PRODUCTIVITY MEASUREMENT, R&D ASSETS AND MARK-UPS IN OECD COUNTRIES

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Economic Measurement Group Workshop
University of New South Wales, Nov 2018
• SNA 2008: R&D capitalisation

• Added investment and GDP

• Added source of capital services

• Effect on MFP?
Is R&D special?

• ‘Shifter’ rather than individual contributor

• Upfront investments, sunk costs

• Non-constant returns, mark-ups

• Hard to measure, much own-account production of R&D
  – Value of investment = value of costs
  – Volume of investment = volume of inputs
Questions

• Can we treat R&D capital services as normal input?

• Can we reject non-constant returns to scale?

• What can we say about mark-ups
  – Over marginal costs?
  – Over average costs?
R&D as a ‘shifter’

- Restricted cost function

\[ C(Q, w_X, R, t) = \min \left( \sum_{X} w_{Xi} X_i \mid f_Q(X, R, t) \geq Q \right) \]

- \( Q \): output
- \( X \): non-R&D inputs
- \( w_X \): price of R&D inputs
- \( R \): R&D input
Productivity measurement

- Cost minimisation for non-R&D inputs

\[
\frac{\partial \ln C(Q, w_X, R, t)}{\partial \ln w_{X_i}} = \frac{w_{X_i} X_i(Q, w_X, R, t)}{C}
\]

- R&D inputs – measured or shadow values?

\[
\frac{\partial C(Q, w_X, R, t)}{\partial R} \equiv -w_{RS} = (?) w_R
\]
Productivity measurement

- Differentiating cost function
- Obtain growth accounting equation

\[ \frac{d \ln Q}{dt} = \epsilon \left( \sum_i \frac{w_{X_i} X_i}{C} \frac{d \ln X_i}{dt} - \frac{w_{RSR}}{C} \frac{d \ln R}{dt} + \frac{\partial \ln C}{\partial t} \right) \]
Problems: endogeneity and errors in variables

- Issues around reverse regression – Diewert and Fox (2008)

\[
\Delta \ln X^t = \frac{1}{\epsilon} \Delta \ln Q^t - \frac{w_{RS} R}{C} \Delta \ln R^t - \Delta \pi^t
\]

\[
\Delta \ln Q^t = \epsilon \left[ \Delta \ln X^t + \frac{w_{RS} R}{C} \Delta \ln R^t + \Delta \pi^t \right]
\]

\[
\begin{align*}
\Delta \ln X^t & = 1.008 + 0.533 \Delta \ln Q^t - 0.045 \Delta \ln R^t; \text{adj } R^2 = 0.65; DF = 564 \\
& \quad \text{(0.316) } \quad \text{(0.026) } \quad \text{(0.008)}
\end{align*}
\]

\[
\begin{align*}
\Delta \ln Q^t & = 1.011 + 0.797 \Delta \ln X^t + 0.115 \Delta \ln R^t; \text{adj } R^2 = 0.77; DF = 564.
\end{align*}
\]
Cost-elasticities of R&D: distribution of unrestricted measures and econometric results

...no strong arguments for econometric measure of shadow price for R&D...
…but returns to scale are retained…

\[
\Delta \ln Z^{*t} = \frac{1}{\varepsilon^*} \Delta \ln Q^t - \Delta \pi^t, \\
\Delta \ln Q^t = \varepsilon^* (\Delta \ln Z^{*t} + \Delta \pi^t);
\]

Where standard cost-share weighted inputs are:

\[
\Delta \ln Z^{*t} \equiv 0.5 \left( \frac{C^t}{C^{*t}} + \frac{C^{t-1}}{C^{*t-1}} \right) \Delta \ln X^t + 0.5 \left( \frac{w_R^t R^t}{C^{*t}} + \frac{w_R^{t-1} R^{t-1}}{C^{*t-1}} \right) \Delta \ln R^t
\]

- Again direct and reverse estimates
- Various combinations of fixed effects for countries and years
- 12 results between 0.8 and 1.6
- We settle for geometric average $\varepsilon^* = 1.2$
- Broadly in line with other results e.g., Diewert and Fox (2008), Basu and Fernald (1997)
...de-composition of MFP growth...

\[ MFP^t = \Delta \ln Q^t - \Delta \ln Z^{*t} \]
\[ = (1 - 1/\epsilon^*) \Delta \ln Q^t + \Delta \pi^t_S \]

\[(1 - 1/\epsilon^*) \Delta \ln Q^t: \text{scale effect}\]
\[\Delta \pi^t_S: \text{‘pure’ productivity effect}\]
...both effects are important...

Scale effects and residual MFP,
Average annual percentage change, 1985-2016

Source: authors’ calculations, based on OECD Productivity Database May 2018
• Effect of demand on productivity
  • longer-term demand effects (eg from rising income inequality and declining average propensity to consume (Summers 2015) or precautionary savings by low incomes (Auclert and Rognlie 2018)

• Short term procyclical nature of productivity growth Basu and Fernald (1997)

• Market size matters for MFP: positive effects of expanding trade and vice versa

• Increasing returns to scale imply the existence of mark-ups over marginal costs – relevant for competition policy
...mark-ups over marginal costs...

\[ 1 + m^{*t} = \epsilon^* \left( 1 - \frac{M^{*t}}{P^t Q^t} \right) \]^{-1} = \epsilon^* \left( 1 + \frac{M^{*t}}{C^{*t}} \right). \]

- \( M^{*t} \) = nominal value of output at basic prices minus labour compensation minus user costs of capital
- **Average mark-up factor** \( 1+m^{*t} \), across all countries and years is around 1.3 or a 30% addition to marginal costs
- **Possible reasons:**
  - Need to cover average costs
  - Pure rents
  - Unmeasured inputs (KBC)
  - R&D services from headquarters
  - Under-stated returns to measured capital....
...have been rising nearly everywhere...

Mark-ups over marginal costs

Source: authors’ calculations, based on OECD Productivity Database May 2018
Mark-ups over marginal costs, OECD unweighted average

Source: authors’ calculations, based on *OECD Productivity Database* May 2018
In conclusion

- **R&D capital stock measures** now widely available in OECD countries
- Measurement of R&D capital services more complicated than other assets, and potentially R&D has a different role in production
- Established **index number approach** still appears sensible
- **Evidence for moderately increasing returns** at the aggregate economy level
- This implies **effect from output and demand on MFP**
- The dual picture is **mark-ups** over marginal and average costs that have trended upwards
- This chimes well with effects of **globalisation and digitalisation** but other causes possible as well.
• Working paper with latest data from the 2018 OECD Productivity Compendium

Thank you!