The Productivity Slowdown and Intangibles

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The UK slowdown: back to the 1970s?

UK TFP in post recession years

UK and US TFP
From 1970
Particularly troubling in the UK since UK core and non-core inflation has been very high.

Source: ONS inflation data
The UK slowdown

• Emerging work on labour productivity
  – Burriel/Oulton, Grice, Pattinson, Hughes/Saleheen
• Work here on TFP. DlnTFP slowed because
  • Banking sector flattered pre-recession TFP growth anyway
  • Intangibles not measured in standard GDP so DlnTFP mismeasured => slowdown artificial
  • Unmeasured utilization has fallen
  • Measured real growth in recession too low due to mismeasurement of price deflators
  • TFP affected by spillovers and source of spillovers have fallen
    – Intangibles? E.g. R&D?
    – Tangibles e.g. telecoms equipment
How might Financial services affect dlnTFP?

\[
\text{contrib} = \left( \frac{GO_{Finance}}{\Sigma VA} \right) d \ln TFP_{Finance}^G
\]

\[
\text{contrib} = \left( \frac{GO_{Finance}}{\Sigma VA} \right) (d \ln G_{Finance}^G - s^G X d \ln X_{Finance}^G - s^G R d \ln R_{Finance}^G)
\]

• Memo: UK data, 2000-07
  – dlnTFP(fin)=1.84, Domar=0.22 => contrib to dlnTFP(mkt)=0.4
  – Now dlnTFP(mkt)= 1.64,
  – => So dlnTFP(fin)=24% of dlnTFP(mkt)

• If Fin very intangible intensive e.g. software, training,
  – dlnTFP(fin) mismeasured
  – Domar weight mismeasured

• if FISIM level too high (inappropriate risk treatment, margin rises due to market power)
  – GO too high, so Domar too high (small effect on \(\Sigma VA\))
  – dlnG(fin) too high (in data dlnG(FISIM)> dlnG(non-FISIM) : reduced FISIM weight, reduces dlnG). So dlnG(fin) is too high (assume small effect on shares of \(x, sx\)).
UK financial services real output growth with and without FISIM
DlnTFP and FISIM

\[ \text{contrib} = \left( \frac{GO_{Finance}}{\Sigma VA} \right) d \ln TFP_{Finance}^{GO} \]

\[ \text{contrib} = \left( \frac{GO_{Finance}}{\Sigma VA} \right) (d \ln G_{Finance}^{GO} - s_{X}^{GO} d \ln X_{Finance}^{GO} - s_{R}^{GO} d \ln R_{Finance}^{GO}) \]

• Memo: UK data, 2000-07
  – dlnTFP(fin)=1.84, Domar=0.22 => contrib to dlnTFP(mkt)=0.4
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  – => So dlnTFP(fin)=24% of dlnTFP(mkt)

• With intangibles, UK data, 2000-07
  – dlnTFP(fin)=1.66, Domar=0.19 => contrib to dlnTFP(mkt)=0.32
  – dlnTFP(mkt)= 1.18,
  – => So dlnTFP(fin)=27% of dlnTFP(mkt)

• With intangibles, exclude 0.25 of FISIM
  – dlnTFP(fin)=0.84, Domar=0.17 => contrib to dlnTFP(mkt)=0.15
  – Since dlnTFP(mkt)= 1.18,
  – => excluding 25% of FISIM (ceteris paribus) make dlnTFP(mkt)= 1.01, => reduces dlnTFP(mkt) by 14%

• With intangibles, exclude 0.5 of FISIM
  – dlnTFP(fin)=0.02, Domar=0.16 => contrib to dlnTFP(mkt)=0
  – => excluding 50% of FISIM (ceteris paribus) make dlnTFP(mkt)= 0.86, => reduces dlnTFP(mkt) by 27%
TFP and omitting intangibles

Extended asset boundary

\[ Y = F(X, R, t), \quad X = K, L; \quad R = \text{knowledge stock}, \quad \Delta R = N - \delta^N R_{t-1} \]

\[ Y = C + I + N \quad \text{GDP includes N.} \]

Measured

\[ Y^M = F(X, t^M) \]

\[ Y^M = C + I, \quad \Rightarrow \quad \ln Y = s_N d \ln N + (1 - s_N) d \ln Y^M \]

Define growth due to knowledge accum \( \equiv \) dln + \( s_R d \ln R \)

Relation to measured TFPG, dln^M

\[ \text{Extended} \quad \frac{\text{dln} + s_R d \ln R}{\text{Measured}} = \frac{\text{dln}^M_{\text{Extended}}}{\text{Measured}} + s_N (d \ln N - d \ln Y^M) + (s^M_X - s^X_X) d \ln X \]

- Schankerman (1982) type bias expressions
- In recessions
  - If dlnX<0, measured falls relative to true
  - If dlnYm>dlnN (intangible investment relatively stable), measured rises relative to true
TFP with R&D capitalised

<table>
<thead>
<tr>
<th></th>
<th>DlnV/H</th>
<th>sDln(L/H)</th>
<th>sDln(K/L) cmp</th>
<th>sDln(K/L) telecom</th>
<th>sDln(K/L) othtan</th>
<th>sDln(K/L) intan</th>
<th>DlnTFP</th>
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<tbody>
<tr>
<td>National Acc's Intangibles: just software (ONS); mineral exploration (ONS); artistic originals (GH)</td>
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<tr>
<td>1990-95</td>
<td>3.26%</td>
<td>0.23%</td>
<td>0.32%</td>
<td>0.01%</td>
<td>0.84%</td>
<td>0.24%</td>
<td>1.63%</td>
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<tr>
<td>1995-00</td>
<td>3.29%</td>
<td>0.29%</td>
<td>0.71%</td>
<td>0.07%</td>
<td>0.37%</td>
<td>0.26%</td>
<td>1.59%</td>
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<tr>
<td>2000-09</td>
<td>1.47%</td>
<td>0.30%</td>
<td>0.23%</td>
<td>0.02%</td>
<td>0.64%</td>
<td>0.11%</td>
<td>0.16%</td>
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<tr>
<td>1995-09</td>
<td>2.12%</td>
<td>0.30%</td>
<td>0.40%</td>
<td>0.04%</td>
<td>0.55%</td>
<td>0.16%</td>
<td>0.67%</td>
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<tr>
<td>% of DlnV/H</td>
<td>14%</td>
<td>19%</td>
<td>2%</td>
<td>26%</td>
<td>8%</td>
<td>32%</td>
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<tr>
<td>National Accounts plus R&amp;D</td>
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<td>0.28%</td>
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<td>0.29%</td>
<td>1.60%</td>
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<tr>
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<td>2.08%</td>
<td>0.29%</td>
<td>0.39%</td>
<td>0.04%</td>
<td>0.54%</td>
<td>0.19%</td>
<td>0.62%</td>
</tr>
<tr>
<td>% of DlnV/H</td>
<td>14%</td>
<td>19%</td>
<td>2%</td>
<td>26%</td>
<td>9%</td>
<td>30%</td>
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</tbody>
</table>

• Just R&D in addition to standard intangibles
• Innovation = 39% in both methods
Spillover effects

• DlnK in R&D and telecoms
  – Compare early 90s to early 00s: Speeds up
  – Compare early 00s to mid 00s: slows down

• If spillovers take time, shows up in
  – dlnTFP should speed up early 00s to mid 00s
  – dlnTFP should slow down mid 00s to late 00s

• Effect depends on
  – Extend of speedup and slowdown = measurement
  – Spillover effect from dlnK to dlnTFP = econometrics
Has UK investment slowed?

- R&D/GDP has slowed, then rose
- Intan/GDP rose then fell
Seems like DlnK slowed coming into recession
Lagged spillover effects

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak/Trough</th>
<th>DlnTFP</th>
<th>DlnK(rd)</th>
<th>DlnK(com equip)</th>
<th>dlnTFP slowdown</th>
<th>0.25*lagged dlnK(rd) slowdown</th>
<th>0.04*lagged dlnK(com equip) slowdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-98</td>
<td>T-P</td>
<td>1.83%</td>
<td>1.60%</td>
<td>1.86%</td>
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<td></td>
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<tr>
<td>1998-02</td>
<td>P-T</td>
<td>1.26%</td>
<td>3.75%</td>
<td>8.77%</td>
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</tr>
<tr>
<td>2002-07</td>
<td>T-P</td>
<td>1.39%</td>
<td>1.87%</td>
<td>2.28%</td>
<td>0.12%</td>
<td>0.54%</td>
<td>0.28%</td>
</tr>
<tr>
<td>2007-10</td>
<td>P-T</td>
<td>-2.29%</td>
<td>1.20%</td>
<td>-1.94%</td>
<td>-3.68%</td>
<td>-0.47%</td>
<td>-0.26%</td>
</tr>
</tbody>
</table>

Overpredicts mid 00s speedup
Underpredicts end 00s slowdown
Deflator problems

• 7.4% of VA uses average weekly earnings index AWE as deflator with productivity adjustment (Drew, S, Deflation improvements in the UK National Accounts, Table B2)

\[ \text{DlnP} = \text{DlnAWE} - \text{Dln}(Y/L) \]

• In recession
  – measured Dln(Y/L) <0
  – If its “too low”, then DlnP “too high” and so DlnY “too low”
  – (circularity)
  – If bias is, say 2%, then DlnY too low by 0.14%
Utilisation

- Basu et al, dlnTFP includes unobserved utilisation (but note Berndt/Fuss/Hulten utilisation is in capital share)
- Idea: hours per worker (H/N) is measure of unobserved utilisation
- Run regression: dlnTFP(measured)=βdln(H/N), obtain β(hat)
- Correction: dlnTFP(utilisation corrected) = dlnTFP(measured )-β(hat)*dln(H/N)
- Note that in US this makes a big difference: β>1, dln(H/N) falls very sharply in 2008-10, negative measured dlnTFP is rendered positive by this adjustment
- UK results
  - β=0.35
  - dln(H/N) does not change much
  - Makes small difference to current slowdown
The bottom line

• Before Great Recession: 2002-07
  – UK DlnTFP \approx +1.4\%
  – Inflation \approx 2\%

• Since 2007
  – 2007-10, UK DlnTFP \approx -2.3\% (2008-9 = -5\%, \approx 0 \text{ since then})
  – Inflation \approx 4-5\%

• Is the DlnTFP slowdown real?
  – Financial services: pre07 DlnTFP may be overstated by 0.17pppa, so part of slowdown is pre-DlnTFP is too high (depending on current FISIM in current period).
  – Deflator problems: recession DlnTFP is too low by 0.14%pa
  – Accounting for intangibles
    • Reduces measured DlnTFP but raises contribution of knowledge assets. Total effect about the same
    • Intangible spillovers => post07 slowdown in DlnTFP by 0.73pppa

• Summary
  – Pre to post is +1.4 to -2.3 = -3.7\%
  – Of which
    • Fin services= 0.17%pa: Deflators= 0.14%pa: Spillovers = 0.73%pa:
    • Grand total= 1.04%pa = 28\% of slowdown

• Policy
  – Is slow DlnTFP a given? No
    • Additional knowledge investment boosts growth
    • DlnTFP depends on spillovers so maybe amenable to e.g. science or IP policy
Spares
Other work

• Comms equipment
  – Using ONS deflator

• More econometric approaches on spillovers
Traditional Grilliches-type approach to Intangible spillovers

Production function, industry $i$ time $t$

$$\Delta \ln Y_{it} = \Delta \ln A_{it} + \varepsilon_{M,i} \Delta \ln M_{it} + \varepsilon_{K,i} \Delta \ln K_{it} + \varepsilon_{L,i} \Delta \ln L_{it} + \varepsilon_{N,i} \Delta \ln N_{it} + \varepsilon_{-N,i} \Delta \ln N_{-it}$$

Definition

$$\Delta \ln TFP_{it} \equiv \Delta \ln Y_{it} - \sum_{X=L_{it},K_{it},N_{it}} \bar{s}_{X,it} \Delta \ln X_{it}$$

Assumption

$$\varepsilon_{X,it} = s_{X,it} + d_{X,it}, \quad X = M_{it}, K_{it}, L_{it}, N_{it}$$

$$\varepsilon_{N_{-i,t}} \Delta \ln N_{-i,t} = \alpha_{i} \left( M \Delta \ln N_{-i,t} \right) + \lambda_{t}$$

Estimating equation

$$\Delta \ln TFP_{it} = \alpha_{i} \left( M \Delta \ln N_{-i,t} \right) + \lambda_{t} + a_{i} + \sum_{X=L,K,N^{PRIV}} d_{X} \Delta \ln X + \nu_{it}$$
Interpretation of estimation equation

\[ \Delta \ln TFP_{it} = \alpha_1 \left( M \Delta \ln N_{i,t} \right) + \lambda_t + a_i + \sum_{X=L,K,N^{PRIV}} d_x \Delta \ln X + \nu_{it} \]

- Industry and time effects as controls
- Outside effects might be
  - Non-pecuniary knowledge spillovers: e.g. learning from others
  - Pecuniary spillovers via mismeasurement e.g. more knowledgable others are selling unmeasured better quality goods
- Within-ind effects
  - Spillovers, non-constant returns, mismeasurement e.g. of factor stocks
- Two weighting matrices M
  - Interindustry intermediate flows from IO tables
  - Interindustry labour flows from Labour Force Survey
- What do we do that’s new?
  - Other industry level findings: Uses R&D/Y as DlnN (assumes \( \delta(R&D)=0 \)). Most don’t capitalise R&D in Y. Uses manufacturing. Most find \( \alpha_1 > 0 \). Few UK studies. Griffiths et al interact M with R&D to test absorptive capacity.
  - We use all intangibles, construct stocks, \( \delta \) from our micro-survey, capitalise Y and add intang inputs for consistent dlnTFP.
Data

- Years, 2000-07
- 7 industries
  - Measurement: finance, agriculture
- Output: Gross output adjusted for own account intangibles
- Inputs: Tangible, intangibles

<table>
<thead>
<tr>
<th>SIC(2003)</th>
<th>Industry Description</th>
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</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Agriculture, Forestry and Fishing</td>
</tr>
<tr>
<td>D</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>E</td>
<td>Electricity, Gas &amp; Water Supply</td>
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<tr>
<td>F</td>
<td>Construction</td>
</tr>
<tr>
<td>GHI</td>
<td>Distribution; Hotels &amp; Restaurants; Transport, Storage &amp; Communications</td>
</tr>
<tr>
<td>J</td>
<td>Financial Services</td>
</tr>
<tr>
<td>K</td>
<td>Business Activities (excluding real estate)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Broad category of intangible asset</th>
<th>Includes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computerised information</td>
<td>Computer software, computer databases</td>
</tr>
<tr>
<td>Intellectual property</td>
<td>Artistic originals, Scientific R&amp;D, Non-scientific R&amp;D, Mineral exploration, Financial product innovation, and Architectural and engineering design</td>
</tr>
</tbody>
</table>
Measurement, contd

- **Tangibles**
  - Plant, building, vehicles. EU KLEMS. Capital service weighted

- **Intangibles**
  - Software: EUKLEMS
  - R&D: own calculations. BERD for own-account. R&D performed in R&D industry assigned to funder via IO tables. (IO performer data not used)
  - Finance: new method based on own-account
  - Design: own-account: software method. Purchased: IO tables. All purchased design in bus services excluded (assumed to be subcontracting). This reduces total design spend a lot
  - Training: own-account survey
  - Marketing: IO tables
  - Managerial: own-account plus purchased
Graphs

Note: all data is deviation from industry and time means
Regressions using intermediate consumption and labour transition weights

<table>
<thead>
<tr>
<th>ASSET</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tbody>
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<tr>
<td>External R&amp;D</td>
<td>0.43***</td>
<td>2.31**</td>
<td>0.38***</td>
<td>1.57**</td>
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<td></td>
<td>(4.61)</td>
<td>(3.05)</td>
<td>(7.42)</td>
<td>(2.52)</td>
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<tr>
<td>Internal R&amp;D</td>
<td>0.043</td>
<td>0.074*</td>
<td>0.0027</td>
<td>0.036</td>
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<td></td>
<td>(1.86)</td>
<td>(1.95)</td>
<td>(0.15)</td>
<td>(0.83)</td>
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<tr>
<td>Total External Intangibles</td>
<td></td>
<td>0.52**</td>
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<td>0.58</td>
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<td>(2.97)</td>
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<td>(0.59)</td>
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<tr>
<td>Total Internal Intangibles</td>
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<td>-0.20***</td>
<td>-0.18***</td>
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<td>(-5.06)</td>
<td>(-5.64)</td>
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<tr>
<td>Total External Intangibles ex. R&amp;D</td>
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<td>0.39*</td>
<td>0.070</td>
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<td>(2.22)</td>
<td>(0.074)</td>
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<td>Total Internal Intangibles ex. R&amp;D</td>
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<td>-0.17***</td>
<td>-0.16***</td>
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<td>(-5.26)</td>
<td>(-5.14)</td>
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| Observations                  |         |           | 91        |         | 91        |           |
| R-squared                     | 0.185   |           | 0.147     | 0.287    | 0.228     | 0.372     |
| Number of industries          |         |           | 7         | 7        | 7         | 7         |
| Elasticity of external R&D    | 0.25    |           | 0.21      | 0.30     | 0.054     | 0.22      |
| Elasticity of other external variable |           |           |           | 0.15     |           |           |
|                              |         |           | 0.22      | 0.0065   |           |           |