The Measurement of Productivity in Australia: Results and Measurement Problems

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Introduction

- First present joint work with Denis Lawrence for the Productivity Commission on measuring Australia's productivity (gross and net)
- Second talk about "Productivity Perspectives in Australia"
- Finally talk about some outstanding productivity measurement problems

The Basic Framework

- **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 **is output;** x^t **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 economic welfare measure.

Identifying the Contributions

- The main determinants of growth in real income generated by the market sector of the economy are:
  - Technical progress or improvements in Total Factor Productivity;
  - Growth in domestic output prices or the prices of internationally traded goods and services relative to the price of consumption; and
  - Growth in primary inputs.
- We need a way of identifying the effect of each of these factors in isolation, ie what would have happened to real income if only each of these changes had occurred separately and all else remained the same?

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? It can be done by assuming a translog technology.**

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:** $\alpha_L{}^t \equiv \alpha(p^{t-1},p^t,x^{t-1},t\text{-}1)$

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

- **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 $\rho^t/\rho^0 = T^t\ A^t\ B^t$

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

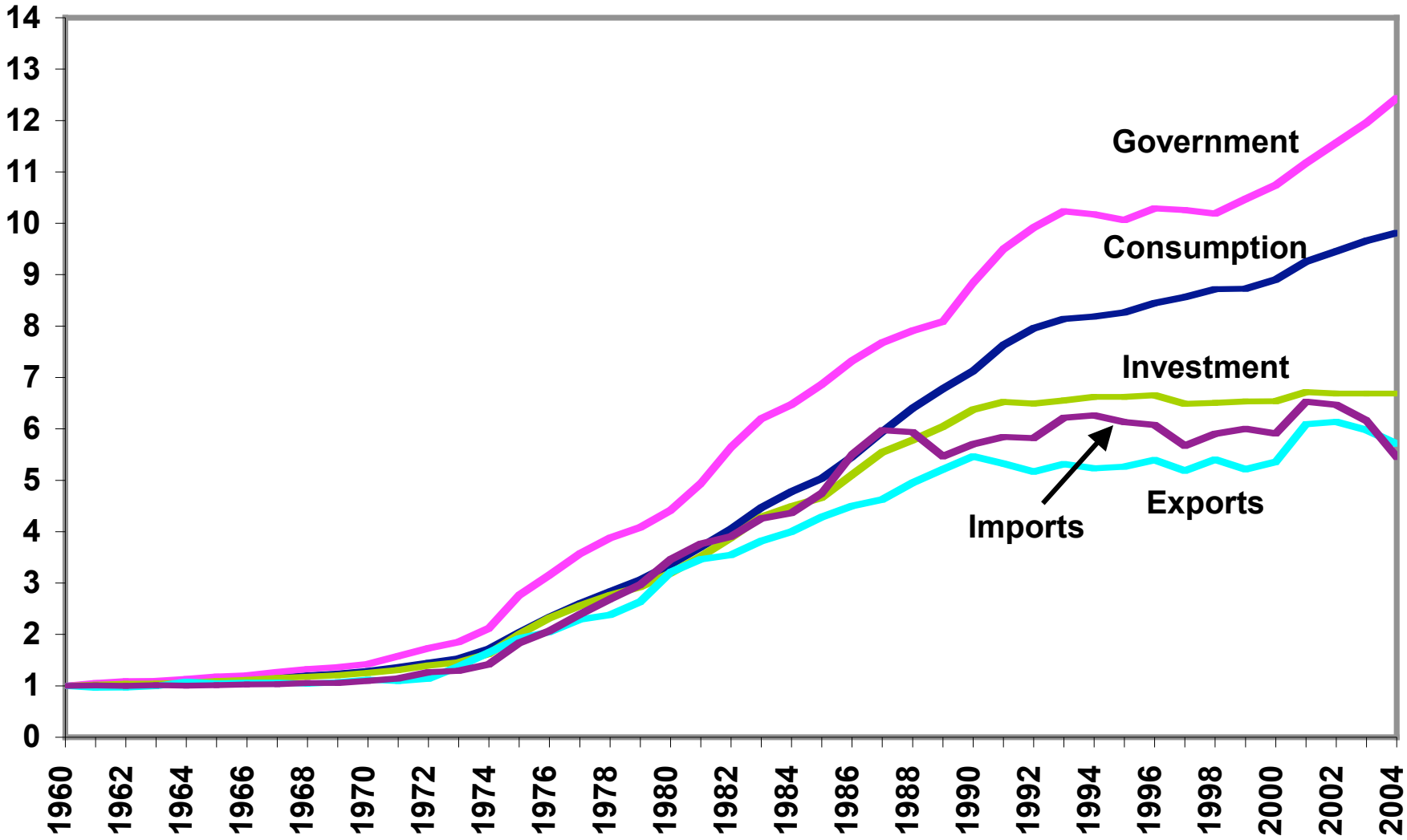
The Real Net Income Approach

- In our Productivity Commission study, 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.

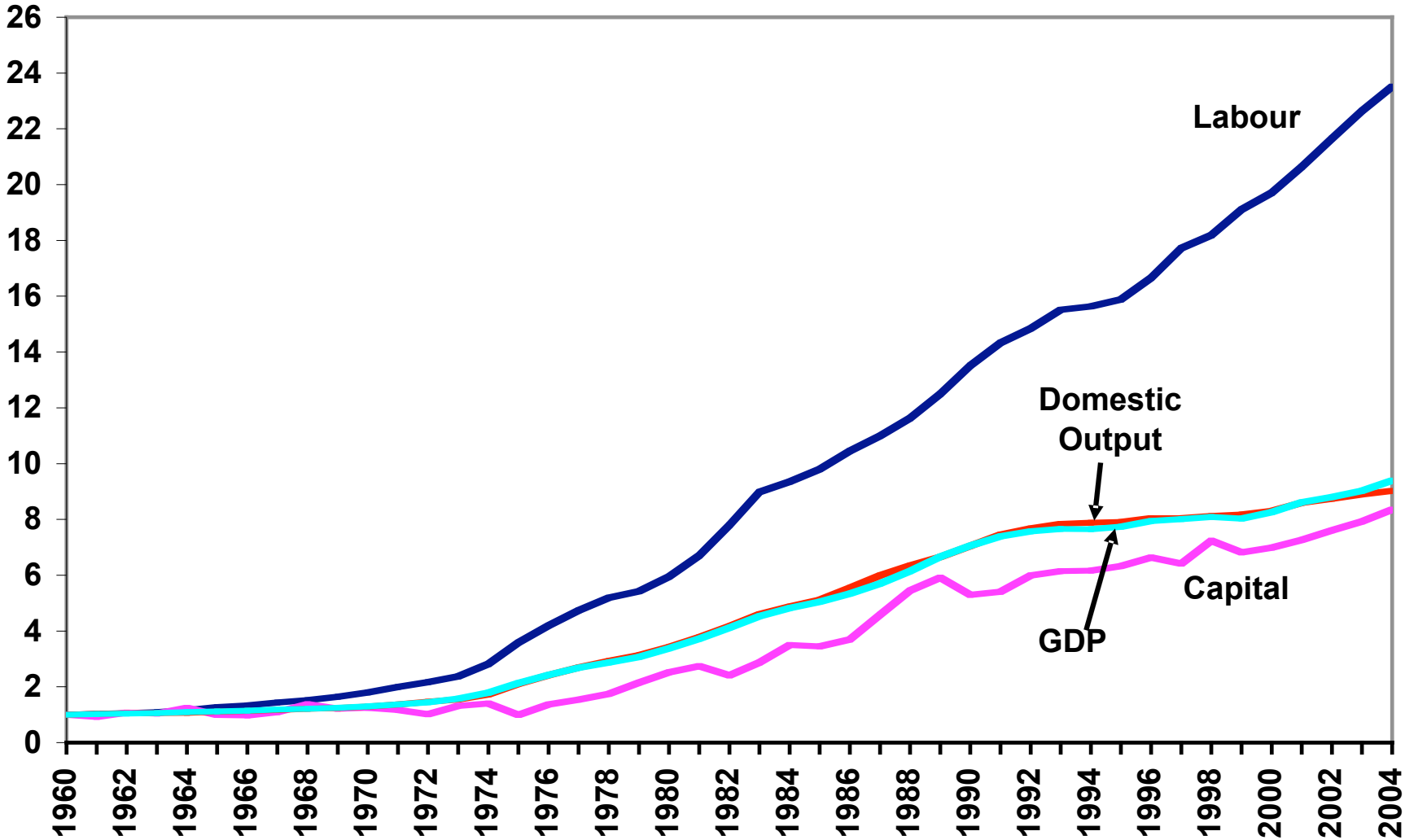
Diewert-Lawrence Database

- 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

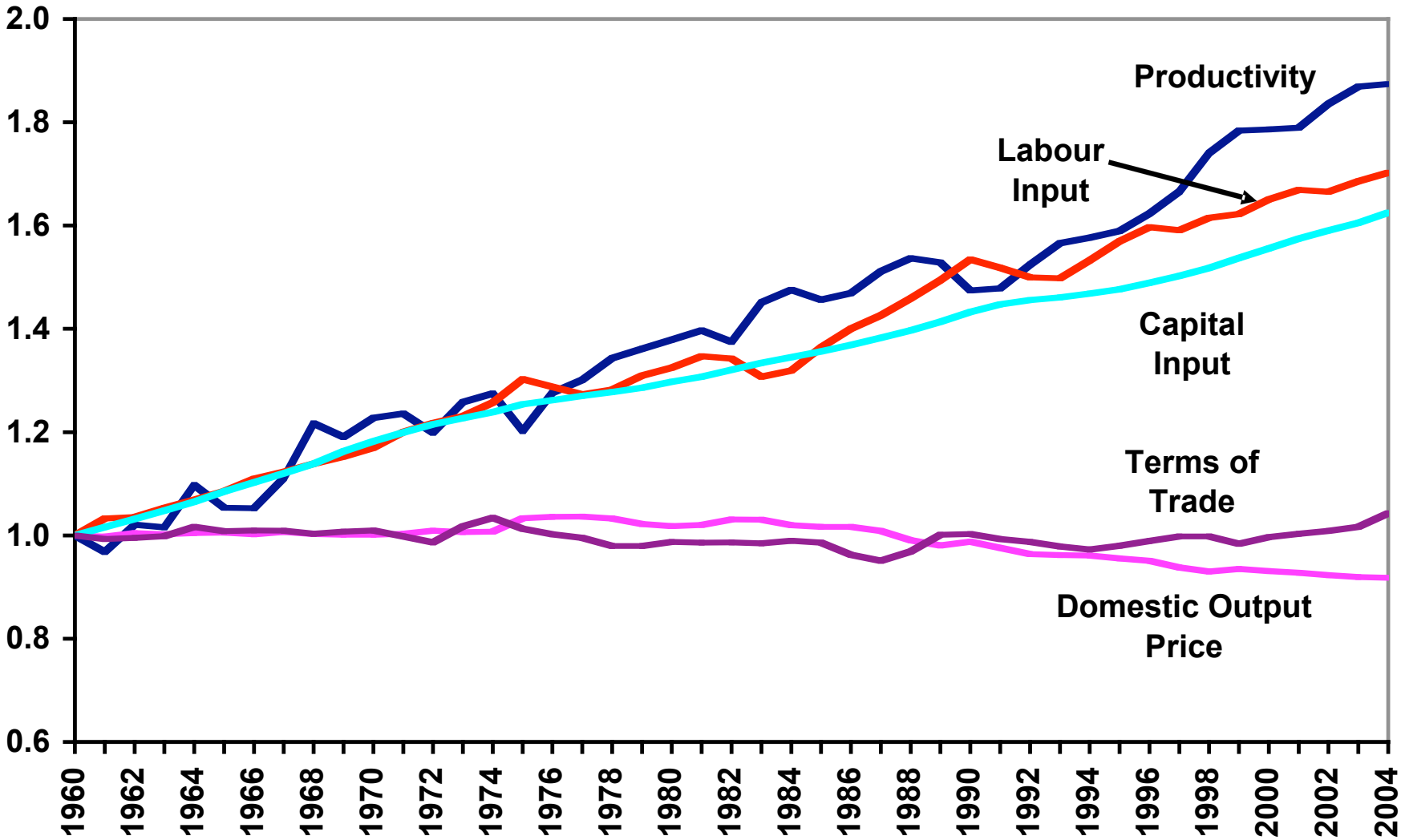
Price Indexes



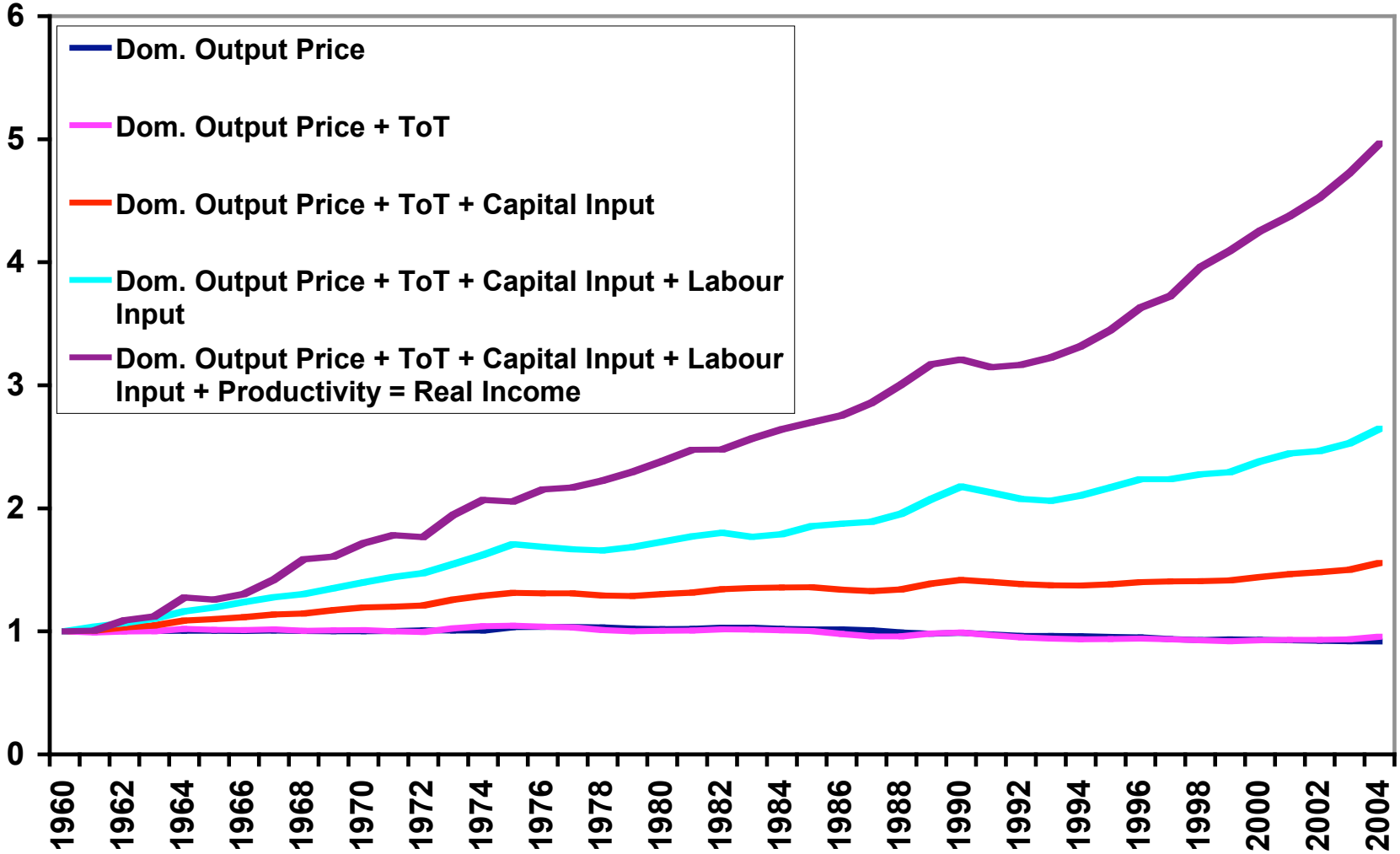
Price Indexes (cont'd)



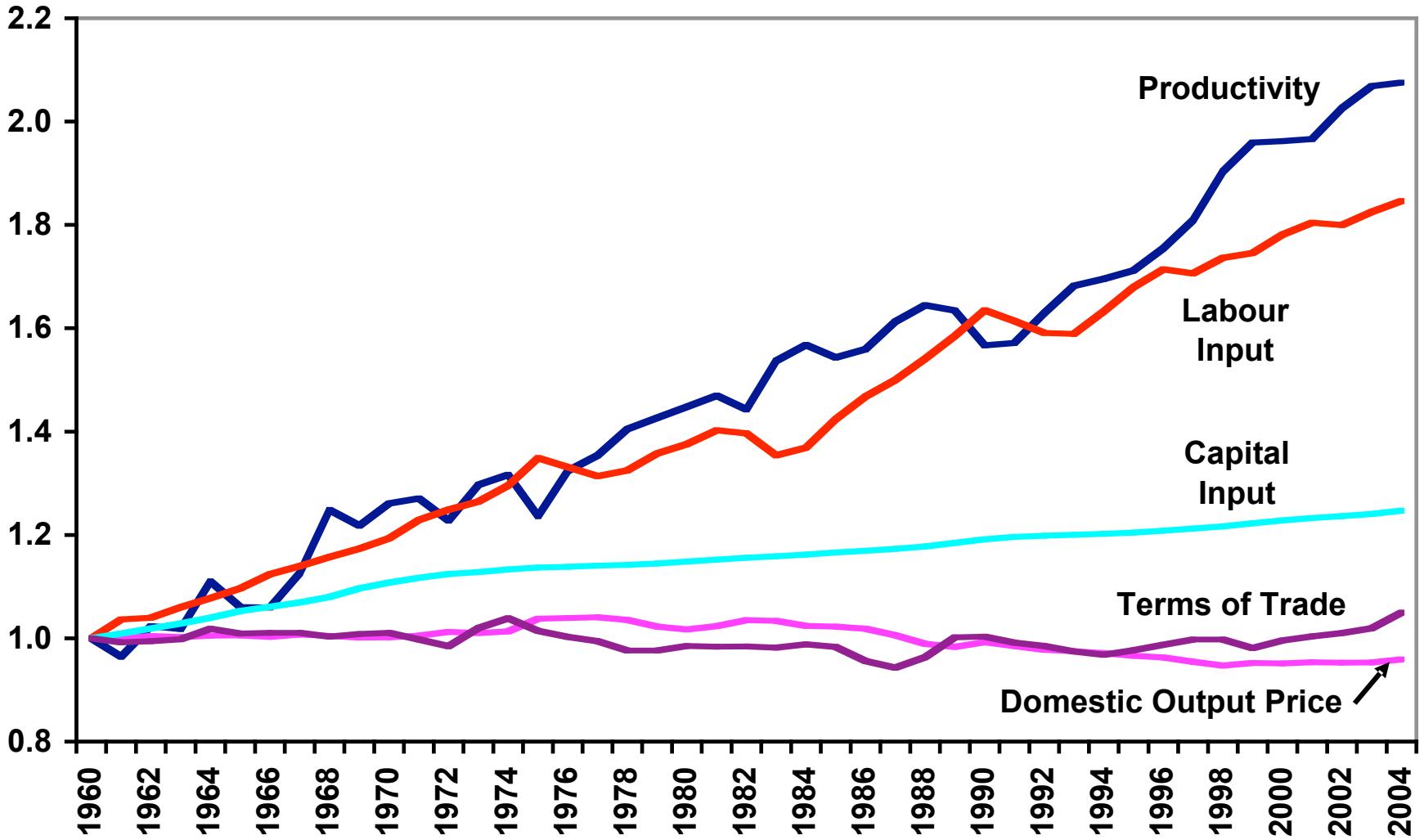
Individual Contributors to Real Income - GDP



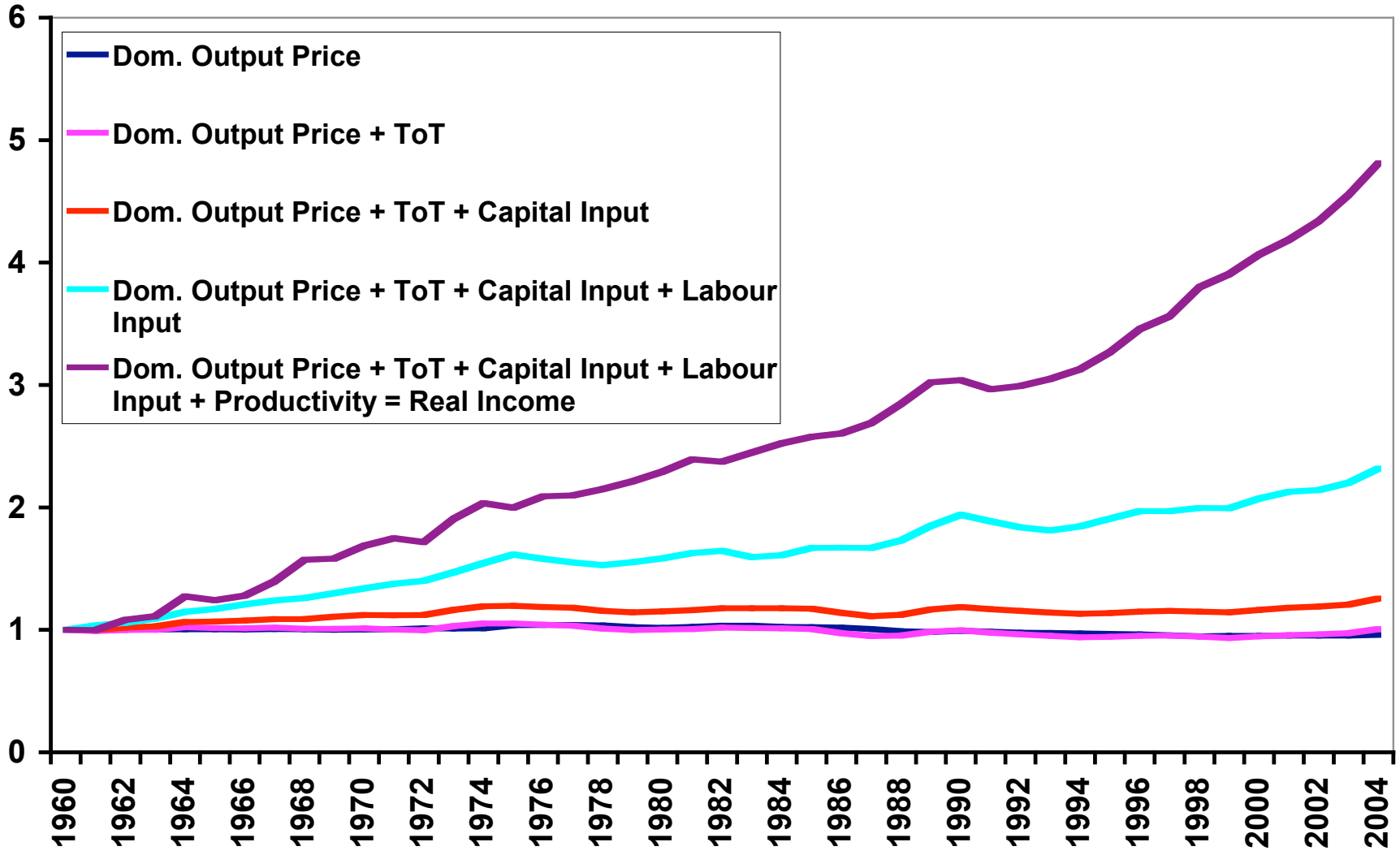
Cumulative Contributions to Real Income - GDP



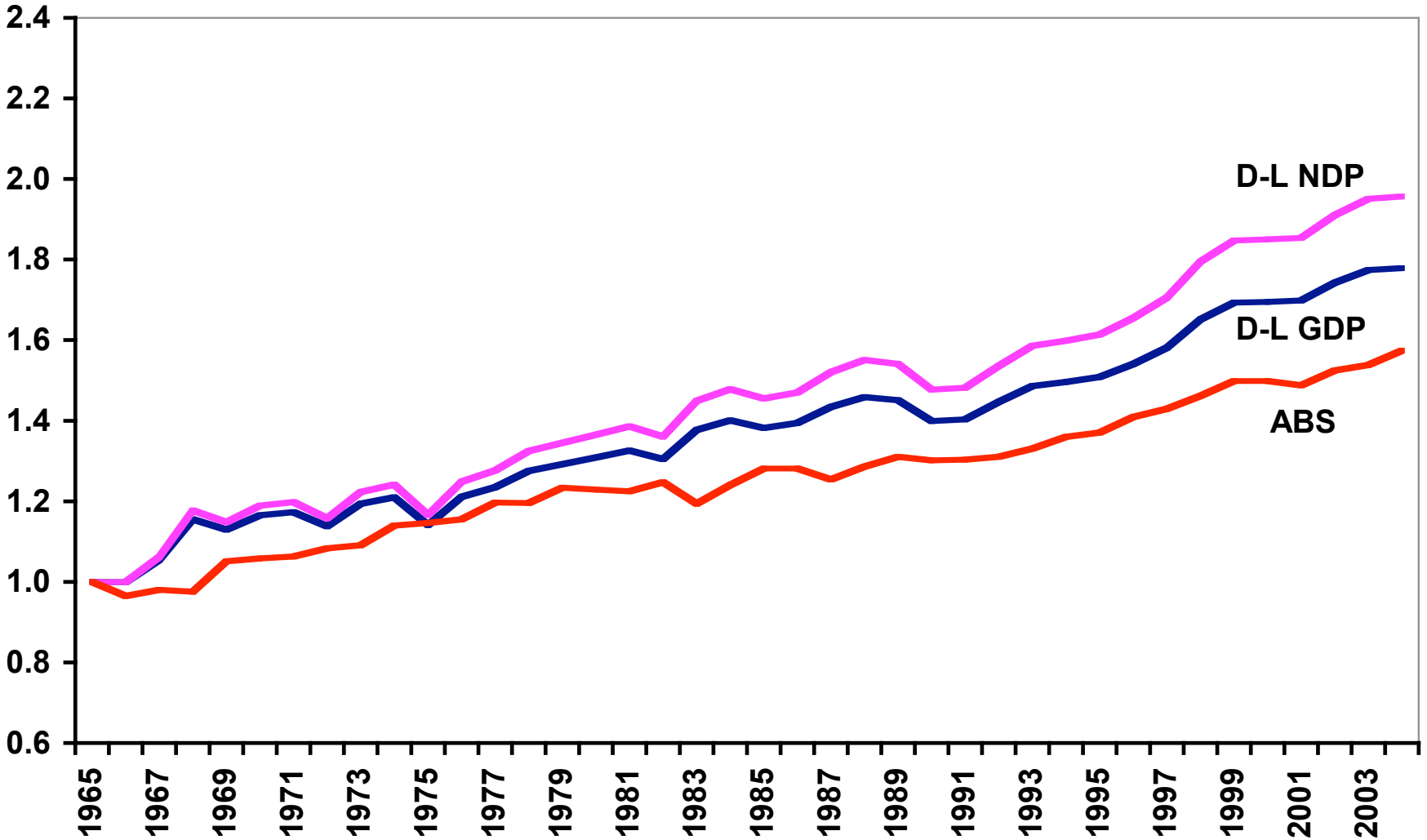
Individual Contributors to Real Income - NDP



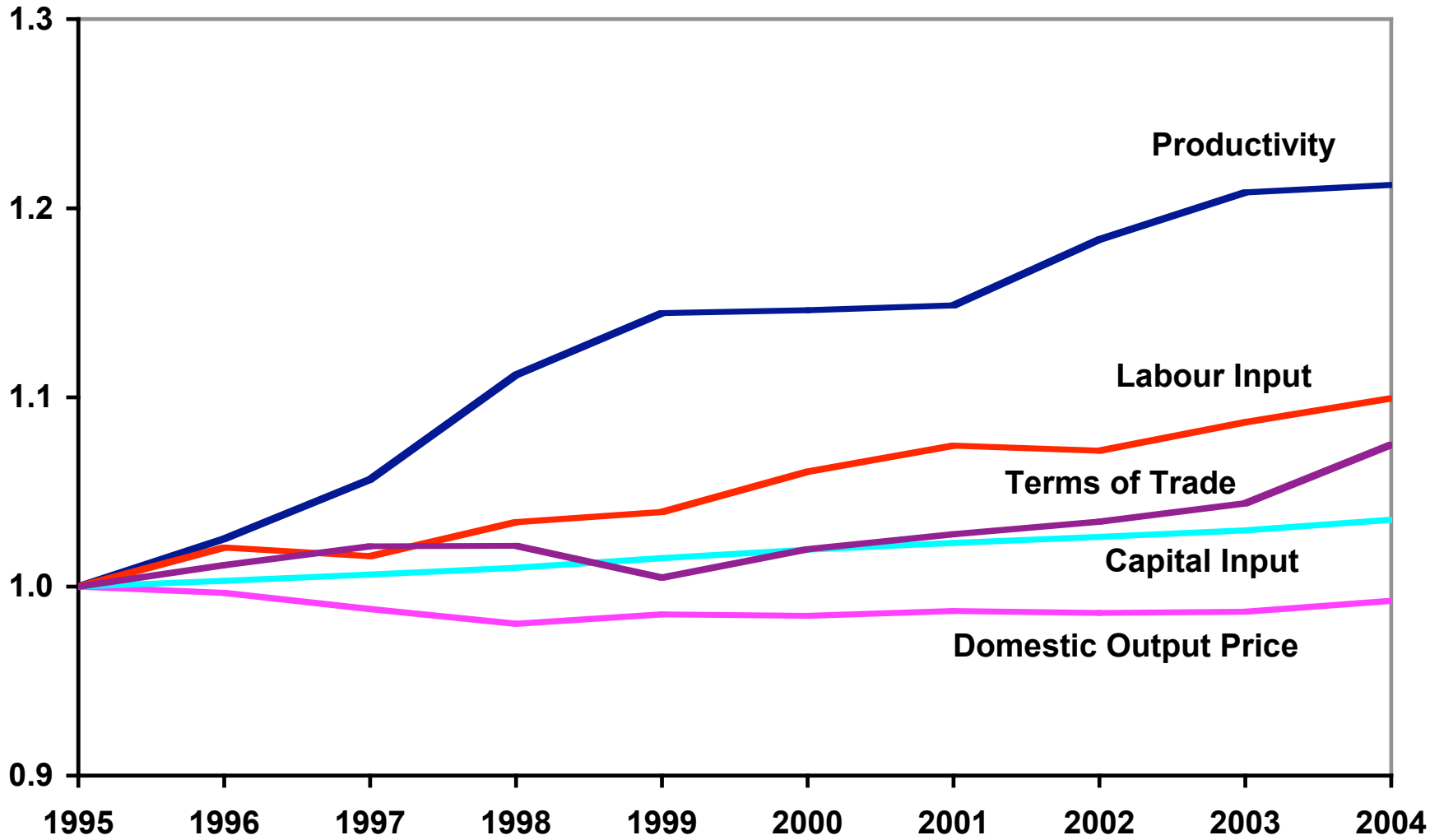
Cumulative Contributions to Real Income - NDP



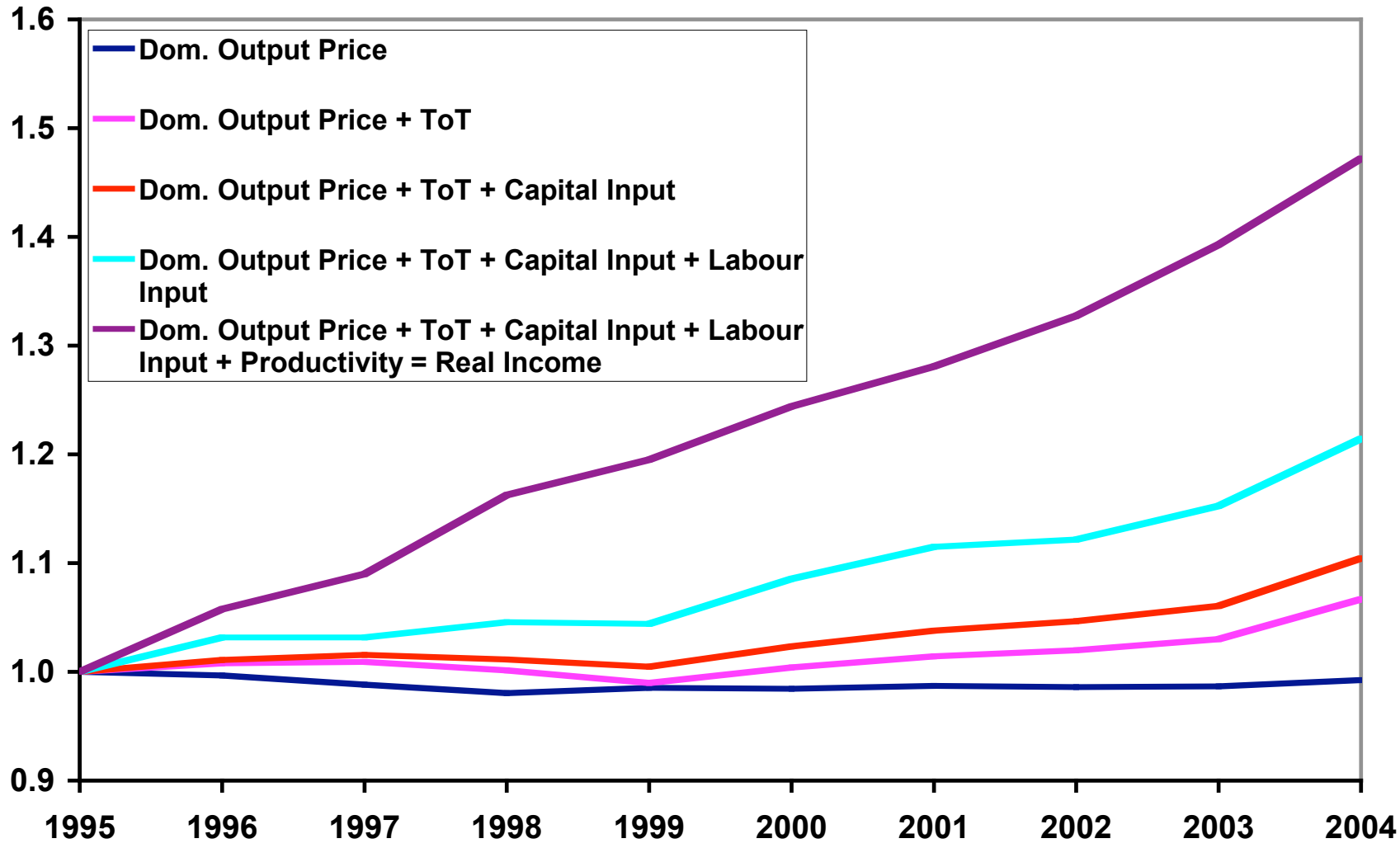
Alternative TFP Indexes



Individual Contributors to Real Income - NDP



Cumulative Contributions to Real Income - NDP



Empirical Conclusions

- **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.**
- **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.**
- **Now we turn to productivity perspectives in Oz**

- It is not a trivial exercise to measure productivity, particularly at the industry level (as opposed to the national level) and making cross country comparisons of productivity levels is particularly hazardous;
- Even if the productivity of a sector has been accurately measured, it is not a trivial exercise to determine exactly what factors “explain” the sector’s productivity performance.
- Focus on problem areas in the measurement of productivity for *outputs*, *labour inputs* and *capital inputs*

Output Measurement Problems

- Service Sector Measurement Problems: no deflators for many products
- For some products, no agreement on methodology for measurement
- Unique products
- Complex products (eg telecommunications)
- Bundled products
- Marketing and advertising products
- Financial products; risky products

Intermediate Inputs measurement problems

- Lack of accurate value information ie, intermediates bundled together with labour as cost of sales
- Lack of information on deflators
- Are output deflators appropriate for deflating intermediate inputs? Deficiencies of the Input Output system
- Treatment of indirect taxes

Labour Measurement Problems

- Labour Force Survey industry classification is not accurate
- Establishment surveys miss the self employed (and they are being discontinued!)
- Are all labour hours equivalent?
- But it is difficult to come up with long term consistent classifications for labour
- Problem of imputing the wages of the self employed

Capital Measurement Problems

The Gross Operating Surplus of a country (less the labour contribution of the self employed) should be decomposed into several components:

- Depreciation;
- A return to the financial capital employed;
- A charge for any obsolescence of the capital employed;
- Rents to land and resources;
- Amortization of intangible capital components such as goodwill, R&D, trademarks, advertising, etc.;
- A charge (or credit) due to anticipated changes in the prices of assets over the accounting period; and
- Taxes paid to governments that do not fall on outputs, intermediate inputs or labour (profits taxes)

Difficulties

- What is the right depreciation rate?
- What is the right opportunity cost of capital?
- Exogenous or endogenous?
- Expected holding gains and losses or anticipated?
- Obsolescence charges (computers)
- The problem of land prices
- How exactly should intangible capital items be amortized?
- How exactly should the tax component be calculated? (marginal user costs or average?)

- R&D amortization problems
- The matching problem
- The problem of freely available R&D

Other Problems

- The treatment of inventory change is a disaster in the System of National Accounts
- The problem of new products and adjusting for quality change
- Problems with how we collect our statistics in separate surveys

Other Problems (cont)

- Growth accounting methodology needs to be revised to deal with the capitalization of R&D
- How to account for infrastructure investments in the growth accounting framework
- Pricing of outputs and the treatment of indirect taxes; what to do with indirect taxes that fall on intermediate inputs?
- The effects on productivity growth of entry and exit of new firms
- Consistency of quarterly estimates with annual estimates; the problem of seasonality

Future Directions for the ABS

- Institute a systematic program to measure the prices of service sector outputs.
- Improve the measurement of labour input by dealing with the self employment problem and disaggregating labour input into reasonably homogeneous types of labour.
- Put additional resources into the measurement of capital input. For reproducible capital components, institute a capital retirements survey.
- Improve the measurement of the contribution of inventories and land.
- Implement several user cost concepts and make them available to users, with full documentation of methods used.
- Experiment with computer intensive methods for collecting price and quantity data from firms in a cost effective manner.