Never Stand Still · Business School · Centre for Applied Economic Research

Prospects and Policies for Innovation and Productivity Growth

Kevin Fox

Presentation to the Crawford School of Public Policy

ANU
6 May 2016

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Business School

Some Recent Research (with Various Co-authors)

1. "Price Discounts and the Measurement of Inflation," *Journal of Econometrics* (2016).

2. "A Newly Identified Source of Potential CPI Bias: Weekly versus Monthly Unit Value Price Indexes," *Economics Letters* (2016)

3. "R&D, Innovation and Productivity: The Role of Public Support," *KDI Journal of Economic Policy* 37(1), 73–96, 2015

4. "Sunk Costs and the Measurement of Commercial Property Depreciation," *Canadian Journal of Economics, forthcoming.*

5. "Consumer Benefits of Infrastructure Services," R&R, *Journal of Urban Economics.*

6. "Decomposing Productivity Indexes into Explanatory Factors," R&R, *European Journal of Operational Research*

7. "The User Cost of Nonrenewable Resources and Green Accounting," to be presented at the NBER Summer Institute 2016, Boston.

8. "Decomposing Value Added Growth over Sectors into Explanatory Factors," to be presented at the IMF and U.S. Bureau of Economic Analysis, Washington D.C., July 2016.

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"…the need for productivity, innovation and incentive in our economy has never been more important."
Scott Morrison, Federal Treasurer, National Press Club Address, 17 February 2016.

(http://sjm.ministers.treasury.gov.au/speech/009-2016/)

http://www.acola.org.au/index.php/projects/securing-australia-s-future/project-4

SECURING
AUSTRALIA'S
FUTURE

The role of science,
research and
technology in lifting
Australia's productivity

4

FINAL REPORT

PROJECT

AUSTRALIAN ACADEMY
OF THE HUMANITIES

AUSTRALIAN
ACADEMY OF SCIENCE

ACADEMY OF THE SOCIAL
SCIENCES IN AUSTRALIA

AUSTRALIAN ACADEMY
OF TECHNOLOGICAL
SCIENCES AND ENGINEERING

ACOLA

AUSTRALIAN
COUNCIL OF
LEARNED
ACADEMIES

EXPERT
WORKING
GROUP

Dr John Bell FTSE (Chair)
Dr Bob Frater AO FAA FTSE (Deputy)
Leslie Butterfield
Professor Stuart Cunningham FAHA
Professor Mark Dodgson FASSA
Professor Kevin Fox FASSA
Professor Tom Spurling AM FTSE
Professor Elizabeth Webster

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Overview

- Productivity, innovation and "technological anxiety"

- Positive relationships between innovation, productivity and economic growth, but can be difficult to quantify.

- Advance understanding of these relationships in Australia.

- Particular focus on the impact of publically financed R&D on productivity.

- Productivity and the accumulation of unproductive assets

Plan

1. Productivity

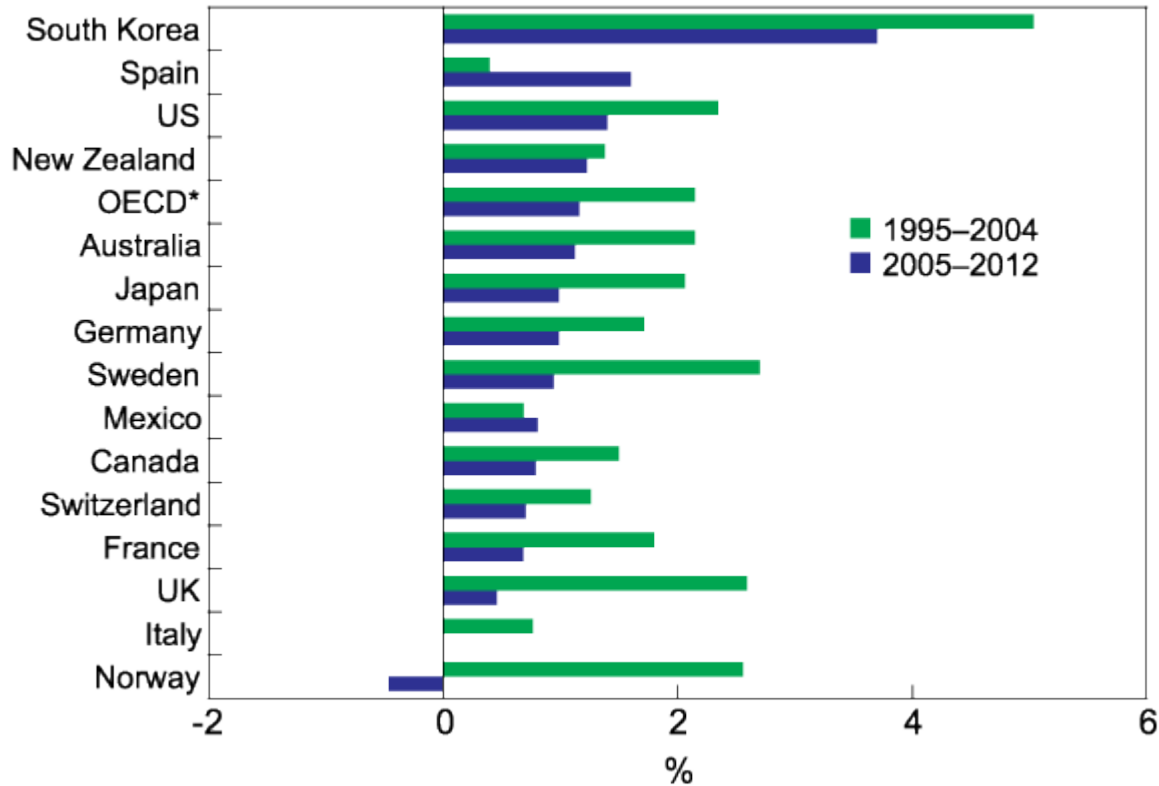2. R&D and other intangibles

3. Public Support for R&D

4. Unproductive Assets

5. Conclusions

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International Productivity Performance

Labour Productivity Growth
Real GDP per hour worked, annual average

Legend: 1995–2004, 2005–2012

* 1995–2004 period estimated based on 28 out of 34 countries
Sources: IMF; OECD; RBA

From a speech by Dr. Phillip Lowe, Deputy Governor, Reserve Bank of Australia: "Demographics, Productivity and Innovation," The Sydney Institute, Sydney, 12 March 2014. http://www.rba.gov.au/speeches/2014/sp-dg-120314.html

Innovation and Economic Growth

Robert Gordon: "Why Innovation Won't Save Us" (Wall Street Journal, 22-23 Dec. 2012)

-Drying up of big breakthroughs:

- Can economic growth be saved by Google's driverless car?

- I am not forecasting an end to innovation, just a decline in the usefulness of future inventions in comparison with the great inventions of the past.

Innovation and Economic Growth

But what about the evidence of a decline in "inventiveness" ....?

*I interpret most of the proffered evidence as reflecting the impact of **reduced aggregate demand and less favourable economic prospects** for inventive activity in the late 1970s, rather than as the result of technological springs running dry.*

Griliches (1988): "Productivity Puzzles and R&D: Another Nonexplanation," *Journal of Economic Perspectives* 2(4), 9 – 21.

"The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?"
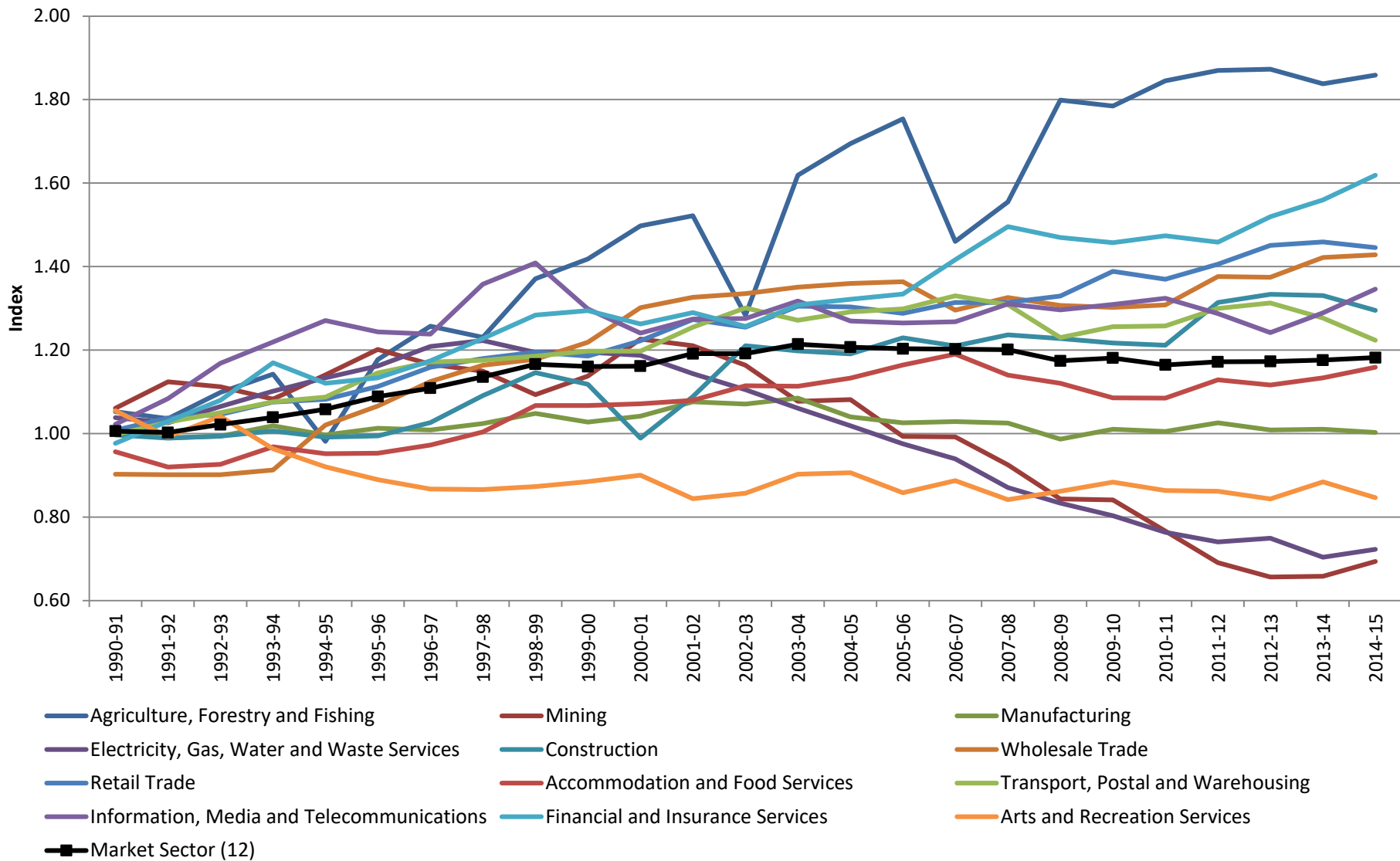
Alvin Hansen's1938 book *Full Recovery or Stagnation?*
"Hansen drew on the macroeconomic ideas of John Maynard Keynes in fearing that economic growth was over, with population growth and technological innovation exhausted."

Labour Productivity Growth Slowdown, Annual Averages, Australian Market Sector
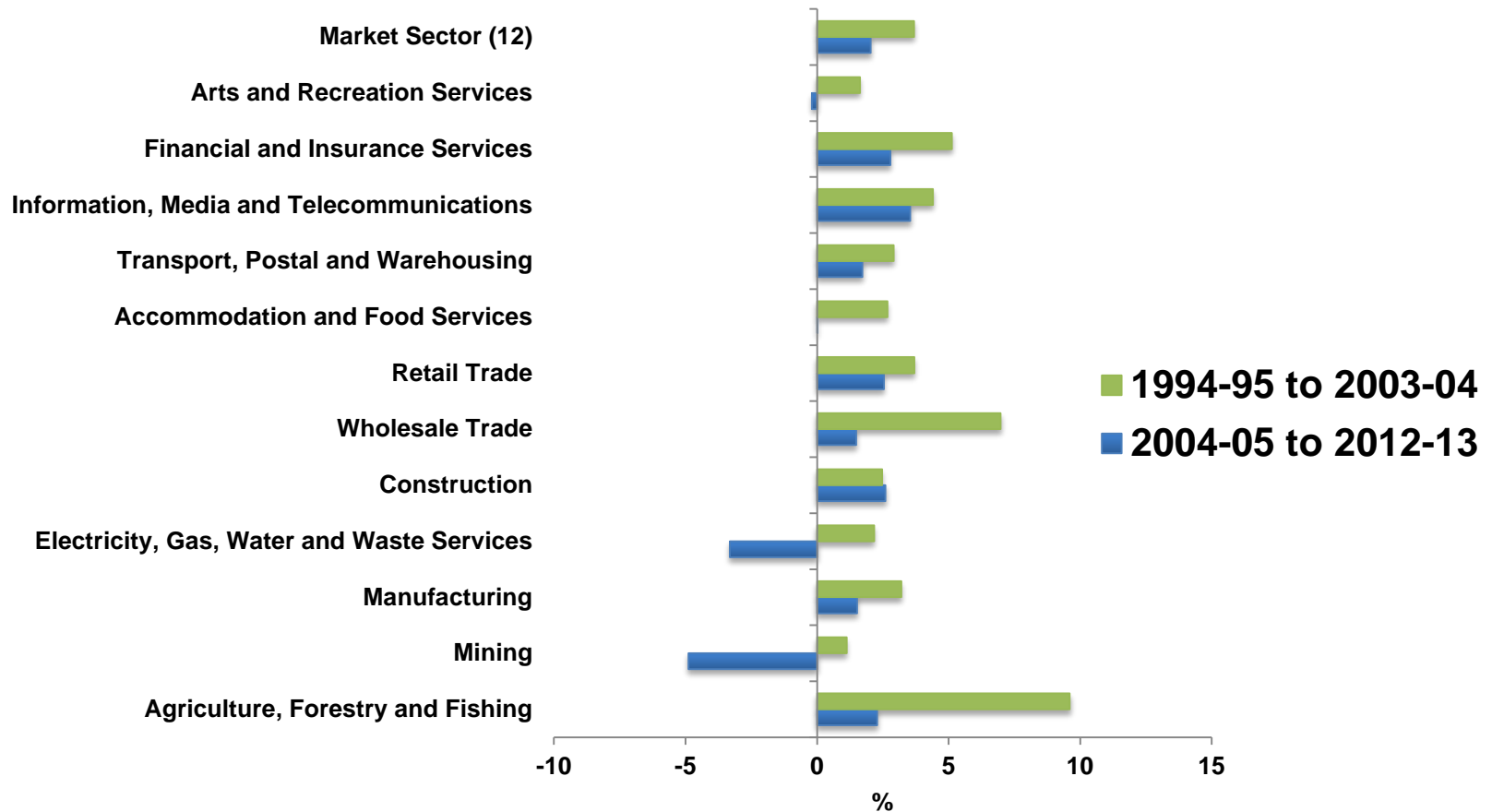
Market Sector Cumulative Multifactor Productivity Indexes

Legend:
- Agriculture, Forestry and Fishing
- Mining
- Manufacturing
- Electricity, Gas, Water and Waste Services
- Construction
- Wholesale Trade
- Retail Trade
- Accommodation and Food Services
- Transport, Postal and Warehousing
- Information, Media and Telecommunications
- Financial and Insurance Services
- Arts and Recreation Services
- Market Sector (12)

Plan

1. Productivity

2. R&D and other intangibles
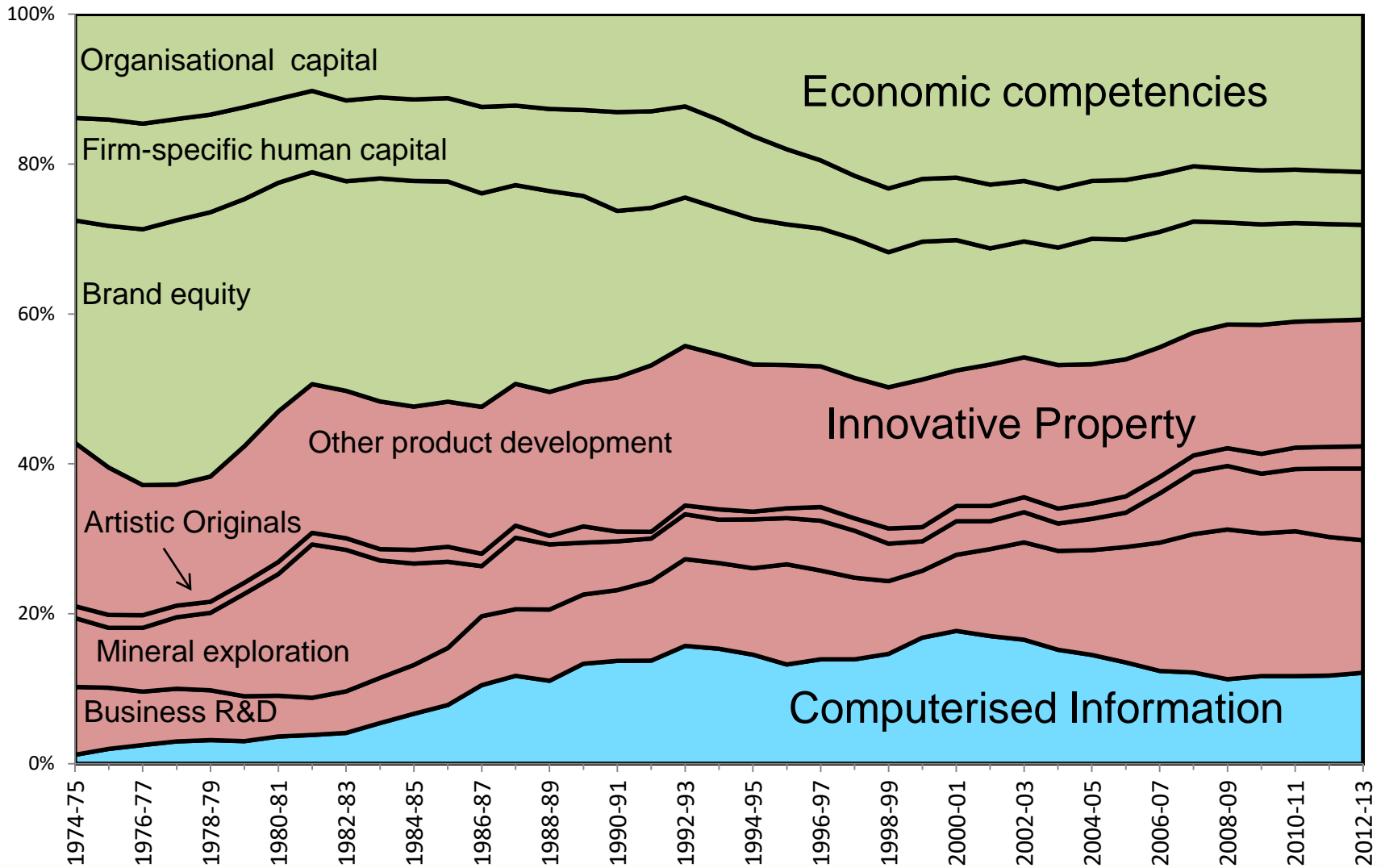
3. Public Support for R&D

4. Unproductive Assets
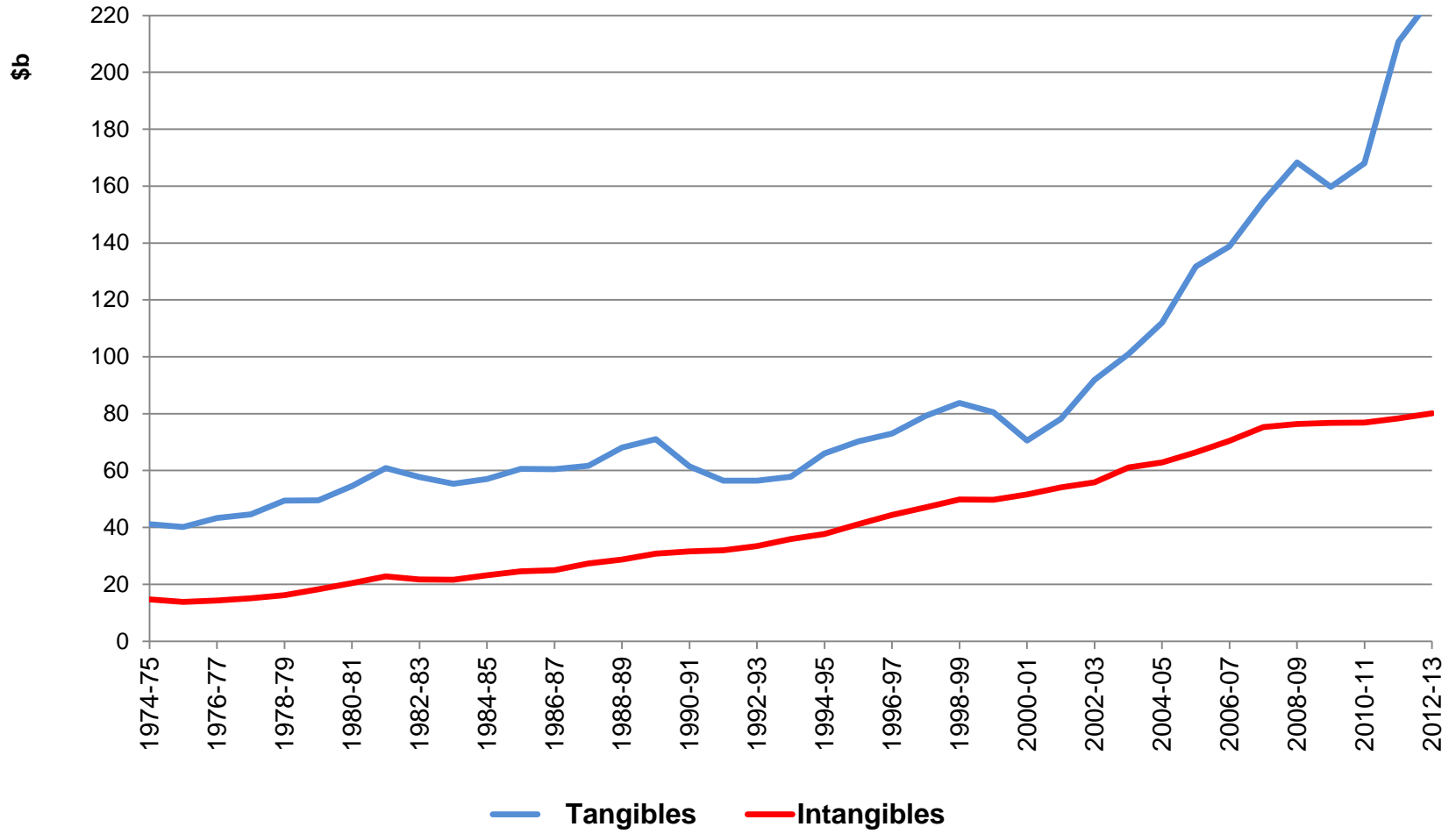
5. Conclusions

Intangibles

- Thought to be important, but measurement difficult.

- Excluding investment in intangibles leads to an understatement of output (GDP) and possibly productivity

- Capitalising poses challenges in determining appropriate deprecation rates and asset lives.

- Some intangibles already included in ASNA:
  – Computer software, artistic originals, mineral exploration and R&D (from December 2009)

Facts about Intangibles (Elnasri and Fox, 2015)

Market sector real investment
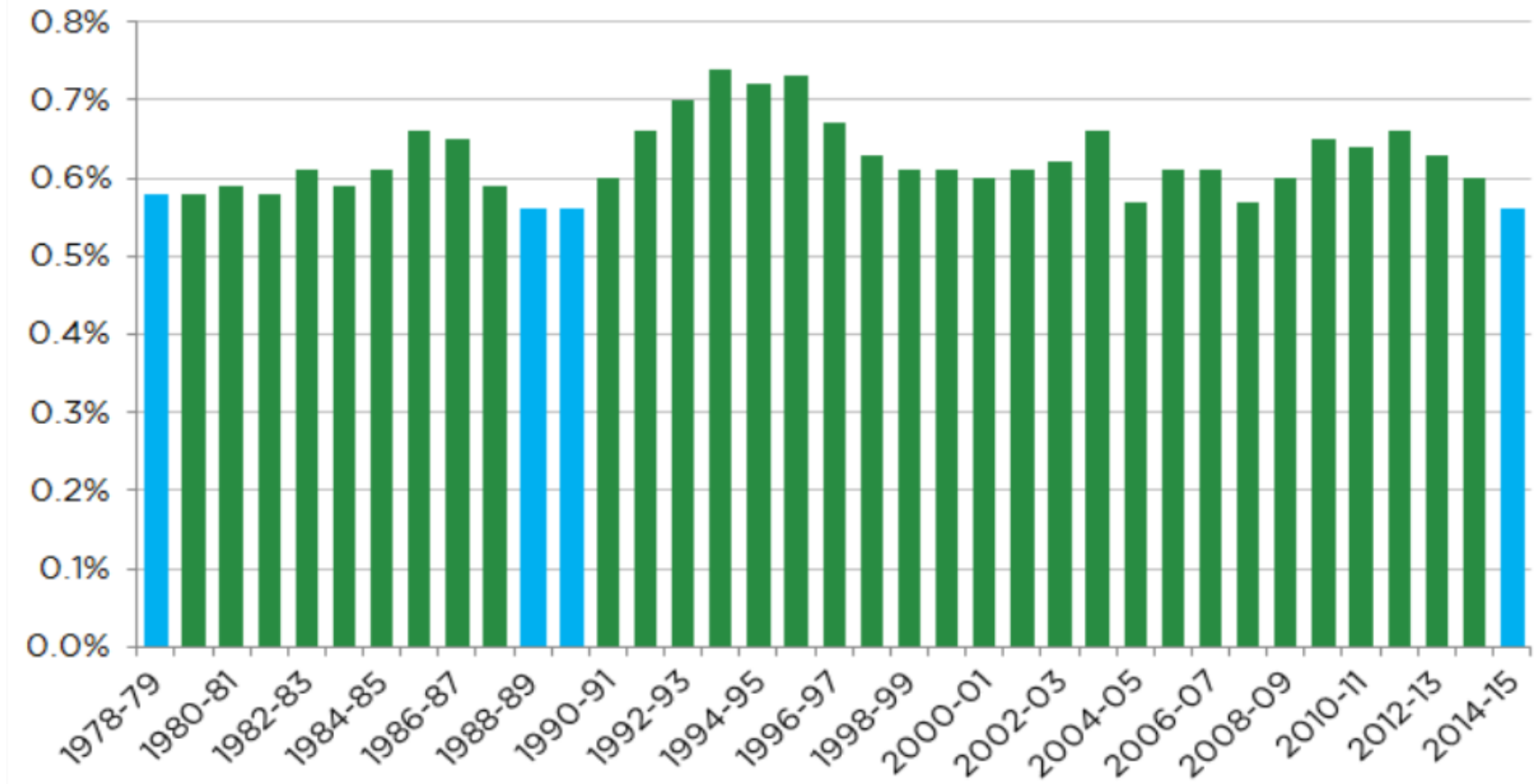## 2011-12 dollars, chain volume measures

Plan

1. Productivity

2. R&D and other intangibles

3. Public Support for R&D

4. Results

5. Conclusions

Australian Government Spending on R&D
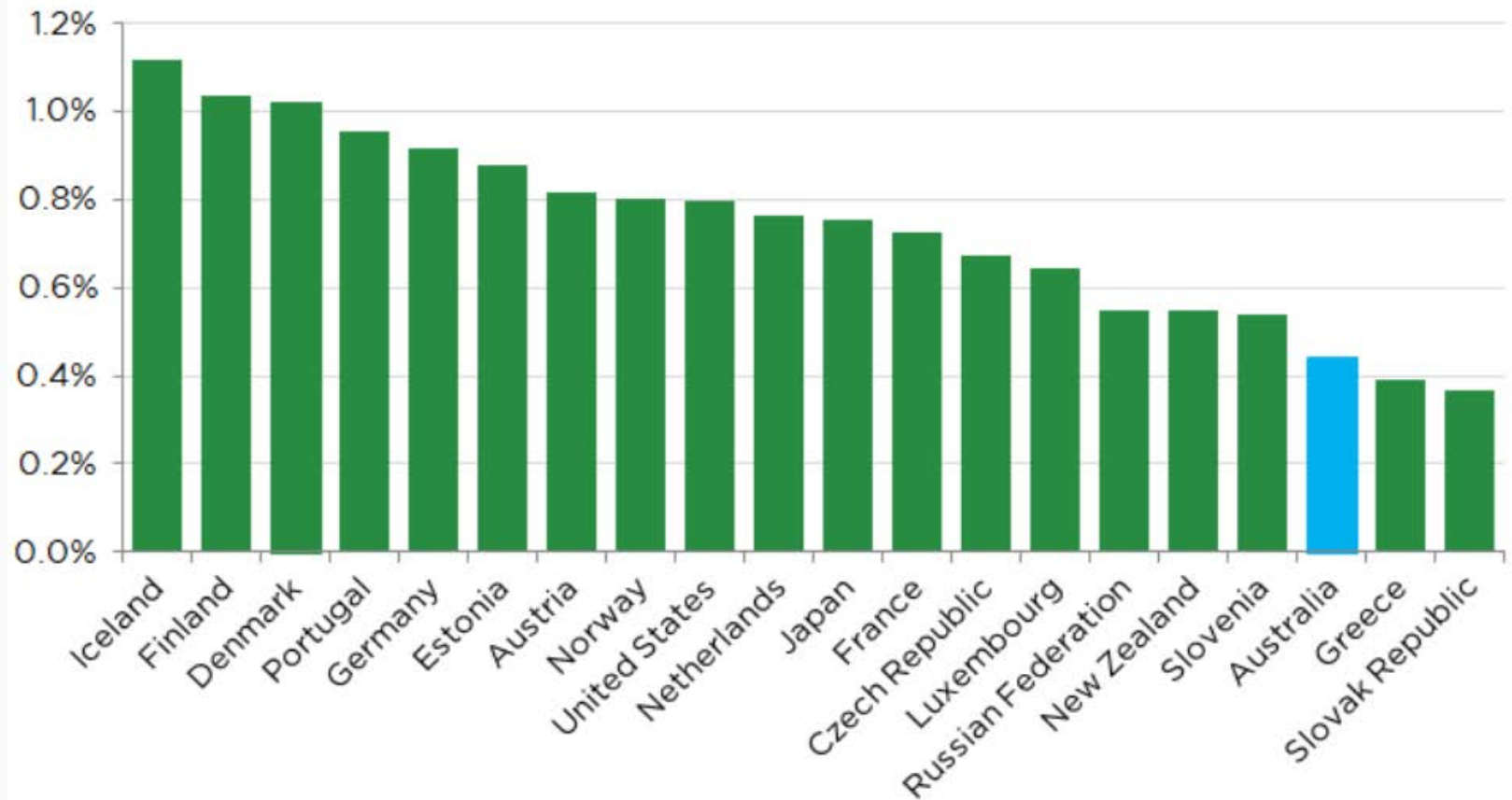## Percentage of GDP

INFOGRAPHIC: Australian government spending on research and development, 1978-79 to 2014-15. Data by Parliamentary Library. (ABC Fact Check)

http://www.abc.net.au/news/2014-10-07/adam-bandt-research-development-spending-claim-checks-out/5789134

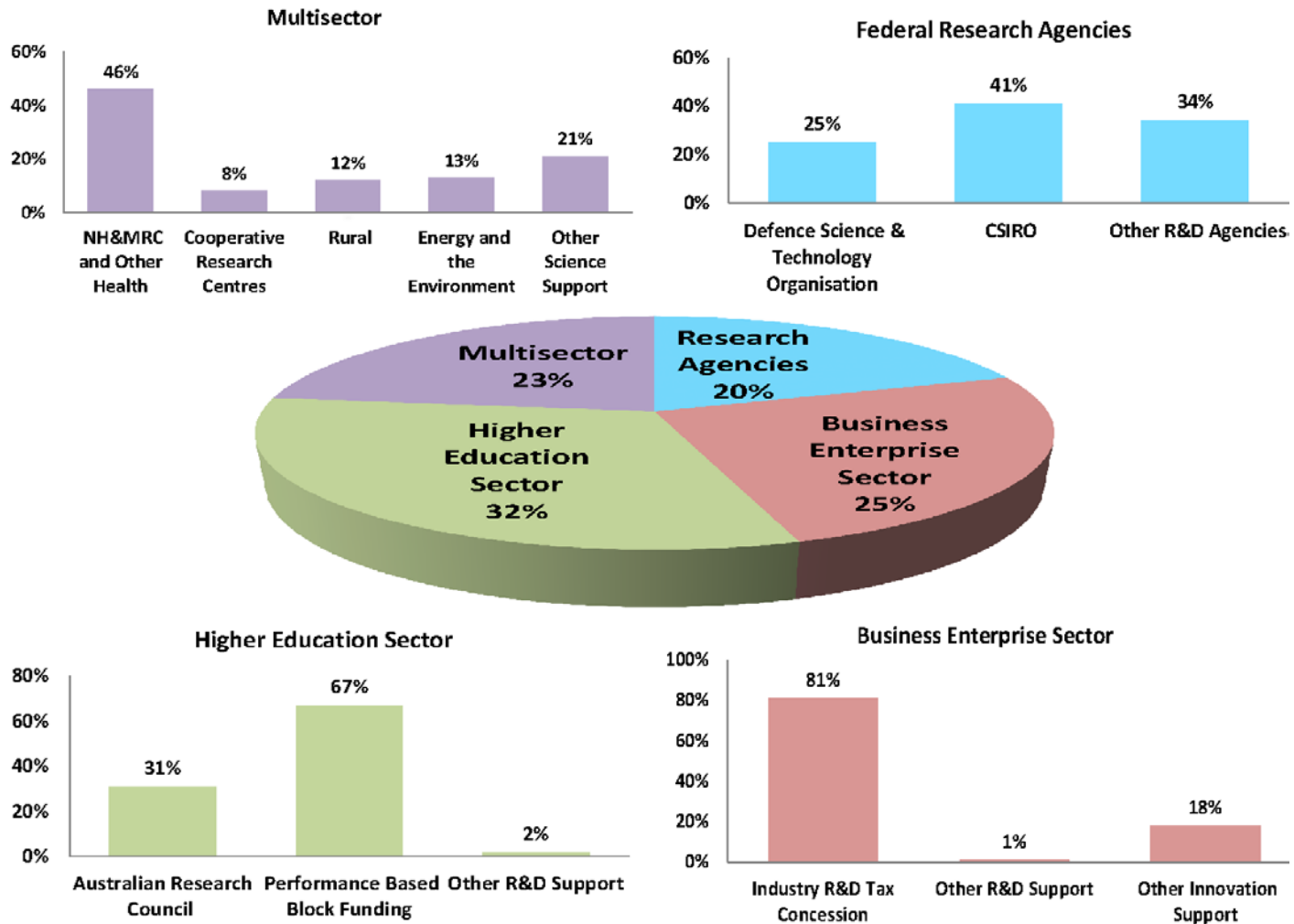# Government Spending on R&D
Percentage of GDP, 2013

INFOGRAPHIC: OECD figures on government spending on research and development as a percentage of GDP in 2013. (ABC Fact Check)

http://www.abc.net.au/news/2014-10-07/adam-bandt-research-development-spending-claim-checks-out/5789134
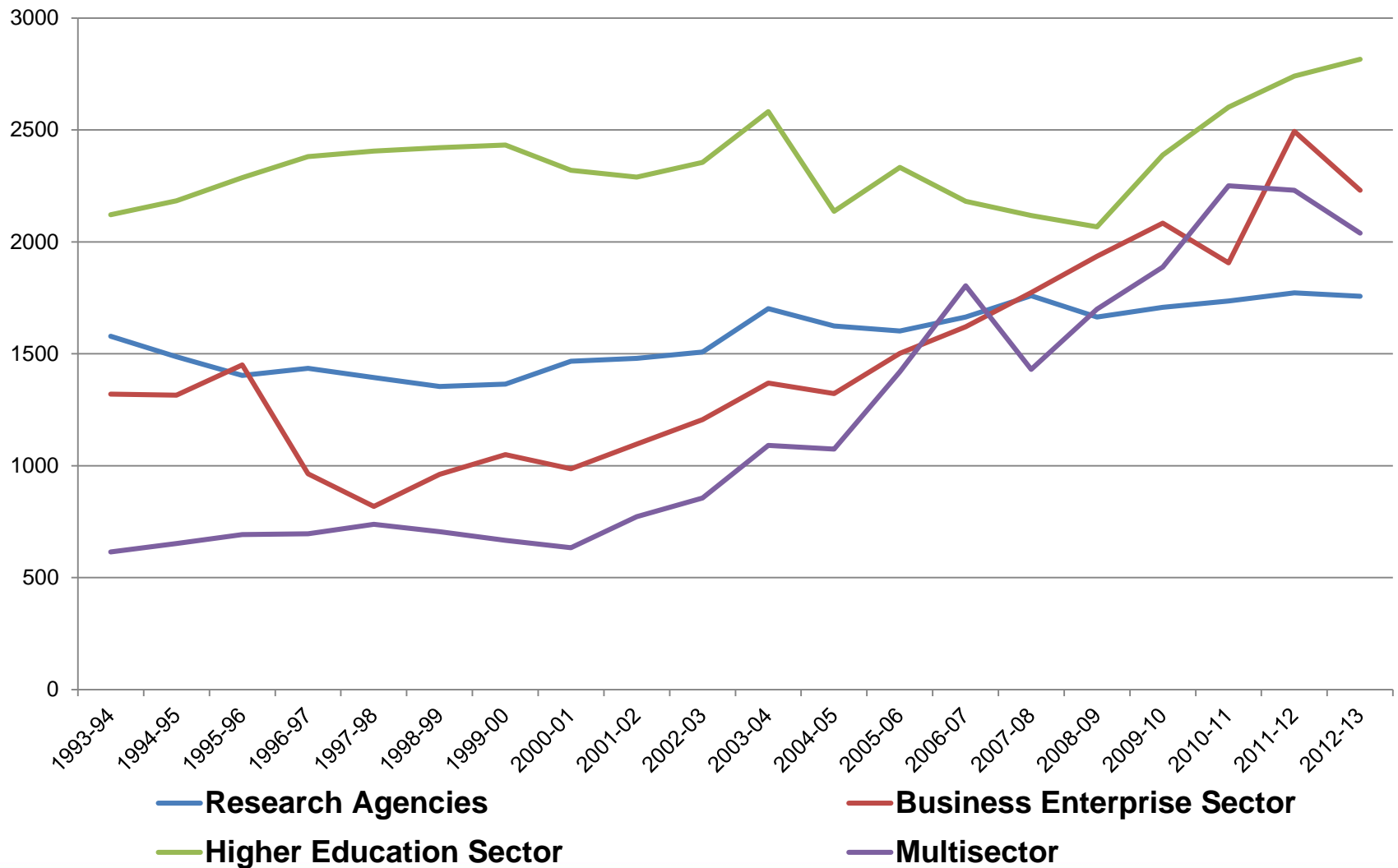
Australian Government spending on science, research and innovation 2012-13

Public support for science, research and innovation
($m 2011-12)

Legend:
- Research Agencies
- Business Enterprise Sector
- Higher Education Sector
- Multisector

Public support for science, research and innovation
(shares of GDP current prices)

Results

Multifactor productivity, market sector, 1974-75 to 2012-13

Legend:
- Excluding all intangible capital
- Including national accounts intangible capital
- Including all intangible capital
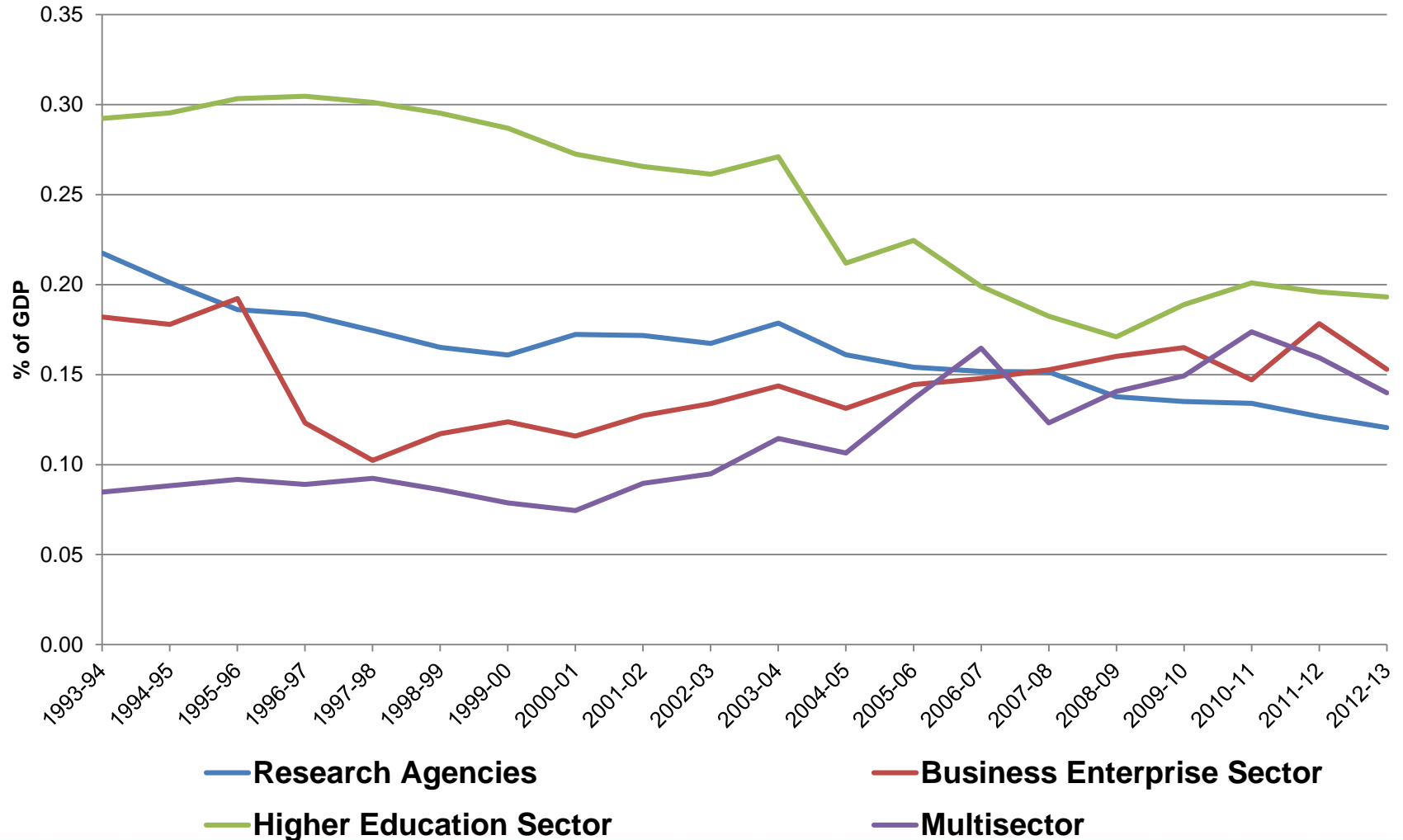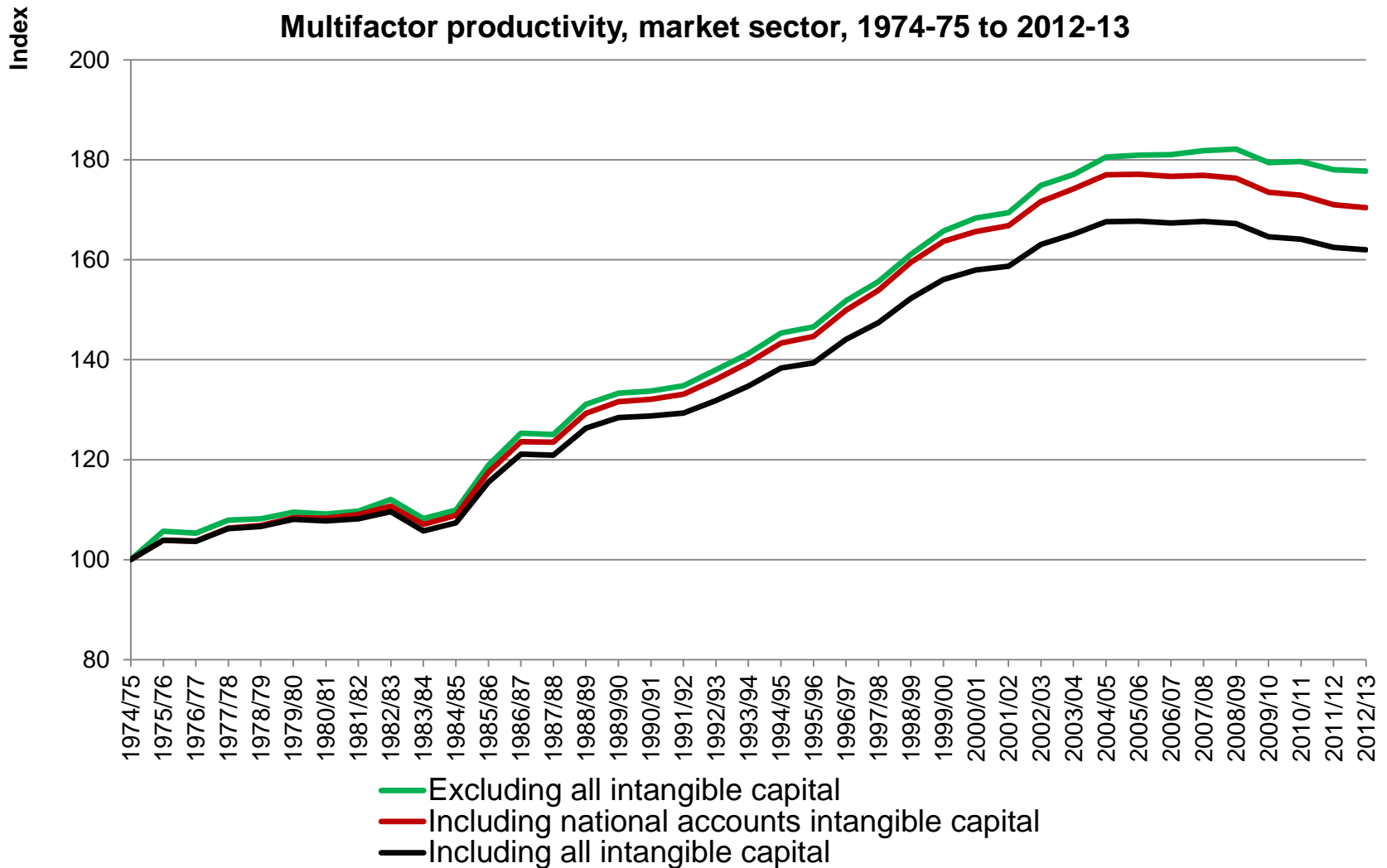
Results

Market sector MFP growth and public support to research agencies & business sectors

Legend:
- Smoothed MFP growth
- Government spending on research agencies
- Government spending on business enterprise sector
- Government spending on higher education
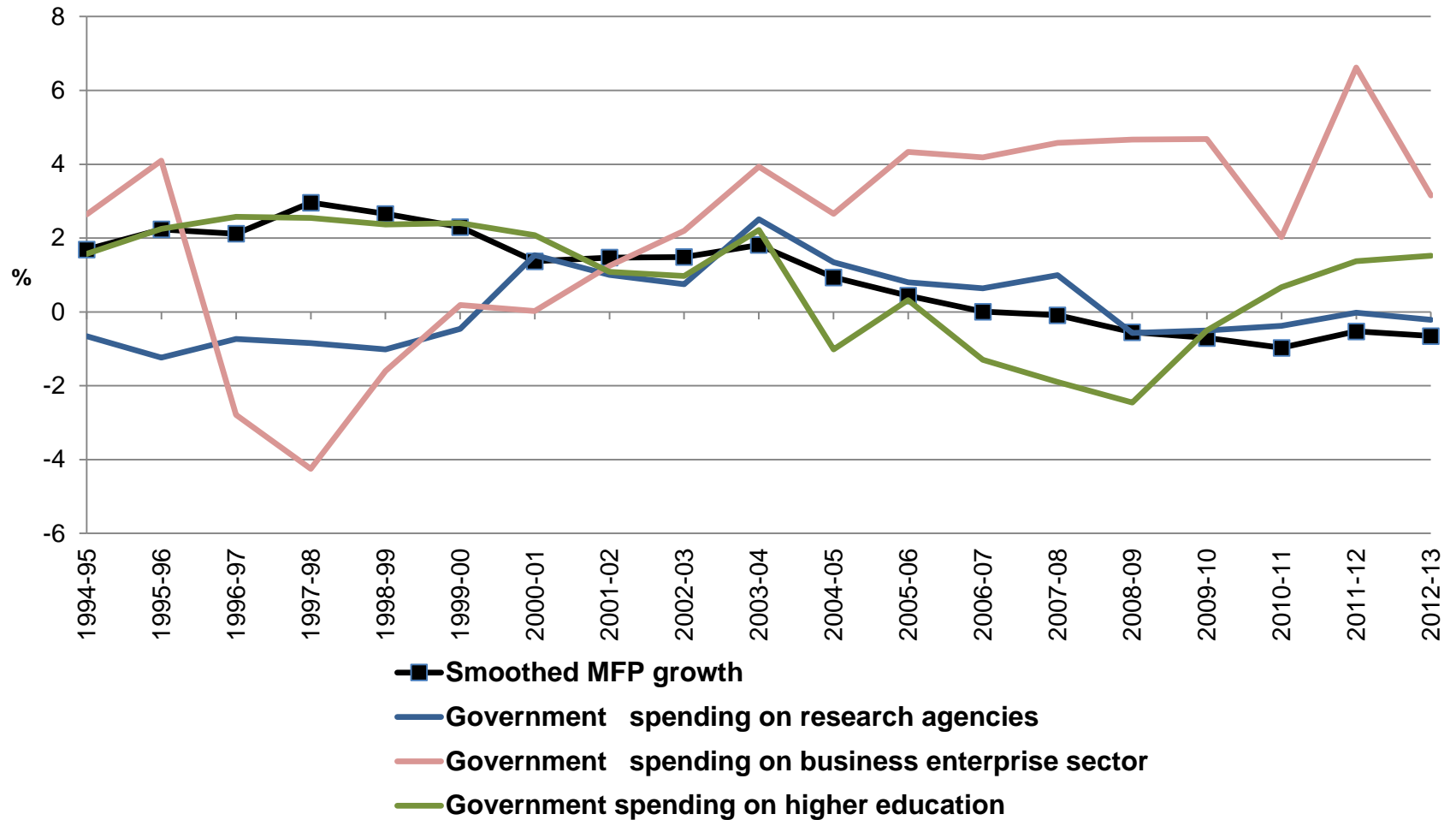
Estimating Equations

$$\ln \text{MFP}_t = \alpha_o + \sum_{X=L,K,N^{PRV}} d_X \ln X + \varepsilon_{N^{PUB}} \ln N_t^{PUB} + \alpha_1 \ln Z_t + \upsilon_t.$$

$$\Delta \ln \text{MFP}_t = \alpha_o + \sum_{X=L,K,N^{PRV}} d_X \Delta \ln X + \varepsilon_{N^{PUB}} \Delta \ln N_t^{PUB} + \alpha_1 \ln Z_t + \upsilon_t.$$

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Spillovers from Intangible Investment

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.175	-0.434**	-0.129*	-0.024
	(0.165)	(0.137)	(0.068)	(0.105)
Labour	-0.663***	-0.136	-0.579***	-0.098
	(0.137)	(0.096)	(0.074)	(0.057)
Intangible capital	0.579***	0.329		
	(0.062)	(0.226)		
Software			0.134***	0.100
			(0.007)	(0.059)
Innovative property			0.117*	-0.107
			(0.055)	(0.112)
Economic competencies			0.112***	0.256***
			(0.028)	(0.026)
Business cycle	0.734***	-0.094	0.826***	-0.026
	(0.181)	(0.122	(0.118)	(0.041)
Public infrastructure	0.194	-0.149	0.038	-0.140
	(0.216)	(0.302)	(0.123)	(0.149)
Openness	0.012**	-0.001	0-.001	0.006*
	(0.005)	(0.001)	(0.000)	(0.003)
Terms of Trade (t-1)	-0.106**	-0.022	-0.022*	-0.022
	(0.044)	(0.050)	(0.011)	(0.050)
$\bar{R}^2$	0.99	0.85	0.99	0.74
Durbin-Watson	1.66	1.15	2.73	3.03
Jarque-Bera test	0.624	0.285	0.467	0.083
Number of Observations	19	18	19	18

Spillovers from Total Public Support

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.423**	-0.523**	-0.168	-0.223*
	(0.173)	(0.179)	(0.118)	(0.103)
Labour	-0.758***	-0.025	-0.547***	-0.008
	(0.159)	(0.108)	(0.117)	(0.094)
Intangible capital	0.461***	0.328	0.440***	0.339*
	(0.066)	(0.217)	(0.067)	(0.166)
Total public support	0.399**	-0.235		
	(0.143)	(0.243)		
Research agencies			0.349***	0.007
			(0.064)	(0.141)
Higher education			0.175*	0.324*
			(0.076)	(0.157)
Business enterprise			-0.056	-0.056
			(0.060)	(0.066)
Multisector			-0.032	-0.021
			(0.035)	(0.051)
Business cycle	1.188***	-0.073	0.876***	0.083
	(0.202)	(0.119)	(0.156)	(0.134)
Public infrastructure	0.521**	-0.328	0.308	-0.432
	(0.222)	(0.319)	(0.211)	(0.404)
Terms of Trade (t-1)	-0.106**	-0.018	-0.037	-0.009
	(0.044)	(0.050)	(0.027)	(0.022)
$\bar{R}^2$	0.99	0.75	0.99	0.87
Durbin-Watson	1.41	1.42	2.33	2.33
Jarque-Bera test	0.732	0.514	0.167	0.320
Number of Observations	19	18	19	18

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Spillovers from Public Support: Research Agencies

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.381***	-0.586***	-0.419***	-0.505**
	(0.111)	(0.163)	(0.120)	(0.130)
Labour	-0.789***	-0.043	-0.845***	-0.007
	(0.097)	(0.103)	(0.133)	(0.121)
Intangible capital	0.477***	0.289	0.449***	0.078
	(0.038)	(0.276)	(0.053)	(0.268)
Research agencies	0.295***	-0.1376		
	(0.052)	(0.193)		
Research agencies (t-1)			0.358***	-0.490*
			(0.048)	(0.163)
Business cycle	1.163***	-0.006	1.274***	-0.033
	(0.130)	(0.135)	(0.182)	(0.086)
Public infrastructure	0.778***	-0.373	1.025***	-1.023**
	(0.197)	(0.365)	(0.249)	(0.388)
Terms of Trade (t-1)	-0.066**	-0.003	-0.092**	0.022
	(0.034)	(0.050)	(0.038)	(0.032)
$\bar{R}^2$	0.99	0.75	0.99	0.85
Durbin-Watson	2.02	1.42	2.17	1.85
Jarque-Bera test	0.656	0.514	0.876	0.517
Number of Observations	19	18	19	18

Spillover from Public Support: Research Agencies - breakdown

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.347***	-0.543**	-0.390***	-0.509***
	(0.072)	(0.217)	(0.063)	(0.147)
Labour	-0.696***	-0.007	-0.527***	0.027
	(0.097)	(0.143)	(0.110)	(0.119)
Intangible capital	0.414***	0.308	0.224***	0.095
	(0.053)	(0.263)	(0.027)	(0.293)
Research agencies (x defence)	0.256***	-0.038		
	(0.040)	(0.145)		
Defence	-0.065	-0.140		
	(0.075)	(0.196)		
Research agencies (x defence) (t-1)			0.295***	-0.339
			(0.031)	(0.204)
Defence (t-1)			-0.417	-0.176
			(0.073)	(0.178)
Business cycle	1.120***	-0.024	1.206***	-0.028
	(0.107)	(0.145)	(0.097)	(0.108)
Public infrastructure	0.698***	-0.304	0.857***	-0.953
	(0.127)	(0.361)	(0.104)	(0.748)
Terms of Trade (t-1)	-0.045	-0.002	0.026	0.029
	(0.027)	(0.043)	(0.028)	(0.033)
$\bar{R}^2$	0.99	0.72	0.99	0.84
Durbin-Watson	1.80	1.27	2.70	1.82
Jarque-Bera test	0.702	0.777	0.837	0.618
Number of Observations	19	18	19	18

Spillovers from Public Support: Higher Education

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.162	-0.263**	-0.074	-0.254**
	(0.197)	(0.115)	(0.155)	(0.177)
Labour	-0.375	-0.046	-0.426***	-0.044
	(0.221)	(0.093)	(0.101)	(0.064)
Intangible capital	0.535***	0.357**	0.412***	0.460***
	(0.061)	(0.127)	(0.062)	(0.097)
Higher education	0.305**	0.409***		
	(0.120)	(0.123)		
Higher education (t-1)			0.352***	0.378***
			(0.068)	(0.116)
Business cycle	0.519***	0.148**	0.594***	0.075
	(0.230)	(0.076)	(0.075)	(0.070)
Public infrastructure	-0.288	-0.378	-0.098	-0.170
	(0.362)	(0.324)	(0.184)	(0.262)
Terms of Trade (t-1)	-0.019	0.002	-0.045	-0.015
	(0.044)	(0.022)	(0.025)	(0.028)
$\bar{R}^2$	0.99	0.89	0.99	0.89
Durbin-Watson	1.10	2.44	1.92	2.54
Jarque-Bera test	0.656	0.422	0.534	0.810
Number of Observations	19	18	19	18

Spillovers from Public Support: Business Enterprise

	$\ln MFP$	$\Delta \ln MFP^a$	$\ln MFP$	$\Delta \ln MFP^a$
Tangible capital	-0.445***	-0.306**	-0.259	-0.480**
	(0.218)	(0.129)	(0.197)	(0.158)
Labour	-0.795***	0.078	-0.522***	-0.018
	(0.205)	(0.090)	(0.154)	(0.118)
Intangible capital	0.604***	0.228	0.589***	0.328*
	(0.050)	(0.166)	(0.063)	(0.097)
Business enterprise	0.108	-0.179**		
	(0.073)	(0.061)		
Business enterprise (t-1)			-0.077	-0.150*
			(0.052)	(0.068)
Business cycle	1.100***	-0.106	0.684***	-0.062
	(0.257)	(0.090)	(0.168)	(0.099)
Public infrastructure	0.558	-0.534	0.199	-0.205
	(0.330)	(0.377)	(0.282)	(0.338)
Terms of Trade (t-1)	-0.087	-0.033	-0.071	0.015
	(0.058)	(0.026)	(0.063)	(0.036)
$\bar{R}^2$	0.99	0.84	0.99	0.82
Durbin-Watson	1.26	1.84	1.23	1.87
Jarque-Bera test	0.896	0.396	0.564	0.888
Number of Observations	19	18	19	18

Conclusions from Elnasri and Fox (2015)

- Treating investment in intangible assets as capital considerably affects the level of MFP.

- Evidence of market sector spillovers from intangibles.

- Similar to Haskel and Wallis (2013) for the UK, find evidence of spillovers from public R&D spending on research agencies and higher education, but not from the other types of public support.

Plan

1. Productivity

2. R&D and other intangibles

3. Public Support for R&D

4. Unproductive Assets

5. Conclusions

The Puzzle of Cash Holdings

"The rise in profitability left a lot of cash lying around, and 69 per cent of companies lifted their interim dividends, while cash holdings also grew 6 per cent to $111 billion."
ABC News Online (3 March 2014).

"Companies are sitting on significant cash reserves and are well placed to invest, employ and embrace future opportunities such as mergers and acquisitions. Indeed investors will want to know how Aussie companies plan to utilise cash reserves to lift future returns."
Craig James, Chief Economist CommSec, ABC News Online (3 March 2014).

The Puzzle of Cash Holdings

"…at some point, it is going to be in the interests of the owners for investment to take place in new technologies, better processes, new lines of business and, in time, more capacity. At some stage, the equity analysts, shareholders, fund managers, commentators and so on will want to be asking not 'where's your cost cutting or capital return plan?', but 'where's your growth plan?'"
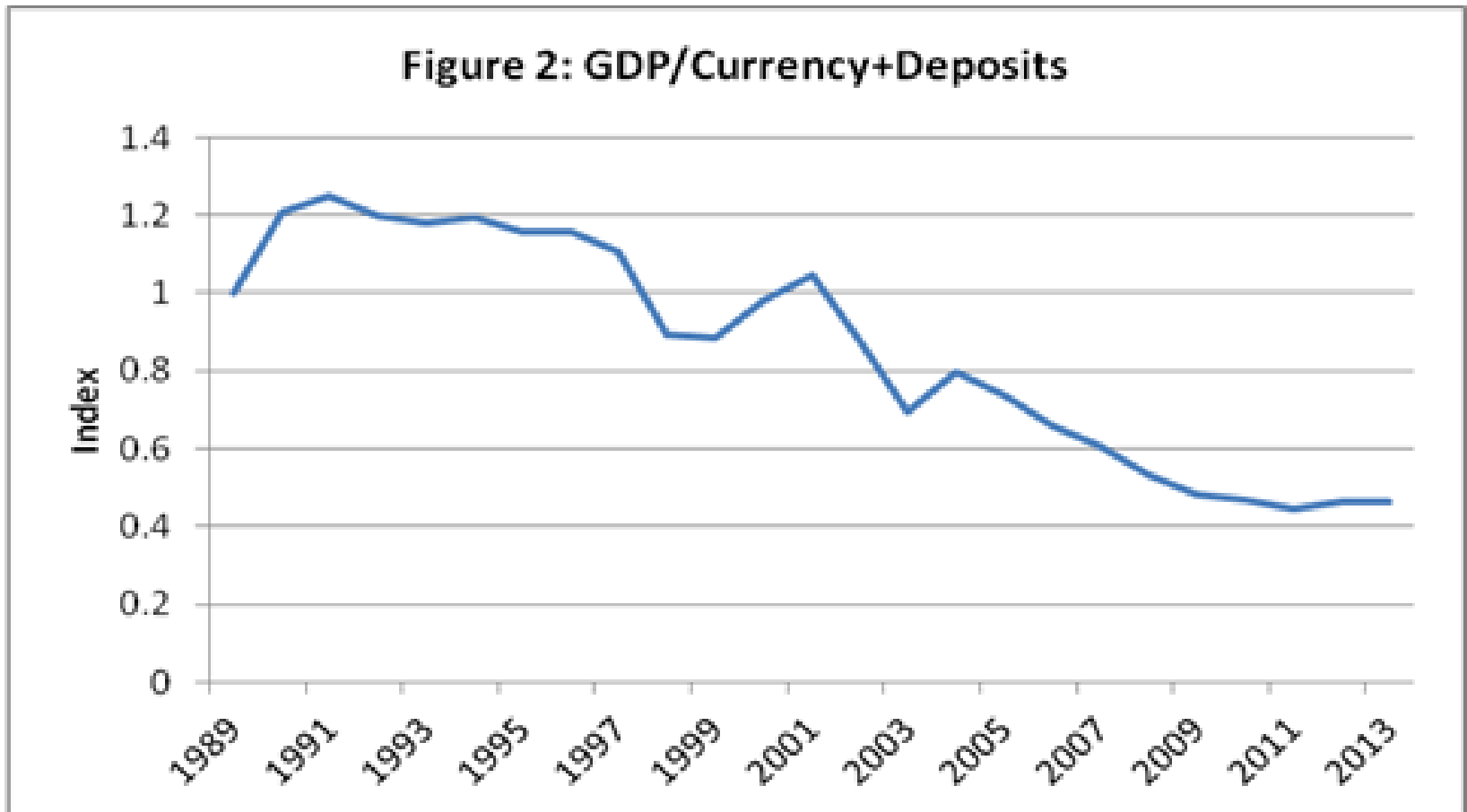
Glenn Stevens, Governor of the Reserve Bank of Australia (2014)

The Puzzle of Cash Holdings

Figure 1: Currency +Deposits
Non-Financial Corporations
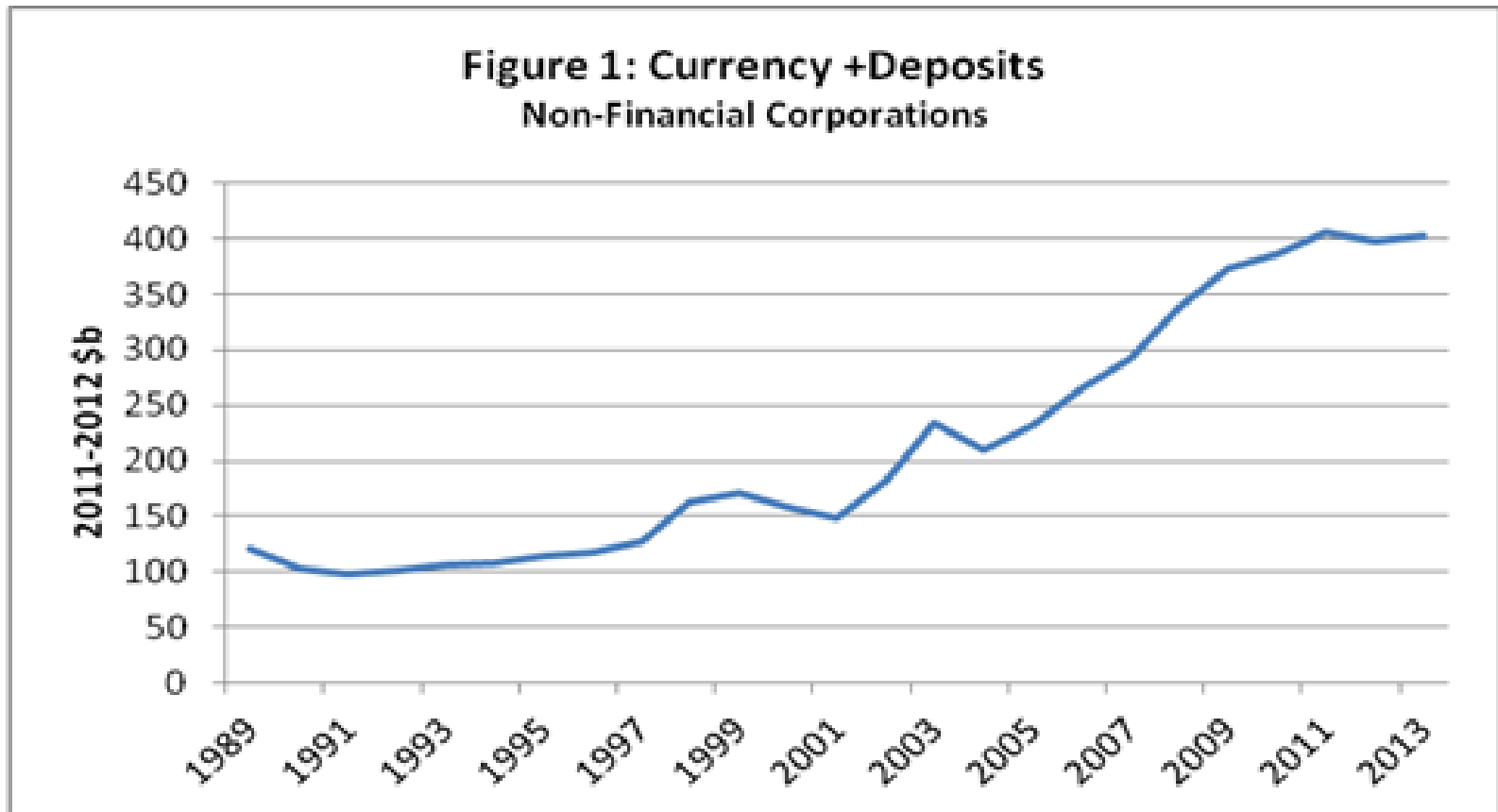
Data sources: Australian System of National Accounts, 2012-13, Cat. No. 5204.0 Table 20 and Cat. No. 6401 - Consumer Price Index, All Groups CPI.

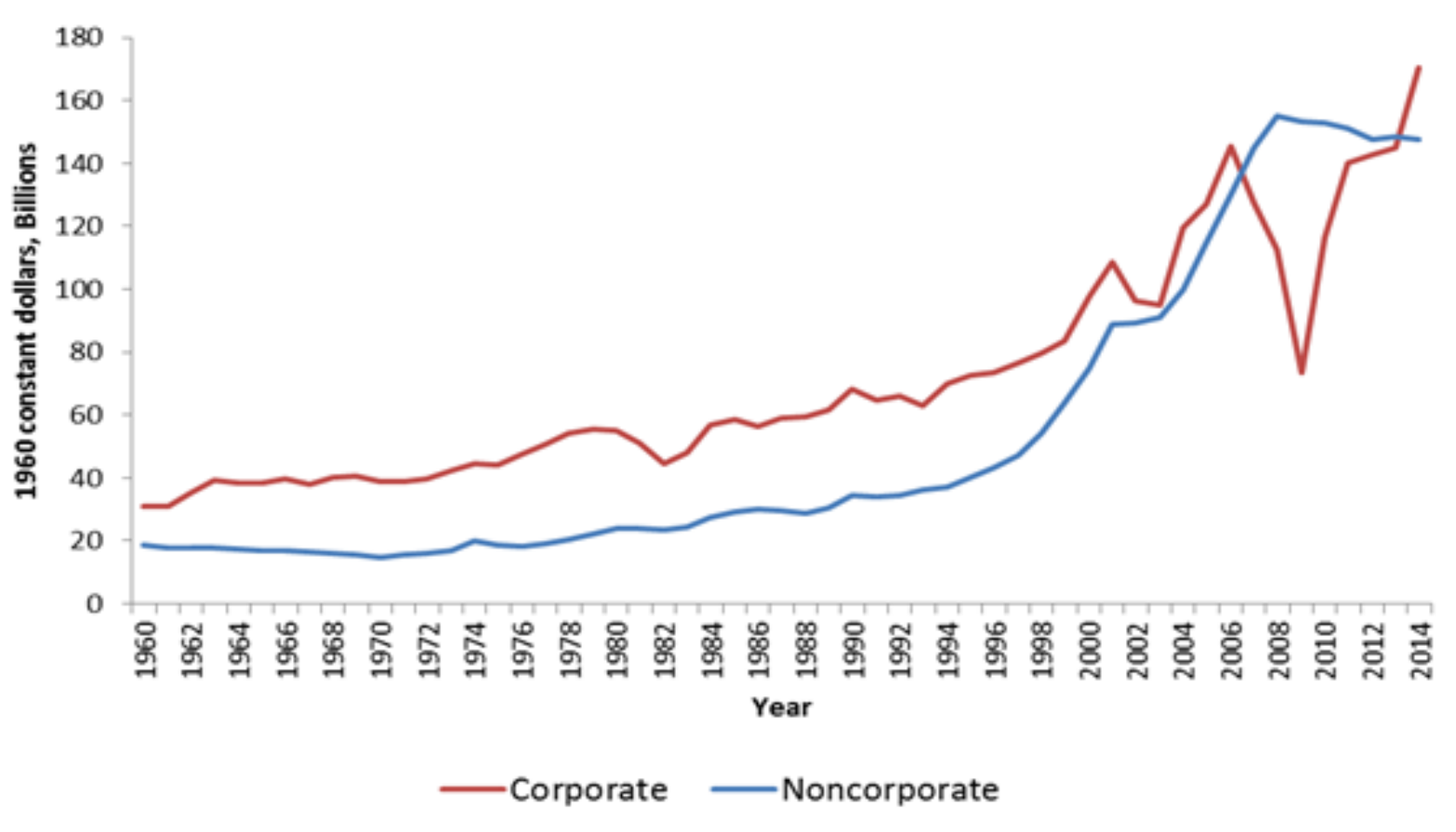# The Puzzle of Cash Holdings

Figure 2: GDP/Currency+Deposits

Additional data source: Australian System of National Accounts, 2012-13, Cat. No. 5204.0 Table 1.
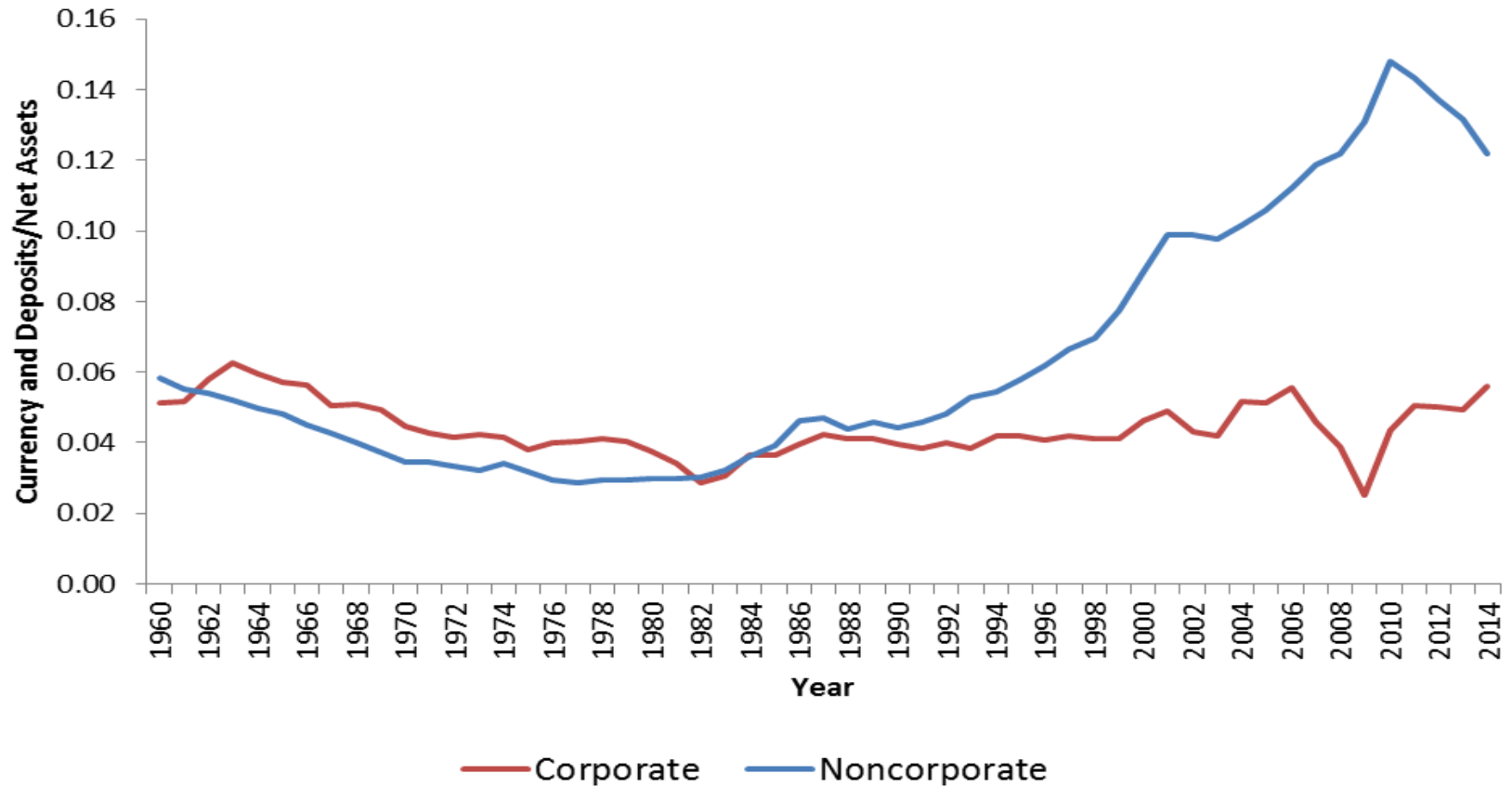
The Puzzle of Cash Holdings

Diewert and Fox (2015): "Money and the Measurement of Total Factor Productivity
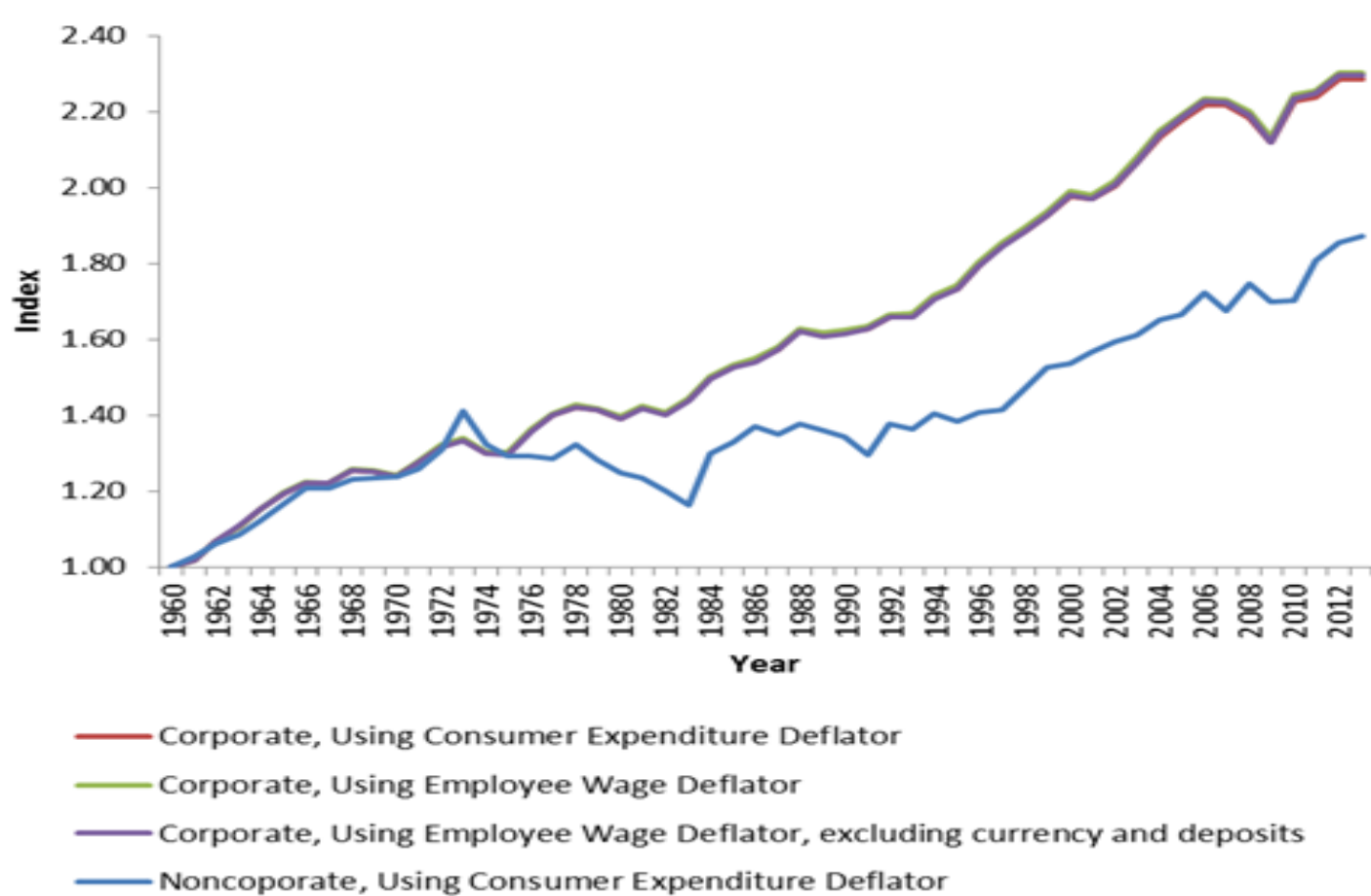
U.S. Real Currency and Deposits

The Puzzle of Cash Holdings

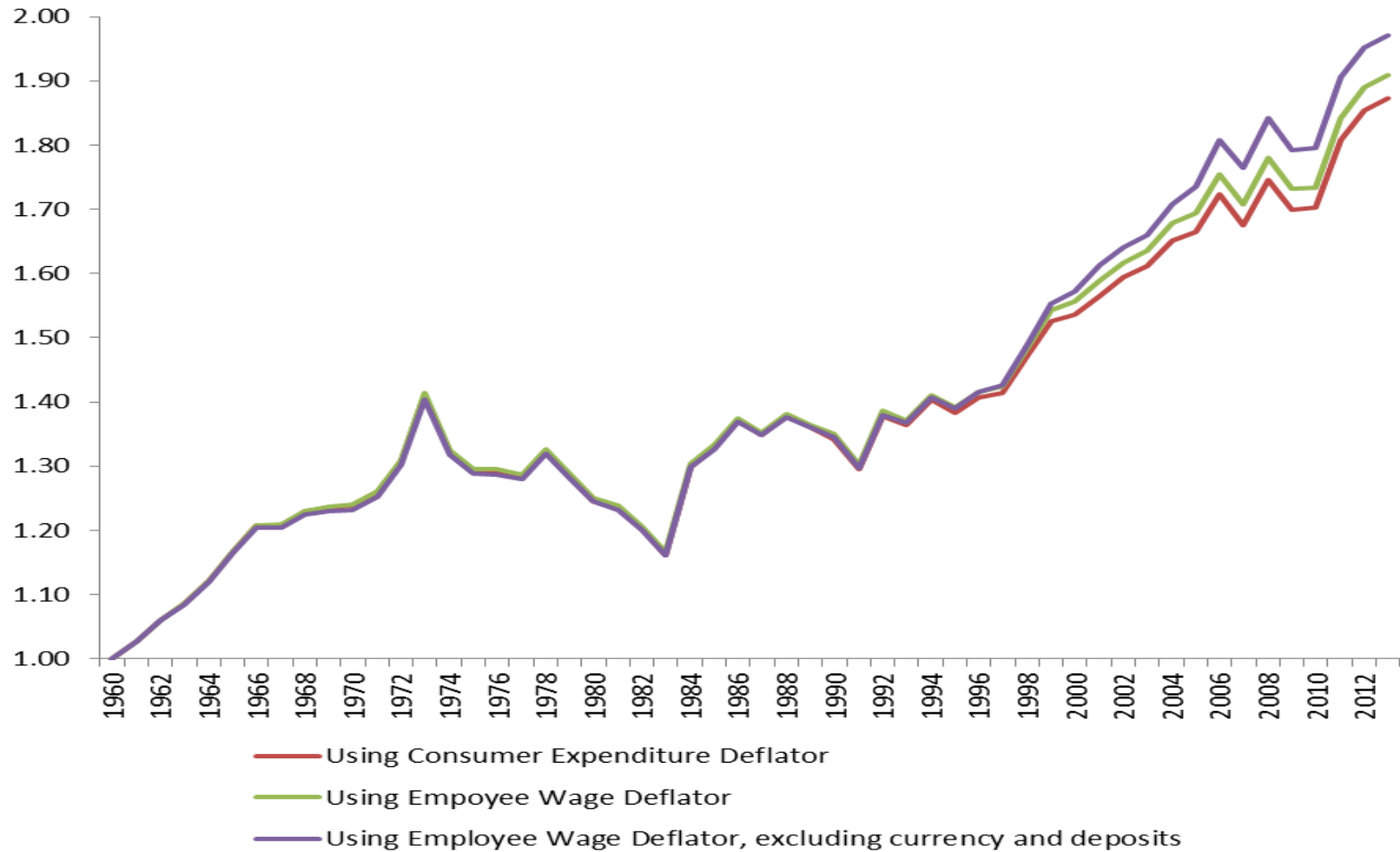## Ratio of Currency and Deposits to Net Assets

The Puzzle of Cash Holdings

Total Factor Productivity, Corporate and Noncorporate Sectors

The Puzzle of Cash Holdings

Total Factor Productivity, Noncorporate Sector

Using Consumer Expenditure Deflator

Using Empoyee Wage Deflator

Using Employee Wage Deflator, excluding currency and deposits

Overall Conclusions

Significant uncertainty around measured future productivity.

Measurement problems becoming more difficult as the economy transitions more to service sector?

Are we measuring productivity the right way (treatment of land, inventories, cash balances….)?

It seems that government support for R&D can raise productivity, but perhaps not through an R&D tax incentive.