Impact of the Terms of Trade on the Australian Economy

by W. Erwin Diewert, University of British Columbia and the University of New South Wales, and Denis Lawrence, Economic Insights Pty Ltd

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Introduction

We aim to address three key questions:

- **What have been the relative contributions of productivity growth and changes in the terms of trade to improvements in Australia's economic welfare?**
- **What have been the contributions of price changes in different types of exports and imports to welfare improvements?**
- **Does the ABS "bottoms" up approach to measuring TFP growth give the same answer as our "top down" approach?**

Introduction (cont)

- **We adapt the Diewert and Morrison (1986), Kohli (1990), Diewert, Mizobuchi (2005) and Diewert and Lawrence (2006) methodology to decompose the growth in real income generated by the Expanded Market Sector of the Australian economy over the June Years 1960-2012 into contributions from 3 sources:**
- **Productivity growth;**
- **Growth in primary inputs;**
- **Changes in real export and import prices.**

The presentation updates and extends work undertaken for the Productivity Commission in 2005-2006

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, i.e., 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, including the real prices of X and M**

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 the observable period t growth in real income and

  ln α^t = ln $P_T(p^{t-1},p^t,y^{t-1},y^t)$ and ln β^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 these observable relationships

  $\rho^t/\rho^{t-1} = \tau^t\ \alpha^t\ \beta^t$

  into the "levels" relationship $\rho^t/\rho^0 = T^t\ A^t\ B^t$

Terms of Trade Contribution Factors

The effects of changes in the price of exports relative to the price of consumption and in the price of imports relative to the price of consumption show up as two of the three price effects in our model.

- **The real export price effect adds to real income growth if the price of exports *increases* more rapidly than the price of consumption and**
- **The real import price effect which adds to real income growth if the price of imports *falls* compared to the price of consumption**
- **The third price effect in our model looks at the price of C+G+I relative to the price of C. This effect tends to be negative due to falling prices of I goods relative to C goods. Note that G here is not the usual G because government production is excluded.**

Database

Basic Approach: Use information on aggregate final demand expenditures, aggregate labour and capital input and then adjust these data to remove the outputs produced and the inputs used by the housing and the public administration sectors.

Using ABS data covering the June Years 1960-2012 and our earlier Diewert-Lawrence data base, we constructed data on the Expanded Business Sector data for:

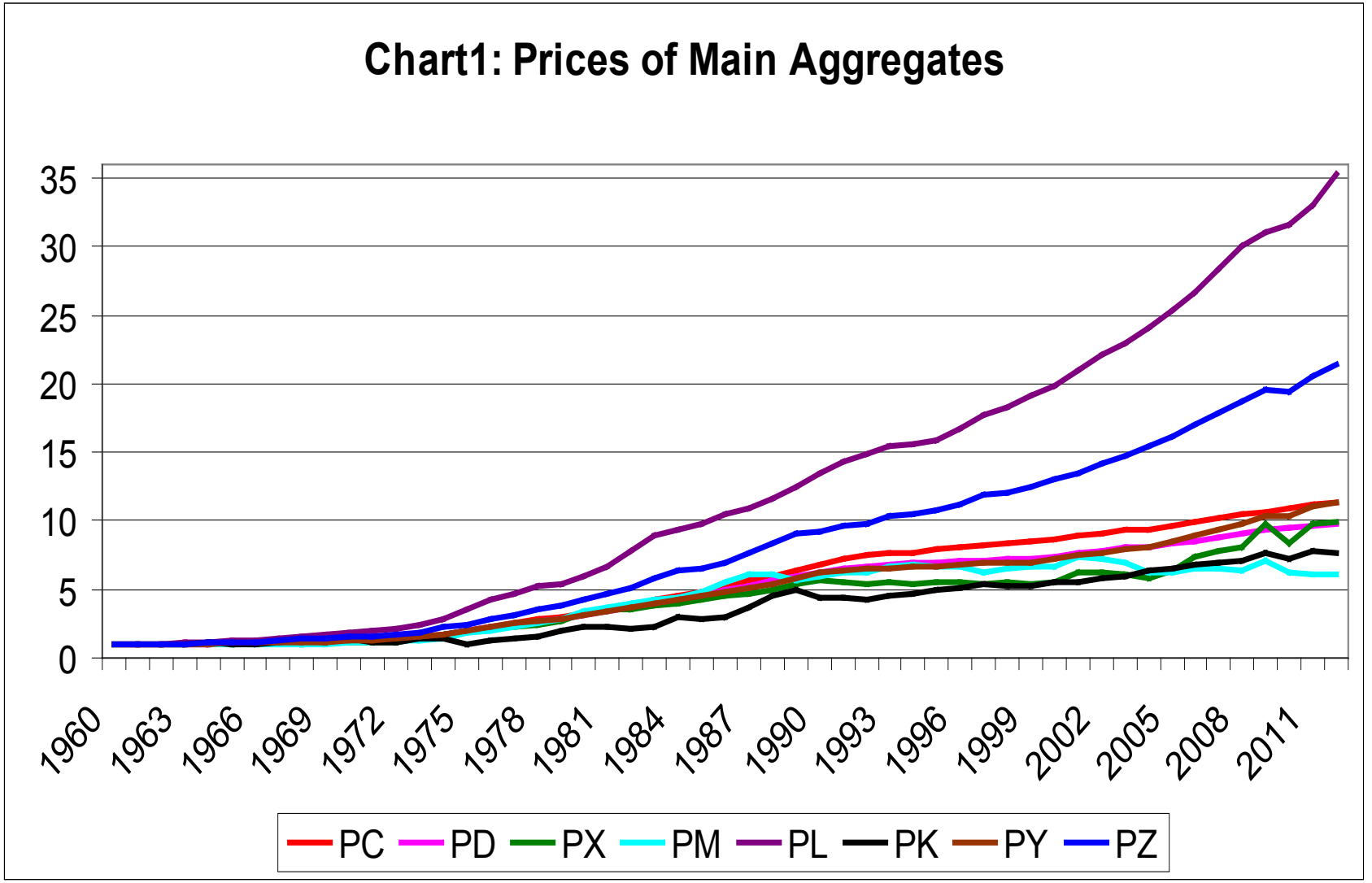
- **1 household consumption aggregate;**
- **4 government consumption aggregates;**
- **18 investment and inventory change aggregates;**
- **4 trade aggregates**
- **1 labour aggregate and**
- **16 capital stock and service flow aggregates**
- **For the years 1986-2012, we could construct 18 export aggregates and 28 import aggregates using ABS data.**

The above data were aggregated into:

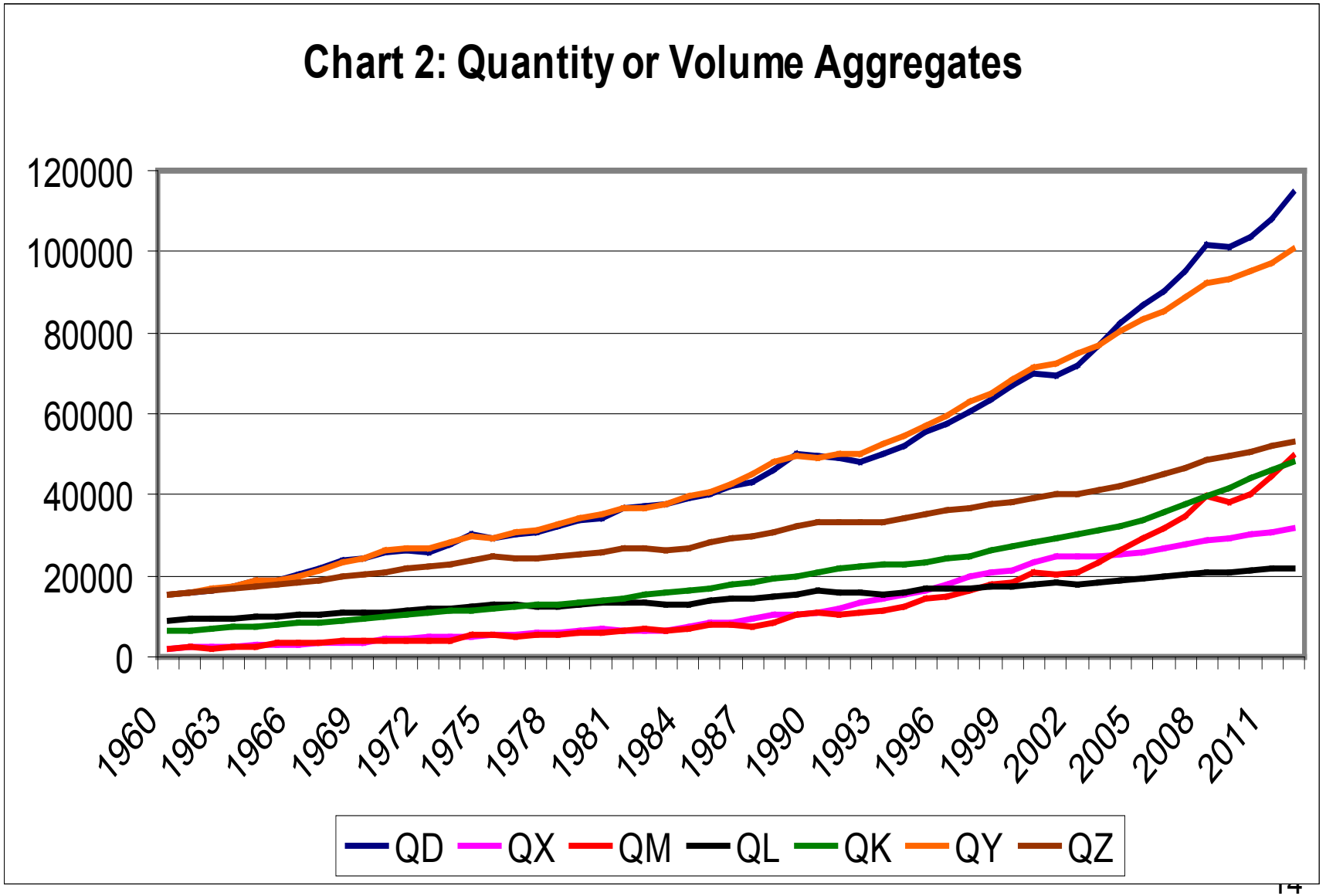
- **C domestic consumption excluding housing at producer prices**
- **D domestic final demand at producer prices (an aggregate of C+I+G)**
- **X exports (disaggregated later)**
- **M imports (disaggregated later)**
- **L labour services**
- **K capital services**

In order to calculate productivity growth, we also need aggregate output Y and aggregate input Z

Aggregate Price Data



Quantity Data



Real Prices

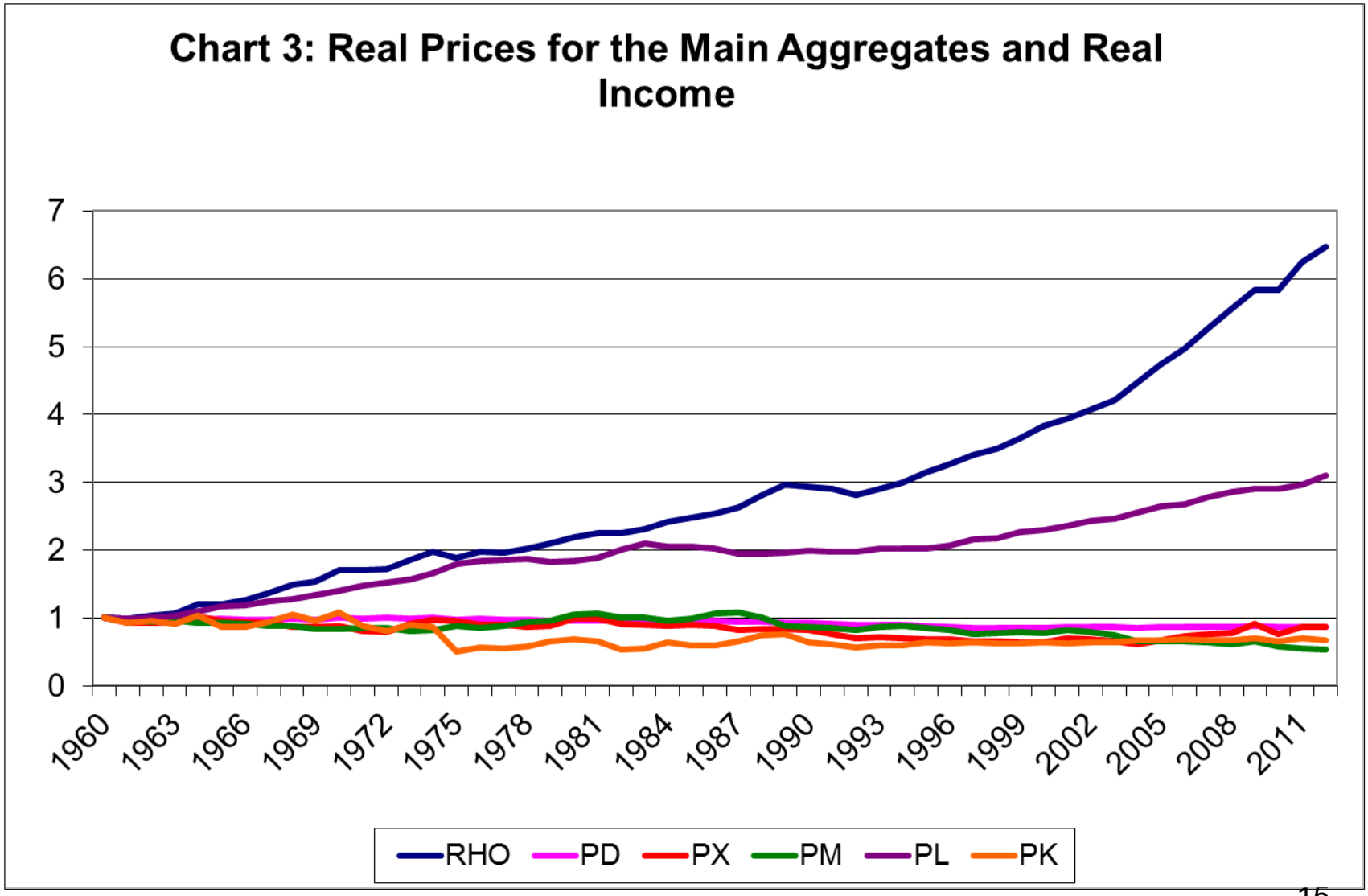


Chart 3: Real Prices for the Main Aggregates and Real Income
7
6
5
4
3
2
1
0
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
RHO
PD
PX
PM
PL
PK

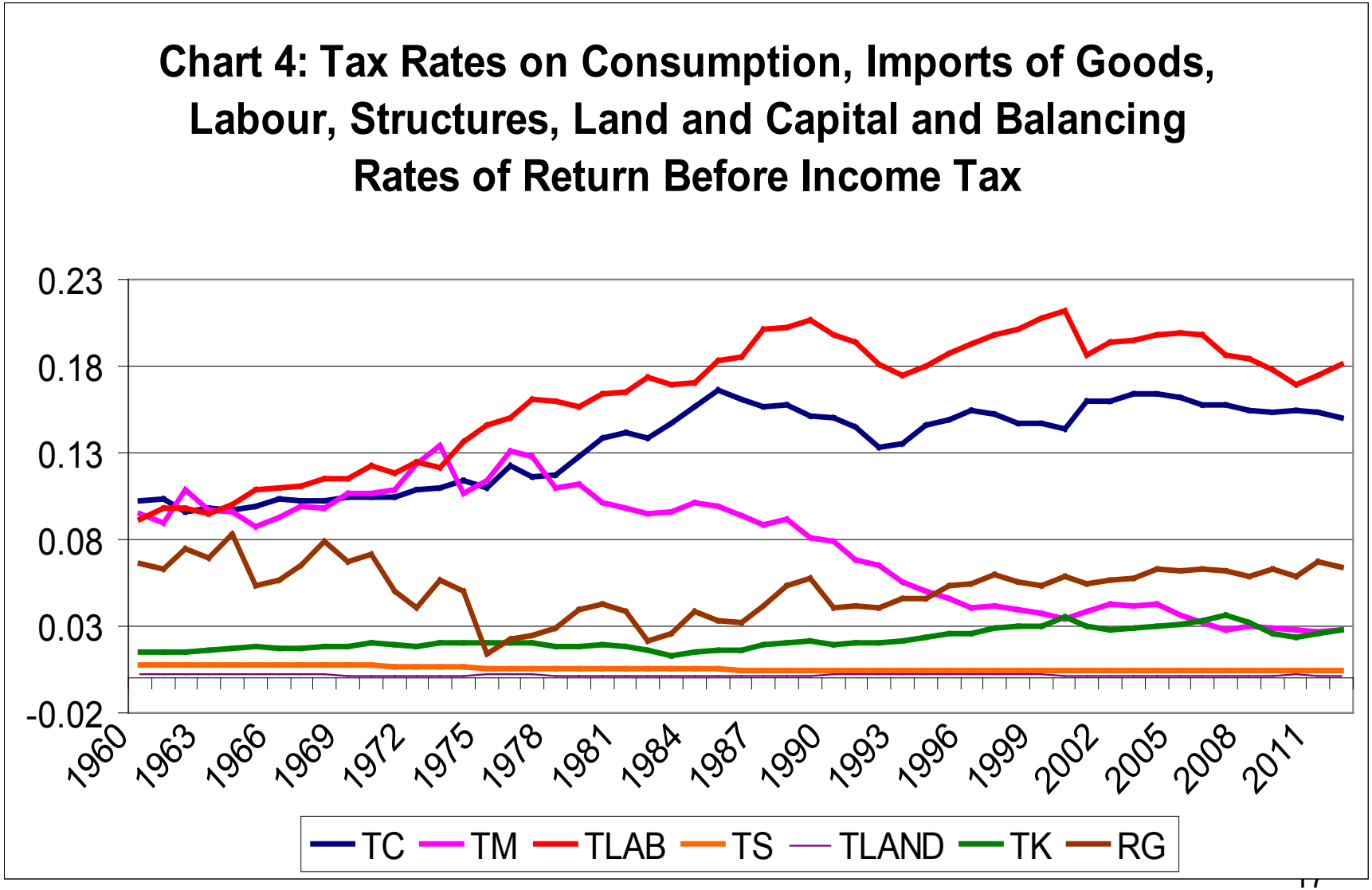
User Cost Formula for Capital Services

$$U^t = [r^t + \tau_B{}^t + \tau_P{}^t + \delta]P_I^t$$

where

- r^t **is the after tax real rate of return**
- $\tau_B{}^t$ **is the business income tax rate**
- $\tau_P{}^t$ **is a specific property tax rate (if applicable)**
- δ **is the geometric depreciation rate and**
- P_I^t **is the asset price.**

Tax Rates and Before Tax Balancing R's

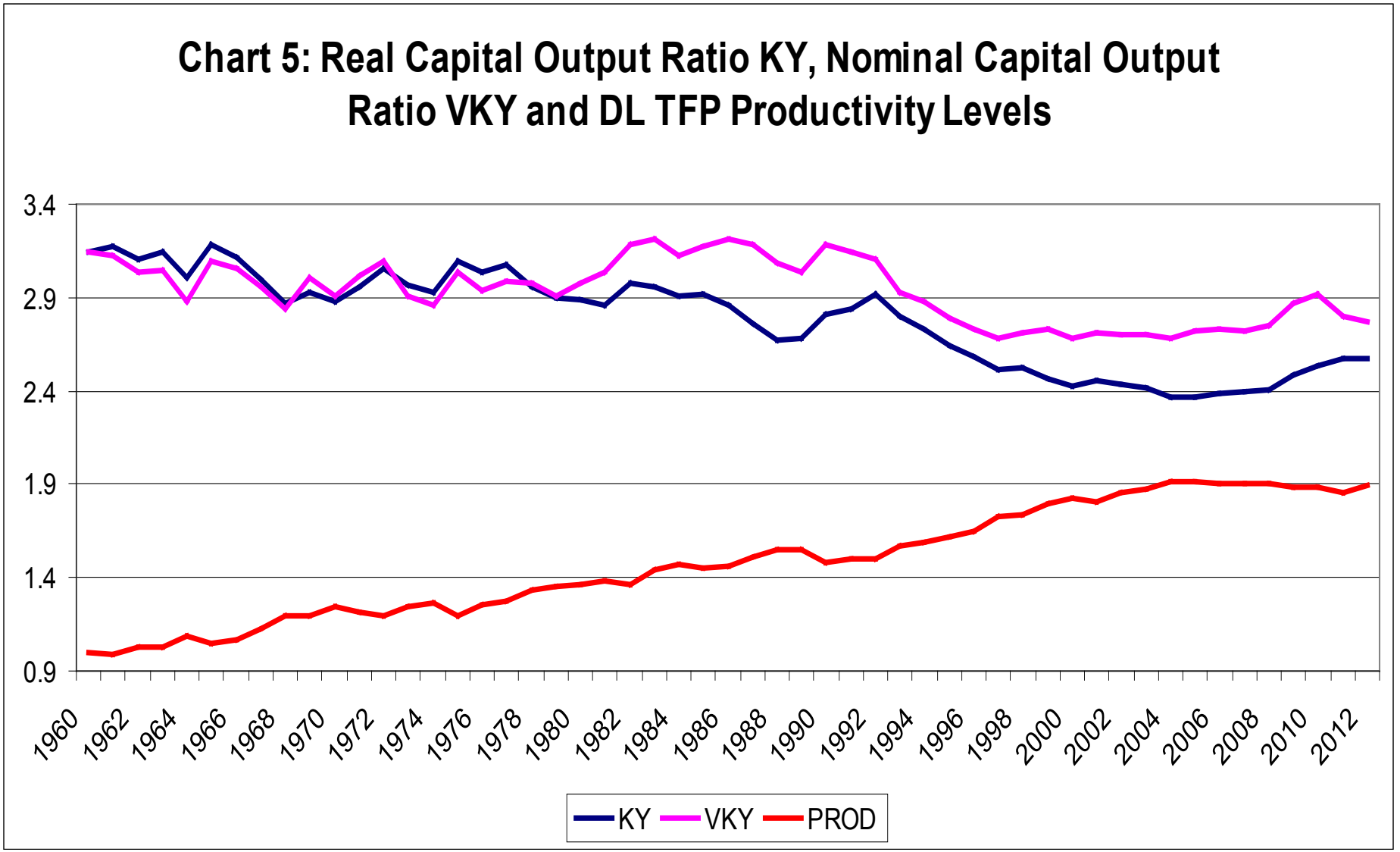


- **The gross rate of return on assets RG is an efficiency measure. The Australian economy has done pretty well on this metric in the 1960's, 1990's and the naughts.**
- **The relatively high rate of business income taxation and low levels of structure and land taxation are noteworthy.**
- **Once aggregate output Q_Y^t and aggregate input Q_Z^t for the Australian Expanded Business Sector for year t have been defined, *Total Factor Productivity* or *Multifactor Productivity* can be defined as output divided by input:**

- **$TFP^t \equiv Q_Y^t/Q_Z^t$.**

- **The annual geometric average rate of growth of TFP over 1960-2012 has been 1.24% per year.**

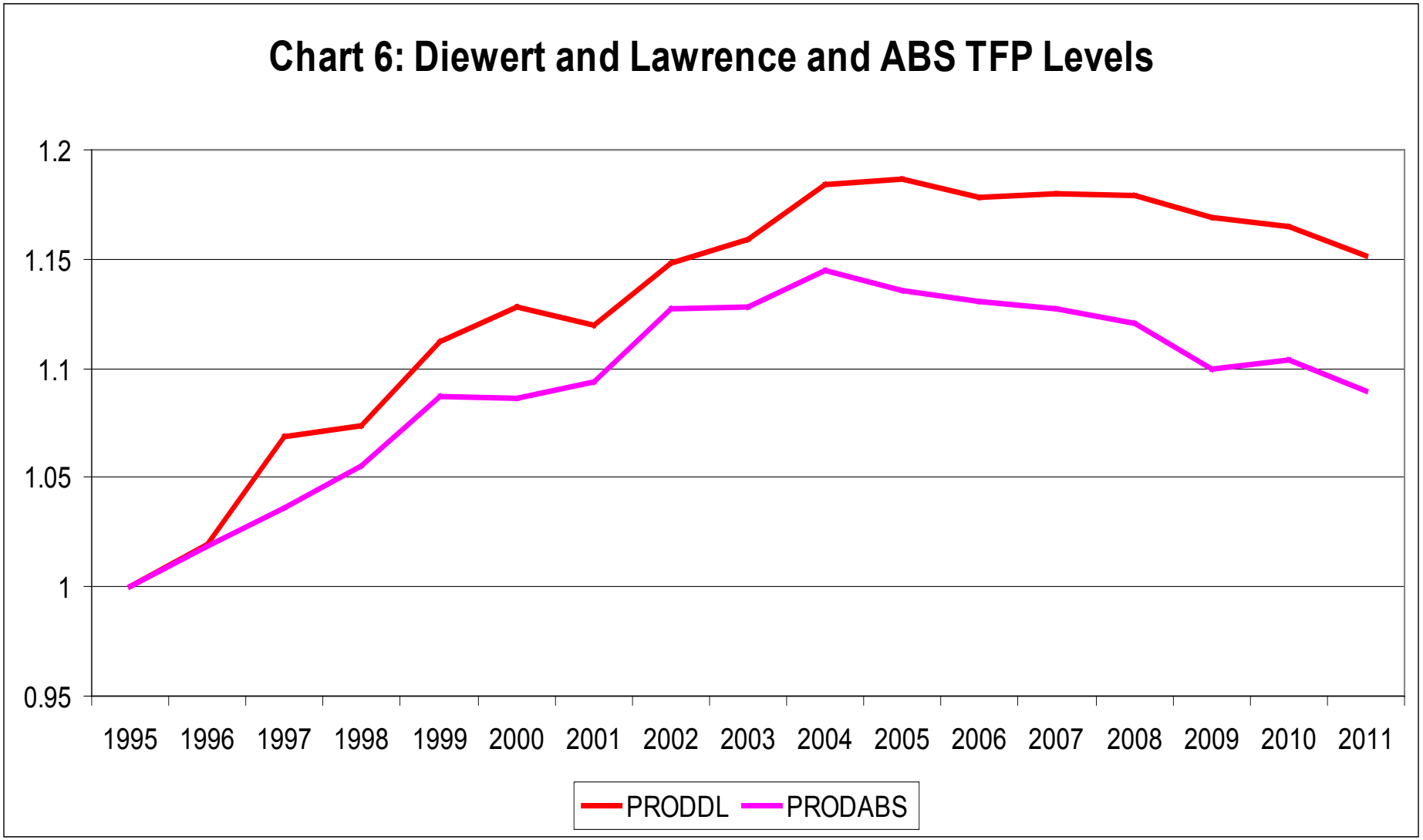
TFP and Real and Nominal Capital Output Ratios



TFP Growth in Australia

- From the previous Chart, it can be seen that the TFP level peaked in 2005 and has just about recovered this last year.
- The real and nominal capital output ratios have been trending downwards over the sample period.
- The nominal capital output ratio is above the real one due to the rapid increases in the price of agricultural, commercial and industrial land.
- In the following slide, we compare our estimates of TFP growth over the period 1995-2011 with the ABS estimates of TFP growth for their 16 market sectors.
- Note that our business sector is bigger than the ABS 16 Market Sector Industries since we include the education and health sectors in our aggregate.

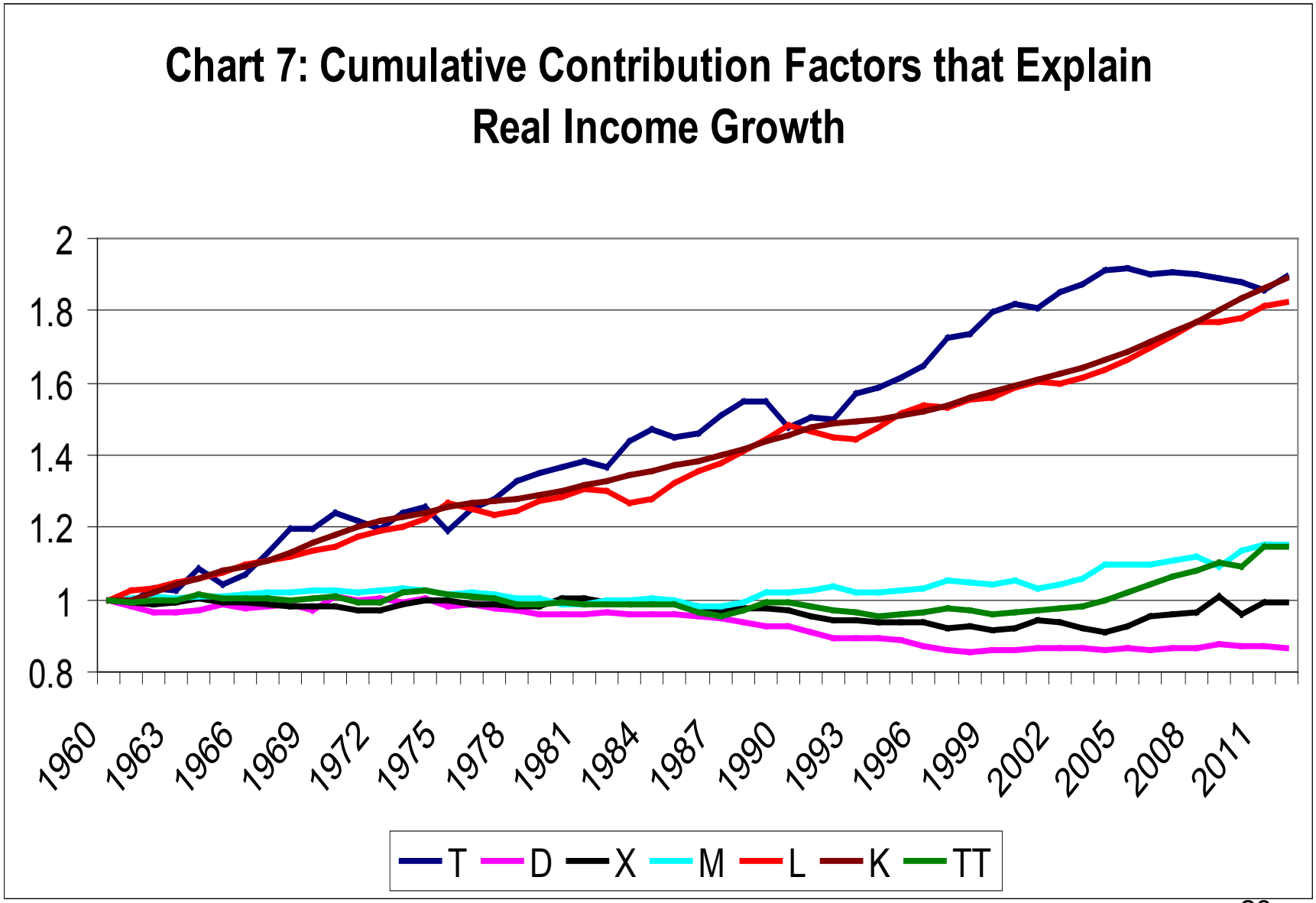
Comparison of DL TFP with ABS 16 Market Sector Industries, 1995-2011



Comparison of DL TFP with ABS 16 Market Sector Industries, 1995-2011 (cont)

- It is a bit puzzling why the DL productivity levels are above the ABS levels since the DL Expanded Market Sector includes the education and health industries which have a substantial government component.
- Government output is usually measured by input and so the inclusion of government dominated industries in our business sector aggregate should lead to lower DL productivity growth; not higher.
- We press on and give our decomposition of Expanded Business Sector Real Income growth into explanatory factors (price effects, growth of primary input effects and TFP effects)

Cumulative Contribution Factors



Discussion of Explanatory Factors

- **It can be seen that TFP growth T, capital services growth K and labour growth L explain most of the increase in the real income generated by the Expanded Market Sector in Australia.**
- **However, during the naughts, the price of imports has fallen dramatically and the price of exports has increased as well so the TT growth factor (a combination of the effects of changes in import and export prices has become very significant and has made up for the leveling off of TFP improvements.**
- **On the next slide, we present some decade by decade arithmetic averages of the annual contribution factors**

Discussion of Explanatory Factors (cont)

Arithmetic average annual growth factors over the entire sample period 1960-2012

RLINK 1.0370 (Real income growth)
TLINK 1.0127 (TFP growth)
PDLINK 0.99725 (Effects of declining prices of C+I+G relative to price of C)
PXLINK 1.0000 (Effects of real export price changes—neglible over the sample period)
PMLINK 1.0028 (Effects of real import price changes—not neglible over the sample period)
QLLINK 1.0117 (Growth of labour input)
QKLINK 1.0123 (Growth of capital input)
PTLINK 1.0027 (Combined effect of changes in real export and import prices)

Arithmetic average annual growth factors over the sample period 2001-2012

RLINK 1.0448 (Much higher than average!)
TLINK 1.0034 (Productivity growth has fallen well below trend)
PDLINK 1.0005 (Not much of an effect here)
PXLINK 1.0070 (Significant increases in real export prices)
PMLINK 1.0078 (Significant decreases in real import prices)
QLLINK 1.0116 (Growth of labour input is about average)
QKLINK 1.0143 (Capital services growth is above average: problems here!)
PTLINK 1.0145 (The effects of changes in the prices of imports and exports is bigger than any other explanatory factor during the naughts! Amazing. But it will not last!

We do not have time to look at our detailed export and import contribution factors.

Conclusion

- **Our results seem to differ substantially from the ABS results; need to explore why this is.**
- **The effects of improvements in Australia's Terms of Trade has made up for the fall in TFP growth in the past decade but these effects cannot be expected to persist.**
- **Our labour input was not quality adjusted and this is a problem with our results. It would be good if the ABS could follow the example of Statistics Canada and EU KLEMS and provide more disaggregated labour data (compensation by demographic and industry characteristics: industry, age, sex, education level and type of worker).**
- **The ABS does provide a great wealth of information on its website and this made our job a lot easier!**