# Productivity, Capacity Constraints and their Financial Consequences

C. A. K. Lovell (U of Queensland)

# Motivation

Linkage: productivity & capacity constraints

Impact of each on financial performance

Example: ABARES (2012)

- boat level financial performance ($\pi$, ROA)
- fishery level economic performance ($\pi$, NER)
- key drivers of each: $\Delta p$, $\Delta w_v$, $\Delta x_f$ (but not Y/X or CU)

# Background on Y/X, CU & $

Hypotheses

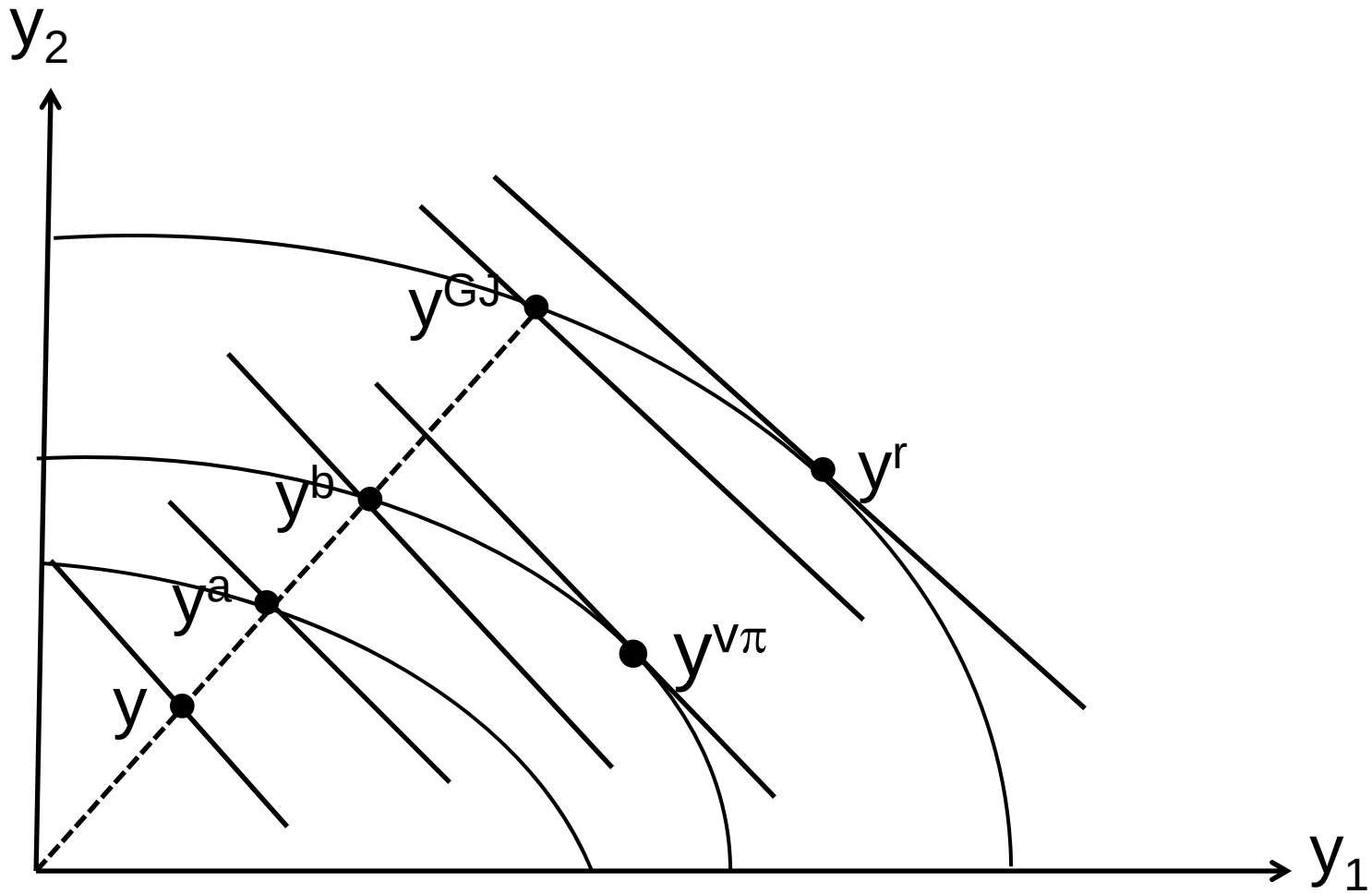
$$CU \Rightarrow \$$$

$$Y/X \Rightarrow \$$$

$$CU \Rightarrow Y/X$$

# CU

- Output max
- Revenue max
- Variable profit max (SAC min)
- Indirect versions of each




$IP(x)$ $IP(x_f, x_v^{v\pi})$ $IP(x_f)$

# CU $\Rightarrow$ \$

$$\pi/A = \pi/R \times R/A$$

$$= \pi/R \times p^T y/p^T y^c \times p^T y^c/A$$

$$= \text{margin} \times \text{CU} \times \text{potential asset turnover}$$

($y^c$ can be $y^{GJ}$ or $y^b$ or $y^r$ or $y^{v\pi}$ or indirect)

# CU $\Rightarrow$ Y/X

"common knowledge"

Kendrick (1961): macro, pro-cyclical

Morrison (1985): micro, pro-cyclical

Gold (1955): $Y/X = Y^c/X \times Y/Y^c$

$= \text{potential } Y/X \times \Delta CU$

pro-cyclicality is testable $H_o$

# $Y/X \Rightarrow \$$

Seems obvious, but…

Davis (1955), Kendrick & Creamer (1961):

$$Y/X \Rightarrow \Delta\pi$$

Georgescu-Roegen (1951):

$$Y/X \Rightarrow \Delta\Pi \; [= Y/X \times P/W]$$

?: $Y/X \Rightarrow \Delta ROA$

Objective:

$$\pi/A = \pi/R \times p^T y/p^T y^c \times p^T y^c/A$$

$$Y/X = Y^c/X \times Y/Y^c$$

Problem: Y/X $\Rightarrow$ $\pi$/R linkage is conjectural

Solution: move from levels to differences

(like Davis, Kendrick & Creamer)

# Intertemporal Analysis

$$\frac{ROA^1}{ROA^o} = \frac{M^1}{M^o} \times \left[\frac{p^{1T}y^1/p^{1T}y^{1c}}{p^{oT}y^o/p^{oT}y^{oc}}\right] \times \frac{PAT^1}{PAT^o}$$

Result: $\Delta CU \Rightarrow \Delta ROA$

…and $\Delta$M decomposes

$$\frac{M^1}{M^o} = \left[\frac{\pi^1/R^1}{\pi_o^1/R_o^1}\right] \times \left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right]$$

= price effect × quantity effect

Result: Y/X $\Rightarrow$ $\Delta$margin $\Rightarrow$ $\Delta$ROA

# Quantity Effect (Laspeyres)

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] = \frac{\pi_o^1}{R_o^1 - \frac{Y_L}{X_L}\left(w^{oT}x^1\right)}$$

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] \gtreqless 1 \Leftrightarrow \frac{Y_L}{X_L} \gtreqless 1$$

# Quantity effect (Malmquist)

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] = M_{CCD}{}^1(y^1,y^o,x^1,x^o) \times SE^1$$

$SE^1$ weights movement along $T^1$ on $[x^o, x^1]$

$$SE^1 = \left[\frac{(p^o - c_o^1)}{R_o^1}\right]^T \left[\frac{y^1}{D_o^1(x^1,y^1)}\right] / \left[\frac{(p^o - c^o)}{R^o}\right]^T \left[\frac{y^o}{D_o^1(x^o,y^o)}\right]$$

Result: $\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right]$ really *is* a productivity effect

Result so far:

$$\frac{ROA^1}{ROA^o} = \left[\frac{\pi^1/R^1}{\pi_o^1/R_o^1}\right] \times \left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] \times \frac{CU^1}{CU^o} \times \frac{PAT^1}{PAT^o}$$

…but [$\Delta$CU $\Rightarrow$ Y/X] is missing

# CU $\Rightarrow$ Y/X (Laspeyres)

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] = \frac{\pi_o^1}{R_o^1 - \left[\frac{Y_L^c}{X_L}\right]\left[\frac{Y_L}{Y_L^c}\right](w^{oT}x^1)}$$

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] = 1 \Leftrightarrow \left[\frac{Y_L^c}{X_L}\right]\left[\frac{Y_L}{Y_L^c}\right] = 1$$

$$\frac{ROA^1}{ROA^o} = \left[\frac{\pi^1/R^1}{\pi_o^1/R_o^1}\right] \times \frac{\pi_o^1}{R_o^1 - \left[\frac{Y_L^c}{X_L}\right]\left[\frac{Y_L}{Y_L^c}\right](w^{oT}x^1)}$$

$$\times \left[\frac{p^{1T}y^1/p^{1T}y^{1c}}{p^{oT}y^o/p^{oT}y^{oc}}\right] \times \frac{PAT^1}{PAT^o}$$

$y^c$ can be $y^{GJ}$ or $y^b$ or $y^r$ or $y^{v\pi}$ or indirect,
& $\Delta$CU is non-radial in both locations

# $\Delta$CU $\Rightarrow$ Y/X (Malmquist)

$$\left[\frac{D_o^1(x^1,y^1)}{D_o^1(x^o,y^o)}\right] = \left[\frac{D_o^1(x_f^1,y^1)}{D_o^o(x_f^o,y^o)}\right] \times \left[\frac{D_o^1(x^1,y^1)/D_o^1(x_f^1,y^1)}{D_o^o(x^o,y^o)/D_o^o(x_f^o,y^o)}\right] \times \left[\frac{D_o^o(x^o,y^o)}{D_o^1(x^o,y^o)}\right]$$

$$\left[\frac{\pi_o^1/R_o^1}{\pi^o/R^o}\right] = \left[\frac{D_o^1(x_f^1,y^1)}{D_o^o(x_f^o,y^o)}\right] \times \left[\frac{D_o^1(x^1,y^1)/D_o^1(x_f^1,y^1)}{D_o^o(x^o,y^o)/D_o^o(x_f^o,y^o)}\right] \times \left[\frac{D_o^o(x^o,y^o)}{D_o^1(x^o,y^o)}\right] \times \left[\frac{SE^1}{SE^o}\right]$$

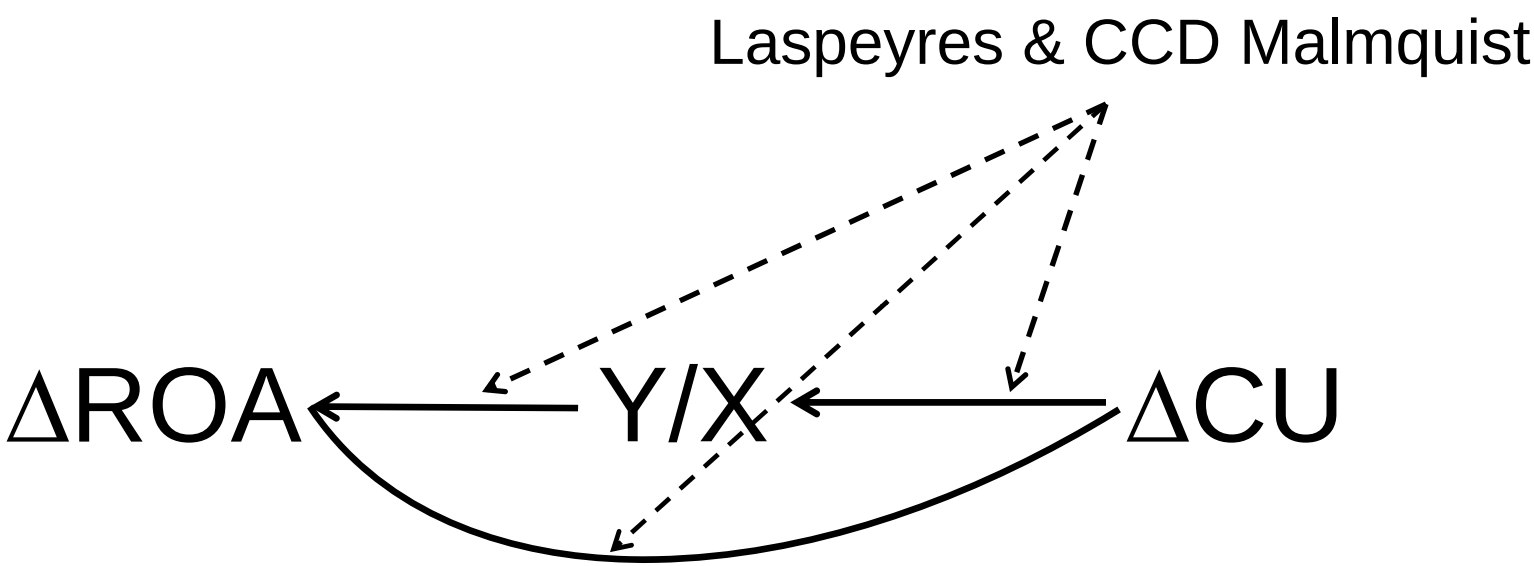
$$= \Delta TE \times \Delta T \times \Delta SE \times \Delta CU$$

$$\frac{\pi^1/A^1}{\pi^o/A^o} = \left[\frac{\pi^1/R^1}{\pi_o^1/R_o^1}\right] \times \left[\frac{D_o^1(x_f^1, y^1)}{D_o^o(x_f^o, y^o)}\right] \times \left[\frac{D_o^1(x^1, y^1)/D_o^1(x_f^1, y^1)}{D_o^o(x^o, y^o)/D_o^o(x_f^o, y^o)}\right]$$

$$\times \left[\frac{D_o^o(x^o, y^o)}{D_o^1(x^o, y^o)}\right] \times \left[\frac{SE^1}{SE^o}\right] \times \left[\frac{p^{1T}y^1/p^{1T}y^{1c}}{p^{oT}y^o/p^{oT}y^{oc}}\right] \times \left[\frac{PR^1/A^1}{PR^o/A^o}\right]$$

$$= \Delta PE \times [\Delta TE \times \Delta T \times \Delta SE \times \Delta CU]$$

$$\times \Delta CU \times \Delta PAT$$


Laspeyres & CCD Malmquist
ΔROA
Y/X
ΔCU

# Summary

I have developed an analytical framework within which to test hypotheses concerning the three linkages

$$\Delta CU \Rightarrow \Delta ROA$$

$$Y/X \Rightarrow \Delta ROA$$

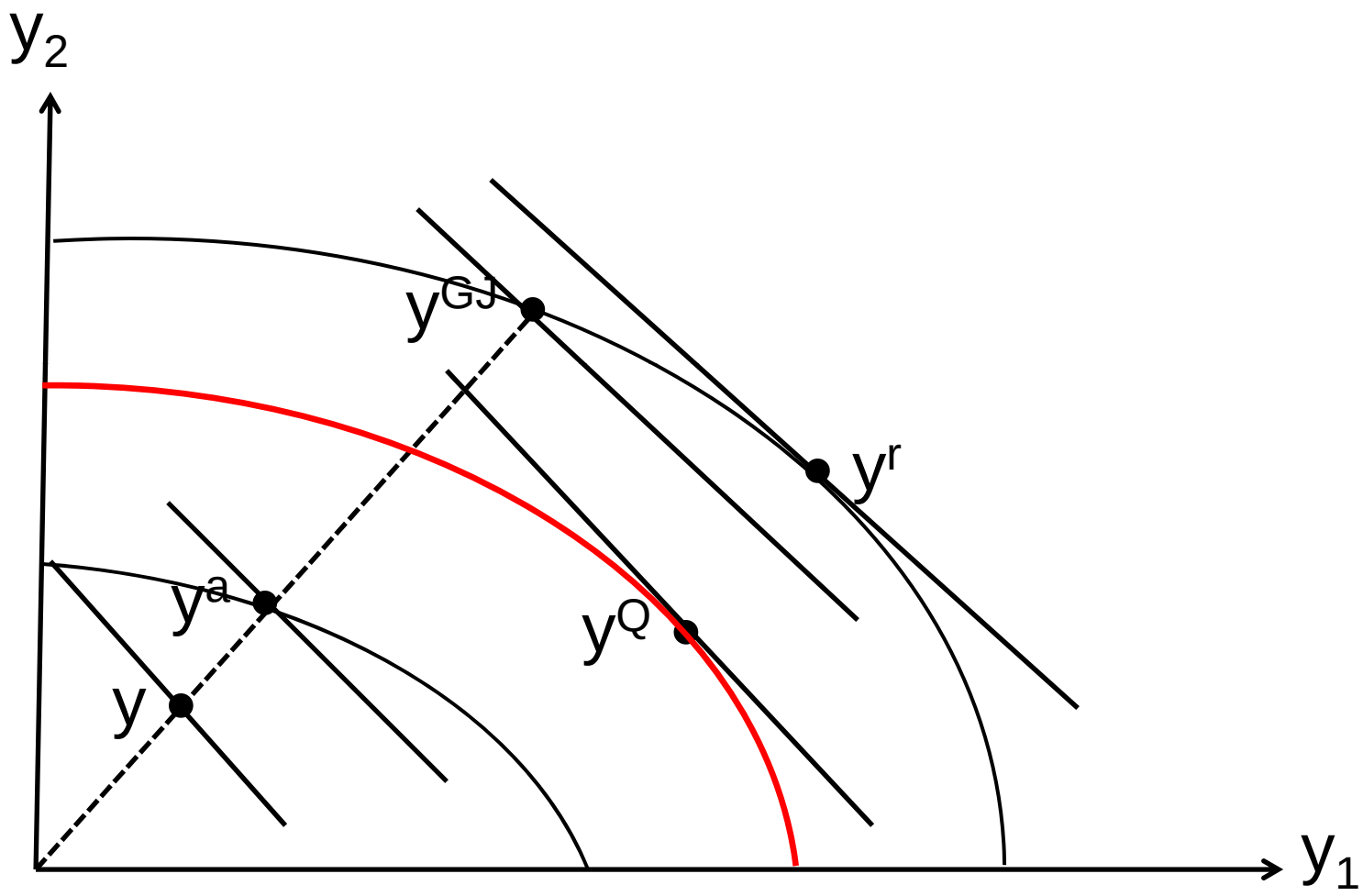
$$\Delta CU \Rightarrow Y/X$$

# Questions

1. Direct or indirect CU measure? $x_f$ or $w_f/C_f$?

2. Do TACs & ITQs $\rightarrow$ cost-based CU?

3. Is the capacity constraint internal (textbook) or external (fisheries?) or both (mining)? If both, how to model them?




IP(x) IP(TAC,ITQ) IP($x_f$)

4. If fisher(ie)s have a financial objective, why has FAO adopted an engineering CU measure?

5. How might $\Delta$CU influence $\Delta$ROA independently of its impact on Y/X?

6. Any evidence of the impact on ROA of changing capacity constraints?

7. Skill v. luck?

8. Monitoring?

9. Are answers to these questions different for fishers and fisheries?