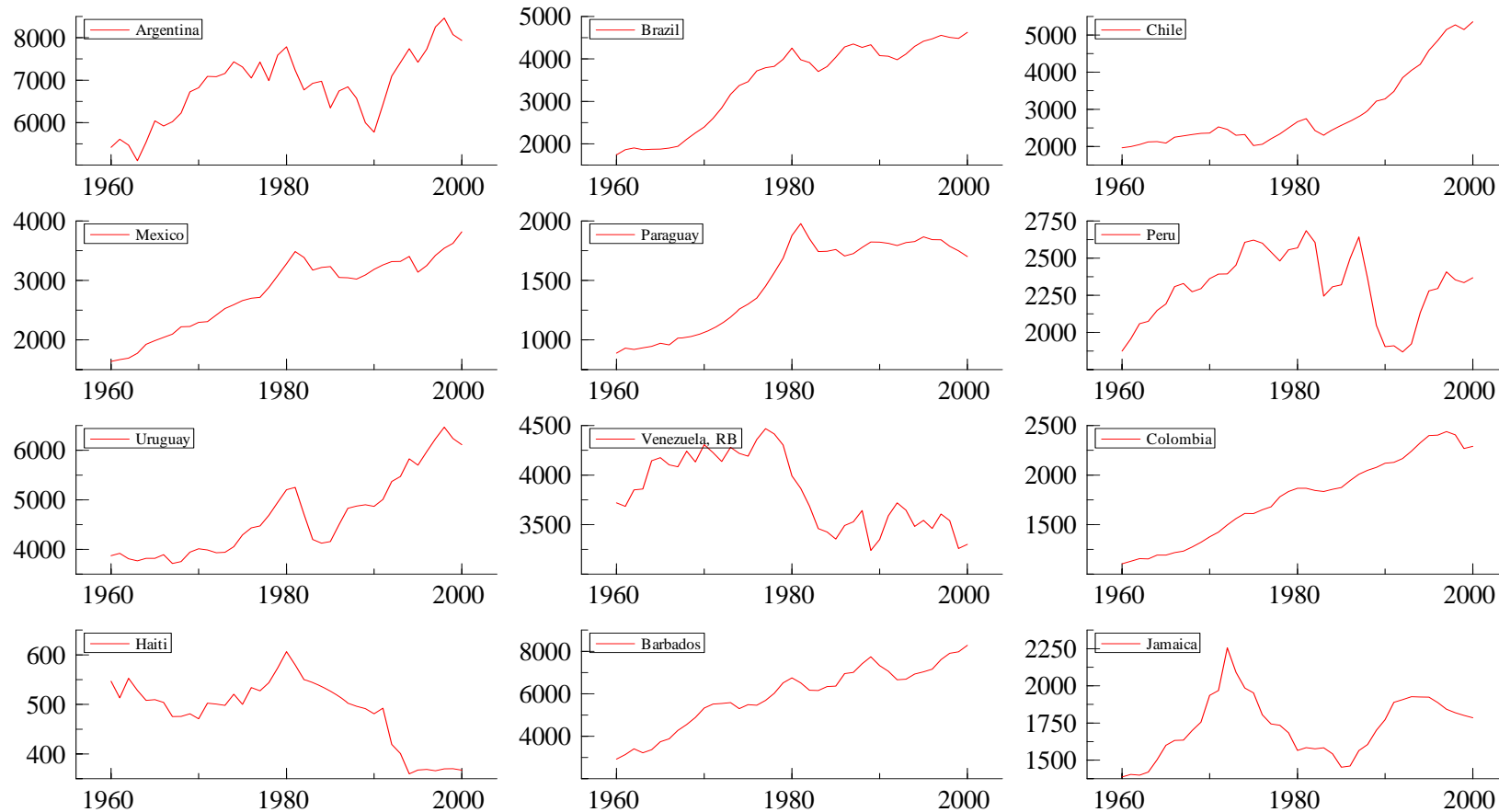
# Evidence on Economic Growth -4

## Per capita income in Trouble-prone Mid-income countries 1960-2000



# Evidence on Economic Growth -5

## Per capita income Latin and Central American and Caribbean countries 1960-2000



Source: World Bank

# Growth Models

- Classical
- Harrod-Domar (Keynesian)
- Neo-classical (Solow-Swan)
- Endogenous (Lucas, Romer)
- Human Capital, technology adoption (Parente-  
Prescott)
- Case study approach
- Socio-Political and Institutional Approach
- Growth Regressions

# Relevant Literature (there are too many to list!!!)

## Growth Theories and Sessions in this conference

### One or two sector growth models

Ramsey (1928), Harrod (1939), Domar (1947), Solow (1956), Cass (1965),  
Koopman (1965), Uzawa (1962), Lucas (1988), Rebelo (1991)  
Romer (1989), Barro (1998) and Barro and Sala-i-Martin(1995), Quah (1997),  
Parente and Prescott (1993) Rankin (1992) Dixon H (1987) Jones (1995)  
Greenwood and Jovanovic (1990), Turnovsky (1993)

### Empirical growth study

Maddison (1991). Nicolas Kaldor (1961) Rodrik (1999) Mankiw et. al. (1992), Hendry D.F.  
(1997)  
Temple (1999) McMahon G and L. Squire(2003) Holly S and M Weale Eds.(2000)  
Perroti (1996) Grossman and Helpman (1991) HM Treasury (2002)

### Dynamic General Equilibrium Models and stochastic DGEM

Debreau (1954), Solow (1956), Cass(196), King and Fullerton (1984),  
Miller and Spencer (1977), Aurback and Kotlikoff (1987), Ballard, Fullerton, Shoven and  
Whalley(1985), Piggott and Whalley (1985), Bhattarai and Whalley (1999),  
Hutton and Kenc (1994), Perroni (1995), Rutherford (1995),  
Bhattarai (1997,1999) Doornik and Hendry (2001), Cooly (1995)

# Some Studies on Global Evidence

- Abramovitch (1986)
- Maddison (1991): OECD economies
- Barro (1991)
- Mankiw-Romer-Weale (1992)
- Barrow and Sala-i-Martin (1995)
- Jones (1995)
- Qua (1997)
- Temple (1999)
- Yifu (2003)
- World Bank Annual Reports

# Major Growth issues

- Capital accumulation
- Technology and its adoption
- Openness, trade and growth
- Tax policy
- Human Capital, Education
- Country specific factors
- Political Freedom and Market Economy

# Determinants of Growth: Panel Regression Model

$$y_{i,t} = \alpha_i + x_{i,t}\beta_{i,t} + \lambda_t + e_{i,t}$$

$$\begin{bmatrix} y_{i,1} \\ y_{i,2} \\ \cdot \\ \cdot \\ y_{i,T} \end{bmatrix} = \begin{bmatrix} x_{i,1}\beta \\ x_{i,2}\beta \\ \cdot \\ \cdot \\ x_{i,T}\beta \end{bmatrix} + \begin{bmatrix} \alpha_i \\ \alpha_i \\ \cdot \\ \cdot \\ \alpha_i \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \cdot \\ \cdot \\ \lambda_T \end{bmatrix} + \begin{bmatrix} e_{1i} \\ e_{2i} \\ \cdot \\ \cdot \\ e_{mi} \end{bmatrix}$$

$$y_i = x_i\beta + \lambda_t + \iota_i\alpha_i + e_i$$

Baltagi (1995), Doornik and Hendry (2001)

## Estimator of a Panel Data Model

$$y_i = x_i \beta + D_i \delta + e_i$$

$$y = W\beta + e$$

$$\hat{\beta} = (W'W)^{-1}W'y$$

## Dynamic Panel Data Model

$$y_{i,t} = \sum_{s=1}^p a_k y_{i,t-s} + \beta^t(L)x_{i,t} + \lambda_t + \alpha_i + e_{i,t}$$

$$y_i = W_i \delta + \iota_i \alpha_i + e_i$$

GMM Estimator ( Baltagi (1995), Doornik and Hendry (2001)):

$$\hat{\delta} = \left[ \left( \sum_i W_i^* Z_i \right) A_N \left( \sum_i Z_i' W_i \right) \right]^{-1} \left( \sum_i W_i^* Z_i \right) A_N \left( \sum_i Z_i' y_i^* \right)$$

$$A_N = \left( \frac{1}{N} \sum_i Z_i' H_i Z_i \right)^{-1}$$

## Determinants of Economic Growth in Newly Emerging Growth Miracle Economies.

2-step estimation using dynamic panel data model				
	Coefficient	Std.Error	t-value	t-prob
Gdpprcap(-1)	0.12036	0.01812	6.64000	0.00000
GDP60	-0.00159	0.00043	-3.73000	0.00000
china	0.00288	0.00137	2.11000	0.03700
Hkong	-0.00171	0.00077	-2.21000	0.02800
Ireland	0.00110	0.00128	0.86300	0.38900
Korea	0.00335	0.00074	4.53000	0.00000
Malta	-0.00197	0.00068	-2.90000	0.00400
Portugal	-0.00061	0.00096	-0.63700	0.52500
Singapore	0.00113	0.00027	4.21000	0.00000
Sratio	0.15583	0.04257	3.66000	0.00000
Irattio	0.18329	0.02995	6.12000	0.00000
Prindex	-0.00510	0.00487	-1.05000	0.29700
rint	-0.02795	0.06357	-0.44000	0.66100
xmratio	-0.00461	0.00097	-4.74000	0.00000
Japan	-0.00056	0.00086	-0.65300	0.51500
sigma	4.914753	sigma^2	24.1548	
RSS	3526.6004	TSS	2240.0576	
no. of observations	161	no. of parameters	15	

Table 2  
Determinants of Growth across OECD Countries

	Coefficient	Std.Error	t-value	t-prob
Grpercap(-1)	0.180988	0.05395	3.35	0.00
Sy	0.216942	0.03	7.23	0.00
Iy	-0.00045	0.05464	-0.00824	0.99
Xmy	0.0648251	0.01251	5.18	0.00
Popg	-1.88968	0.4329	-4.37	0.00
Govy	-0.203699	0.0558	-3.65	0.00
Txy	-0.132421	0.0445	-2.98	0.00
Australia	0.972477	0.4075	2.39	0.02
Austria	-1.6312	0.3127	-5.22	0.00
Belgium	-1.8475	0.3254	-5.68	0.00
Canada	-0.463298	0.1385	-3.34	0.00
Denmark	-0.170403	0.04258	-4	0.00
Finland	-0.209737	0.05947	-3.53	0.00
France	0.077469	0.07293	1.06	0.29
Germany	-0.362554	0.04693	-7.73	0.00
Greece	-0.585984	0.06581	-8.9	0.00
Iceland	-0.207666	0.05016	-4.14	0.00
Ireland	-0.411256	0.0768	-5.35	0.00
Italy	-0.0800266	0.0598	-1.34	0.18
Japan	-0.398036	0.06241	-6.38	0.00
Luxembourg	-0.718133	0.1419	-5.06	0.00
Netherlands	-0.221358	0.04843	-4.57	0.00
New Zealand	-0.127106	0.04085	-3.11	0.00
Norway	-0.153097	0.03551	-4.31	0.00
Portugal	-0.216048	0.04225	-5.11	0.00
Spain	-0.114415	0.0264	-4.33	0.00
Switzerland	-0.330109	0.04088	-8.07	0.00
United Kingdom	-0.0111015	0.01851	-0.6	0.55
Constant	6.88023	0.9513	7.23	0.00
Sigma 1.645049 ; sigma^2 2.71; R^2 = 0.453642; N =390; K 29				
Wald (joint): Chi^2(28) = 580.8 [0.000] **				
Wald (dummy): Chi^2(1) = 52.31 [0.000] **				
AR(1) test: N(0,1) = 3.091 [0.002] **				
AR(2) test: N(0,1) = -0.1074 [0.915]				

Table 5  
Determinants of growth in Growth-disaster Countries.

	Coefficient	Std.Error	t-value	t-prob
Sy	0.0536652	0.0578	0.929	0.357
Iy	0.387516	0.03472	11.2	0
Popg	1.58804	0.6546	2.43	0.018
Xmy	-0.0645406	0.04199	-1.54	0.13
Infl	-0.000239639	5.52E-05	-4.34	0
Govy	-0.254936	0.05758	-4.43	0
Rint	-0.0128252	0.001408	-9.11	0
Rexch	-0.00829239	0.0006404	-12.9	0
Central African Rep.	-0.567217	1.896	-0.299	0.766
Ghana	0.764814	0.909	0.841	0.404
Nicaragua	-0.267793	0.1168	-2.29	0.025
Sierra Leone	-0.0683136	0.128	-0.534	0.596
Venezuela, RB	-0.294535	0.1456	-2.02	0.048
Constant	-0.894037	2.785	-0.321	0.749
Sigma	4.263287	Sigma^2	18.17	562
R^2	0.3457624			
RSS	1072.361362	TSS	1639.1007	168
No. of observations	79	no. of	parameters	20
Wald (joint):	Chi^2(19)	180.1	[0.000]	
Wald (dummy):	Chi^2(1)	0.103	[0.748]	
AR(1) test:	N(0,1)	-0.9735	[0.330]	
AR(2) test:	N(0,1)	-1.269	[0.204]	

Table 7  
Determinants of growth in Latin and Central American countries.  
Panel GMM (one Step) Estimation with Individual Effects

	Coefficient	Std.Error	t-value	t-prob
iy	0.1306	0.0522	2.5000	0.0130
xmy	0.0302	0.0209	1.4500	0.1490
infl	-0.0009	0.0002	-4.0000	0.0000
cadef	0.0475	0.0306	1.5500	0.1220
Constant	-4.4425	3.6730	-1.2100	0.2270
Antigua and Barbuda	2.3244	3.0800	0.7550	0.4510
Argentina	0.3609	1.0630	0.3390	0.7340
Bahamas, The	-0.0664	1.2470	-0.0533	0.9580
Barbados	0.9192	1.0350	0.8880	0.3750
Belize	1.4098	2.5280	0.5580	0.5770
Bolivia	2.5282	3.0420	0.8310	0.4060
Brazil	3.9497	2.2790	1.7300	0.0840
Chile	2.1572	2.7650	0.7800	0.4360
Colombia	0.6180	1.8630	0.3320	0.7400
Costa Rica	2.1726	2.1460	1.0100	0.3120
Dominican Republic	0.1568	2.3280	0.0674	0.9460
Ecuador	0.8159	2.3880	0.3420	0.7330
El Salvador	1.1222	1.0850	1.0300	0.3010
Grenada	1.5311	2.6970	0.5680	0.5700
Guatemala	-2.7476	0.4757	-5.7800	0.0000
Guyana	-0.3287	2.7390	-0.1200	0.9050
Haiti	-0.9212	1.9150	-0.4810	0.6310
Honduras	-1.3697	1.3050	-1.0500	0.2940
Jamaica	1.5202	2.5750	0.5900	0.5550
Mexico	-0.1066	2.1300	-0.0500	0.9600
Nicaragua	0.2862	1.8670	0.1530	0.8780
Panama	-0.3209	2.1480	-0.1490	0.8810
Paraguay	1.0235	2.7600	0.3710	0.7110
Peru	1.0299	0.7821	1.3200	0.1880
Puerto Rico	0.9467	0.6354	1.4900	0.1370
St. Kitts and Nevis	0.8115	0.6603	1.2300	0.2200
St. Lucia	0.1886	2.1710	0.0869	0.9310
St. Vincent and the Grenadines	-0.3299	1.7820	-0.1850	0.8530
Suriname	2.5300	2.6500	0.9550	0.3400
Trinidad and Tobago	-0.8258	2.4170	-0.3420	0.7330
sigma	4.494	Observations	617	
sigma^2	20.19	Parameters	35	
R^2	0.194			
Wald (Joint)	Chi^2(4)	31.11	[0.000]	**

Wide gap exists in living standards among rich and poor countries.

These gaps can be narrowed if the technical idea, capital and labour could flow freely among them.

It is not possible unless growth in the major objective of households, firms and governments.

# References

- Barro R. J.(1991) Economic Growth in Cross Section of Countries, *Quarterly Journal of Economics*, May, 407-433.
- Bhattarai KR (2004) Economic Growth: Models and Global Evidence, Research Memorandum, University of Hull Business School.
- Baltagi, B.H. (1995) *Econometric Analysis of Panel Data*, John Willey and Sons.
- Barro R. J. and Sala-I-Martin (1995) *Economic Growth*, McGraw Hill.
- Temple J. (1999) The New Growth Evidence, *Journal of Economic Literature*, 37:112-156, March.