Estimating Industry-Level Multifactor Productivity:

methods and experimental results

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Presentation outline

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- Background
- Issues of methodological choice
  - input-output based approach
  - the approach recommended by the OECD
- Data issues
- Experimental estimates
  - gross output & value-added based MFP indices
- Other related issues
  - industry-level vs aggregate MFP approaches
  - open vs closed economy MFP measures
  - quality adjustment for labour inputs
  - impact of using exogenous rate of return on capital services and MFP estimates

Background

- User demand
  - In the ABS publication (ASNA cat. 5204)
    - –labour, capital & mulit-factor productivity estimates for the aggregate market sector & at industry-level: only labour productivity estimates
    - –no industry-level MFP estimates
  - rising interests in MFP estimates at the lower levels of aggregation
- Feasibility
  - improved ABS supply-use tables and full integration between the supply-use tables & national accounts in recent years

Methodological choice

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- **Considerations**
  - use well-established methods in the literature
  - transparent and easy to implement for statistical production (to estimate MFP in 12 market-sector industries)
- **Methods explored:**
  - input-output based approach (Durand 1993, 1996; Cas & Rymes 1990)
    - –has been developed & used by Statistics Canada
    - –relies on the current and constant prices s-u tables
    - –provides a set of consistent MFP measures at different levels of aggregation (the bottom-up approach)
    - –at the industry-level: gross output; value-added; intra-industry & inter-industry MFP measures, reflecting different levels of integration

Methodological choice *(cont.)*

- –different interpretations & theoretical origin
  - •capital can be treated as a reproduced input
    - ◆the Harrod-Robinson-Read concept of TFP/MFP vs. the neoclassical TFP/MFP measure (Rymes 1972, 1983; Cas & Rymes 1990)
- –but it requires good quality and fully-balanced supply-use tables in both current & constant prices
  - •balancing issues at the commodity level in ABS' constant price s-u tables
    - ◆resulted in some implausible industry-level and aggregate MFP estimates

Methodological choice (*cont.*)

- This led us to consider the method recommended by the OECD (OECD 2001)
  - OECD productivity manual recommends
    - both industry-level gross output MFP (also called KLEMS MFP) & value-added MFP
  - they are consistent with the same types of index based on the I/O based approach
  - both are non-parametric and under the growth accounting framework
    - closely related to the approach by Jorgenson et. al. 1987
  - but the commodity dimension is suppressed in the approach recommended by the OECD
  - interpretations - integration vs. production functions: the Hicks neutral technological change

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Methodological choice (*cont.*)

- indices of MFP growth for industry *i*

- value-added based MFP

- gross output based MFP

- the indices can be derived from production functions or from the accounting identities (Balk 2003)
- two assumptions: CRS & competitive equilibrium
  - but the estimated MFP can reflect the combined effects of
    - technical change, scale economy, measurement errors & other non-technological factors (a residual!)

Methodological choice (*cont.*)

- Under discrete approx., the above indices can be directly estimated using the industry-level data
  - we use them to derive the experimental estimates for the 12 market-sector industries in Australia

Data sources & issues

	VA MFP	GO MFP
Output	industry-level gross value added (GVA)- (current prices & chain volume measure) since 1990 for this study	industry-level gross output (current & constant prices) - s-u tables since 1995
intermediate input		s-u tables (current & constant prices), since 1995
Capital	industry-level K services (agg. from 11 or 12 different types of asset)	industry-level K services (agg. from 11 or 12 different types of asset)
Labour	industry-level hours worked	industry-level hours worked

Data sources & issues (*cont.*)

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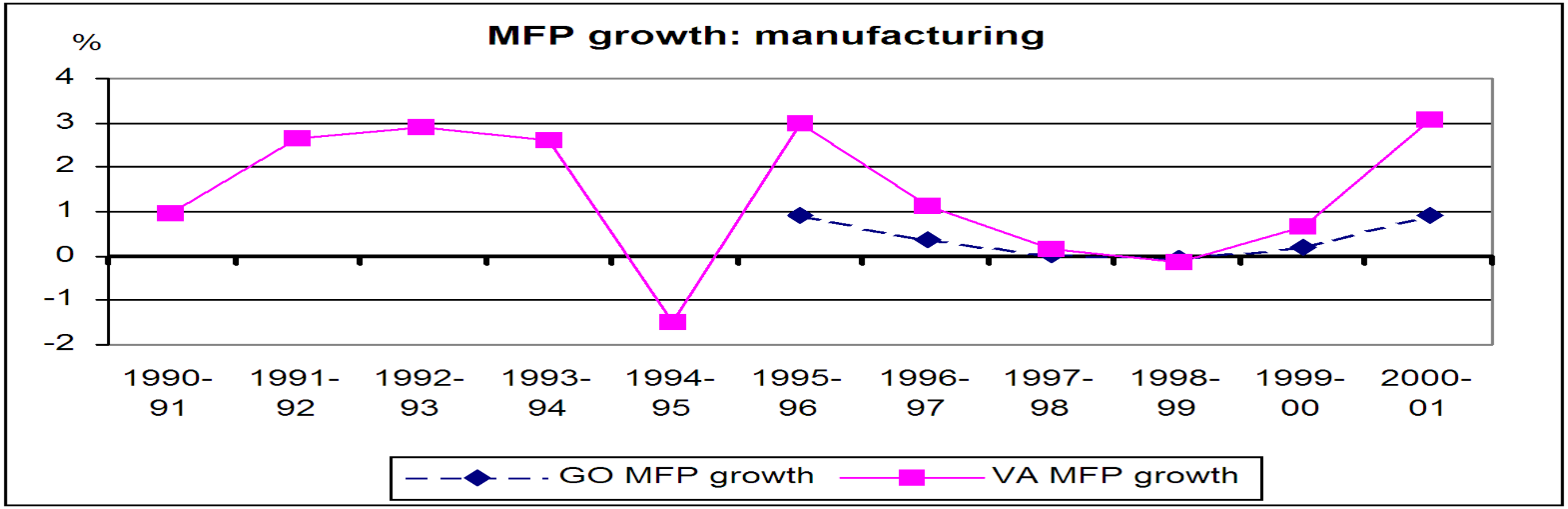
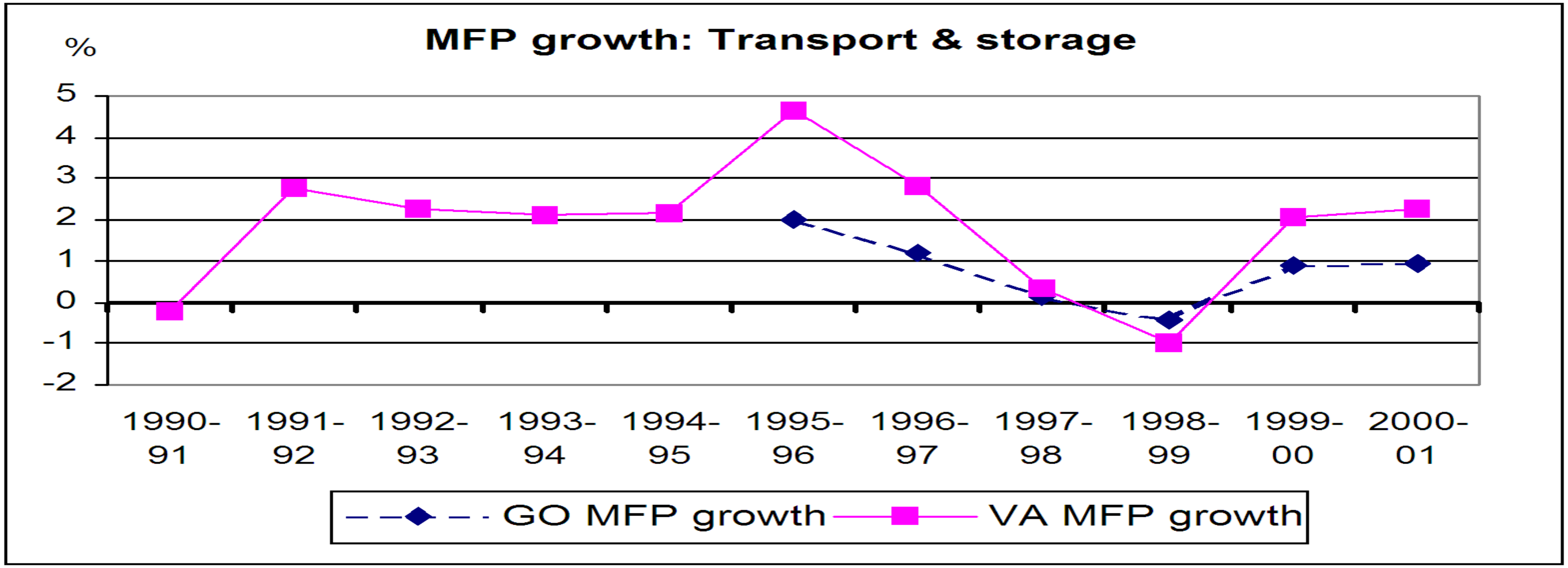
- Issues of valuation
  - based on the s-u tables
    - –industry gross value added (GVA) - at basic prices
    - –industry gross output - at basic prices
    - –intermediate inputs - at purchaser's prices
- As GVA includes other net taxes on production & imports, need to allocate them to K & L to preserve the accounting identity
  - GVA = compensation of employees + GOS + gross mixed income + other net taxes on prodn. & imports
  - we use proportional allocation due to lack of detailed information on these net taxes at industry level

Experimental estimates

- Two types of industry-level MFP estimates for the 12 market-sector industries
  - gross output based MFP (since 1995) & value added based MFP since (1990)

Experimental estimates (*cont.*)



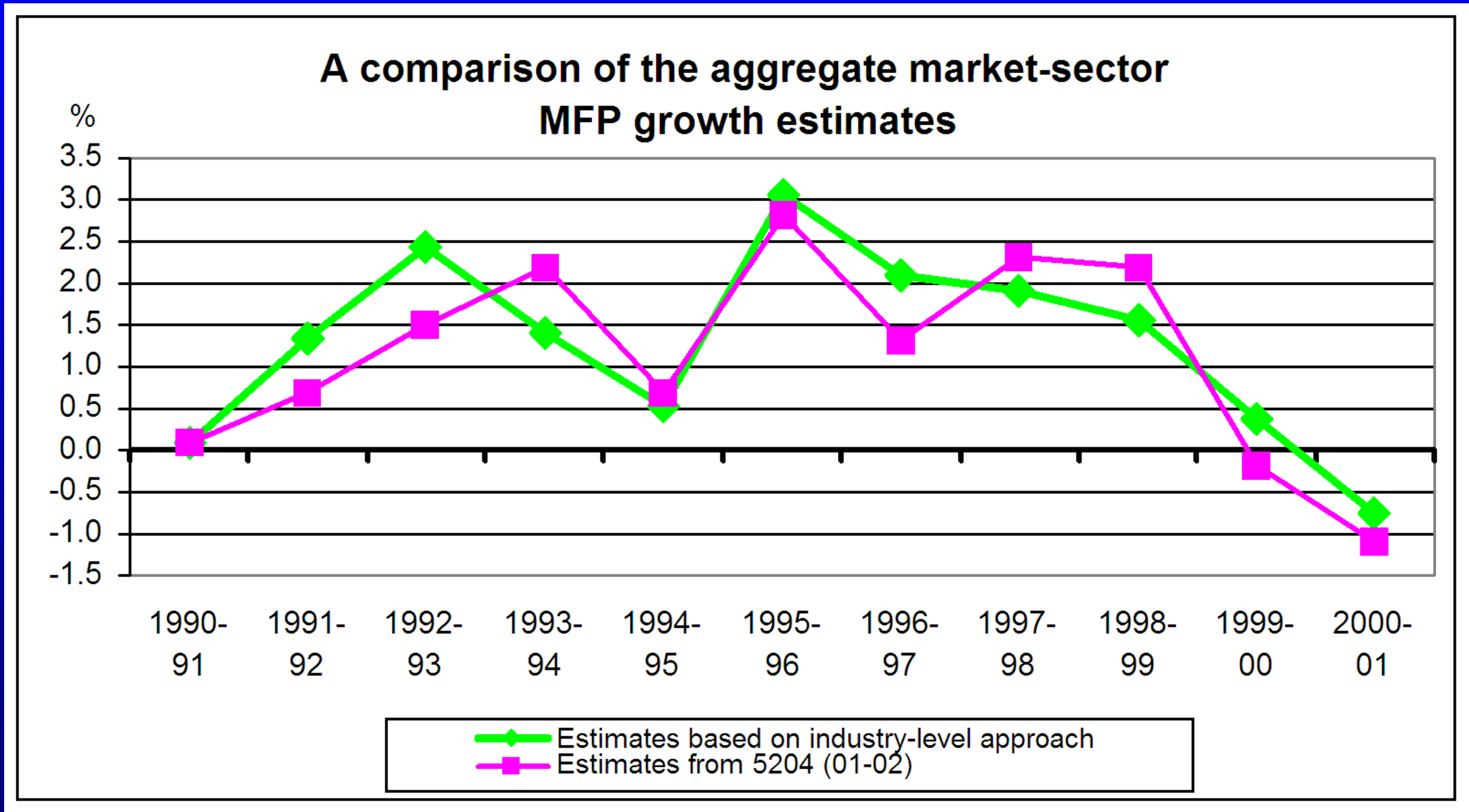


Experimental estimates (*cont.*)

- Note the relationship between the two indices

- Are the experimental estimates plausible?
  - –use aggregation to indirectly assess the estimates
    - industry-level results are aggregated to derive the agg. market-sector estimates
    - the results are then compared with the ABS published agg. MFP estimates
    - also address the issues of consistency in aggregation

Industry-level vs aggregate MFP (*cont.*)



Industry-level vs aggregate MFP (*cont.*)

- Why are the estimates different?
  - the difference due to the diff. in measurement
    - –use different measures for output and factor income shares (see appendix A of the paper)
  - methodological difference
    - –new estimates: based on industry-level approach
    - –5204 results: from direct aggregate approach
      - •both are valid approaches

Industry-level & aggregate MFP (*cont.*)

- **Relationship between industry-level & aggregate approaches to the estimation of agg. MFP**

  An *augmented* Domar aggregation formula (Jorgenson et. al. 1987)

agg MFP from agg. approach = agg MFP based on industry-level approach + contributions of changes in industry distribution of outputs & inputs

Open vs closed economy MFP

- Note that the previous MFP indices do not distinguish between the effects under the open and closed economy
  - according to Gollop (1987): imported intermediate inputs should be treated as additional primary inputs
    - should use Deliveries to Final Demand as a measure of output to derive the *open economy MFP* (see the results in the paper based this approach)
  - other methods (e.g. Diewert & Morrison 1986, Kohli 1990, Fox & Kohli 1998, Cas & Rymes 1990, Durand 1996) have also been suggested - focusing on the terms of trade effect in the open economy
  - but there is no generally accepted solution; many MFP work do not address this issue

Quality adjustment for labour inputs in MFP estimation

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- Hours worked should be adjusted for quality difference
- ABS has produced experimental QALI for the aggregate market sector
  - follows US BLS' approach
    - taking into account the differences in educational attainment & the length of workforce experience in hours worked
  - has incorporated QALI into the market sector MFP estimates in ASNA (5204.0)

Using quality adjusted labour inputs in MFP estimation (*cont.*)

- Adjusting labour quality difference at the industry level may not be possible at this stage due to the data constraint

Impact of using exogenous rate of return on capital services & MFP estimates

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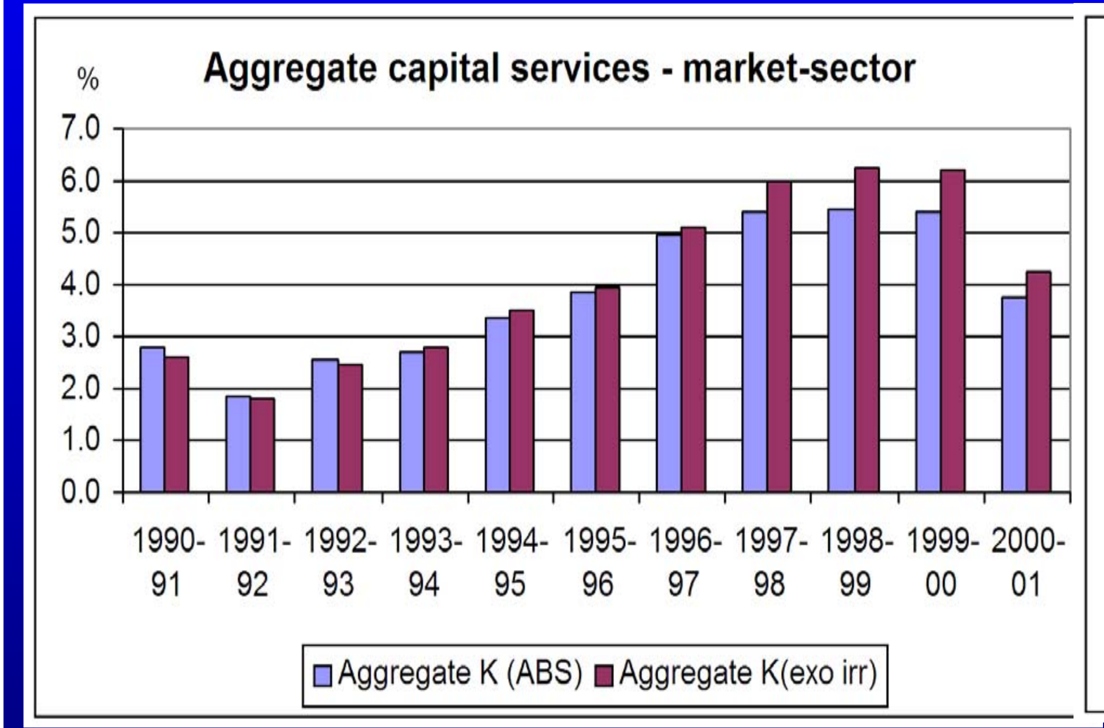
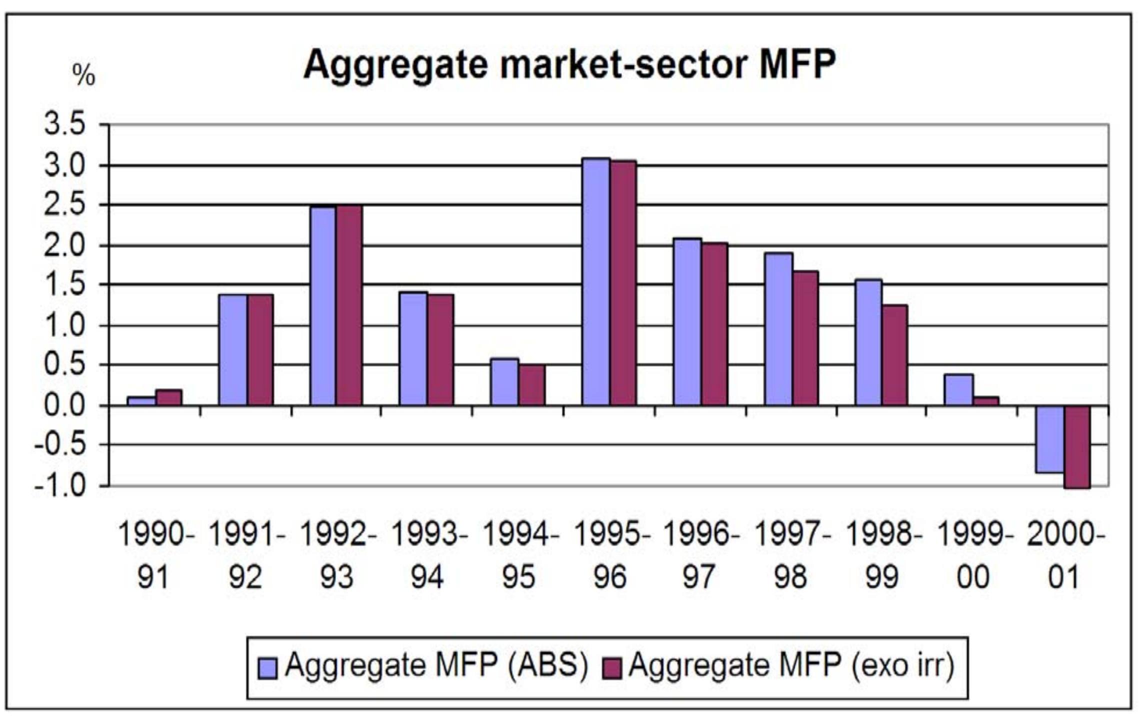
- ABS uses a mixed approach to deriving rental prices (user cost) used for aggregating productive capital stock
  - the internal rate of return (irr), a component in the user cost formula (Hall and Jorgenson 1967), is derived by equating capital income to cost (endo. irr), *or* set to be equal to 4% + CPI (exo. irr) if it is below 4%+CPI from the former
- Erwin & Lawrence (2004) reveal some problems associated with the ABS approach & the industry-level data
  - suggesting to use 4% real irr across industries and time

Impact of using exogenous rate of return on capital services & MFP estimates (*cont.*)





Impact of using exogenous rate of return on capital services & MFP estimates (*cont.*)

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- Highlighted one of the many difficulties in measuring capital & MFP accurately, particularly at the industry-level (see e.g. Diewert 2000)
  - caution has to be exercised in using these estimates
  - further improvements in data sources and measurement are necessary, and are continuously being attempted