Economic Growth and World Food Demand and Supply

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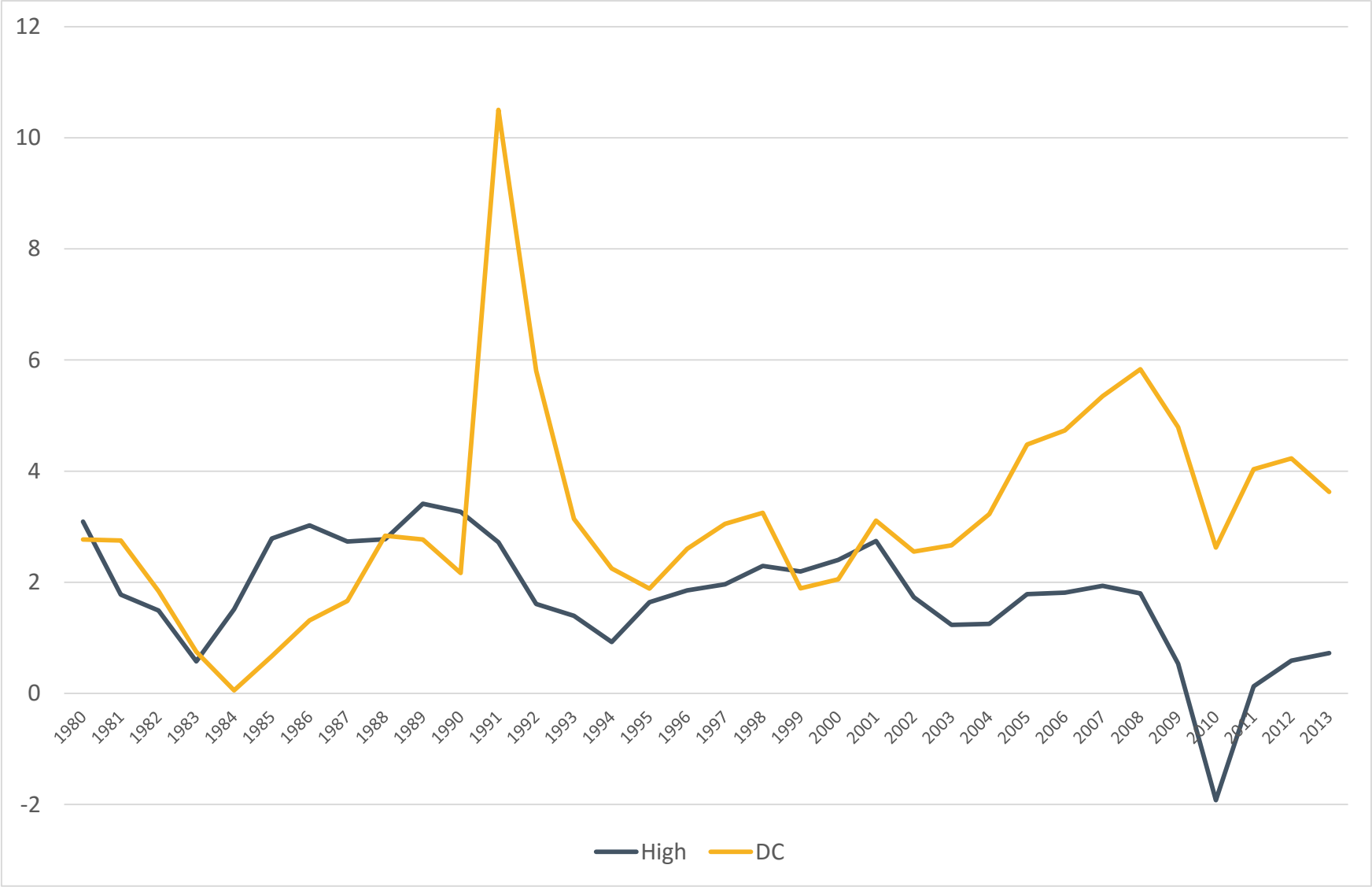
Economic Growth & Food Markets

- Per capita income growth raises food demand
  - Primarily through diet shifts to animal products
    - Food Engel Curves are concave
    - Higher growth in poorer countries raises demand more
      - Theories of convergence suggest higher growth in poorer countries
- Long run per capita income growth is driven by productivity growth
  - Agricultural output grows less than proportionately
- Population growth raises demand proportionately & reduces land per person

Convergence potentially important

- The Solow model suggests that followers should be able to grow more quickly than economies at the frontier
- Some have pointed to high growth in developing countries as potential causes of food price rises
- Higher growth in developing countries has certainly been evident recently
- If higher growth in developing countries is needed to meet the SDGs, do we need to take into account impacts on food demand?

Recent higher growth in developing ctries



Per capita demand growth

Food demand

- One way to capture food demand growth is through multi-product simulation models
  - Rising demand for superior products creates demand for inputs such as grain & oilseeds
    - This requires a huge amount of information and many assumptions
- Is there a simple, econometric alternative?
  - Like the widely-used gravity model of trade

Econometric Approach

- Draw on work by Yotopoulos & by Rask
  - Based on the experience of 155 countries
- Calculate the cereal equivalents required to produce diets as incomes grow
- Estimate reduced-form relationship between real income & cereal equivalent consumption

Some cereal equivalents

Products	Coefficients
Bovine Meat	19.8
Pork	8.5
Poultry	4.7
Fish, Seafood	3.3
Eggs	3.8
Milk	1.2

Why so high?

- Cattle take 7kg of feed for a kilo of beef
  - But this is live weight
    - The FAO numbers we use are carcass weight
- In addition, need to maintain a herd of breeding cows & calves
  - This takes the feed equivalent even higher
- Pork & poultry are more efficient
  - In feed conversion & cost of the breeding herd

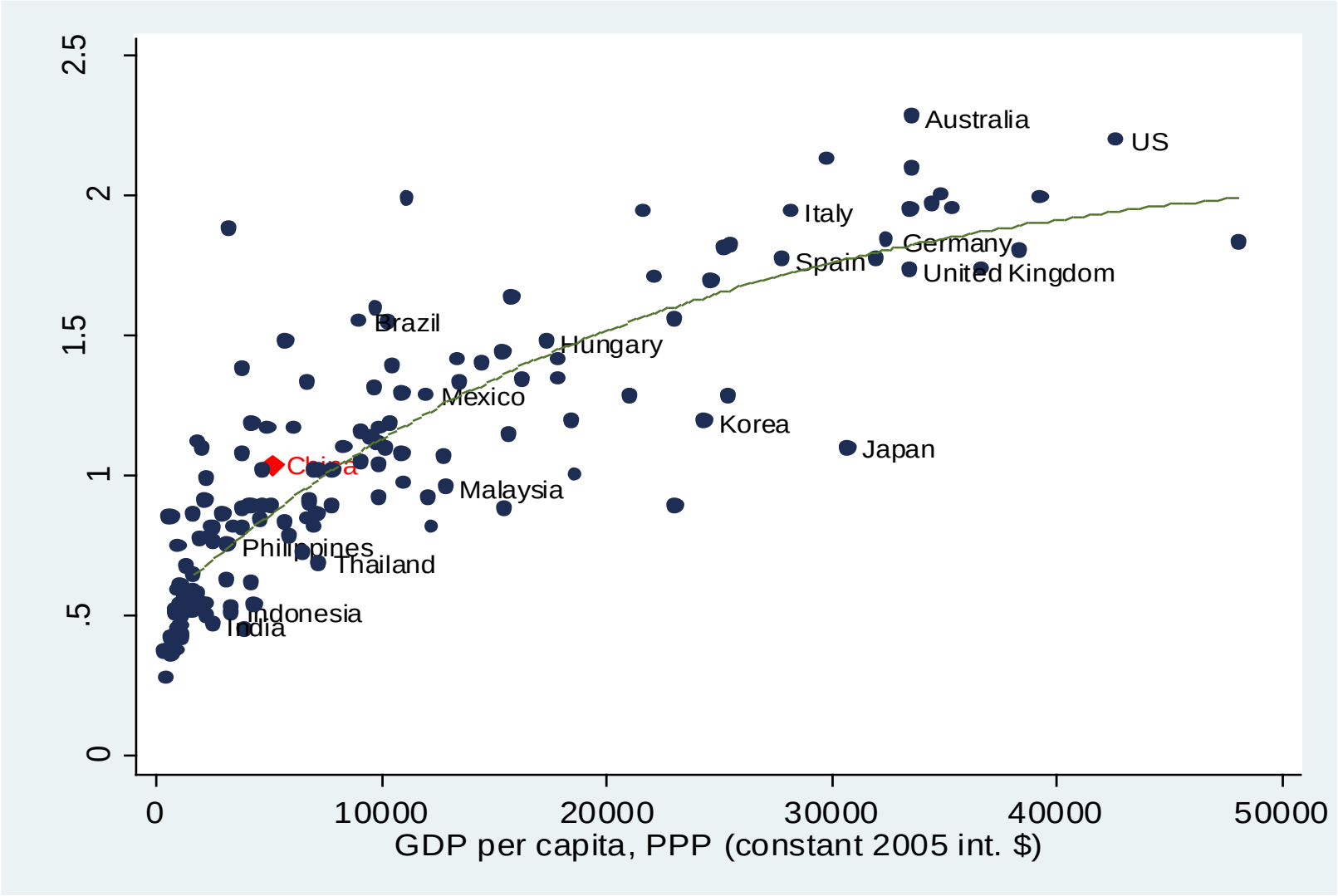
CE Demand equation

$$y = A_1 - A_2 e^{-kx}$$

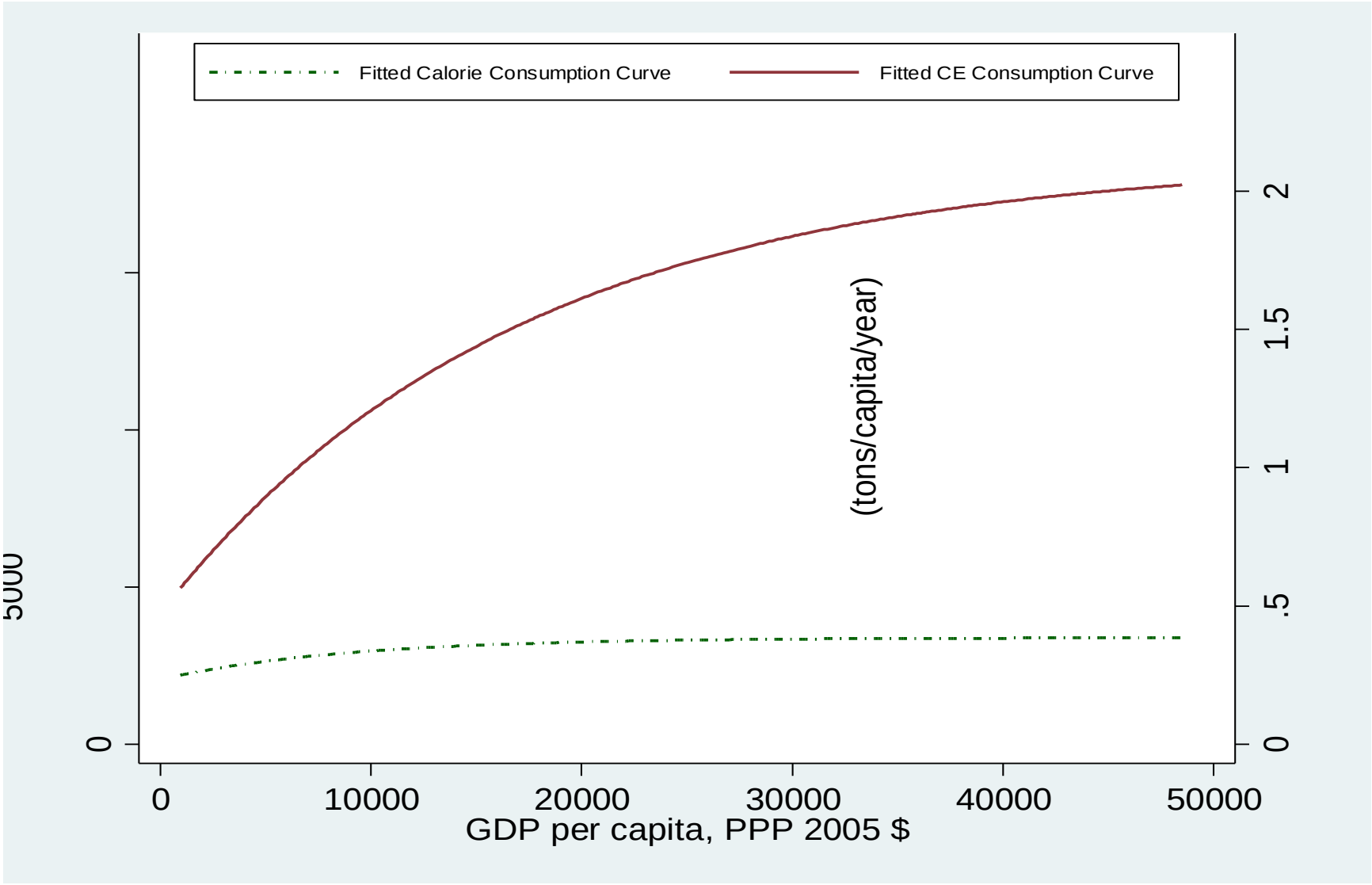
where y is consumption per capita; A_1 is peak potential consumption; and x is income in PPP terms. Cross-sectional regression results:

A_1	2.2*** (.17)
A_2	1.7*** (.16)
K	4.6×10^{-5}*** (9.5×10^{-6})
R^2	.74

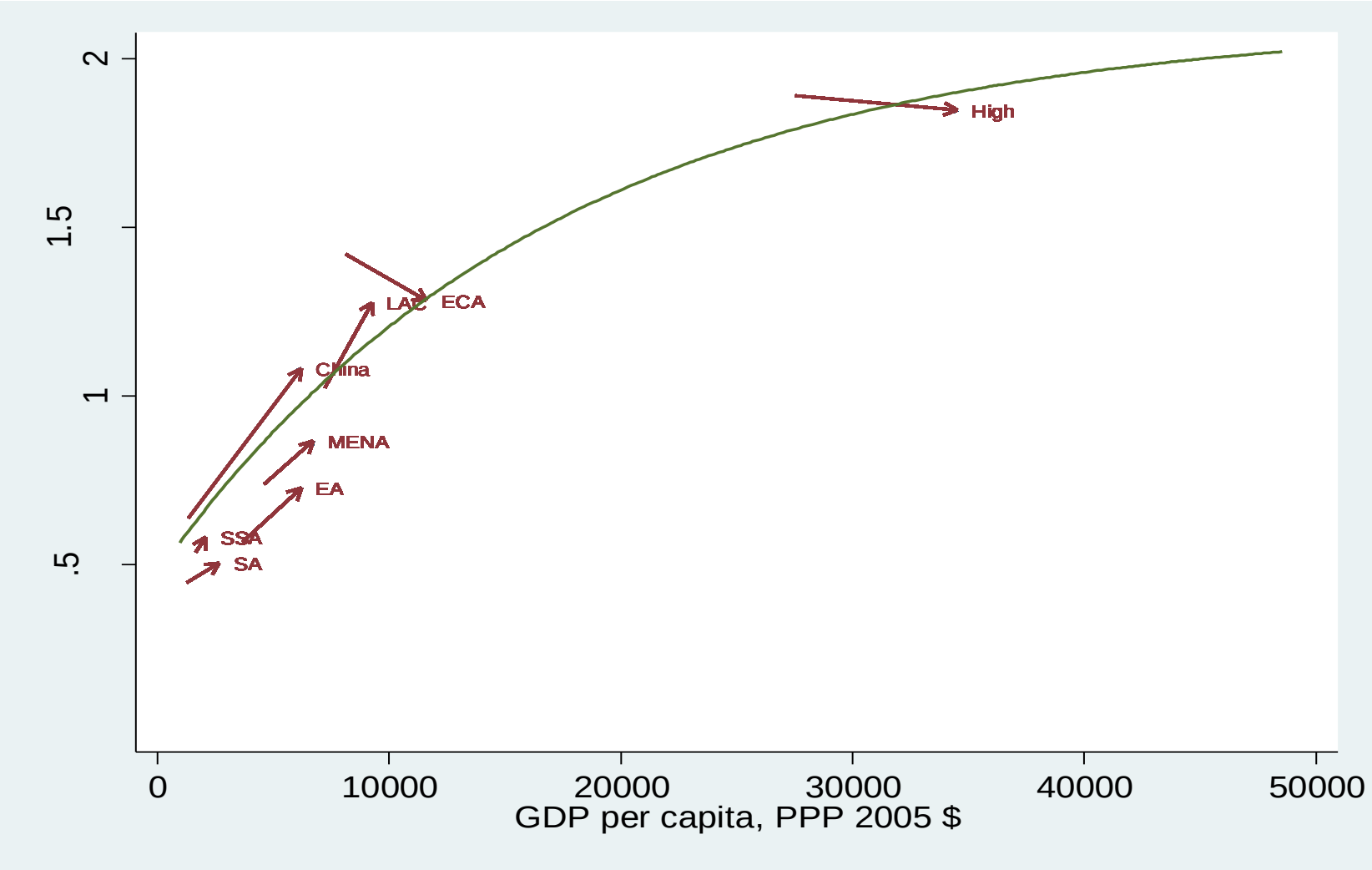
Estimated demand



Calorie vs CE demand



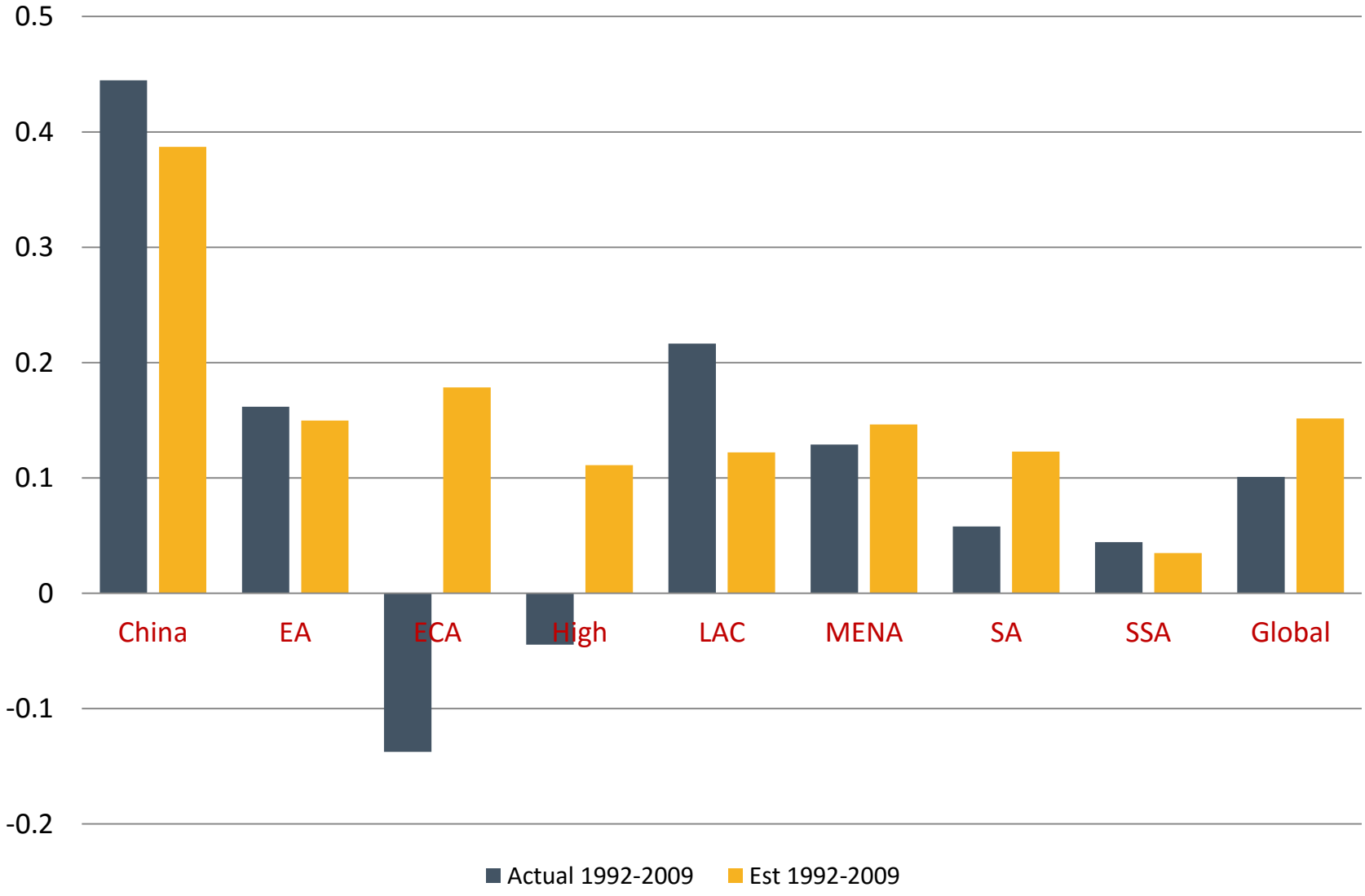
Changes in food demand: 1992-2009



Concavity of the Engel curve important

- Consumption grows rapidly at low income levels
  - Eventually, the growth rate slows
- Global growth depends on whether poorer economies are growing faster than richer
  - ie whether income levels are converging
- Population growth elasticity is unitary

Explaining changes in consumption



Supply per person

Production

$$z = B_0 + B_1 X^{B_2} H^{B_3}$$

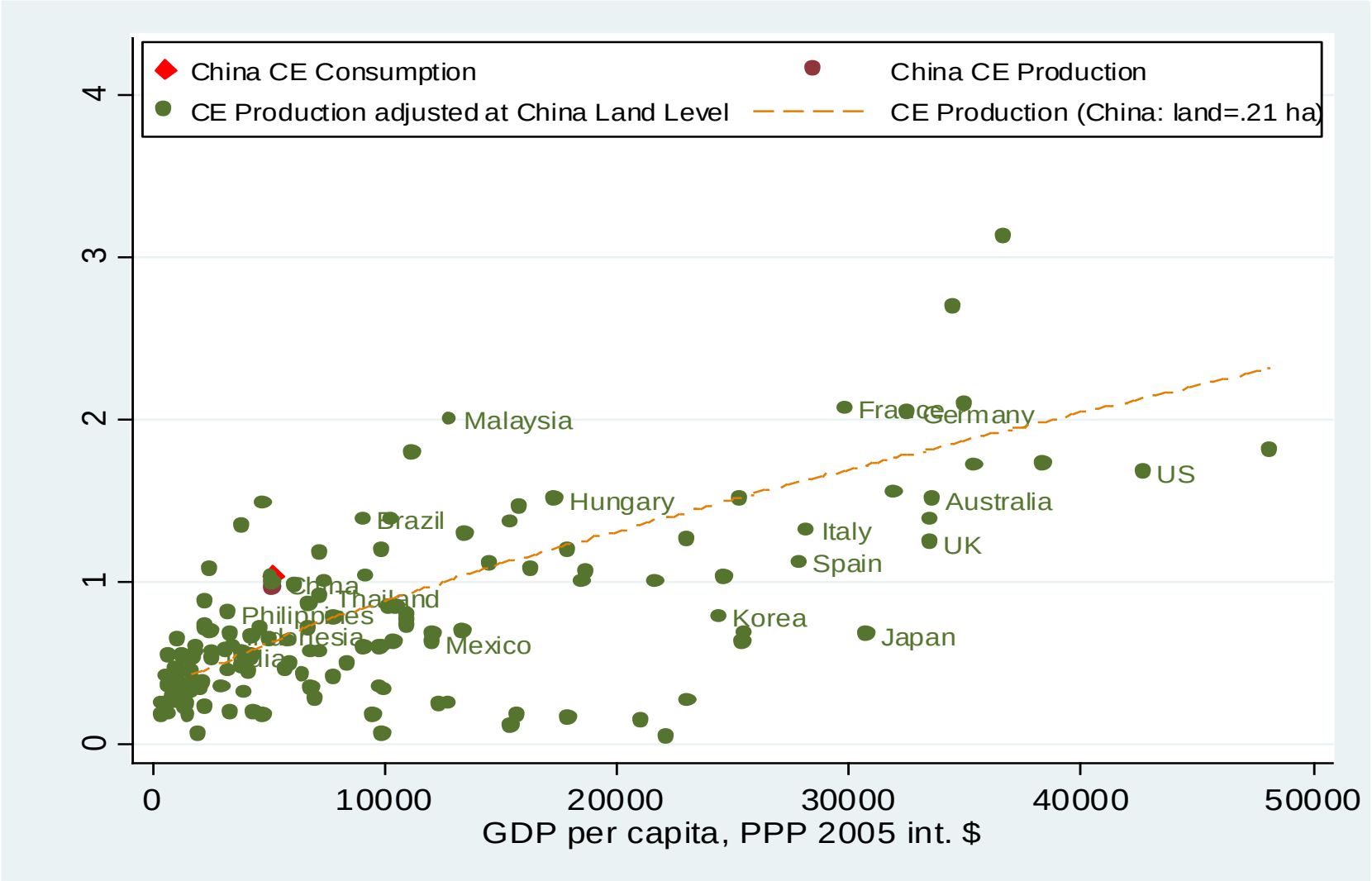
– where *z* is CE production per capita, *X* is PPP GDP per capita, H is ha of agric land per capita

B_0	.27** (.11)
B_1	8.9×10^{-4} (1.5×10^{-3})
B_2	0.77*** (.16)
B_3	0.33*** (.036)
R^2	.56

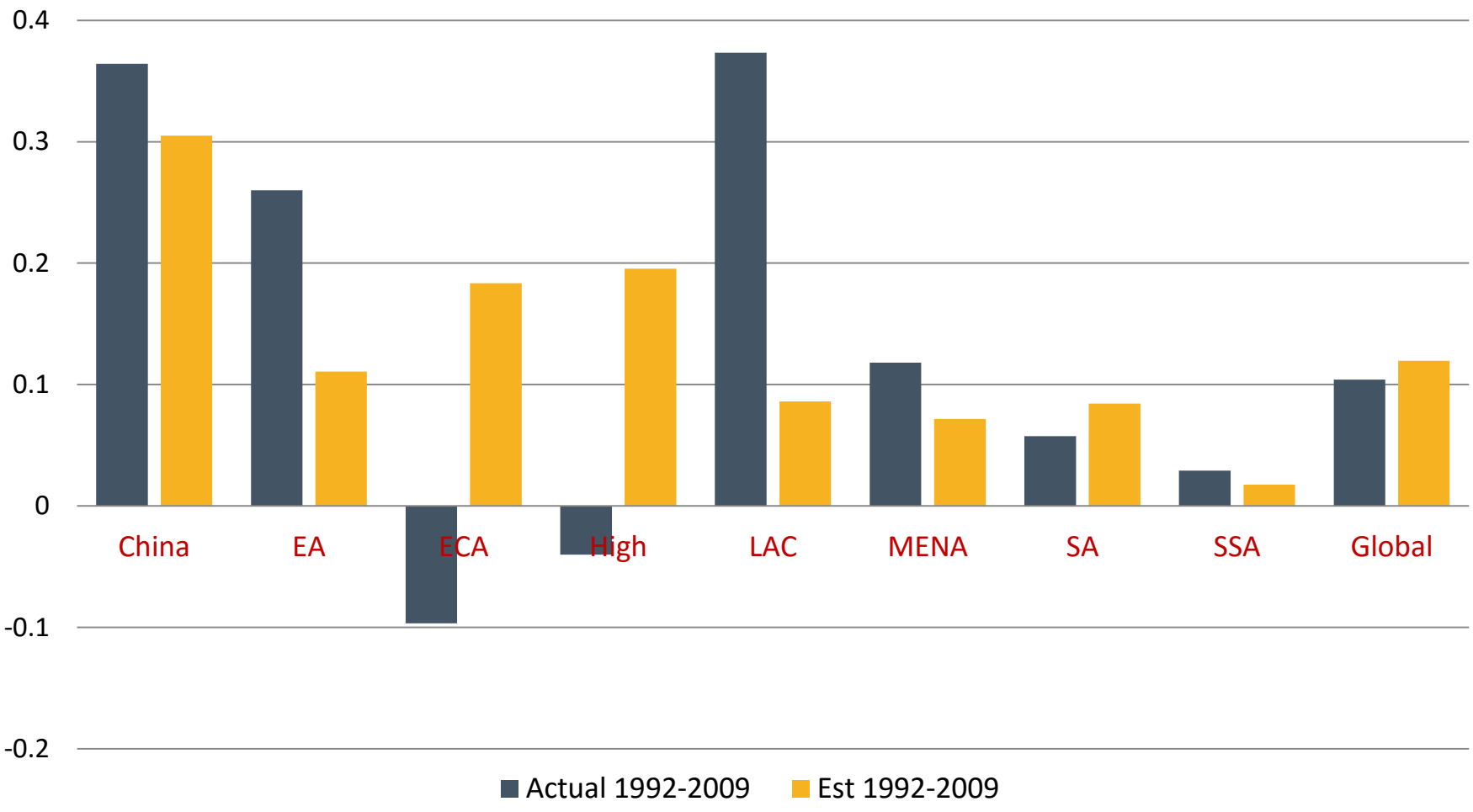
Regression rationale

- Even the poorest countries need some agricultural output
- Agricultural output higher in countries with greater land per person
- Assume sector-neutral productivity growth drives GDP growth
  - And agricultural growth
    - But with a less-than-unitary elasticity

Agric CE prodn vs income



Explaining changes in production



Baseline and projections

Baseline and projections

- Baseline: 1992 to 2009
  - After the entry of the Warsaw Pact countries into the market-oriented trading system
  - Examine the extent of convergence & its impacts

- Projections from 2009 to 2050 from the IIASA Shared Socioeconomic Pathways

Income convergence testing

$$dlny = \alpha + \beta \cdot lny_{initial}$$

	1980-1991		1992-2000		2001-2009		2009-2050 (proj.§)
ß	0.0028 (1.19)		0.0025 (1.34)		-0.0043** (-2.33)		-0.0085*** (-17.20)

- Wrong sign and insignificant the first two periods
- Small & significant the third period (1/4 the Dowrick-Nguyen estimate for OECD)
- Strongly significant in the projection

How important is convergence?

- Change in total food demand
  - $\hat{x} = \Sigma\, \widehat{w_i} \cdot \widehat{B_i} \cdot y_i$
  - where w_i is the share of ctry i in consumption; $\widehat{B_i} \cdot$ is the income elasticity; and y_i is income growth
- If income growth is uniform or is independent of the elasticity, we can use the average elasticity & the average income change
- More generally, we can calculate the effect of a correlation using
- $\hat{x} = \hat{B} \cdot y + \Sigma\, \widehat{w_i} \cdot [\widehat{B_i} - \hat{B}] \cdot [y_i - y]$

Only v rapid convergence has a big impact

	1980-1990	1992-2000	2000-2009	2009-2050 (proj.)
$\Sigma\, \widehat{wi} \cdot \widehat{Bi} \cdot y_i$	0.0604	0.0622	0.0967	0.4756
$\hat{B} \cdot y$	0.0785	0.0707	0.0902	0.4394
$\Sigma\, \widehat{wi} \cdot [\hat{B}i - \hat{B}] \cdot [y_i - y]$	-0.0181	-0.0085	0.0065	0.0362

Conclusions

- Basic econometric framework for food supply/demand provides some powerful insights
- Concavity of the Engel relationship affects countries' supply/demand balances
  - & means economic convergence affects aggregate demand
- Supply a race between improving technology and declining land endowments