

# **Productivity, the Terms of Trade and Australian Welfare: 1960-2004**

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# Introduction



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- **We ask two questions:**
    - **Have changes in Australia’s Terms of Trade improved “welfare”?**
    - **Is labor productivity the “right” measure of welfare to look at?**
  - **To answer the first question, we use the framework in Diewert and Morrison, Economic Journal 1986**
  - **To answer the second question, we suggest using a net real income measure**

# Terms of Trade Problem



- **Market sector GDP function:**  
$$g^t(P,x) \equiv \max_y \{P \cdot y : (y,x) \text{ belongs to } S^t\}$$
- **Value of outputs equals value of inputs in period t:**  
$$g^t(P^t,x^t) = P^t \cdot y^t = W^t \cdot x^t ; y^t \text{ is output; } x^t \text{ is input;}$$
- **Real income generated by market sector in period t is**  
$$\rho^t \equiv W^t \cdot x^t / P_c^t = w^t \cdot x^t = g^t(p^t, x^t) = P^t \cdot y^t / P_c^t = p^t \cdot y^t$$
  
where  $P_c^t$  is consumption price
- **This is the amount of consumption period t income can buy and this will be our suggested “welfare” measure.**

# Productivity Growth



- Definition of a family of period  $t$  productivity growth factors:

$$\tau(p, x, t) \equiv g^t(p, x) / g^{t-1}(p, x)$$

- Laspeyres type measure:  $\tau_L^t \equiv \tau(p^{t-1}, x^{t-1}, t) \equiv g^t(p^{t-1}, x^{t-1}) / g^{t-1}(p^{t-1}, x^{t-1})$

- Paasche type measure:  $\tau_P^t \equiv \tau(p^t, x^t, t) \equiv g^t(p^t, x^t) / g^{t-1}(p^t, x^t)$

- Fisher type measure:  $\tau^t \equiv [\tau_L^t \tau_P^t]^{1/2}$

- But how can we empirically implement the above theoretical definitions? Assume a translog technology and it can be done!

# Real Output Price Growth Factors



- Definition of a family of period  $t$  real output price growth factors:  
$$\alpha(p^{t-1}, p^t, x, s) \equiv g^s(p^t, x) / g^s(p^{t-1}, x)$$
- Laspeyres type measure:  $\alpha_L^t \equiv \alpha(p^{t-1}, p^t, x^{t-1}, t-1)$   
$$\equiv g^{t-1}(p^t, x^{t-1}) / g^{t-1}(p^{t-1}, x^{t-1}).$$
- Paasche type measure:  $\alpha_P^t \equiv \alpha(p^{t-1}, p^t, x^t, t) \equiv g^t(p^t, x^t) / g^t(p^{t-1}, x^t).$
- Fisher type measure:  $\alpha^t \equiv [\alpha_L^t \alpha_P^t]^{1/2}$
- Gives increase in real income due to changes in real output prices

# Input Quantity Growth Factors



- Definition of a family of period  $t$  input quantity growth factors:

$$\beta(x^{t-1}, x^t, p, s) \equiv g^s(p, x^t) / g^s(p, x^{t-1})$$

- Laspeyres type measure:  $\beta_L^t \equiv \beta(x^{t-1}, x^t, p^{t-1}, t-1)$

$$\equiv g^{t-1}(p^{t-1}, x^t) / g^{t-1}(p^{t-1}, x^{t-1}).$$

- Paasche type measure:  $\beta_P^t \equiv \beta(x^{t-1}, x^t, p^t, t) \equiv g^t(p^t, x^t) / g^t(p^t, x^{t-1}).$

- Fisher type measure:  $\beta^t \equiv [\beta_L^t \beta_P^t]^{1/2}$

- Gives the increase in real income due to input growth alone

# Real Income Growth Decomposition



- The input growth and real output price contribution factors (to real income growth) can be broken down into separate effects that are defined in similar ways.
- With the assumption of a translog technology, we can get the following exact decomposition of real income growth into contribution factors:
- $\rho^t/\rho^{t-1} \equiv \gamma^t = \tau^t \alpha^t \beta^t$  where  $\gamma^t = w^t \cdot x^t / w^{t-1} \cdot x^{t-1}$  is observable and  $\ln \alpha^t = \ln P_T(p^{t-1}, p^t, y^{t-1}, y^t)$  and  $\ln \beta^t = \ln Q_T(w^{t-1}, w^t, x^{t-1}, x^t)$ ; where  $P_T$  is the Törnqvist (real) output price index and  $Q_T$  is the Törnqvist input quantity index.
- We cumulate the now observable relationships  $\rho^t/\rho^{t-1} = \tau^t \alpha^t \beta^t$  into the “levels” relationships  $\rho^t/\rho^{t-1} = T^t A^t B^t$

# Terms of Trade Contribution Factors



- The terms of trade contribution factors are made up of two separate effects (which we combine in the following figures):
- A real export price effect which adds to real income growth if the price of exports increases more rapidly than the price of consumption and
- A real import price effect which adds to real income growth if the price of imports falls compared to the price of consumption
- In the present setup, the entire value of investment is converted into consumption equivalents and added to actual consumption and the price of capital is the usual user cost of capital which includes a depreciation term.
- But this framework overstates real (sustainable) consumption by the amount of depreciation



# The Real Net Income Approach



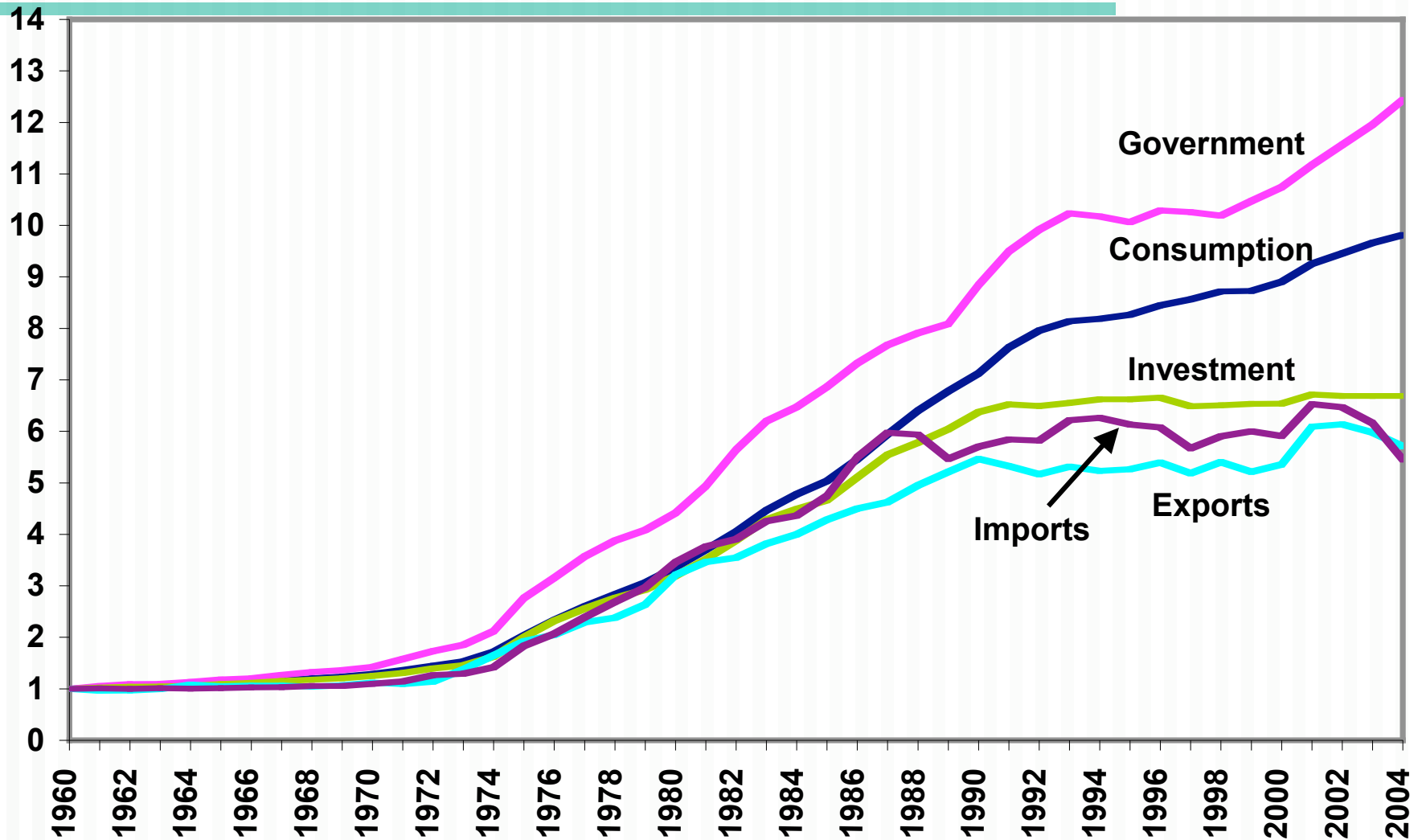
- In the final part of the paper, we take depreciation out of user cost and instead subtract it from gross investment.
- Now investment is converted to consumption equivalents only if it is positive after netting out depreciation; thus, we have moved from real GDP (GDP deflated by the consumption price index) to real NDP (NDP deflated by the consumption price index).
- The remaining user cost term is the reward for waiting or postponing consumption; thus, income is now labour income plus the net return to capital.
- In the net framework, the role of TFP growth is magnified and in the Australian data, the role of capital deepening is diminished as we shall see.

# Diewert-Lawrence Database

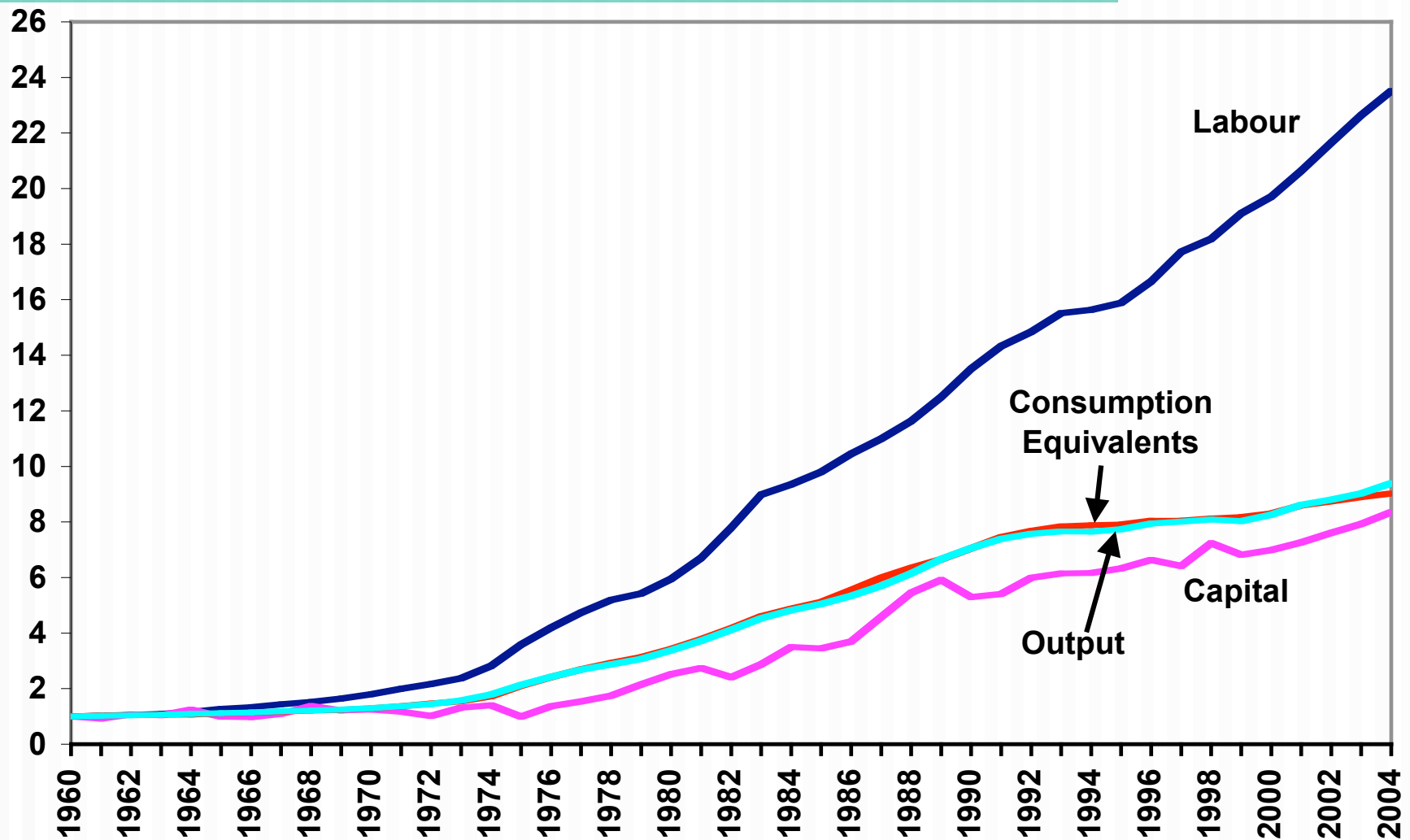


- Initially developed for DCITA
- Extended market sector coverage – covers 16 of the 17 sectors in the National Accounts instead of the ABS MFP's 12 sectors
- Builds up an output measure from final consumption components rather than sectoral gross value added
- Outputs and inputs are measured in terms of producer prices rather than consumer prices
- Constructs consistent capital and inventory input series and measures inventory change in a consistent manner
- Runs from 1959-60 to 2003-04
- This version includes a balancing real rate of return and improved capital tax treatment

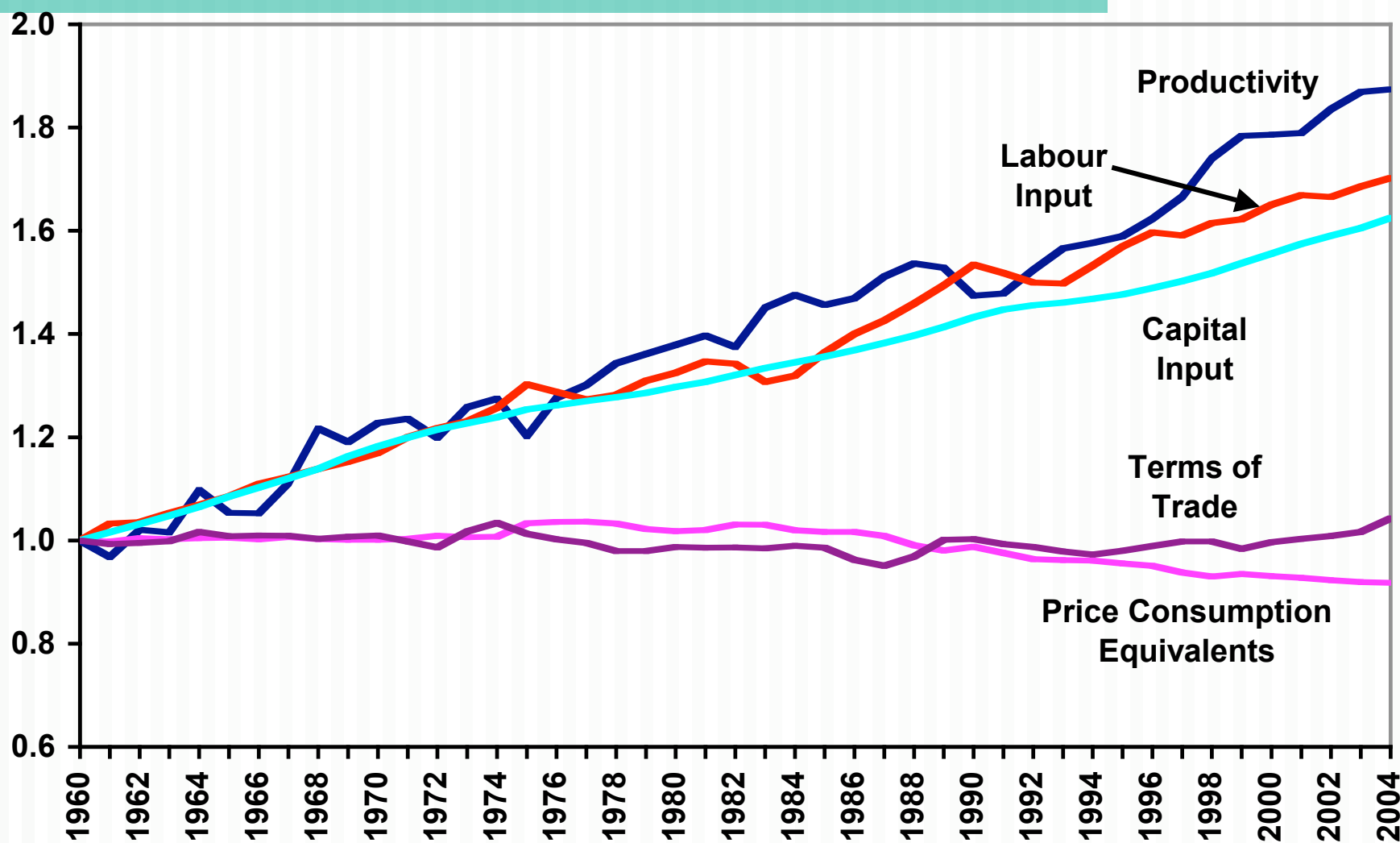
# Price Indexes



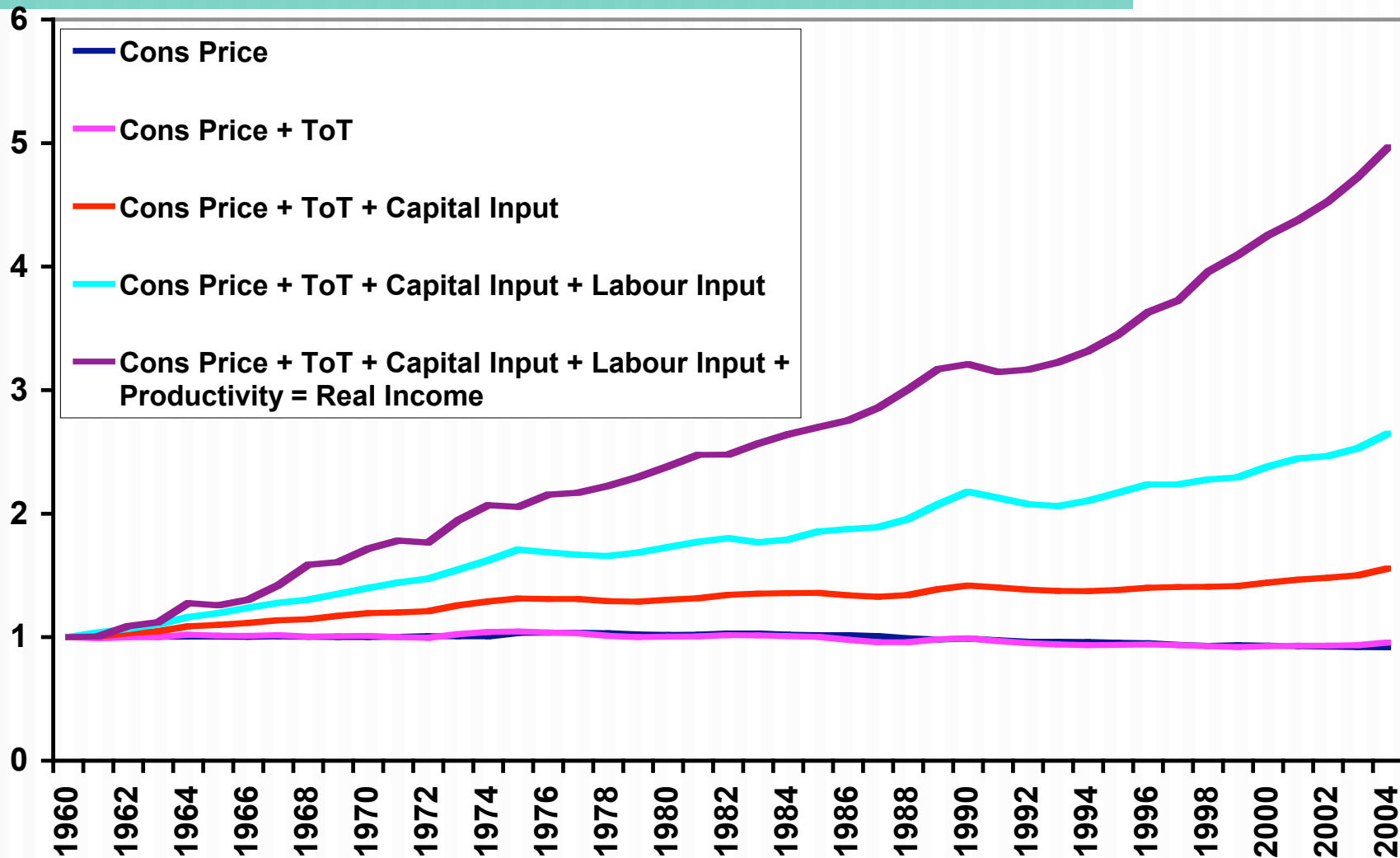
# Price Indexes (cont'd)



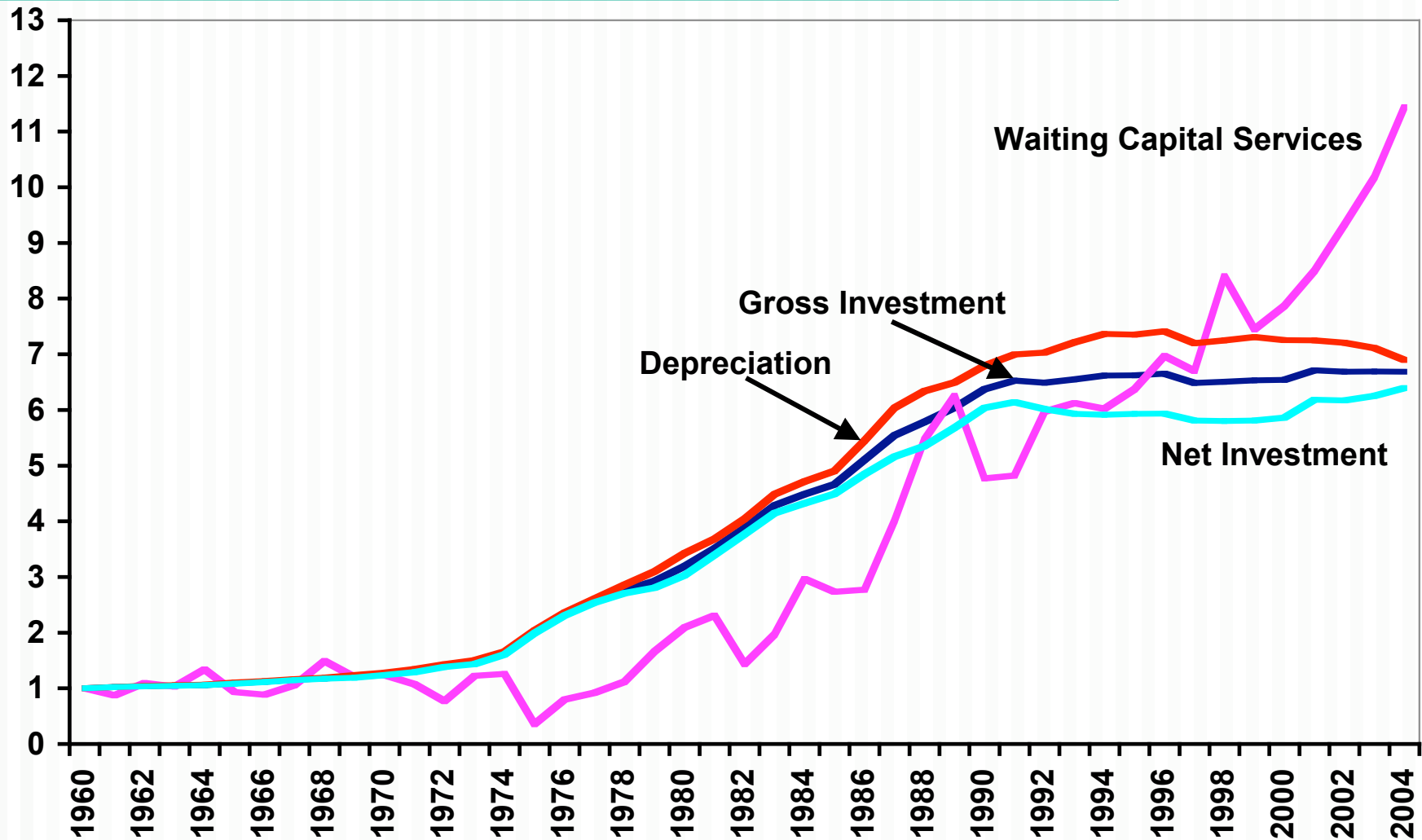
# Individual Contributors to Real Income - GDP



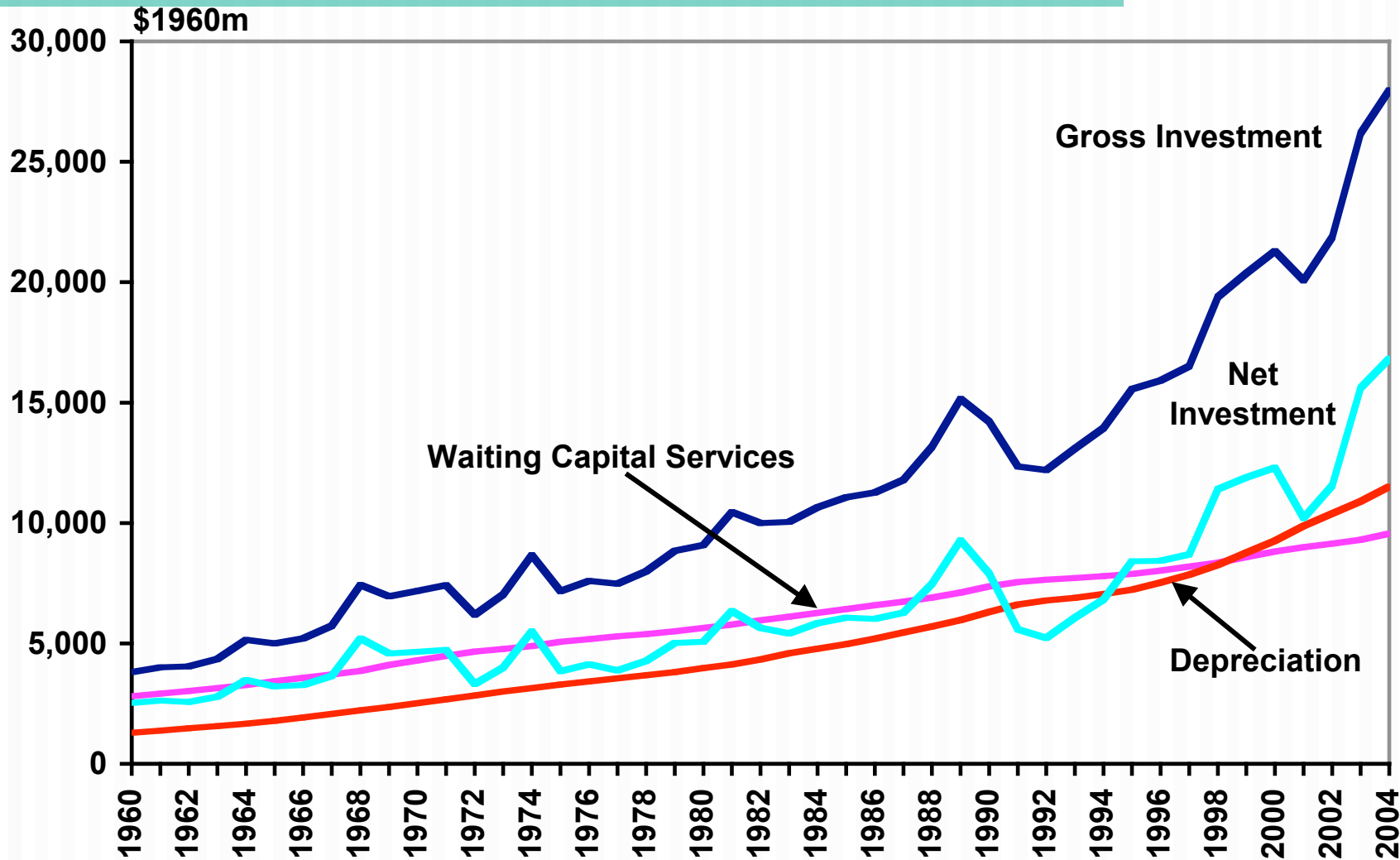
# Cumulative Contributions to Real Income - GDP



# Investment Price Indexes

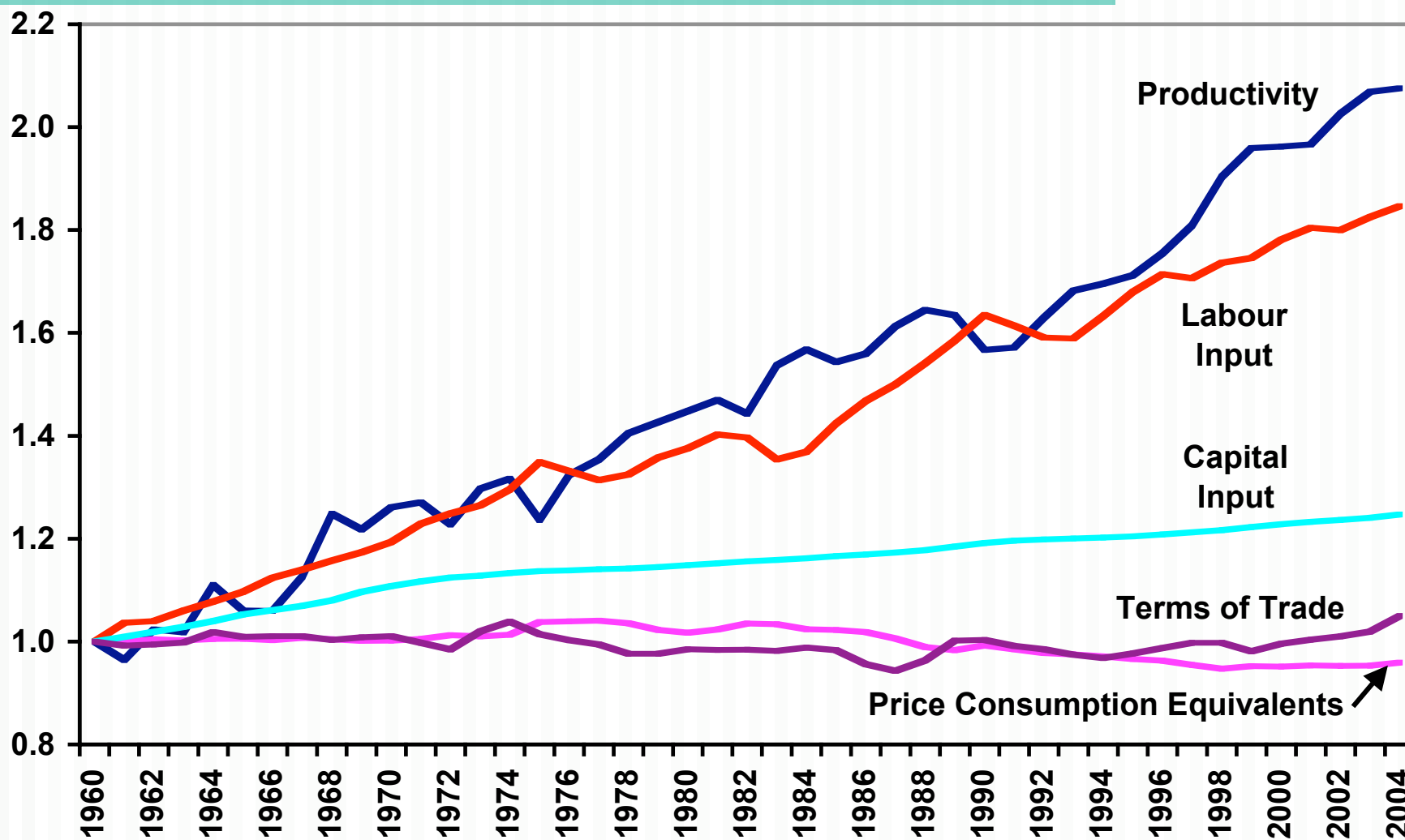


# Investment Quantities

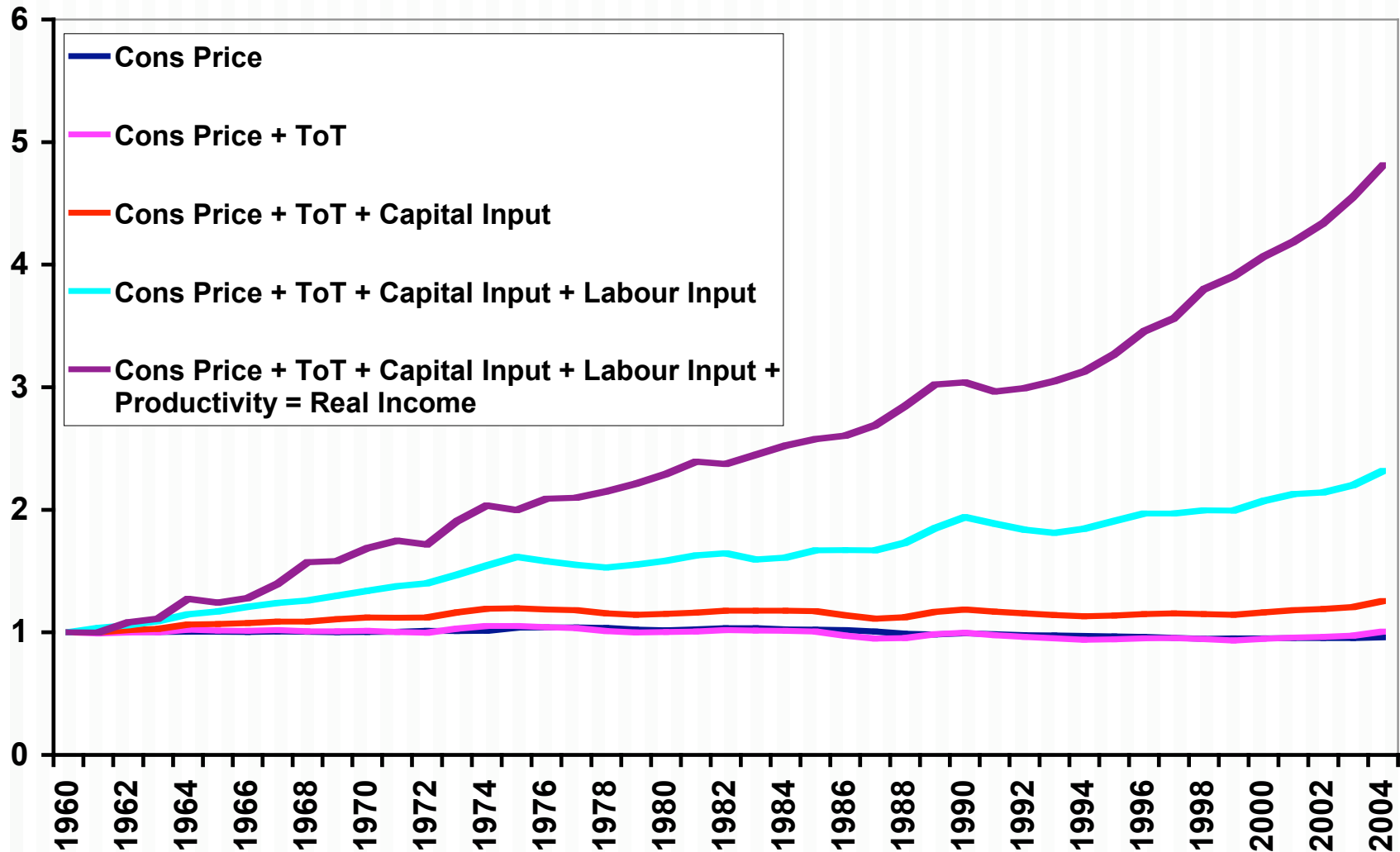




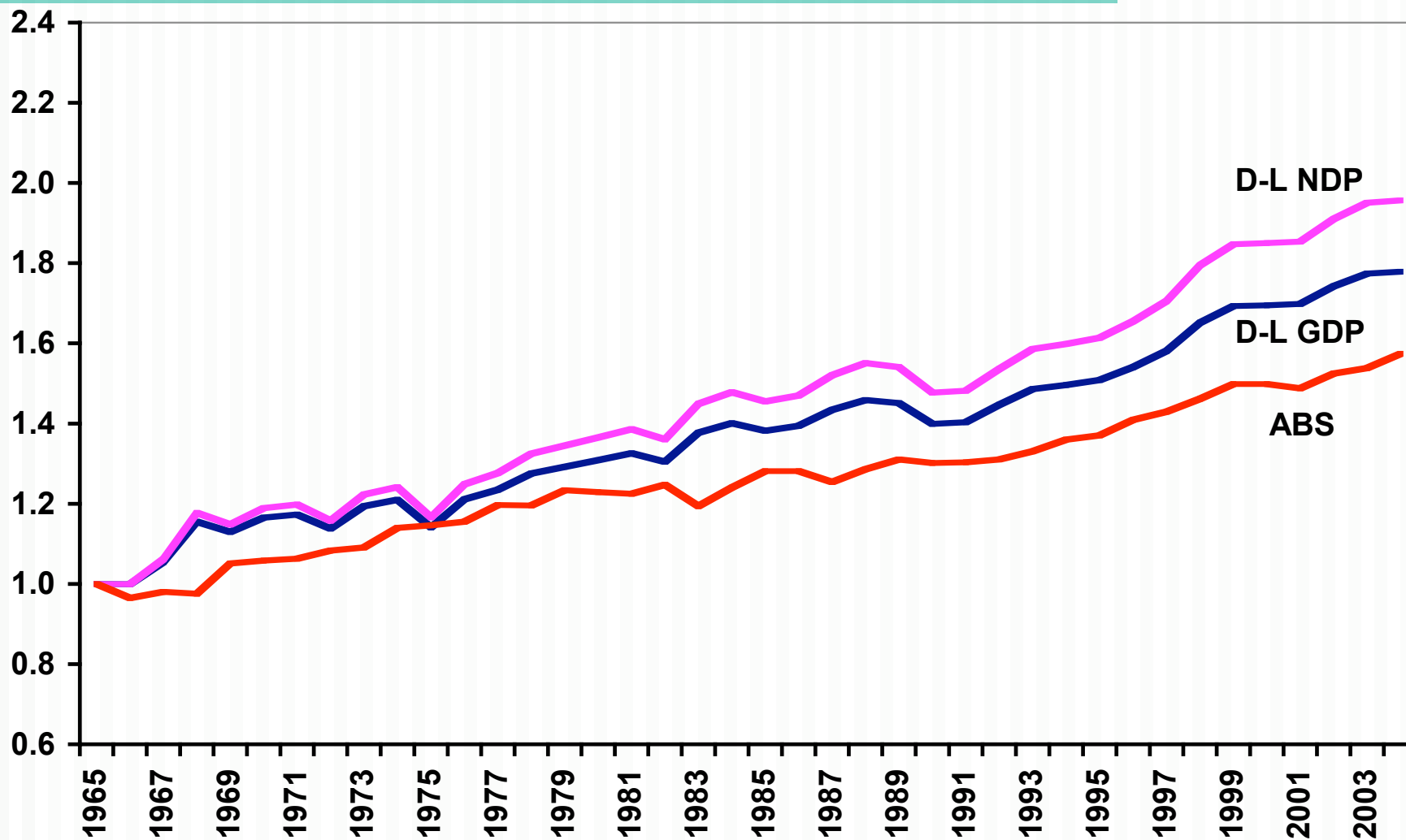
# Individual Contributors to Real Income - NDP



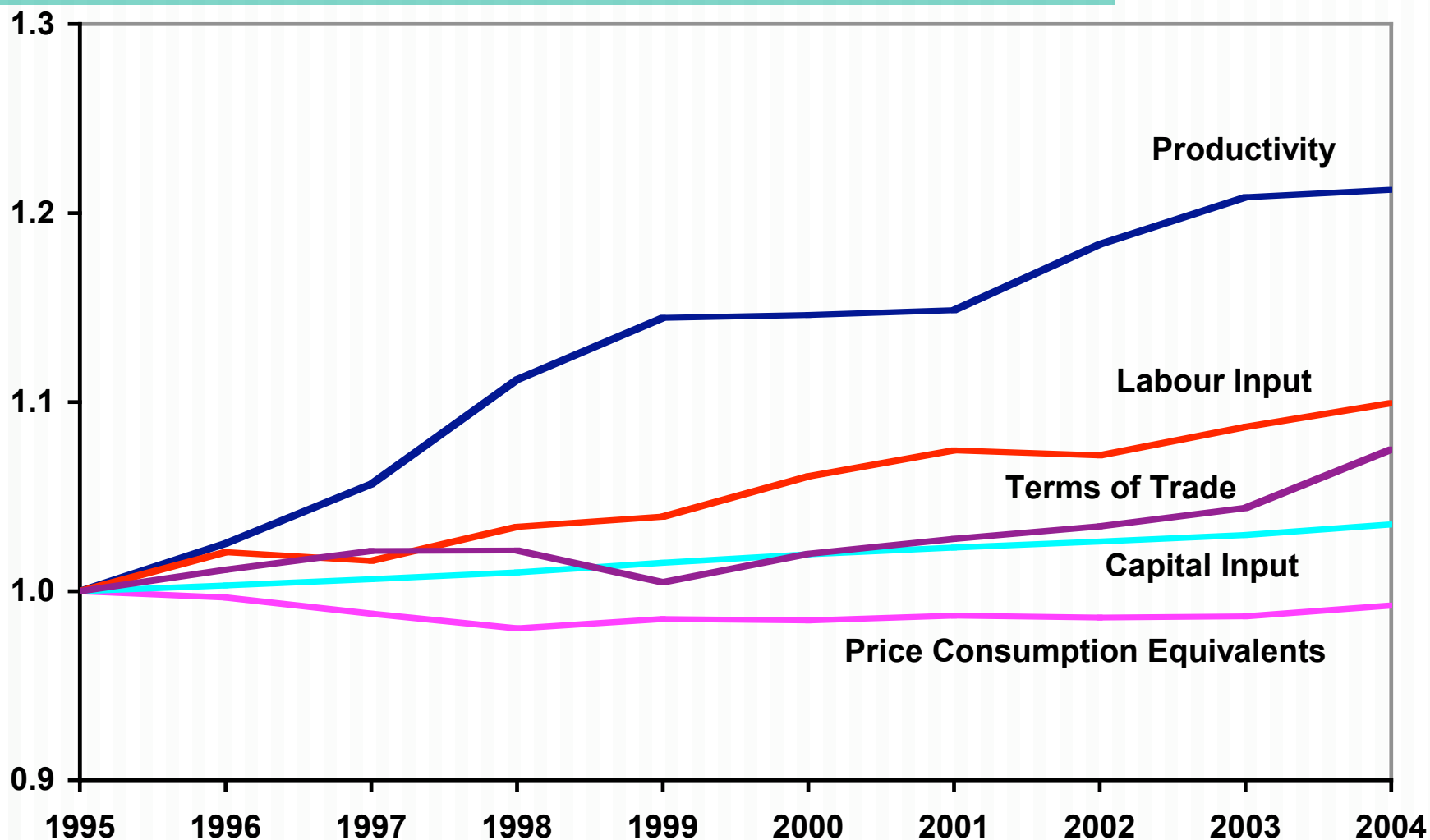
# Cumulative Contributions to Real Income - NDP



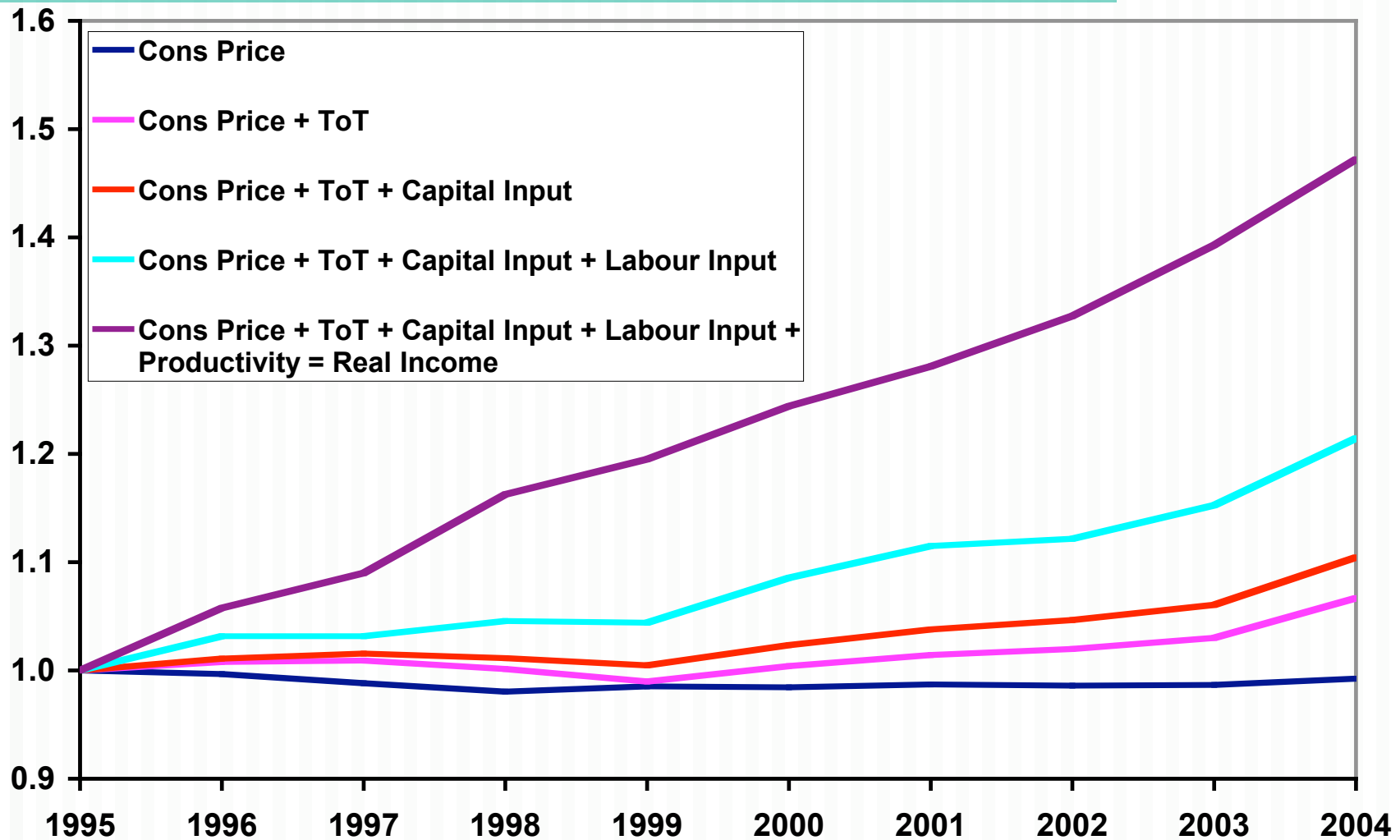
# Alternative TFP Indexes



# Individual Contributors to Real Income - NDP



# Cumulative Contributions to Real Income - NDP



# Conclusions

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- **When we move to a net domestic product framework from a gross domestic market sector framework, the role of capital deepening as an explanatory factor for improving living standards is reduced and the role of technical progress (or TFP growth) and labour growth is increased.**
- **For Australia, we find that changes in the terms of trade, while important over a few short periods (including recent years), are not a long run explanation for the improvement in Australian living standards over the period 1960–2004.**

# Areas for further work

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- **Can we take into account the changing proportion of the Australian capital stock that is foreign owned?**
- **Can we integrate the contributions of resources and intangible capital to real income growth into the above framework?**
- **Can we deal with the various tax wedges that fall within the market production sector?**
- **Can we integrate the present approach with the input-output framework and get industry contribution factors?**