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

Paul Schreyer and Belen Zinni
OECD Statistics and Data Directorate

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OCDE
DES POLITIQUES MEILLEURES POUR UNE VIE MEILLEURE

- 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

$$C(Q, w_X, R, t) = \min_X (\sum_i w_{Xi} X_i \mid f_Q(X, R, t) \geq Q)$$

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

$$\frac{\partial lnC(Q, w_X, R, t)}{\partial lnw_{X_i}} = \frac{w_{X_i} X_i(Q, w_X, R, t)}{C}$$

- 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

$$\frac{dlnQ}{dt} = \epsilon \left(\sum_i \frac{w_{X_i} X_i}{C} \frac{dlnX_i}{dt} - \frac{w_{RS} R}{C} \frac{dlnR}{dt} + \frac{\partial lnC}{\partial t} \right)$$

Problems: endogeneity and errors in variables

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

$$\Delta lnX^t = \frac{1}{\epsilon}\Delta lnQ^t - \frac{w_{RS}R}{C}\Delta lnR^t - \Delta\pi^t$$

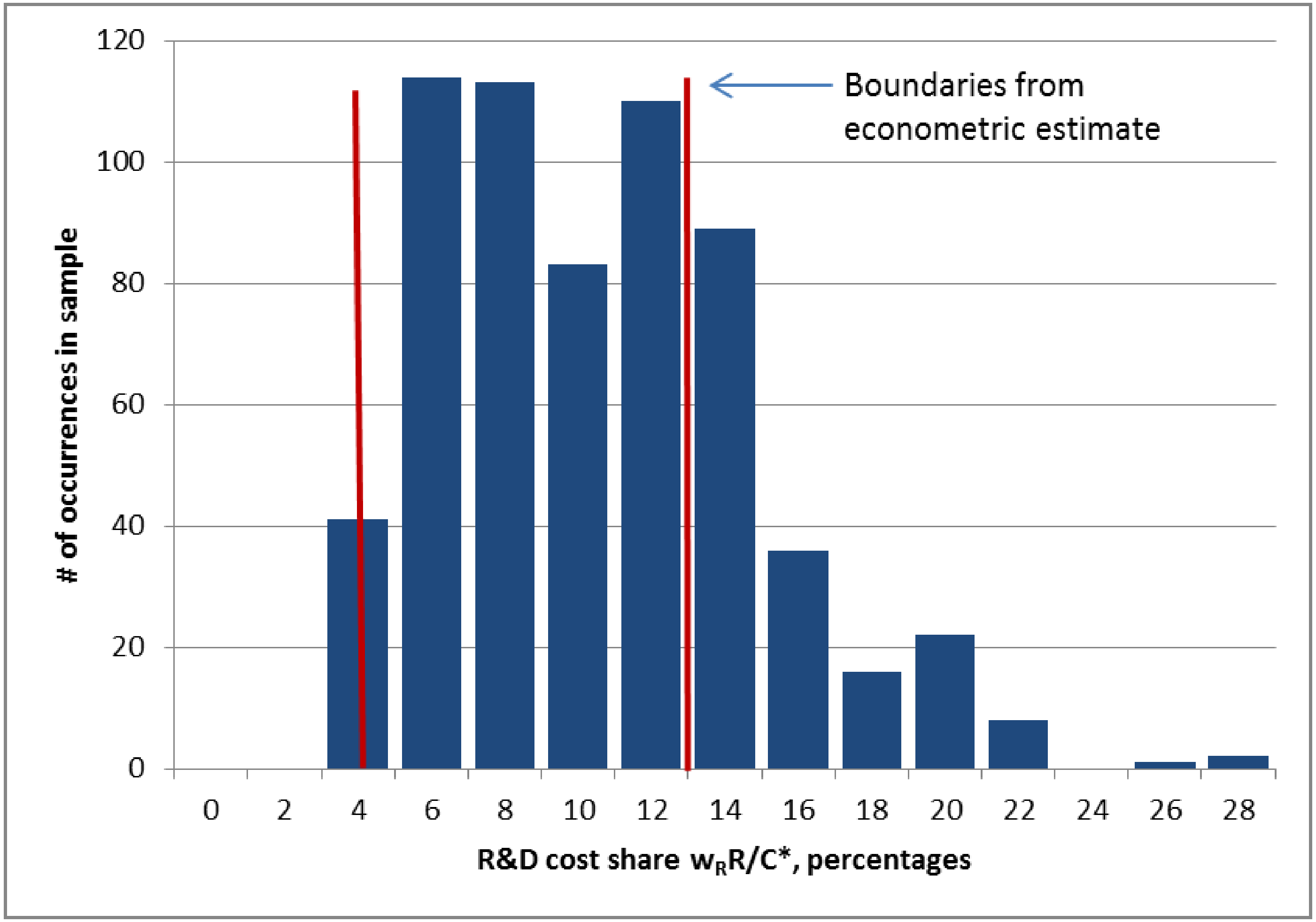
$$\Delta lnQ^t = \epsilon\left[\Delta lnX^t + \frac{w_{RS}R}{C}\Delta lnR^t + \Delta\pi^t\right]$$

$$\Delta lnX^t = \underset{(0.316)}{1.008} + \underset{(0.026)}{0.533}\Delta lnQ^t - \underset{(0.008)}{0.045}\Delta lnR^t; adj R^2 = 0.65; DF = 564$$

$$\Delta lnQ^t = \underset{(0.388)}{1.011} + \underset{(0.039)}{0.797}\Delta lnX^t + \underset{(0.009)}{0.115}\Delta lnR^t; adj R^2 = 0.77; DF = 564.$$

…no strong arguments for econometric measure of shadow price for R&D…

Cost-elasticities of R&D: distribution of unrestricted measures and econometric results



…but returns to scale are retained…

$$\begin{aligned} \Delta lnZ^{*t} &= \frac{1}{\epsilon^*}\Delta lnQ^t - \Delta\pi^t, \\ \Delta lnQ^t &= \epsilon^*\left(\Delta lnZ^{*t} + \Delta\pi^t\right); \end{aligned}$$

Where standard cost-share weighted inputs are:

$$\Delta lnZ^{*t} \equiv 0.5\left(\frac{C^t}{C^{*t}} + \frac{C^{t-1}}{C^{*t-1}}\right)\Delta lnX^t + 0.5\left(\frac{w_R^t R^t}{C^{*t}} + \frac{w_R^{t-1} R^{t-1}}{C^{*t-1}}\right)\Delta lnR^t$$

- 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 ε*=1.2
- Broadly in line with other results e.g., Diewert and Fox (2008), Basu and Fernald (1997)

…de-composition of MFP growth…

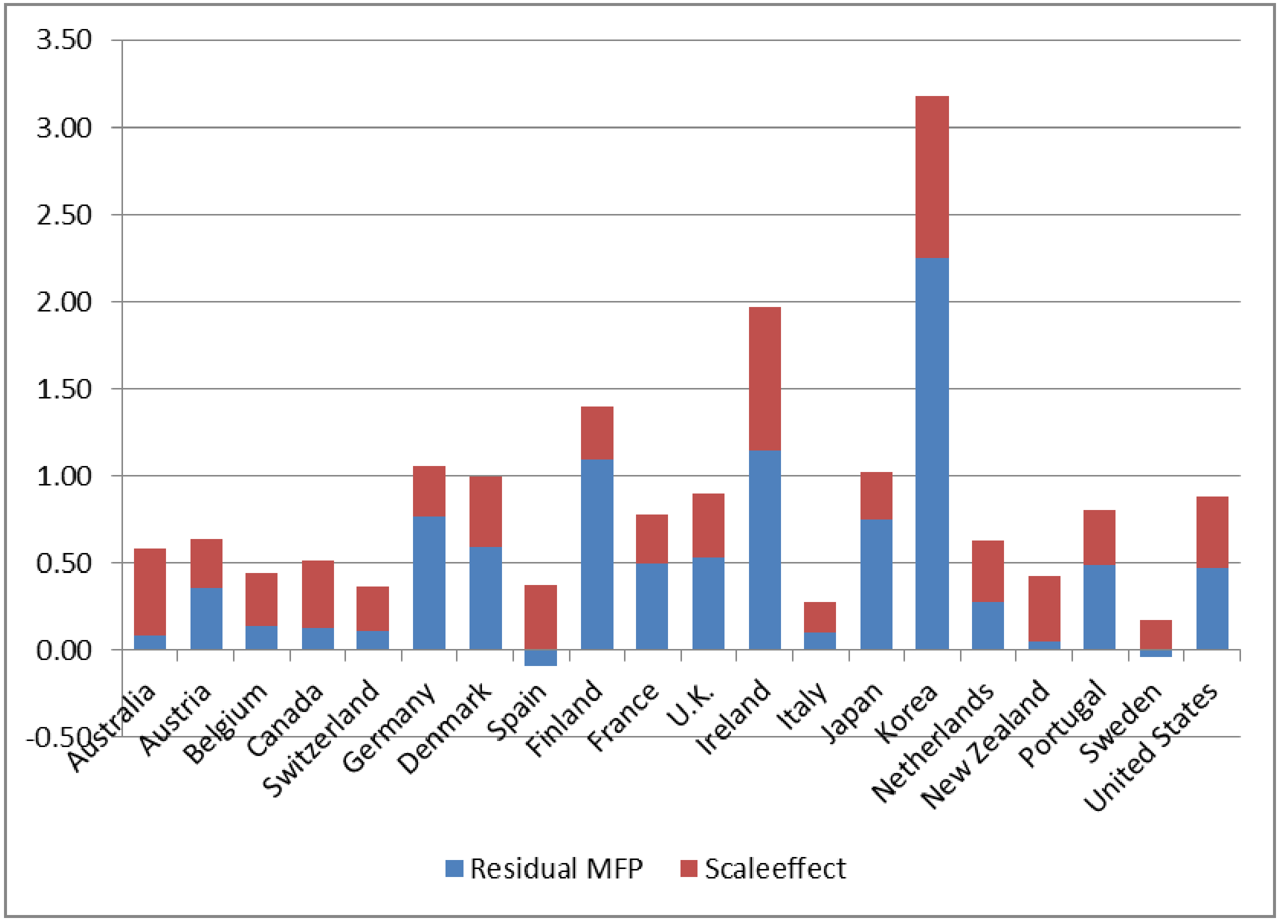
$$MFP^t = \Delta lnQ^t - \Delta lnZ^{*t}$$
$$= (1 - 1/\epsilon^*)\Delta lnQ^t + \Delta\pi_S^t$$

$(1 - 1/\epsilon^*)\Delta lnQ^t$: scale effect

$\Delta\pi_S^t$: '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

…policy relevance…

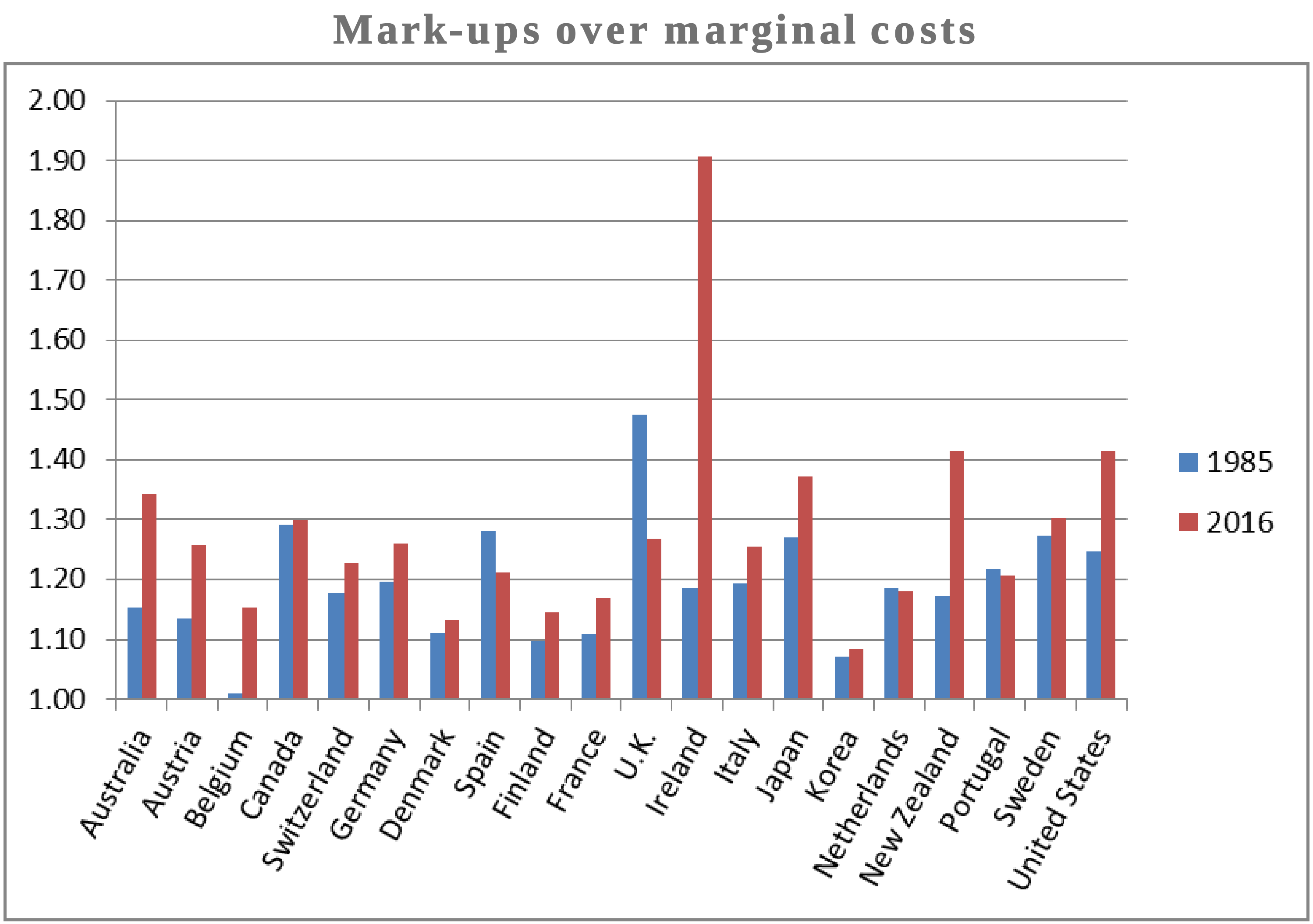
- Effect of demand on productivity
  - longer-term demand effects (eg from rising income inequality and declining average propensity to consume (Summers 2015) or precautionary savings by low incomes (Auclert and Rognlie 2018)
  - Short term procyclical nature of productivity growth Basu and Fernald (1997)
- 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…

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

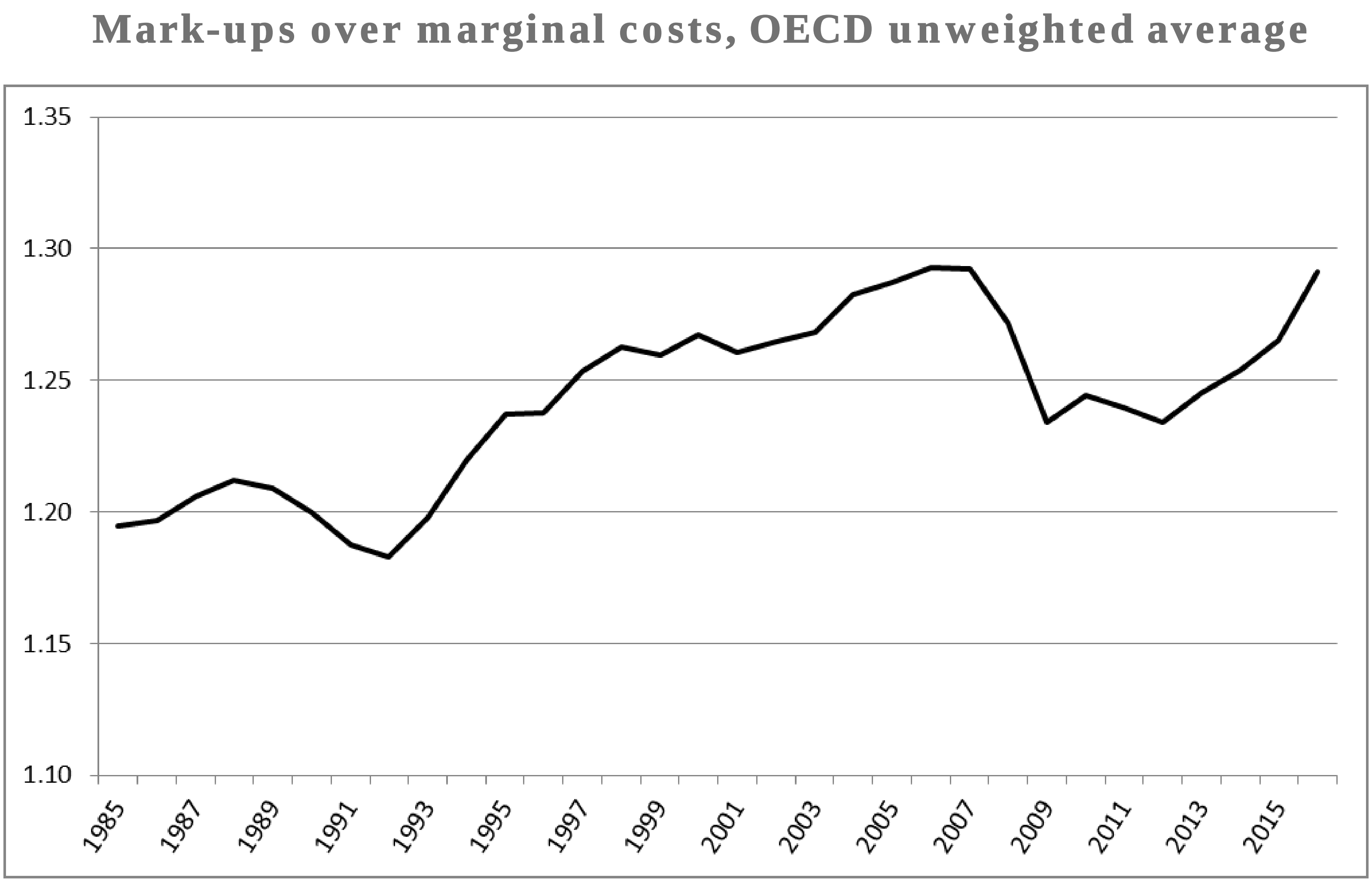
- M^{*t} = nominal value of output at basic prices minus labour compensation minus user costs of capital
- Average mark-up factor $1+m^{*t}$, across all countries and years is around 1.3 or a 30% addition to marginal costs
- Possible reasons:
  - Need to cover average costs
  - Pure rents
  - Unmeasured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

…have been rising nearly everywhere…



Source: authors' calculations, based on *OECD Productivity Database* May 2018

…time profile



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!