The science of science: Why measuring research is necessary to improve the way it is funded

Jonathan Grant

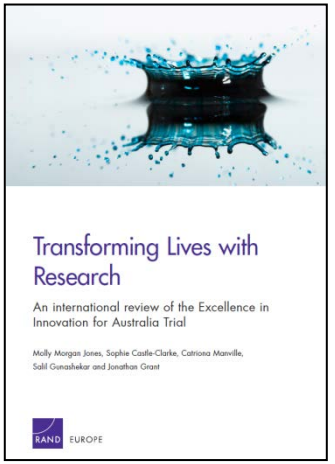
Canberra, June 2013

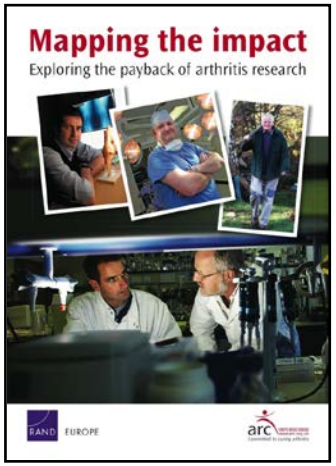
RAND EUROPE

RAND Europe is an independent not-for-profit public policy research institute

- Not a university or management consultancy — but with capabilities of both
- Part of the global RAND Corporation
- Work across the breadth and depth of government
- Strongly held values of quality and objectivity
- Provider of evidence
- Track record in assessing the impact of research

"*help improve policy and decisionmaking through research and analysis*"





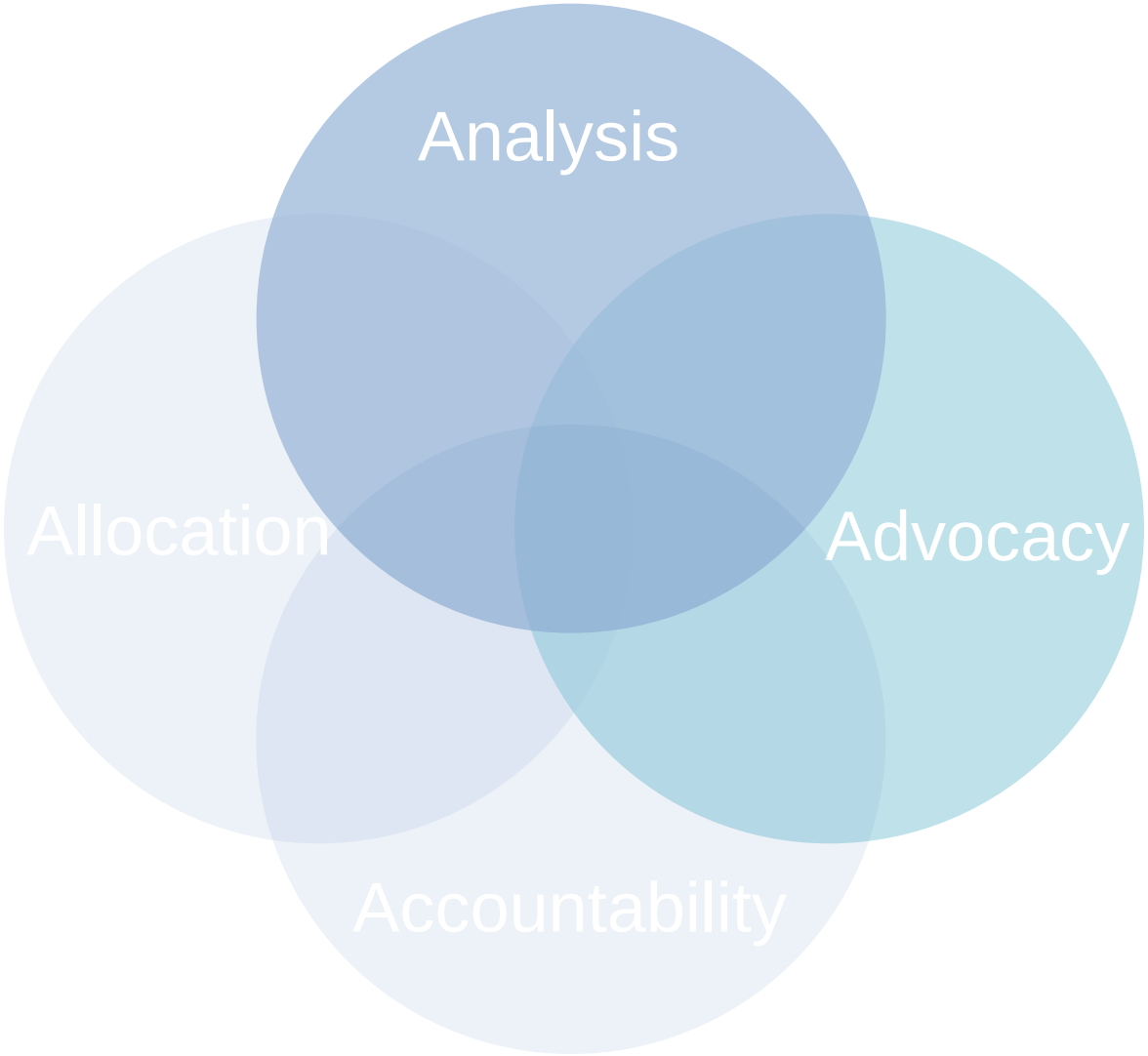
Outline

- The reasons for measuring research
- Case study: Measuring the economic returns from CVD research
- Defining future research questions: Understanding time lags
- Key messages & discussion

Why assess research impact?

Why assess research impact?

Why assess research impact?



ECONOMY WARNING FOR GOVERNMENT

SCIENCE funding is set to take a clobbering. Business Secretary Vince Cable wants to "ration" it, potentially wiping out almost 50 per cent of UK research.

But here Sun Professor Brian Cox explains why such cuts would hammer our economy.

Cutting science is like cutting Spitfires in 1940

BY SUN PROFESSOR BRIAN COX

AMID the doom and gloom about the economy, Vince Cable probably thought he would get away with a speech proposing draconian cuts in scientific research.

Some voices would be raised in protest in the leftie Press but ordinary people would have more pressing concerns.

He surely cannot have been prepared for the avalanche of rhetorical manure poured on his proposals.

Lord May, ex-president of the Royal Society, the world's oldest and most respected scientific body, called one of his claims "just plain stupid".

And Professor Steve Smith, president of Universities UK, described Mr Cable's plans as "the equivalent of the Government cutting back on the production of Spitfires in the early summer of 1940".

But why care if the UK loses its place at the forefront of international science?

First, let's get the money into perspective. The science budget is less than one per cent of what our Government

on the foundations that ally or nationally recognised". efficient scientific nation in

CAN THE BOFFINS SAVE US?

Vince Cable thinks it's time to borrow. David Cameron insists there is no alternative to austerity. But have our universities found the way to secure long-term growth? Karl West reports

on to spin out their own businesses.

Britain's top universities are more than capable

Bhattacharyya said. "You should be at the heart of it — you shouldn't be an outpost."

DAVID CLARK, principal fellow at WMG, believes that the best barometer of how industry views the importance of universities is the amount of cash companies are prepared to invest in research facilities. Glowing references and donations of old bits of equipment are fine, but cash is still king.

By this measure, Jaguar Land Rover must be ecstatic with the work WMG has done. The car maker is partnering the university to open the £90m National Automotive Innovation Campus in March 2015. The centre is being funded by Tata Group, the Indian conglomerate that owns Jaguar Land Rover, and the Higher Education Funding Council for England (Hefce).

Since announcing the venture, WMG has received inquiries from Bosch, which makes car components; the engine maker FEV; and Intel, the computing giant, about setting up their own research facilities there.

"That's what growth is," says Bhattacharyya. "You have to be able to tell companies your idea and let them try it out for themselves. That is really

developed a close relationship with Jaguar Land Rover. It has about 500 of the Midlands car-maker's staff on the Warwick campus, developing products with the university.

For example, the rivet and glue technique used to bond the aluminium body of the new Range Rover model was developed at WMG.

"You have to have strategic relationships with companies,"

fund
educatio
for the acad
2012-13.

Of this sum, £3.
teaching and £1.6bn
an assessment of th
an institution's
research. The imp
research on jobs
economy accounts f
of the evaluation pro

As a result, Brit
demic institutio
become hard-wired
research papers. The
aim is to have
research publish
esteemed academic

Publication in a h
journal, coupled wi
citations, is likely
university a better
grabbing a bigger s
research budget.

Bhattacharyya ha
the system to be rev
wants 50% of this
process to be based
rather than the num
tions a piece of
research receives.

A clearer comme
could also stop the
from engineering ir
that has blighte
industry for the pas
the chemists, eng
rocket scientists
lured into financial
the promise of mu
pound bonuses. But
ment banks are sla
and cutting bonuse
Britain's workshop
ring from their slum

Manufacturing ir
India is no longer as
was and companies
production from eas

Advocacy: Estimating the economic returns from biomedical and health research

"Used as evidence as part of the preparation for the spending review and will be in the foreseeable future" – Science Minister

"few studies that have made a genuine attempt to objectively assess the economic returns of research" –Nature Editorial

BIS | Department for Business Innovation & Skills

The Rt Hon David Willetts MP
Minister for Universities and Science

Our ref: 2010/0080799PODW

Mr Jonathan Grant
President
Rand Europe
Westbrook Centre
Milton Road
Cambridge
CB4 1YG

23 October 2010

Dear Jonathan,

Thank you for your letter of 21 September, updating me about some of your recent work relevant to science research, it provided some very helpful and interesting analysis.

The report on "Medical Research, What's it Worth?" is regarded by BIS Analysis teams as very comprehensive and rigorous. It was used as evidence as part of the preparations for the Spending Review and it will continue to be cited in the foreseeable future. Other research areas would no doubt benefit from a similar approach and analysis.

Your study and findings on "Measuring Research Impacts" are also welcome and have helped to contribute to the evidence base on the feasibility of assessing impact systematically. Together with evidence produced elsewhere, notably in the Organisation for Economic Co-operation and Development, your

in published papers — the Nature journals are at present considering urgently necessary ones.

Unknown quantities

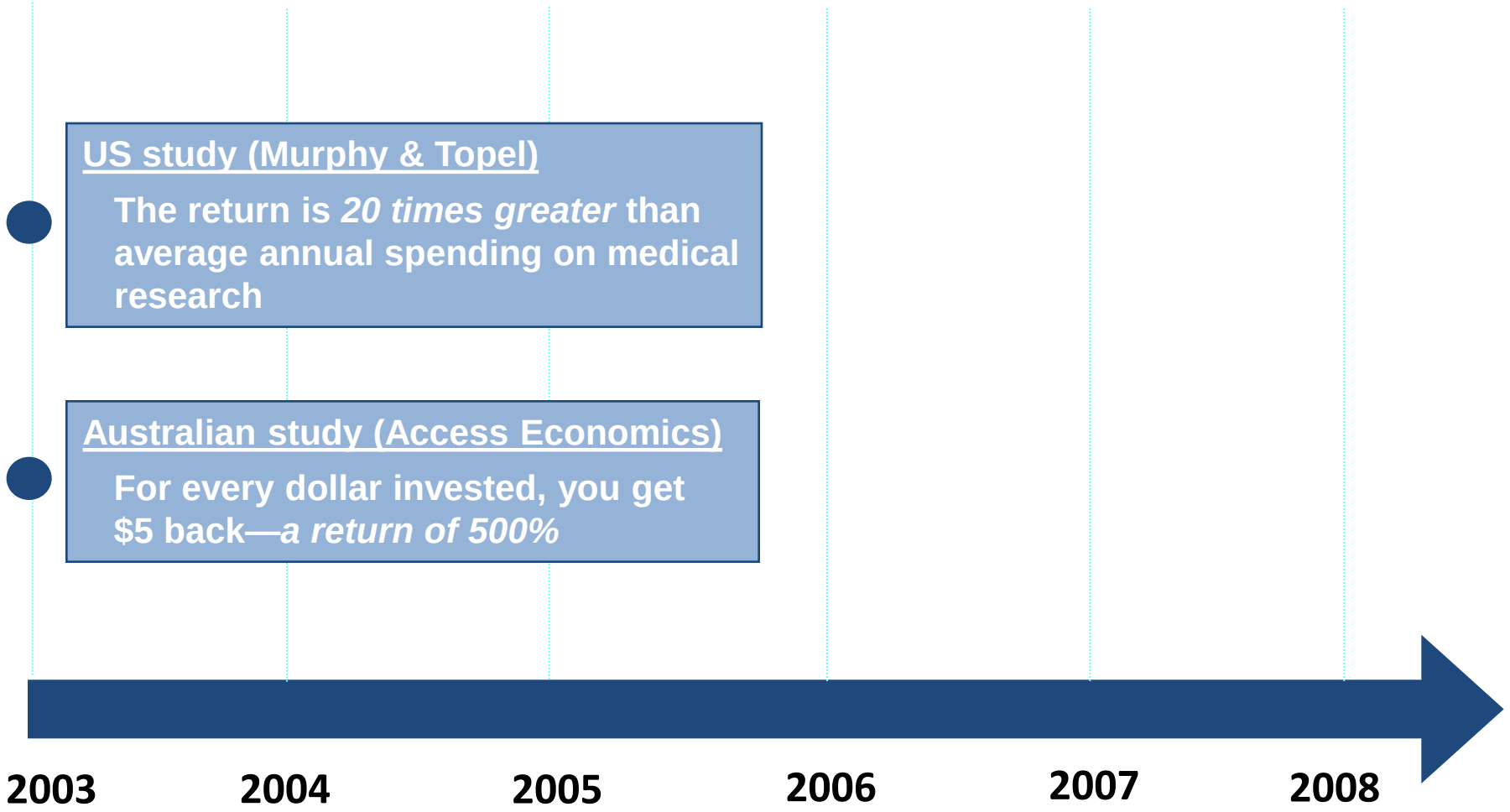
It is in researchers' interests to help funding agencies quantify the economic benefits of their work.

When research agencies are pressed by politicians to quantify the economic value of scientific research, it is only natural that they reach for whatever numbers they can find and then repeat them as well-established fact. Natural, but wrong. The reality is that few of those numbers — typically, assertions that each unit of research investment will yield a certain amount of additional research plays a substantial role in fostering innovation — by which they mean new technologies, services and business methods. They also have good evidence that innovation is essential for strong economic growth, especially when society faces constraints on key inputs such as labour, capital and materials.

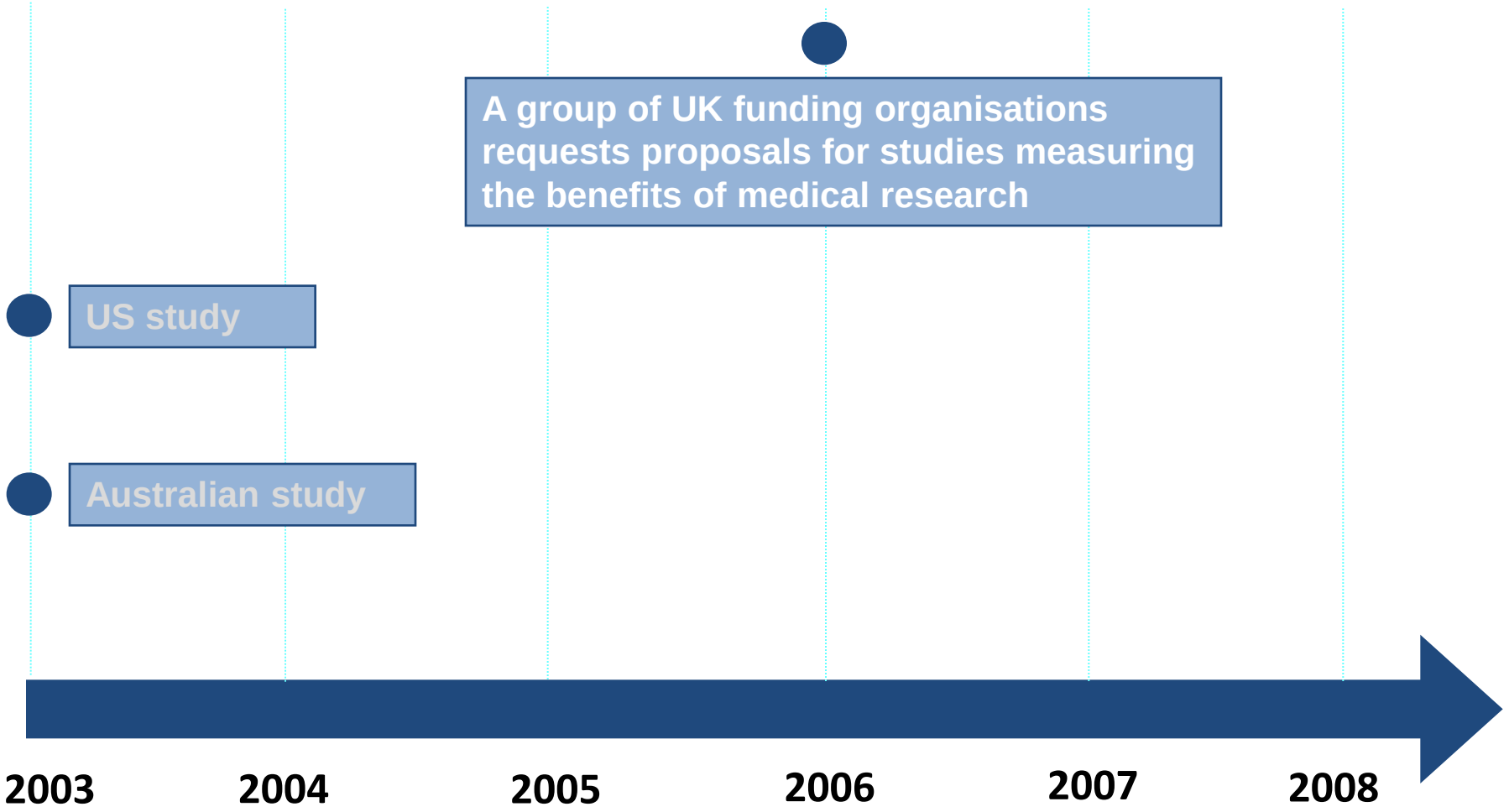
Beyond that, they can't predict which disciplines of scientific research will lead to future innovation — that would require a time machine. Nor, thus far, can they trace how additional research investment will influence a society's ability to innovate.

The problem is that innovation is not a simple, linear system in which basic research begets technology, and technology begets innovation — although that has always been the easiest model for

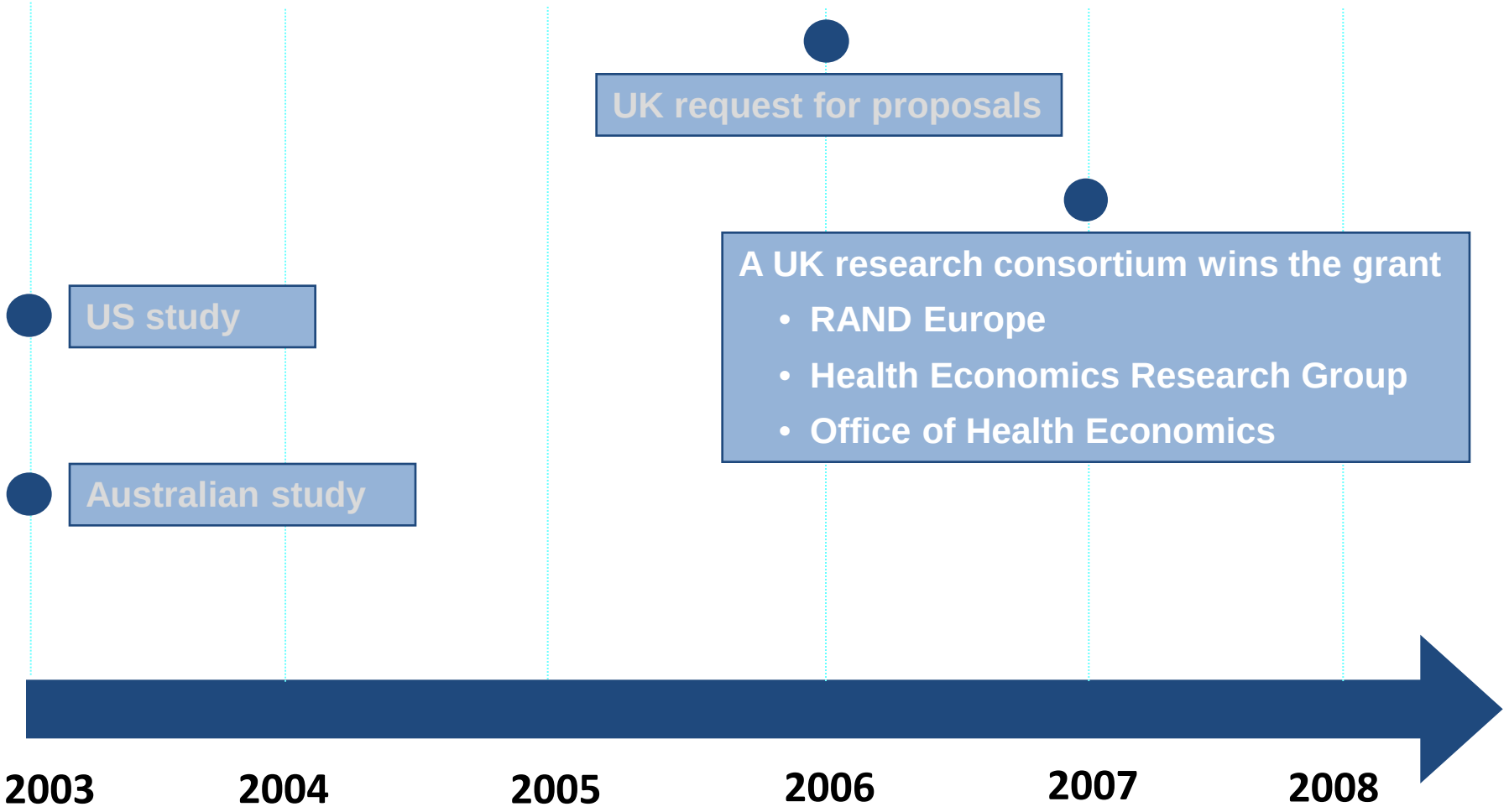
Genesis for study goes back 10 years, with two reports published in the US and Australia



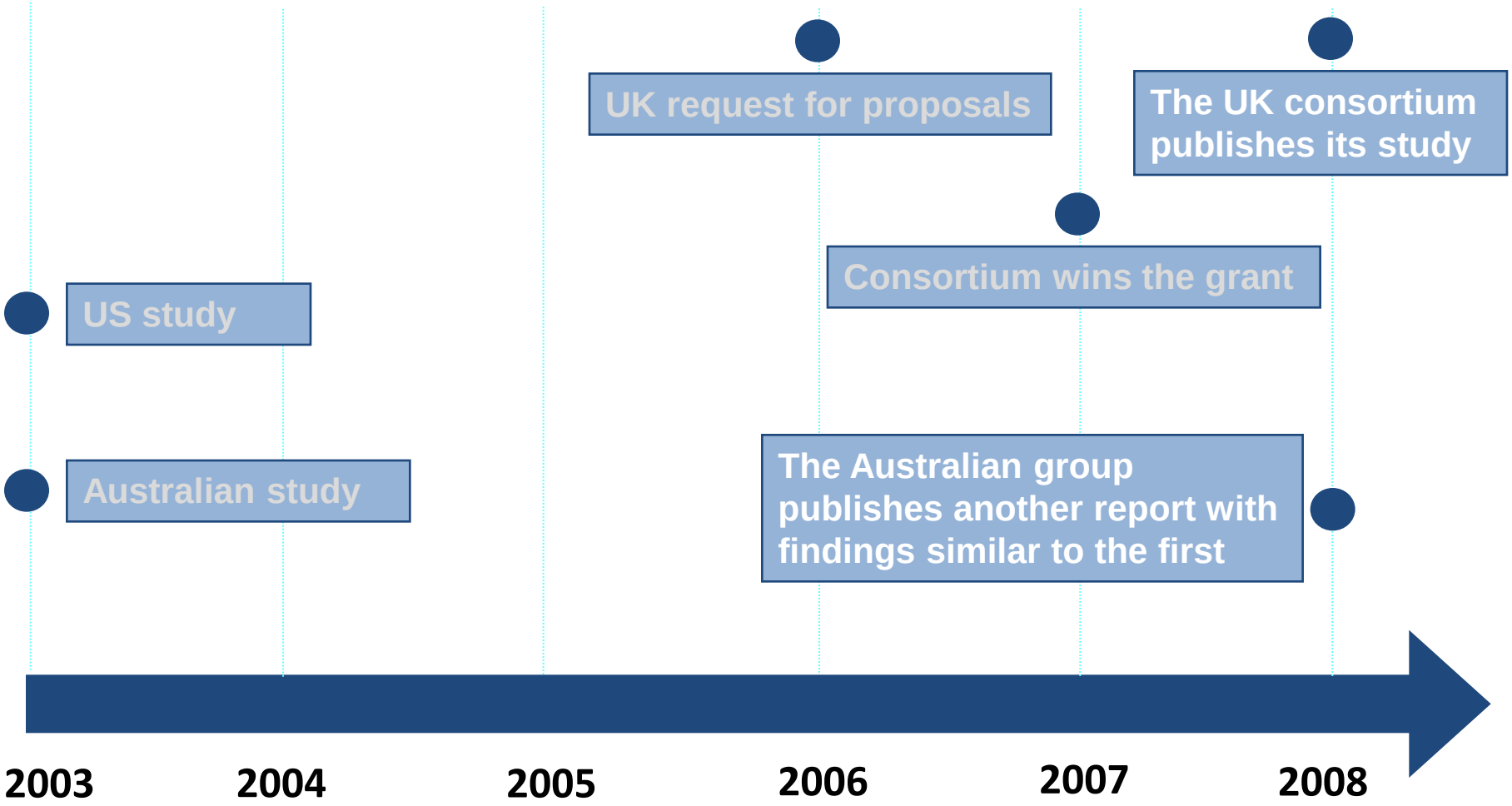
Both reports prompted debate, creating the mandate to conduct a similar study in the UK



Both reports prompted debate, creating the mandate to conduct a similar study in the UK



UK study was published in 2008, as was an update from the Australian group



Remainder of briefing will focus on the *What's it worth?* study

- Methodological approach developed to estimate the return from UK public and charitable spending on cardiovascular (CVD) research
- Compare the UK results with the previous US and Australian estimates of the economic return on medical research
- Illustrate how this work has developed a 'science of science' agenda for future work on this topic

Different elements of economic returns

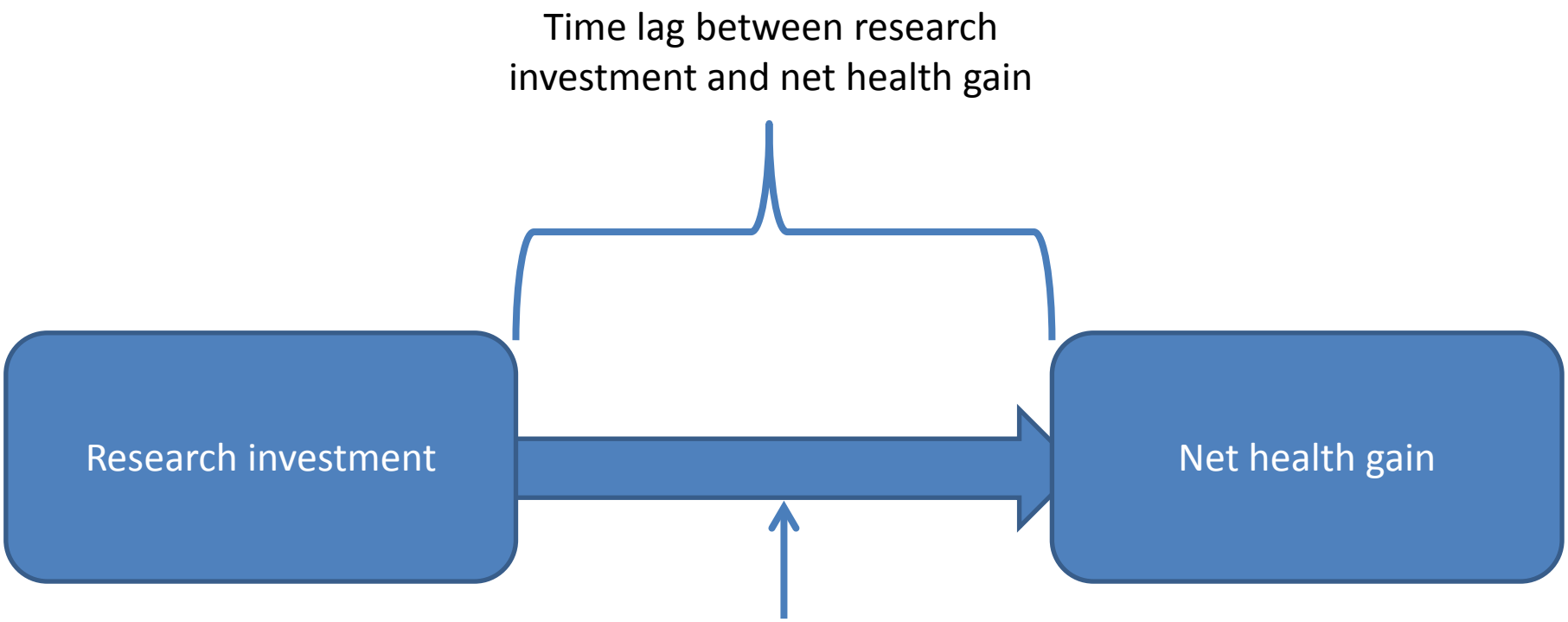
‘Spillover’ or GDP gain

- Direct and indirect impact on the economy from medical research
- Estimates to date are disease independent
- Previously estimated gains to be 30%, based on review of the literature

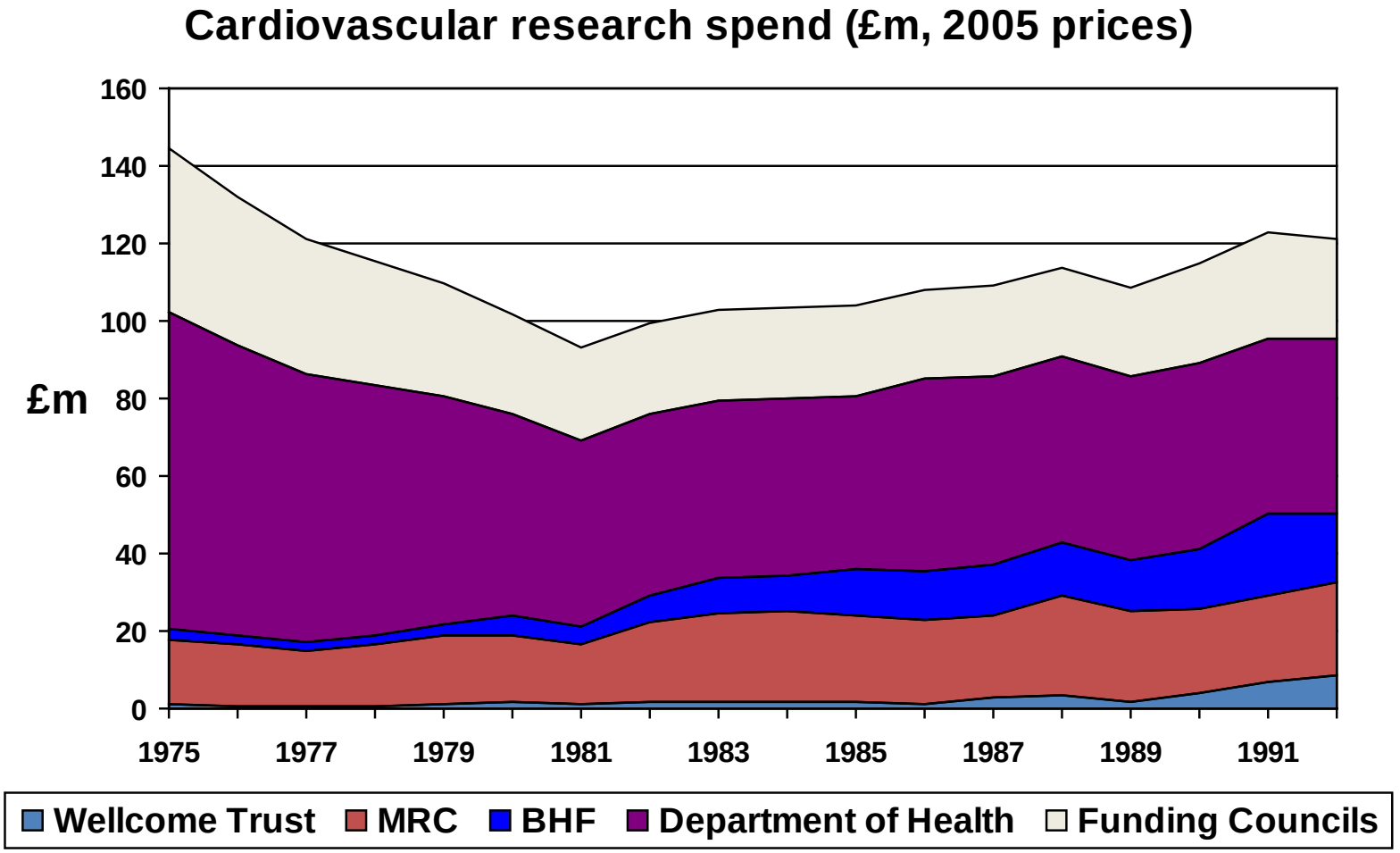
Health gain

- Monetised health gains net of the health care costs of delivering them
- Estimates to date are disease dependent, hence estimating for cancer

To calculate the health gain element, we have to make four key estimates



From 1975-1992, £2 billion in public and charitable funding went to UK CVD research



The time lag between spending on research and health gain is about 17 Years

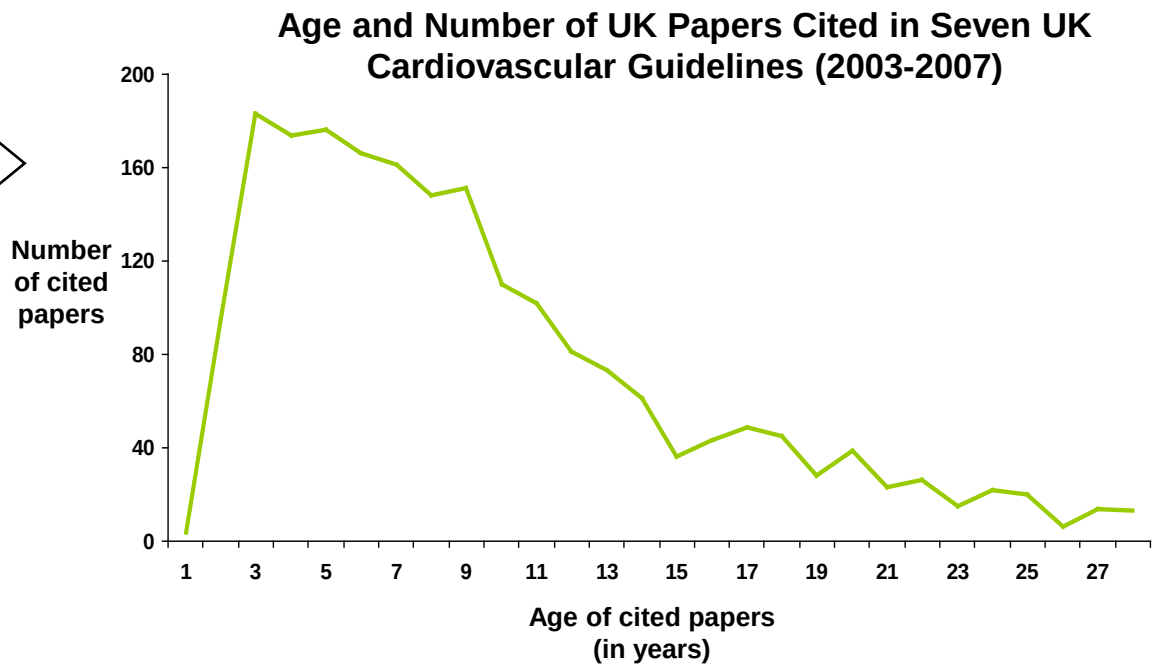
Mean age of cited papers is 12.5 years

+

Period between spending and publication

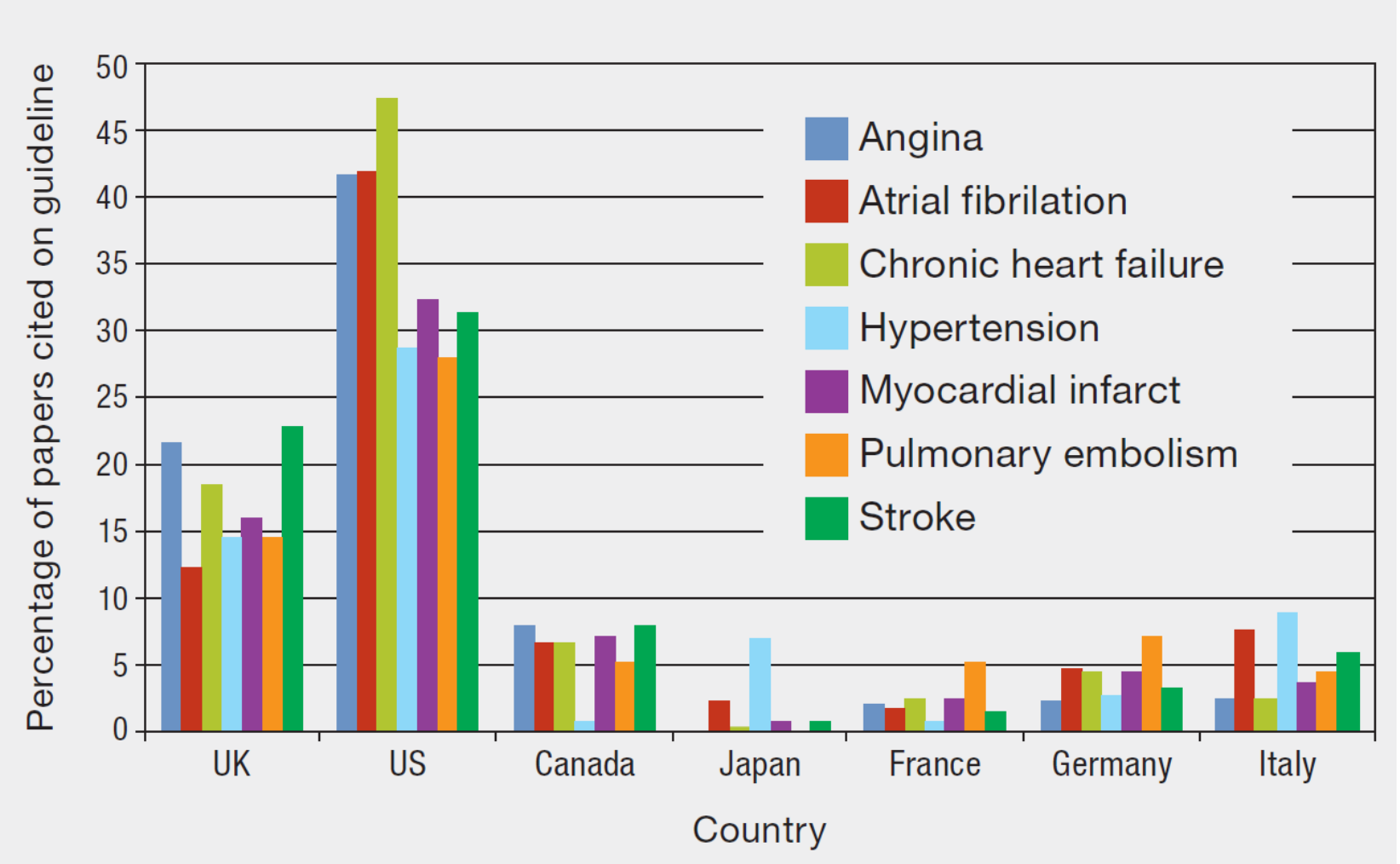
+

Period between recommendation and use

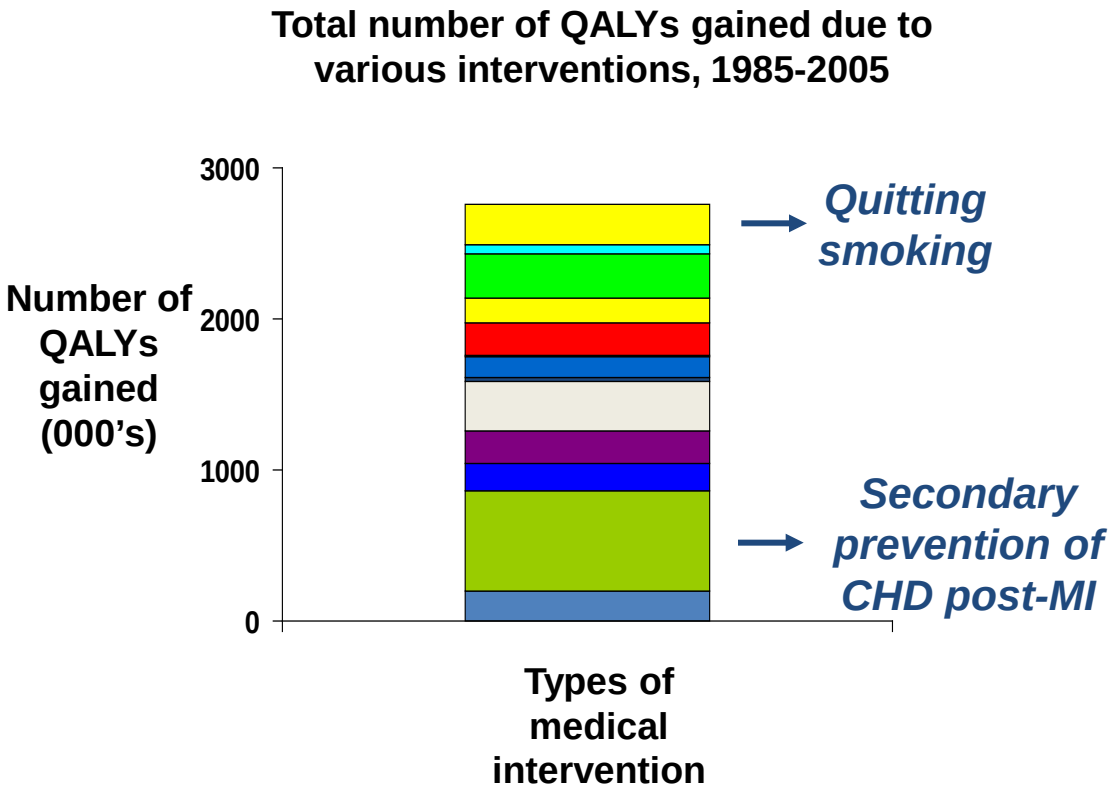


Time Lag = ~17 years

Analysis of clinical guidelines indicates that c17% of evidence is attributable to UK research



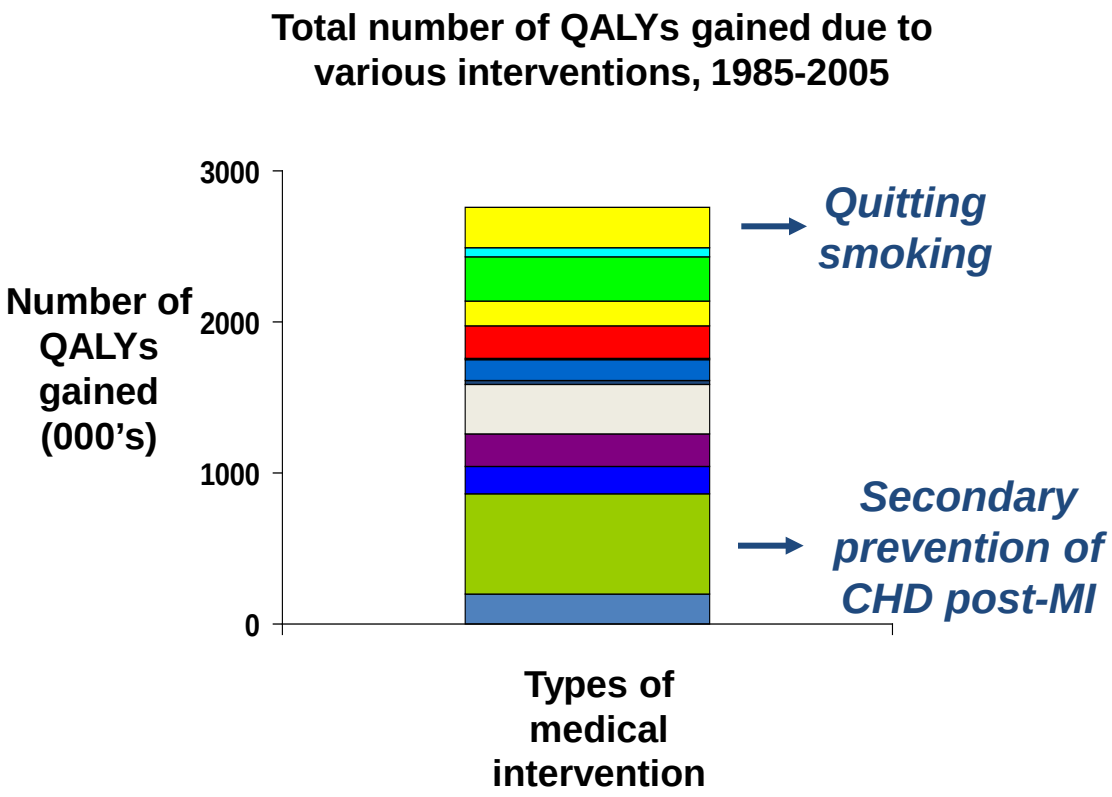
From 1985-2005, net cardiovascular health gains totaled about £53 Billion



We examined *research-based* interventions that have contributed to health gains

Quality Adjusted Life Year (QALY)
=
An additional year of quality life

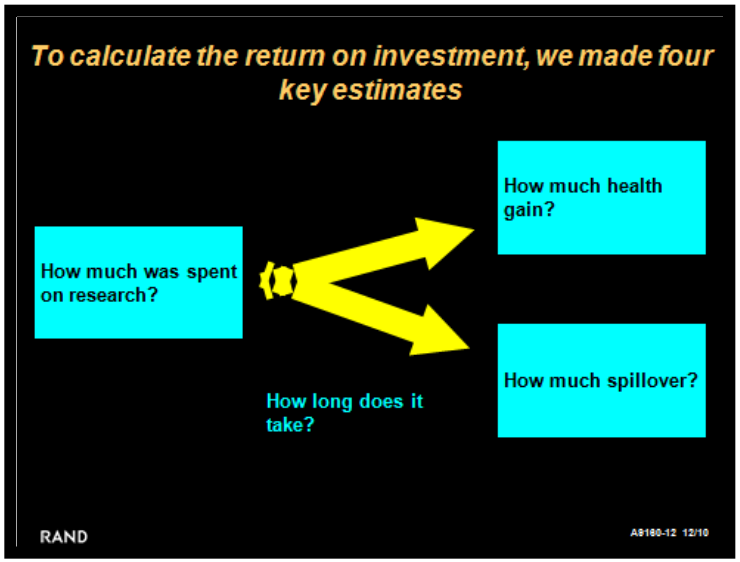
From 1985-2005, net cardiovascular health gains totaled about £53 Billion



- **A total of 2.8m QALYs were gained during this 20-year period**
- **We assigned each QALY a value of £25,000**
- **We multiplied the two to get £69 billion worth of health gains**
- **From that total, we subtracted £16 billion in costs to provide the care**

This led us to a net total of £53 billion in health gains

Combined with the spillover effects, the internal rate of return from public R&D is 39%



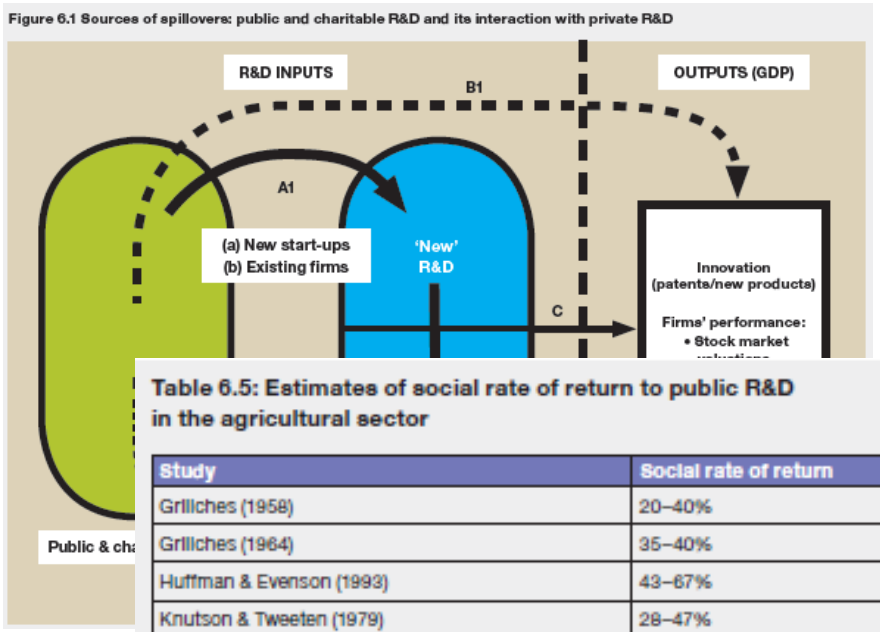


Table 6.5: Estimates of social rate of return to public R&D in the agricultural sector

Study	Social rate of return
Griliches (1958)	20–40%
Griliches (1964)	35–40%
Huffman & Evenson (1993)	43–67%
Knutson & Tweeten (1979)	28–47%
Peterson (1967)	21–25%
Schmitz & Seckler (1970)	37–46%

Sources: Griliches (1991), Salter et al. (2000)

9% + 30% = 39%

However, our numbers result in a total return dramatically lower than the other studies

UK study	US study	Australia I study
39%	“20 times”	“500%”

The studies differ in fundamental ways

The US and Australia I studies	The UK Consortium study
• Take a top-down approach – Look at overall gains in mortality & morbidity—not linked to interventions – Attribute half of these to R&D	• Uses a bottom-up approach – Identifies research-based interventions – Then quantifies health impact

The studies differ in fundamental ways

The US and Australia I studies	The UK Consortium study
• Take a top-down approach – Look at overall gains in mortality & morbidity—not linked to interventions – Attribute half of these to R&D	• Uses a bottom-up approach – Identifies research-based interventions – Then quantifies health impact
• Compare research spending and health benefits in the same year – This implies that the health gains from research are instant	• Assumes a lag of 17 years between research spending and health gains – Normally as the time lag increases, the return will fall

The studies differ in fundamental ways

The US and Australia I studies	The UK Consortium study
• Take a top-down approach – Look at overall gains in mortality & morbidity—not linked to interventions – Attribute half of these to R&D	• Uses a bottom-up approach – Identifies research-based interventions – Then quantifies health impact
• Compare research spending and health benefits in the same year – This implies that the health gains from research are instant	• Assumes a lag of 17 years between research spending and health gains – Normally as the time lag increases, the return will fall
• Do not net off the health-services costs needed to achieve the gains	• Does net off the needed health-services costs

The studies differ in fundamental ways

The US and Australia I studies	The UK Consortium study
• Take a top-down approach – Look at overall gains in mortality & morbidity—not linked to interventions – Attribute half of these to R&D	• Uses a bottom-up approach – Identifies research-based interventions – Then quantifies health impact
• Compare research spending and health benefits in the same year – This implies that the health gains from research are instant	• Assumes a lag of 17 years between research spending and health gains – Normally as the time lag increases, the return will fall
• Do not net off the health-services costs needed to achieve the gains	• Does net off the needed health-services costs
• Use a high 'willingness–to–pay' value of a life year—3 times that used in our study for a QALY	• Uses a lower 'willingness-to-pay' value (as used by UK Government)

A “What If” analysis sheds further light on these differences

1 **We used the Australia I assumptions, without their data**

- **No allowance for the costs of new health care**
- **A QALY value of approximately £75K**
- **No time lag between spending on research and health benefit**

2 **On that basis, we estimated a return on investment between 1986 - 1992**

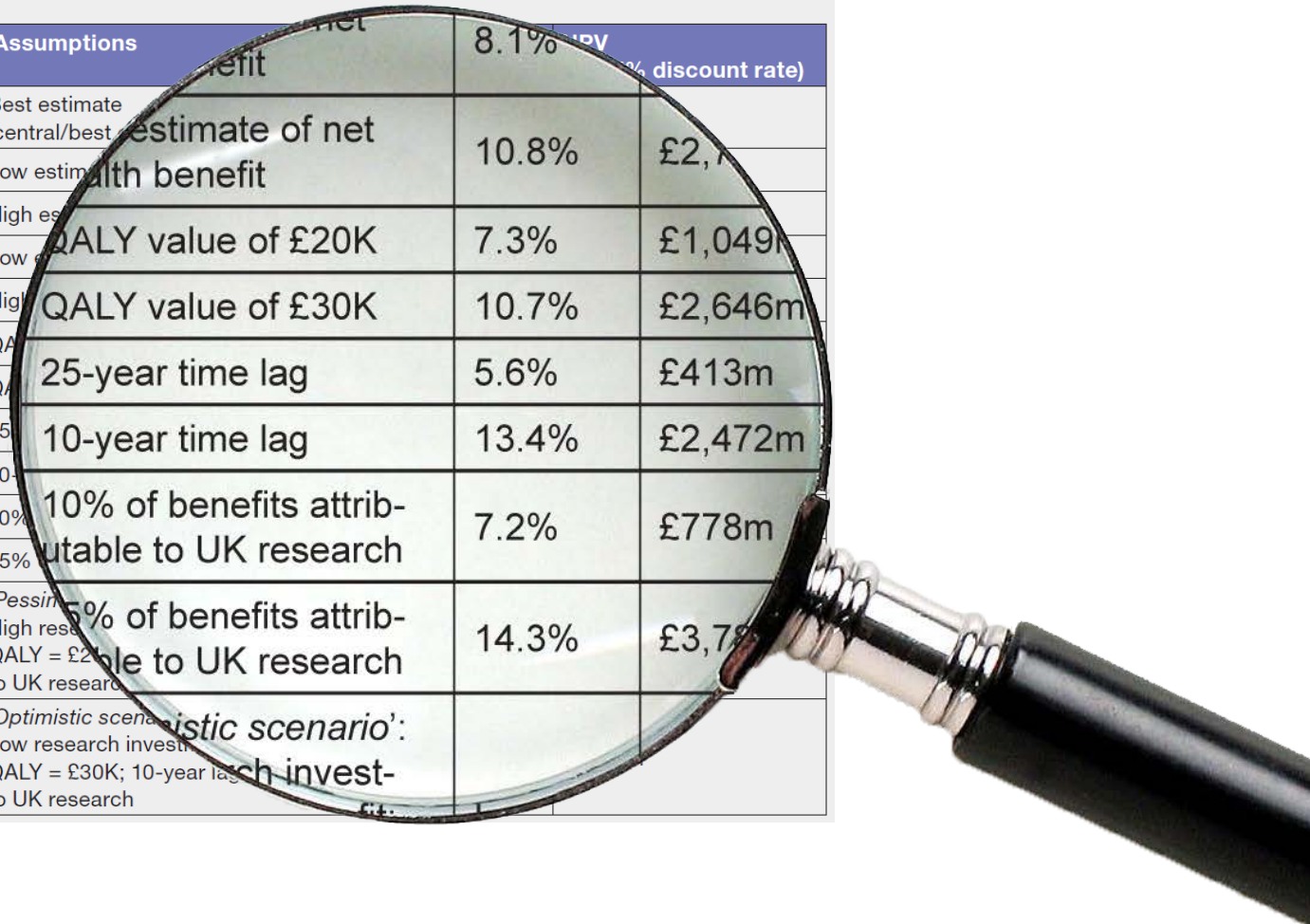
- **Total research spending = £630m**
- **Total health benefits = £5,593m**
- **Benefits for investment = 888%!**

And defines an agenda for future analysis

The time it takes to translate research is key in determining the rate of return from investment

Table 7.1: Estimated IRRs (and NPVs) for the health gain from CVD research

Assumptions	8.1%	NPV (3.5% discount rate)
Best estimate (central/best estimate of net health benefit	10.8%	£2,7
Low estim		
High es		
Low	QALY value of £20K	7.3%	£1,049
Hig	QALY value of £30K	10.7%	£2,646m
QA		
QA	25-year time lag	5.6%	£413m
25	10-year time lag	13.4%	£2,472m
10		
10%	10% of benefits attributable to UK research	7.2%	£778m
25%		
'Pessi	5% of benefits attributable to UK research	14.3%	£3,7
High res		
QALY = £2		
to UK resear		
'Optimistic scena	'Optimistic scenario':		
Low research invest		
QALY = £30K; 10-year la	ch invest-		
to UK research			



But the literature on time lags is sparse

REVIEW

The answer is 17 years, what is the question: understanding time lags in translational research

Zoë Slote Morris[1] • Steven Wooding[2] • Jonathan Grant[2]

[1]Institute of Public Health, University of Cambridge, Cambridge CB2 0SR, UK
[2]RAND Europe, Cambridge CB4 1YG, UK
Correspondence to: Jonathan Grant. Email: jgrant@rand.org

DECLARATIONS

Competing interests
None declared

Funding
This is an independent paper funded by the Policy Research Programme in the Department of Health. The views expressed are not necessarily those of the Department

Ethical approval
Not applicable

Guarantor
JG

Contributorship
ZSM designed, conducted and analysed the literature review, and drafted and revised the paper; JG initiated the project, drafted and revised the paper, and has led a number of studies cited that attempted to measure lags; SW revised the paper

Summary

This study aimed to review the literature describing and quantifying time lags in the health research translation process. Papers were included in the review if they quantified time lags in the development of health interventions. The study identified 23 papers. Few were comparable as different studies use different measures, of different things, at different time points. We concluded that the current state of knowledge of time lags is of limited use to those responsible for R&D and knowledge transfer who face difficulties in knowing what they should or can do to reduce time lags. This effectively 'blindfolds' investment decisions and risks wasting effort. The study concludes that understanding lags first requires agreeing models, definitions and measures, which can be applied in practice. A second task would be to develop a process by which to gather these data.

Introduction

Timely realization of the benefits of expensive medical research is an international concern attracting considerable policy effort around 'translation'.[1,2] Policy interventions to improve translation respond to a vast empirical literature on the difficulties of getting research across research phases and into practice.[3–11]

Both literature and policy tend to assume that speedy translation of research into practice is a good thing. Delays are seen as a waste of scarce resources and a sacrifice of potential patient benefit.[12] Although some lag will be necessary to ensure the safety and efficacy of new interventions or advances, in essence we should aim to optimize lags. One recent study (of which JG and SW were co-authors) estimating the economic benefit of cardiovascular disease (CVD) research in the UK between 1975 and 2005, found an internal rate of return (IRR) of CVD research of 39%.[13] In other words, a £1.00 investment in public/charitable CVD research produced a stream of benefits equivalent to earning £0.39 per year in perpetuity. Of this, 9% was attributable to the benefit from health improvements, which is the focus of this paper. (The remaining 30% arise from 'spillovers' benefiting the wider economy.) This level of benefit was calculated using an estimated lag of 17 years. Varying the lag time from 10 to 25 years produced rates of return of 13% and 6%, respectively, illustrating that shortening the lag between bench and bedside improves the overall benefit of cardiovascular research. What is notable is that all the above calculations depended upon an estimated time lag; estimated because, despite longstanding concerns about them,[14] time lags in health research are little understood.

It is frequently stated that it takes an average of 17 years for research evidence to reach clinical practice.[1,3,15] Balas and Bohen,[16] Grant[17] and Wratschko[18] all estimated a time lag of 17 years measuring different points of the process. Such convergence around an 'average' time lag of 17 years hides complexities that are relevant to

- Identified 23 papers that quantified time lags
- Four studies estimate 17 years
  - Grant et al 2000
  - Balas and Bohen 2000
  - HERG et al 2008
  - Wratschko 2009
- "*But few were comparable as different studies used different measures of different things at different time points*"

And there are issues of definition …

Start of time lag

- Publication
  - first description/original research
  - clinical trial
- Ethics approval
- Clinical test
- Date-of-trial registration
- Completion of study
- First submission
- Academic research
- Funding began
- Date of enabling scientific research
- Patent

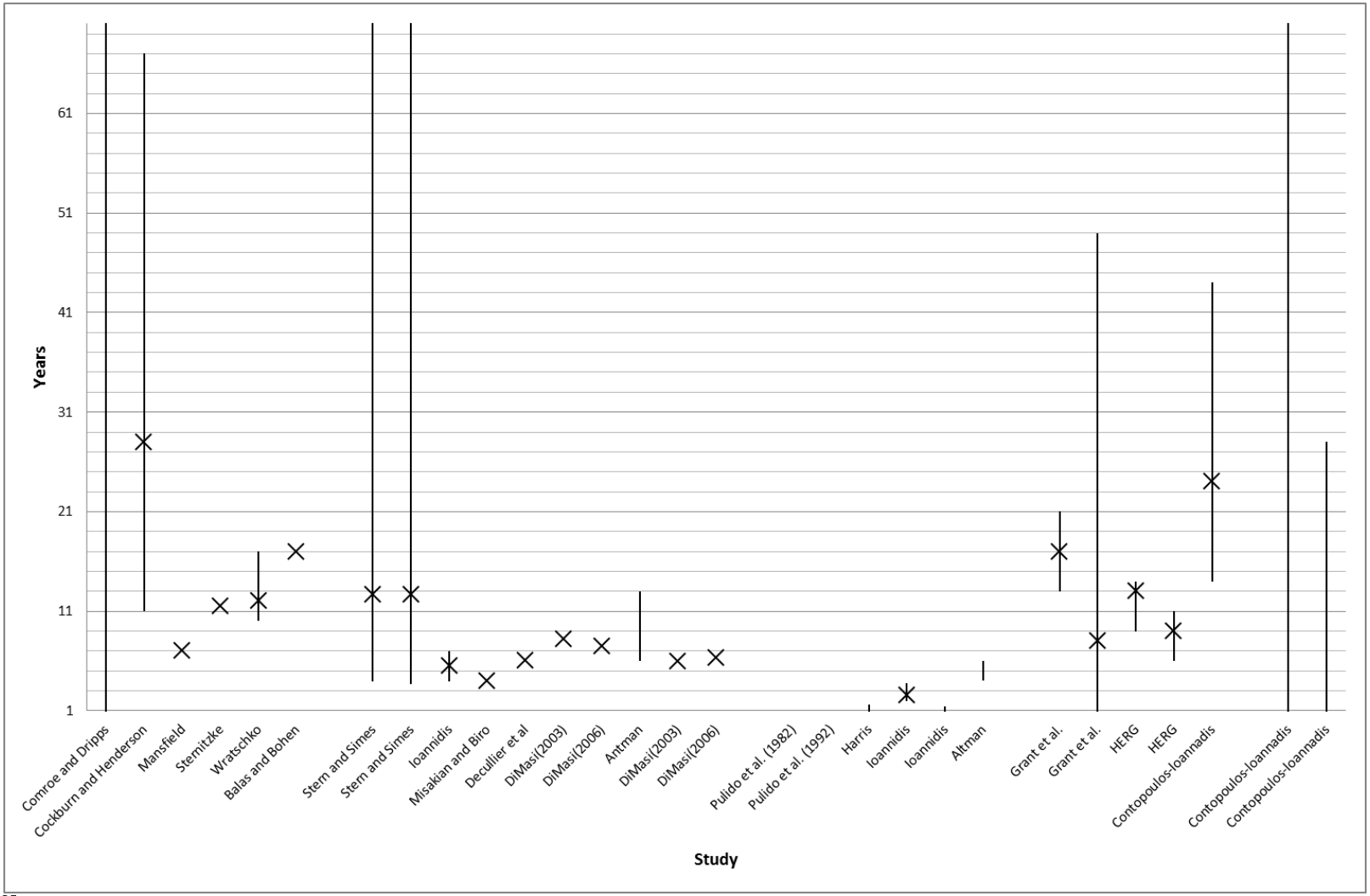
End of time lags

- First human use
- Date for first publication
- Submission to FDA
- Marketing approval
- Guideline
- Date of completion of study
- Publication
  - Describing health effects
- Commercialisation
- Highly cited publication
- Implementation
- Date to market
- New entities
- Clinical advances
- First specific use

The issue of measurement and distributions…

- From when to when
- Mean or median (sometimes “average”)
- Ranges are seldom reported
- Aggregation of different phases

And variance, although 17 years is a common estimate for ‘bench to bedside’



Morris et al 2011

Key messages

- Know why you are measuring research
  - What is the objective of the research evaluation?
- Use a ‘multi-method, multi-dimensional’ approach
  - Don’t rely on one method (e.g., bibliometrics)
- (Research) measurement is not easy
  - No (research) funder has the answer
- Need to move from advocacy to accountability
  - Need ‘science of science’ to understand what works
  - Need a practical evidence base for science policy
  - Need to ‘walk the talk’

Bottom line – you have to measure research if you want to improve the way it is funded


RAND
EUROPE