

VICTORIA UNIVERSITY  
CENTRE FOR STRATEGIC  
ECONOMIC STUDIES SEMINAR  
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**Economic Analysis of Climate  
Change:**  
Substantive Evidence on China's CO<sub>2</sub>  
Emissions-Growth Trade-off and  
UNFCCC/IPCC Policy Relevance

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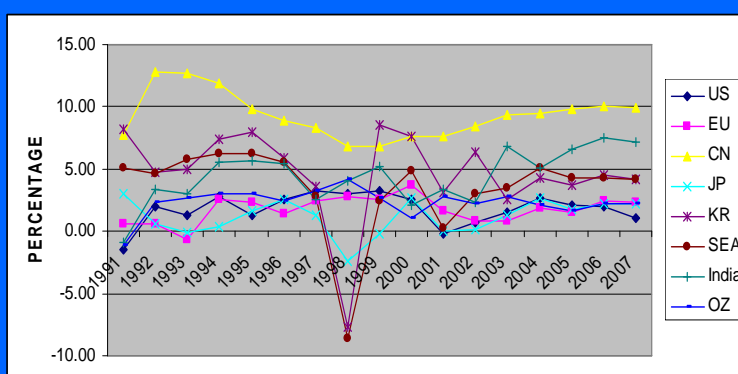
## RESEARCH & POLICY THEME

- Climate Change, Global Warming & Economic Sustainability: **Hot Debates**
- Energy Consumption & Growth (E&G): **Huge Gaps**
- E&G in Developed & Developing countries: **Gaps**
- CO2 Emissions (Environmental Kuznets Curve) and Growth: **Slim Evidence (Stern)**
- CO2 Emissions and Growth in China: **Very limited**
- What is China's CO2-Growth Trade-off (or **What are the economic effects of 390/400/450 parts in a million?**)
- China's Energy Pricing Policy: **Price Cap Effective?**

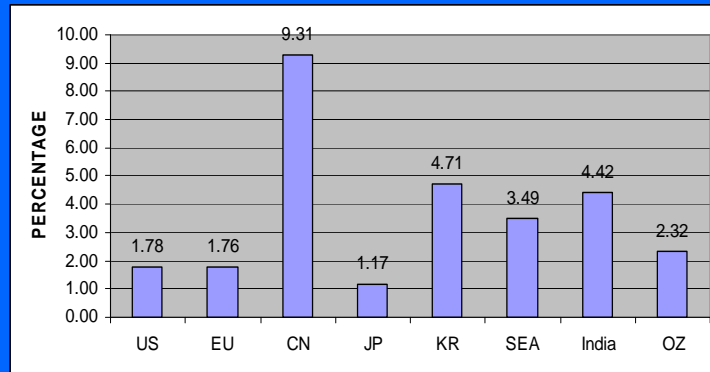
## RESEARCH QUESTIONS

- **Issues** of CO2 Emissions & Growth in China & Major Economies 1991-2006
- Measuring China CO2-Growth Nexus: **A New Endogenous Growth-CO2 Theory in System Framework**
- **Measuring Effects of China Energy Pricing Policy** on CO2 Emissions
- China Energy & Climate Change & **UNFCCC/IPCC Relevance** Policy Recommendations
- For Whom The Bells Toll ? **China Suffers Less!**

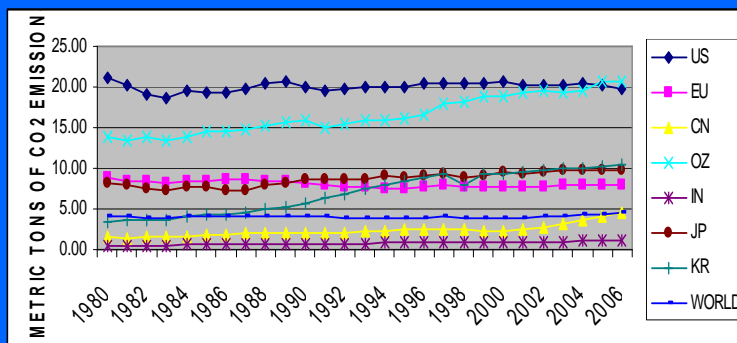
## GROWTH PATH IN MAJOR ECONOMIES, 1991-2007



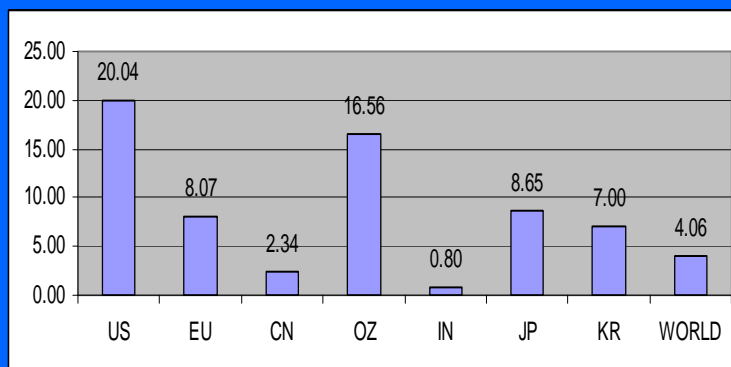
## AVERAGE GROWTH IN MAJOR ECONOMIES, 1991-2007



## PER CAPITA CO2 EMISSIONS (MT) IN MAJOR ECONOMIES, 1991-2007



## AVERAGE PER CAPITA CO2 EMISSIONS (MT) IN MAJOR ECONOMIES, 1991-2007



- **WAYS IN EXPLORING & MODELLING THE CO2-GROWTH CAUSAL LINK:**
  - Descriptive Analysis (popular): **superficial, not 'deep'**
  - **Granger/Engel-Granger (TVH 83, 84, 92, 93): Autocorrelation function time-series foundation**
  - Growth-Environmental Kuznets Curve: **slim evidence (Stern, 2004)**
  - Scenario (incl. IPCC & CGE) Analysis: **extensive but confirmatory / by simulation**
  - **New Approach:** Endogenous Growth-CO2 Nonlinear Simultaneous Equation Modelling incorporating Institutions and the country's 'conditionality' (TVH, 04, 05, 08, 09a, 09b; Kong APEL 07; Krueger AER 07; Kilian, AER 09)

## VETUS PANEL REGRESSION

$$Y_{it} = X_{it} \beta_{it} + u_{it} \quad (\text{Incidental Parameters})$$

$$Y_{it} = X_{it} \beta_i + \alpha_i + u_{it} \quad (\text{BYID})$$

$$Y_{it} = X_{it} \beta + \alpha_i + u_{it} \quad (\text{Fixed-Effect/WITHIN})$$

$$Y_{it} = X_{it} \beta + \alpha + u_{it} \quad (\text{TOTAL})$$

$$Y_i = X_i \beta + \alpha + u_i \quad (\text{BETWEEN})$$

## MODELLING & TESTING CHINA CO2-GROWTH TRADE-OFF

- **The Endogenous Growth-CO2 Model (GCO2)**
  - GDP=GDP(CO2, T, FDI, SV, CR)      SNA93 Expenditure      (1)
  - CO2=CO2(GDP, GDP2, E, CR)      Endogenous Environmental  
Kuznets Curve      (2)
- **Relevant Economic conditionality or IV:**
  - MP, FP, IP, inflation, XR Regime, POP (for gravity), Crises & Reforms
- **Using Taylors series first-order planar expansions**
- (TVH JKE 04 JQE 05 AEP 08 RDE 09; Baier & Bergstrand JIE 08)
  - $Y\% = a1 + a2CO2\% + a3T\% + a4FDI\% + a5SV\%$
  - $\quad + a6CR + u1$       (3)
  - $CO2\% = b1 + b2Y\% + b3Y2\% + b4E\% + b5CR + u2$       (4)

## MATHEMATICAL DERIVATION

- Using planar Taylor Series expansion for nonlinear functions (TVH 1992, Baier & Bergstrand 2008) for say first 2 variables:
  - $dY = (\partial Y / \partial CO_2) dCO_2 + (\partial Y / \partial T) dT + \text{Higher Orders}$
  - $dY/Y = (CO_2 (\partial Y / \partial CO_2) (dCO_2) / CO_2) / Y + (T (\partial Y / \partial T) (dT) / T) / Y$
  - $= [(\partial Y / Y) / (\partial CO_2 / CO_2)] (dCO_2 / CO_2) + [(\partial Y / Y) / (\partial T / T)] (dT / T)$
  - $= E_1 (dCO_2 / CO_2) + E_2 (dT / T), \text{ or}$
  - $Y\% = E_1 CO_2\% + E_2 T\% + U \text{ (stochastic-unknown)}$
- E1, E2, E3, E4 = Elasticity of Y on CO2, T, FDI & SV.  
 Similarly for CO2, T, FDI, SV  
 Canterbury expansions ?  
 Granger=I(0) and Cointegrated=I(1)
- Estimation?: No OLS; 2SLS/2SHI, 3SLS, GMM
- Software required? TSP, Eview...

## THE GCO2 MODEL'S VARIABLES

- CO2 = Per capita CO2 emission (metric tons)
- GDP = Real Per Capita GDP
- T = Per Capita Merchandise Trade/GDP
- FDI = Per Capita FDI/GDP
- SV = Per Capita Financial Services/GDP
- CR = Reforms & Crises
- E = Energy Prices

## **GCO2 MODEL'S IMPROVED FEATURES**

- Robust and efficient evidence-based analysis
- Nonlinear Simultaneous Equations Models
- SNA93 Expenditure perspective
- Endogenising environmental Kuznets Curve
- Admitting energy pricing policy
- A system approach admitting country-specific economic 'conditionality'
- Allowing Johansen multiple structural change
- Achieving Friedman-Kydland data-model consistency

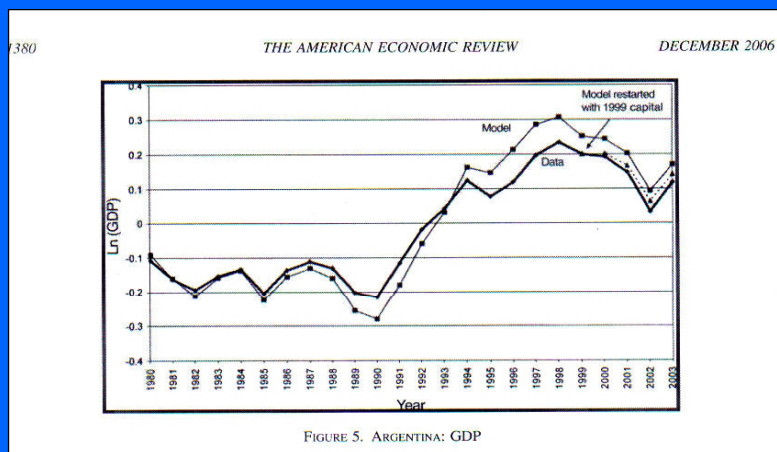
## **DATA & THEIR SOURCES**

- EIA (USA)
- IEA (USA)
- USDA (USA)
- NBS (CHINA)
- CHELEM (FRANCE)
- EIU (UK)

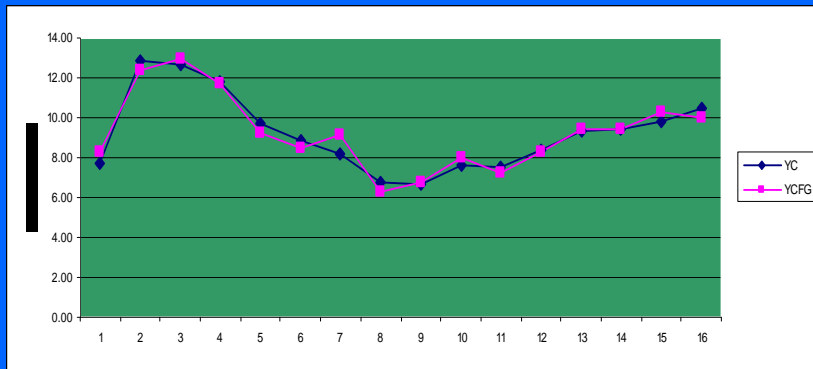
## SUBSTANTIVE FINDINGS: GMM ESTIMATES (P TEST=0.053)

	GROWTH	EKC
Const	6.517**	-63.745**
CO2 emissions/POP	0.070**	
Per capita trade	0.036**	
Per capita FDI	0.007**	
Per capita services	0.000**	
China's growth		12.901**
China's growth squared		-0.600**
Oil prices		-0.049**
China's reform early 1990s	2.087**	
Asia's 1997-98 financial crisis	-1.958**	
China's reform 2000		5.551**
China's reform 2003		9.381**
Flexible exchange rate regime 2005	1.913**	-8.564**
R-squared	0.946	0.854
DW	2.724	2.630

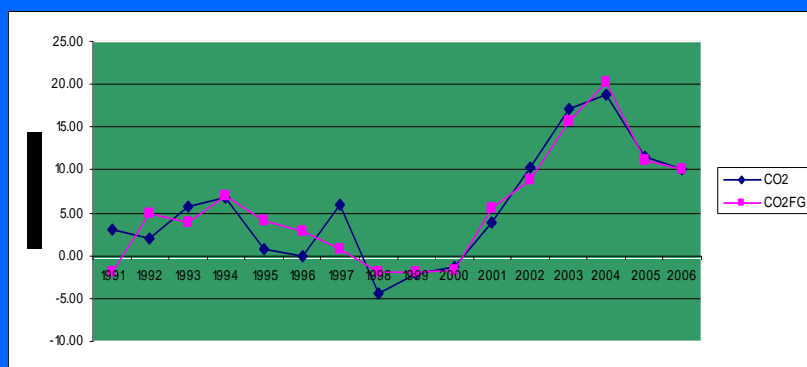
## FRIEDMAN-KYDLAND MODELLING CRITERION



## CHINA GROWTH MODELLING REALIBILITY: FRIEDMAN-KYDLAND TESTS



## CHINA EKC MODELLING REALIBILITY: FRIEDMAN-KYDLAND TESTS



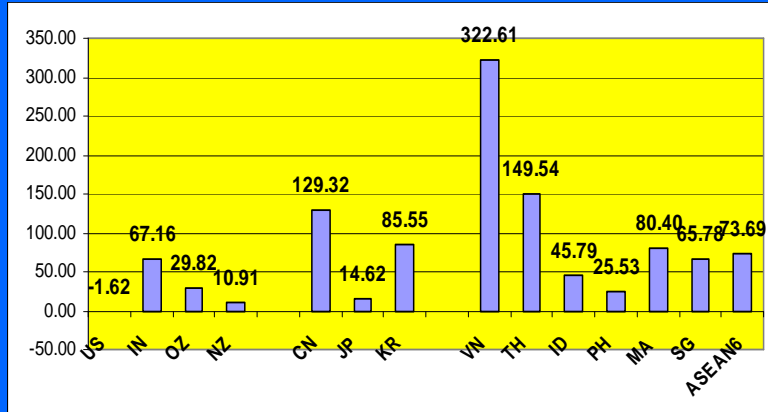
## SUBSTANTIVE POLICY IMPLICATIONS

- Policy recommendations supported by **robust econometric modelling & credible findings**
- China's CO<sub>2</sub>-growth trade-off measured **at 0.07 per year**
- This is only slightly over half of 24-OECD trade-off of 0.14 (**Liu, 2005**)
- China **will gain (suffer less)** from uniform global UNFCCC/IPCC/Copenhagen climate change/CO<sub>2</sub> emission reduction agreements

## SUBSTANTIVE POLICY IMPLICATIONS

- Contrary to general perception, **inverted U-shaped EKC found for China**, a LDC
- Energy pricing policy affects CO<sub>2</sub> emissions: China can use oil pricing policy to **reduce CO<sub>2</sub> emissions**
- **Damages** to China's growth from CO<sub>2</sub> emission reduction can be **mitigated by suitable policy reform and regional & global co-operation**
- **Penny Wong's views (Sept 2009) & Copenhagen (Dec 09): One size fits all vs Country-specific CC to suit their circumstances**

**AND THEN**  
**REALITY VS UNFCCC/IPCC POLICY**  
**CO2 Emissions/Head Change 2006/1990**



• THAT'S ALL