Constructing a Price Deflator for R&D: Calculating the Price of Knowledge Investments as a Residual

Carol Corrado,
Conference Board, New York
Peter Goodridge,
Imperial College Business School, Imperial College London
Jonathan Haskel,
Imperial College Business School, Imperial College London

EMG group, November 2013 Sydney

Objective of paper

- To construct R&D price index
  - Inform forthcoming capitalisation of R&D
  - Inform European heartsearching about R&D spend (as % of GDP) being flat/falling
- Paper
  - First pass
  - Review existing approaches
  - Implement our approach on UK data
  - Robustness checks
- Basic outline of framework: Edison quote
  -

Model outline

- Two sectors
  - knowledge-producing: gets knowledge for free, but charges mark-up
  - knowledge-using: rents knowledge
- Three factors of production
  - labor,
  - capital,
  - knowledge.
- Production and income flow relationships, knowledge stock accumulation, rental/asset prices

$$N_t = F^N(L_t^N, K_t^N, R_t^N, t); \quad P_t^N N_t = \mu(P_t^L L_t^N + P_t^K K_t^N)$$

$$R_t = N_t + \qquad {}_R \; R_t$$

$$Y_t = F^Y \; L_t^Y \; K_t^Y \quad R_t^Y \; t \qquad P_t^Y Y_t = P_t^L L_t^Y + P_t^K K_t^Y + P_t^R R_t^Y$$

$$= \qquad (\; ! \; + \delta \;)$$

Model outline

$$P^N = s_N^K \quad P^K + s_N^L \quad P^L \quad TFP^N$$

$$\Delta \ln P^Y = s_Y^K \Delta \ln P^K + s_Y^L \Delta \ln P^L + s_Y^R \Delta \ln P^R - \Delta \ln TFP^Y$$

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

Model outline

Conceptual issues discussed in paper

-

UK data set

- Essence of approach: upstream and downstream sectors. So use industry data?
- No. Much R&D is in-house. So, to implement we need to “break” industries into upstream, R&D producing, and downstream, R&D renting
- Data sets
  - BERD: Business Enterprise R&D = surveys own-account R&D spending by firms. Reported for 32 products (~market sector industries).
  - UK EUKLEMS data set (March 2008 release),
    - prices and quantities of output and labor and material input for 72 industries
    - and estimates of capital input and TFP for 23 industries.
  - UK supply-use (IO) tables, for more than 100 industries from 1992 to 2006.
    - allocate own-acc R&D of R&D services industry to other (i.e., downstream) industries using input-output data on sales.
  -

Measurement

- Objective: to measure downstream

- What do we have to measure?
  - The downstream materials, labour, capital shares
    - " KLEMS shares, since KLEMS shares are sum of up and downstream
    - So use BERD data to split KLEMS into up- and downstream by subtraction
  - The downstream knowledge capital rental share
    - S(R) downstream = (PrR/PyY).
    - BERD gives us estimate upstream knowledge costs= PnN (measured)
    - Rental price relation between PnN and PrR; #
    - If upstream marks-up over costs then PnN=μ(PnN, measured)
    - => S(R)=μ#(PnN/PyY). Assume μ and #. Check robustness
  - Downstream ! lnTFP(y): econometric method (below)

Summary of shares

- So, shares are

$$s^{M}_{Y\,G} = \frac{P^{M} M^{Y}}{P^{G} G^{Y}} = \frac{P^{M} M^{KLEMS} - P^{M} M^{BERD} - P^{N} N^{IO}}{P^{G} G^{KLEMS}}$$

$$s^{L}_{Y\,G} = \frac{P^{L} L^{Y}}{P^{G} G^{Y}} = \frac{P^{L} L^{KLEMS} - P^{L} L^{BERD}}{P^{G} G^{KLEMS}}$$

$$s^{R}_{Y\,G} = \frac{P^{R}_{t} R^{Y}}{P^{G} G^{Y}} = \tau\mu \frac{\left(P^{N}_{t} N^{BERD} + P^{N}_{t} N^{IO} \right)}{P^{G} G^{KLEMS}} \quad \tau = \frac{\rho + \delta_{R} \quad + \Delta R^{Y\,OA} / R^{Y\,OA}}{\left(\Delta R^{Y\,OA} / R^{Y\,OA} + \delta_{R} \right)}$$

$$s^{K}_{Y\,G} = \quad - s^{M}_{Y\,G}$$

TFP in downstream

- TFP in downstream unoa3unoa3un9999 4 strea.2 ( )

Thus we compute

-

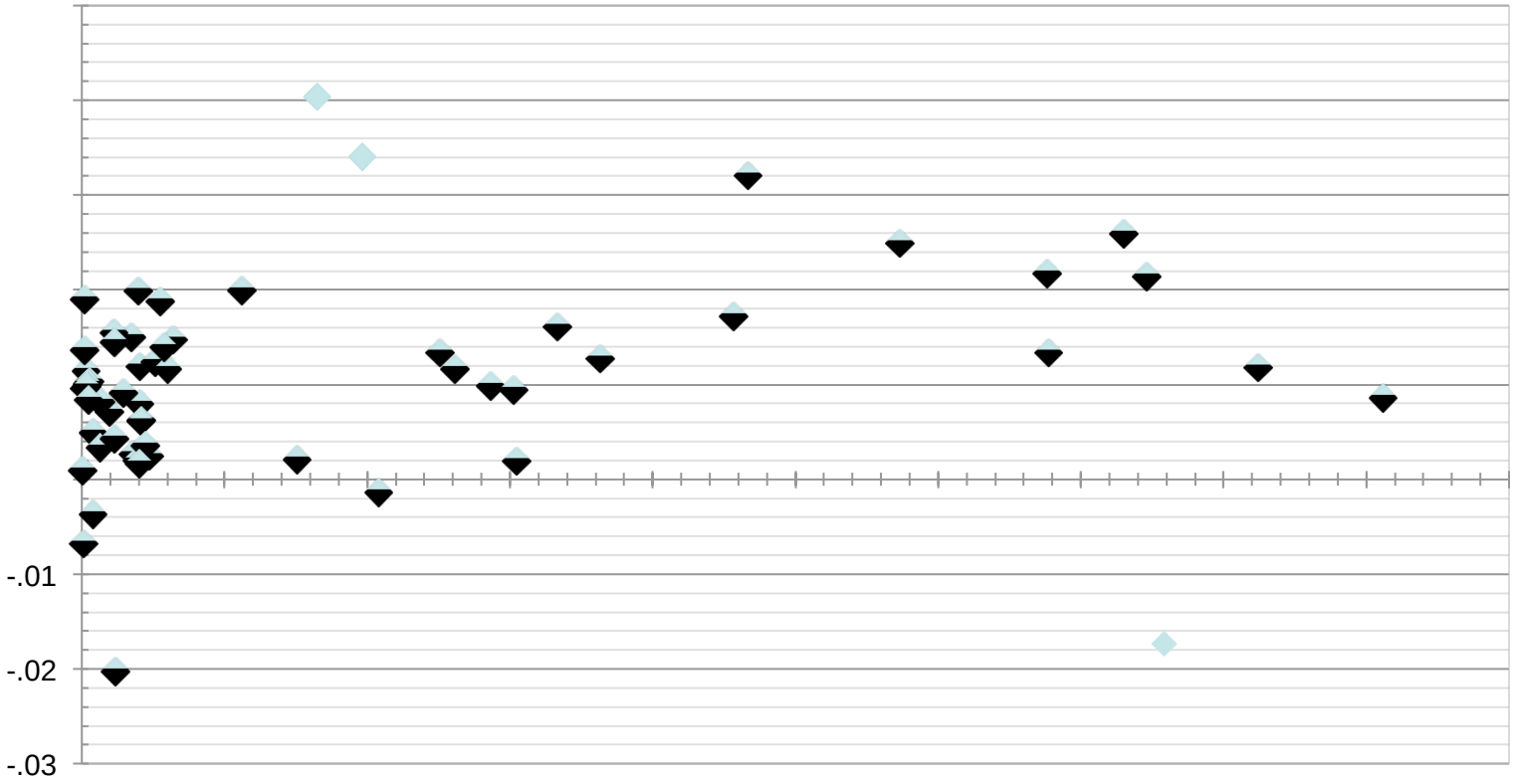
Alternative shares of knowledge spend industry gross output

own-account PnN as share of GO

own-account plus allocated from PnN in R&D services,, as share of GO

knowledge rentals as share

Mean ! lnTFP(J) & Mean sN(J): All market sector industries



Regression: $\Delta \quad TFP_{it}^{KLEMS} = a + b \cdot s_{N,it}^{Y,G} + e_{it}$

$=$

$$= \left(\mu \left(\quad + \quad + \quad + \quad \right) \right)$$

"#$%&'$!

!"#$%&''$((	*Δ)*+,(*	*Δ)*23+,(*	*45*6789(65(:;+(*
	-.01(	*-.01(*	*<75=(>?;*

(#)*+!,-.!/#01'*2!3!4567!"8-!9#:;<'#/!*%'=%'!=2:>#!><1?;#!3!@5A!

!

Summary

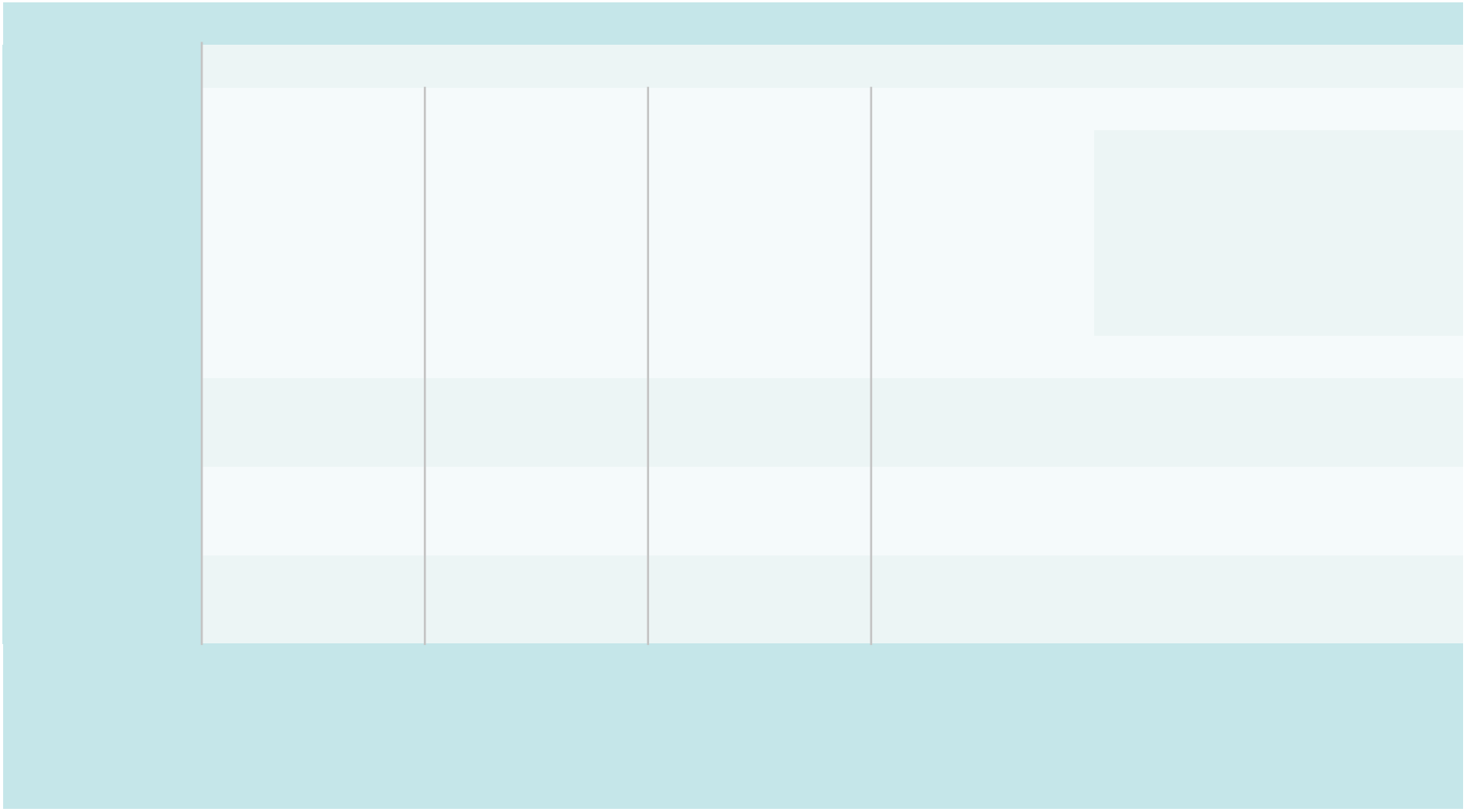
- First pass attempt to measure R&D price from price of downstream R&D users
- Theory suggests needs assumptions on
  - μ = Innovator mark up
  - # = relation $P^N N$ and $P^R R$
  - Downstream $\Delta \ln TFP = \Delta \ln TFP^Y$
- Central estimates:
  - UK R&D prices fall by around 7.5%pa 1985-05.
    - Compare with GDP deflator +3.5%
    -

spares

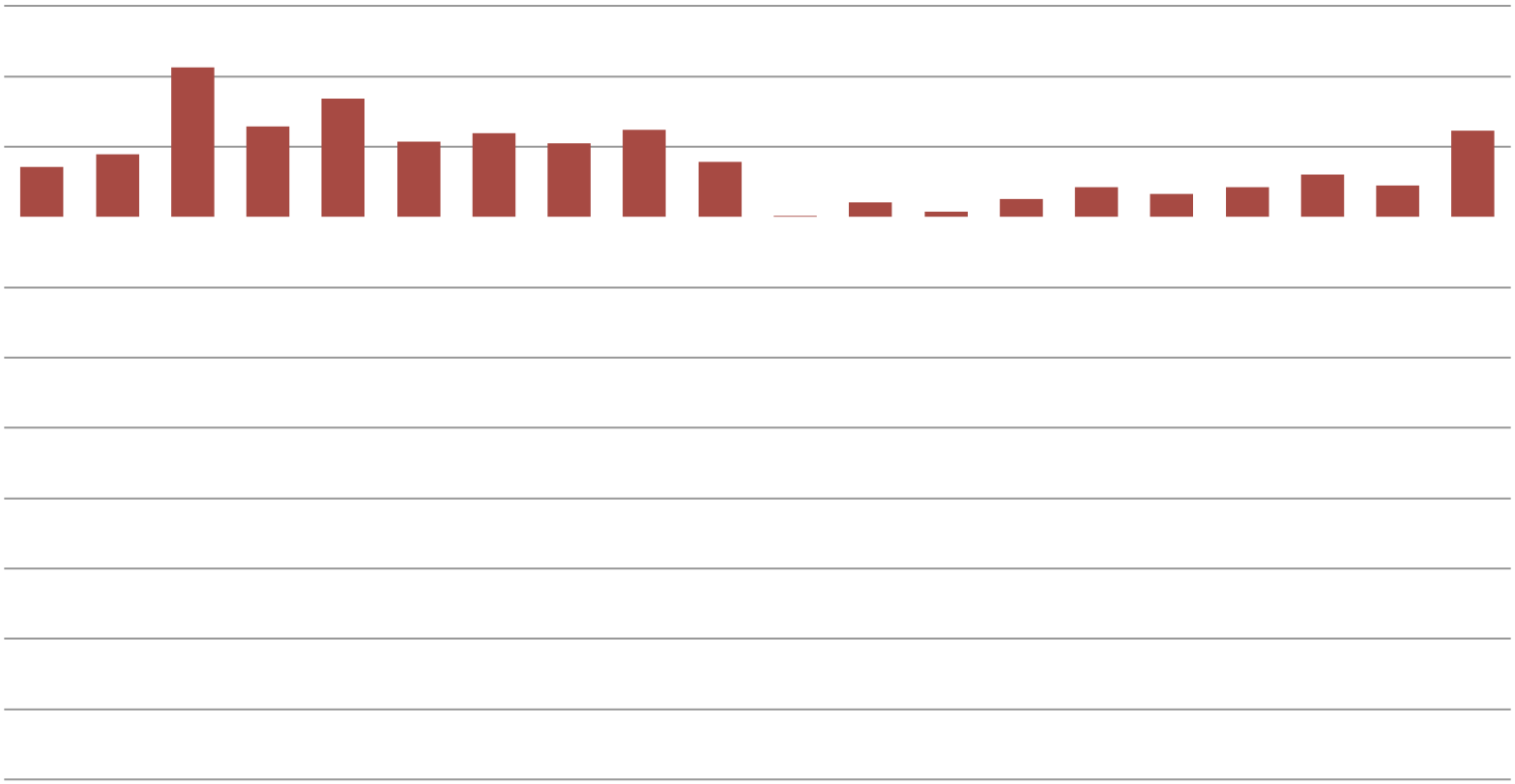
Weights

Memo:

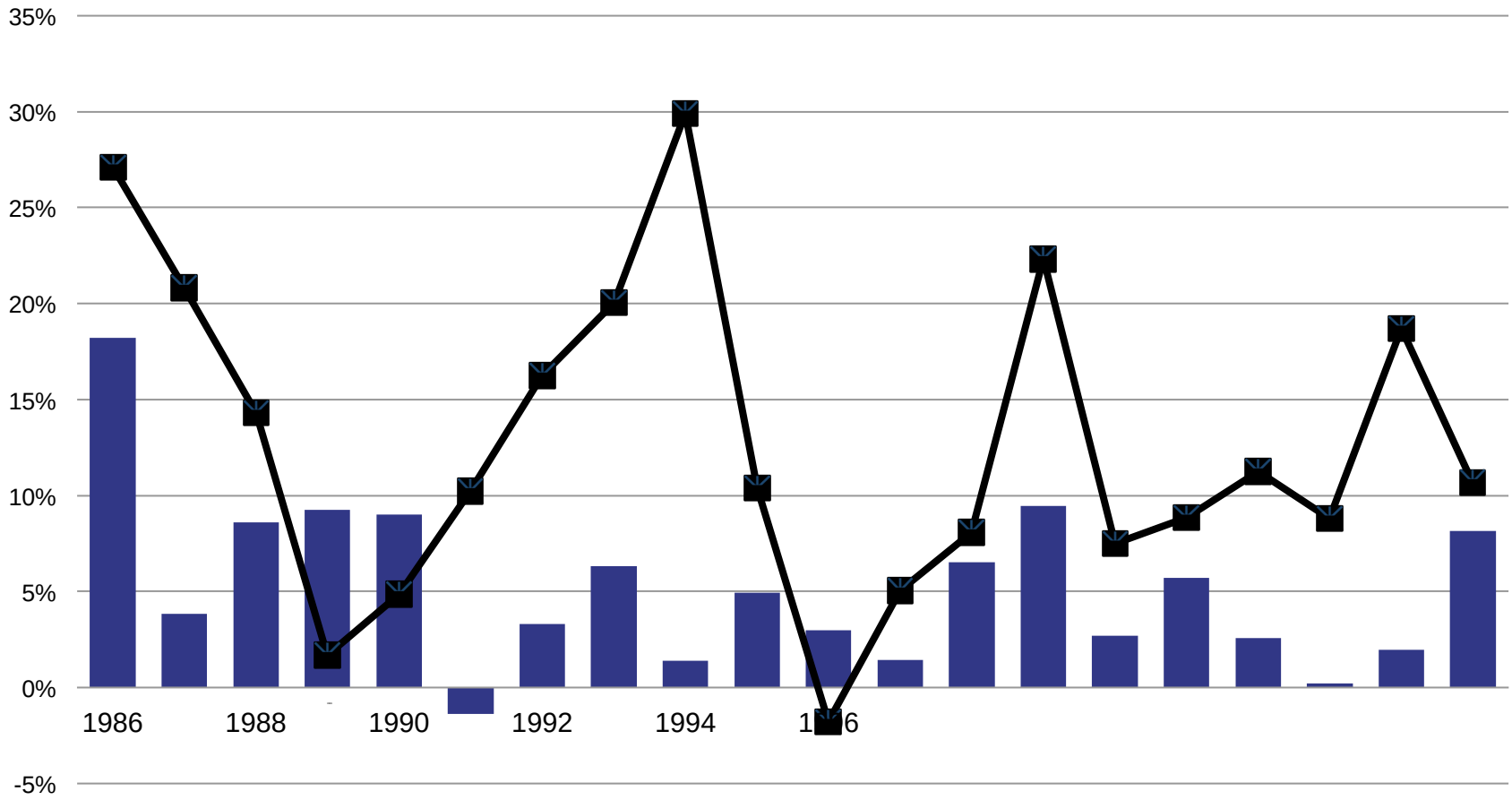
We estimate the contribution of change in R&D rental price to industry GO price:



Results



Results



Robustness: B

	.60!	.70!	.75!	.80!	.90!

Effect of different Pr on growth accounting results with R&D capitalised

& '			
'	1985 to 2005!	1985 to 1995!	1995 to 2005!
& '	2.9!	3.0!	2.8!

Downstream knowledge rental payments, $P^R R$?

- Assume value of new knowledge created in the upstream sector

$$\equiv \mu\left[\left(\quad + \quad + \quad \right) + \quad \right]$$

- To convert $P^N N$ to $P^R R$, use rental and PIM

$$' \quad = \quad (\rho + \delta) \frac{'}{}$$

- To give

Mean lnTFP(J) & Mean sN(J): Excl. outliers, nonperformers, and lowest R&D quartile, 2 productivity episodes