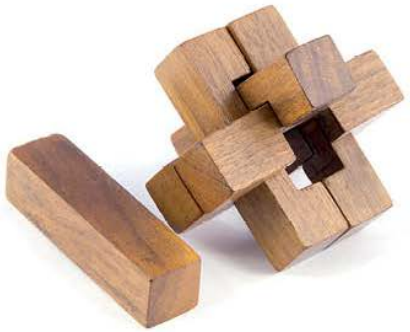


BANFF, CANADA September 7–11, 2014

The International School on Research Impact Assessment

Economic Returns

Martin Buxton

Emeritus Professor, Brunel University

September 10, 2014

Hosted by: Alberta Innovates Health Solutions

In partnership with: Agència de Qualitat i Avaluació Sanitàries de Catalunya — AGENCY FOR HEALTH QUALITY AND ASSESSMENT OF CATALONIA; RAND EUROPE

Session overview

- Introduction: the broader questions
- When and why such studies be most useful?
- Spillover effects on GDP
- The return on investment from the net value of the health gains generated
  - Case study: The returns to public/charitable cancer research in the UK
- Key messages
- Recommended readings

Learning outcomes

- Identify the purpose of the method
- Select when this method is appropriate to use for an assessment
- Understand key methodological issue and the challenges in using the method
  - Design, data sources and collection, analysis, assumptions and reporting

The broader questions

- Is investment in medical research a good investment for the country or region?
- Does it help the economy overall?
- Can we put a value on the health impacts of medical research?
- Can we compare the return with that which could be achieved by using the “money” in a different way?

When to use economic approaches

- Answering economic questions for particular audiences
- Heavily dependent on times series of good data
  - Especially difficult at a sub-national level
- The ‘power’ of a ‘numerical’ answer
- Generally not possible to link economic returns to individual research funders or programmes

What is meant by economic returns?

- Generally returns valued in terms of currency ($, £, yen, etc.)
- Traditionally has focused on impact on GDP
- But may use other “economic indicators”
  - Jobs created
  - Value of commercial medical products sector
- But may also include other valued outcomes (such as improved health)

Rates of return

- Emphasises that health research is an investment
- Competing for resources with
  - Other research investments
  - Other general investments (e.g., infrastructure)
  - Other current consumption (e.g., current health care)
- Therefore, there is always an opportunity cost
  - The value of what could have been achieved with the resources used in an alternative manner

Previous studies of return to health research

- Direct savings to health care system
  - Eg: savings resulting from HTA projects in Quebec (Jacob and MacGregor, 1997)
- Benefits to the economy from a healthy workforce/avoidance of lost production
  - Eg: benefits to work-force in various countries from control of Chagas disease (Moncayo, 2003)
- Benefits to the economy from related commercial development
  - Eg: benefits to USA from methodology for producing monoclonal antibodies (Raiten and Berman, 1993)

Previous studies of return to health research *(cont'd)*

- Generalised spillover effects as reflected in GDP
  - Eg: Review and estimates for UK (HERG, OHE & RAND, 2008)
- Intrinsic value of health gains
  - Eg: Returns from cardiovascular research in UK (HERG,OHE & RAND, 2008) and in Canada (Oliveira et al, 2013)

Adapted from Buxton et al, 2004

Which economic focus and why?

- Focus depends on:
  - national or regional context
  - stated purpose (claims for) research investment
  - key concerns of the primary audience for the assessment
- For example, focus on effect on workforce is likely to be much more important in developing country than in a mature economy with a generally healthy population

Today's foci:

- **Spillovers**
  - Economic return directly relating to GDP
  - Area of much current interest and often a key argument for public investment in research generally
- **Net value of health gains**
  - Economic measure directly reflecting the stated aims and purpose of most charitable medical research funding
  - Approach that is being used increasingly in a number of countries (USA, Australia, UK, Canada)

Spillover effects

- GDP benefits to third parties (primarily, but not exclusively, the private pharmaceutical/ biomedical industry) generated by public medical research investment
- Research investment leads to:
  - Innovation (patents and new products or processes)
  - Improved performance and growth of firms

Spillover effects *(cont'd)*

- Many mechanisms involved, including:
  - Skilled labour
  - Shared knowledge and networks
  - Encouraged entrepreneurship (new start-ups, etc.)
- Geographical dimension to spillovers
  - Narrow locality (science parks)
  - Broader regions (golden triangle [UK]; Silicon Valley, California)
- A by-product OR the main reason for investment?

Measuring spillovers

- Relatively complex econometric analysis
- Requires reliable long time series of data
- Basically measures the lagged effect of changes in public/charitable research on changes in private sector R&D or private sector activity as a whole
- As a result, relatively few studies have been undertaken…

But estimates suggest…

- ***Providing*** we can generalise from limited, mainly US data (not all relating to medical research)
- Substantial returns:
  - Internal rate of return of 20%–67%
  - Our best estimate of around 30%

From HERG, OHE, RAND, 2008

But what about the health gains?

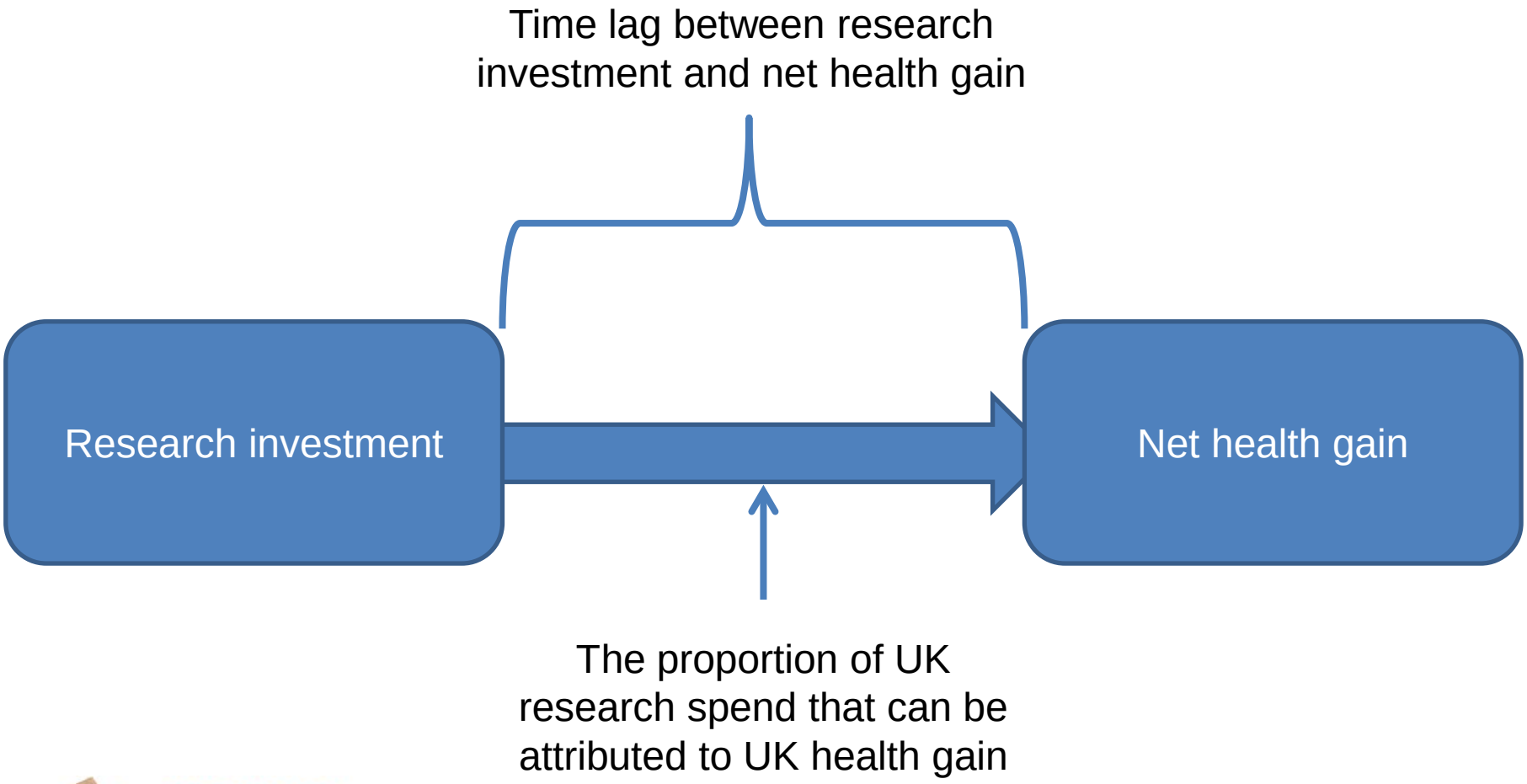
- The overt reason for investing in medical research is to improve health
- This is clearly valued—but not valued within traditional economic accounting (e.g., GDP)
- Can we estimate a rate of return on the investment in research in terms of the net value of the health generated?

But what about the health gains? *(cont'd)*

- A number of studies have now been undertaken, and a methodology developed
- Case study:
  - The economic returns from publicly and charitably funded cancer related-research in the UK

Glover et al, 2014

To calculate the health gain element requires four key estimates



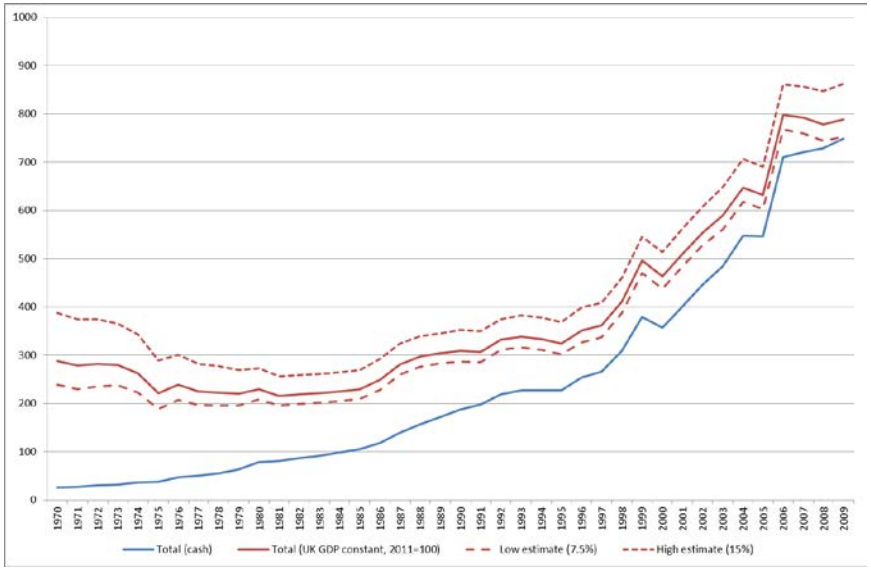
Estimating research investment

Approach

- Collated funding data for 11 research funders, 1970-2009 (40 years)
- Used a combination of public domain sources (e.g., annual reports, government S&T statistics), data provided to us directly from the funders with help of NCRI, and data provided by NCRI
- Made a number of assumptions in developing the time series
- Presented data in current (2011/12) prices including high/low estimates derived from assumptions

UK research investment

- Between 1970-2009, £15b (in 2011/12 prices) of public and charitable funding was invested on cancer-related research in the UK



Assumptions, limitations and caveats

- Costs of private sector research and development (R&D) investments are accounted for in our analysis as elements within the cost of delivering health care as they are assumed to include the private sector's return on its R&D investments
- Definitions of the cancer-related research used by the research funders captures basic research that may have contributed to developments in this area
- Total net flow of knowledge between disciplines is zero

Estimating the time lags from research to impact using clinical guidelines

- We analysed cited references on clinical guidelines
  - Look at the time difference between the date of publication of the guideline and the average date of publication of cited references (i.e., “knowledge cycle time”)
  - Look at the proportion of papers that cite a UK address from the papers cited on guidelines
- We extracted and matched to the Web of Science 90% of cited papers from 22 clinical guidelines

Estimating the time lags from research to impact using clinical guidelines *(cont'd)*

- The time lag between spending on research and health gain is estimated at 15 years

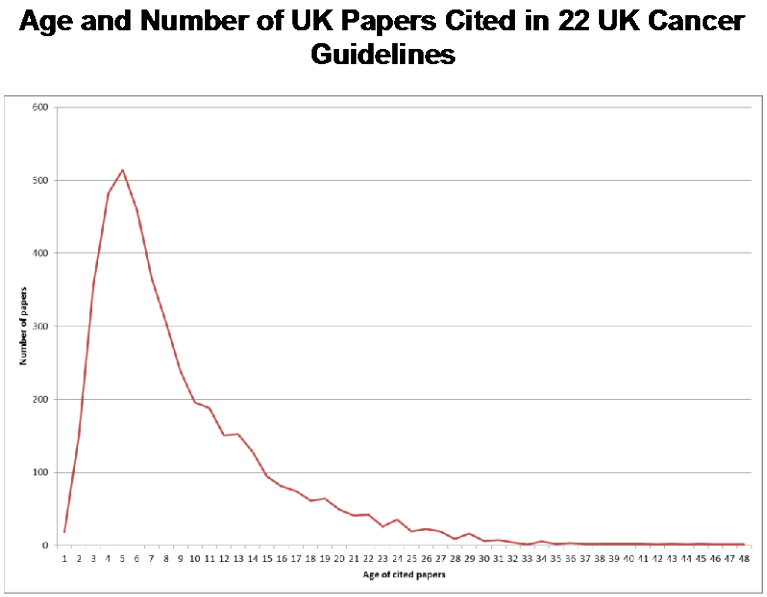
Mean age of cited papers is 8 years

+

Period between spending and publication

+

Period between recommendation and use



Time Lag = ~15 years

Assumptions, limitations and caveats

- The knowledge cycle time is largely determined through bibliometric analysis of clinical guidelines
  - The case studies demonstrate the complexity of biomedical and health innovation, especially when trying to measure the time by which it takes for research to develop into health benefits
  - Whilst the bibliometric approach provides us with an empirical estimate of both time lags, it inevitably is a gross simplification of a complex process

Estimating the attribution to UK research using clinical guidelines

Guideline	Country	P	% P
NHS Screening: Bowel	GREAT BRITAIN	2	100
NHS Screening: Breast	GREAT BRITAIN	9	53
NICE: cancer referal	GREAT BRITAIN	104	30
NICE: Early_breast_canc	GREAT BRITAIN	102	15
NICE: Fam Breast	GREAT BRITAIN	50	26
NICE: Prostate	GREAT BRITAIN	14	12
NICE: Spine	GREAT BRITAIN	10	13
RCOA:CSQ_Lymph	GREAT BRITAIN	16	27
RCOG: PregBreastCanc	GREAT BRITAIN	10	8
RCP: Mgmt_Lung_canc	GREAT BRITAIN	49	13
SIGN: Bladder	GREAT BRITAIN	27	16
SIGN: Breast	GREAT BRITAIN	46	15
SIGN: Cervical	GREAT BRITAIN	28	13
SIGN: Childhood	GREAT BRITAIN	63	21
SIGN: Colorectal	GREAT BRITAIN	54	25
SIGN: Head & Neck	GREAT BRITAIN	46	8
SIGN: Lung	GREAT BRITAIN	53	16
SIGN: Melanoma	GREAT BRITAIN	42	13
SIGN: Oesophageal	GREAT BRITAIN	64	17
SIGN: Ovarian	GREAT BRITAIN	29	44
SIGN: Pain	GREAT BRITAIN	33	16
SIGN: Testicular	GREAT BRITAIN	51	22
	average		24
	Total	903	**17%**

- Analysed 4051 publications to estimate attribution

17% of addresses on papers were from the UK

Assumptions, limitations and caveats

- The rate of attribution is largely determined through bibliometric analysis of clinical guidelines
  - Whilst the bibliometric approach provides us with an empirical estimate to attribute health gain to UK research, it inevitably is a gross simplification of a complex process

Estimating health gain—overview of approach

- Prioritise main sources (by cancer type or intervention) of health benefits delivered in the period 1991-2010
- For each relevant intervention considered, identify relevant studies that have estimated:
  - The (discounted) life time quality adjusted life year (QALY) gains; and
  - The (discounted) net health service costs

Estimating health gain—overview of approach *(cont'd)*

- Estimate numbers of new patients receiving each intervention in each year
- Calculate total QALY gains derived from patients starting treatment with each intervention by year and the net health service costs of doing so
- Place a monetary value on the QALYs gained (using a base case of £25k) and net off the costs

Prioritisation of areas to assess health gains

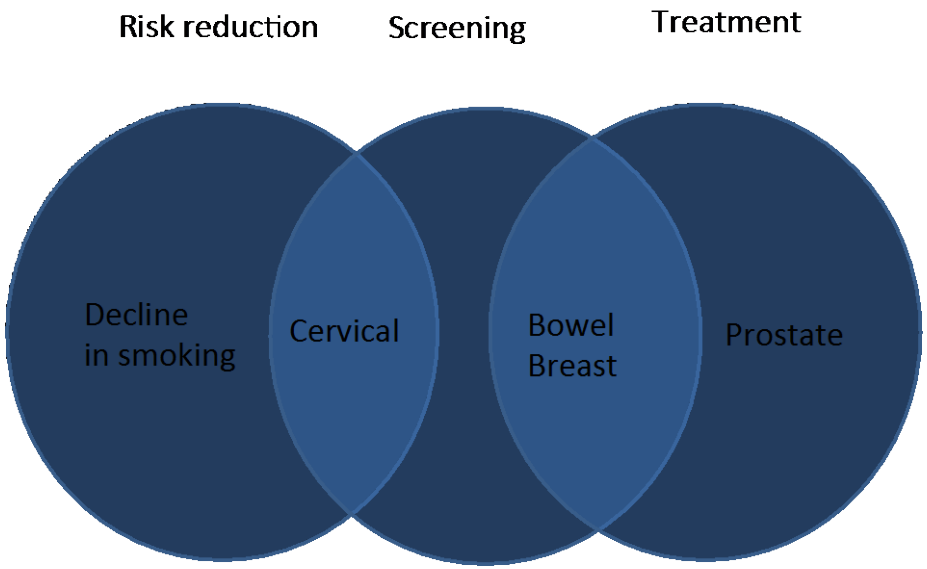
Prioritising cancer sites to investigate health gains and linking to NHS cancer guidance

Key areas where research and resultant health policies have led to health gains through a *reduction in incidence*

Cancers for which screening programmes have led to health gains from *early detection*

Cancer sites where there has been the most significant health gains from *increased survival*

Prioritised sites/source of net health gain



Summary of estimates for net monetary benefit (net value of health gain): UK

Years 1991-2010	TOTAL QALYS GAINED (thousands)	NET NHS COSTS (£ million)	NET MONATARY BENEFIT (£ million)
Reduction in smoking	3,003	- £5,358	£80,437
Breast cancer screening	43	£894	£179
Cervical screening	1,225	£704	£29,927
Bowel cancer screening*	35	- £75	£960
Breast cancer interventions	1,112	£15,469	£12,318
Colorectal cancer interventions	173	£3,755	£566
Prostate cancer interventions	339	£8,403	£65
Total net health gains	**5,930**	**£23,793**	**£124,452**

*Only implemented in full from 2010

Number of patients receiving prostate cancer treatments 1991-2010

		Number of patients receiving intervention (England)				
Patient Group	Intervention	1991	1992	Annually to	2009	2010
Low risk localised	Watchful waiting	5,481	6,125		5,397	5,443
	Active surveillance	0	0		577	533
Intermediate risk localised	Radical Prostatectomy- Open	1,529	1,387		2,196	2,423
	Radical Prostatectomy- Laparoscopic	0	0		1,220	1,454
	Radical Prostatectomy- Robotically assisted laparoscopic	0	0		610	969
	Radical Radiotherapy- Brachytherapy	0	0		1,032	1,092
	LHRH analogue (short course)	4,692	5,243		11,324	11,030
Intermediate/high risk localised	Radical Radiotherapy- Conventional external beam	4,834	5,401		1,190	1,200
	Radical Radiotherapy- 3DCRT	0	0		10,707	10,800
High risk localised/ locally advanced	LHRH analogue (long course)	3,128	3,495		7,549	7,353
	Nonsteroidal antiandrogen	0	0		4,149	2,732
Advanced/Metastatic	Bilateral Orchiectomy	703	785		260	266
	Diethylstilbestrol	297	270		2,120	2,583
	LHRH analogue	3,970	4,436		9,582	9,333
	Nonsteroidal antiandrogen	0	0		5,267	3,467
Castration resistant	Prednisolone	1,096	1,225		2,792	2,694
	Mitotaxtrane and prednisolone	1,644	1,837		1,033	996
	Docetaxel	0	0		2,920	3,113

LHRH = Luteinizing-hormone-releasing hormone (goserelin and leuprorelin) 3DCRT= 3 dimensional conformal radiotherapy

Net monetary benefit resulting from prostate cancer treatments 1991-2010

		Net Monetary Benefit (NMB)					
Patient Group	Intervention	1991	1992	Annually to	2009	2010	Total intervention NMB
Low risk localised	Watchful waiting	£.0m	£.0m		£.0m	£.0m	£.0m
	Active surveillance	£.0m	£.0m		£4.4m	£4.0m	£12.3m
Intermediate risk localised	Radical Prostatectomy- Open	£.4m	£.4m		£.6m	£.7m	£11.1m
	Radical Prostatectomy- Laparoscopic	£.0m	£.0m		£.0m	£.0m	£.0m
	Radical Prostatectomy- Robotically assisted laparoscopic	£.0m	£.0m		-£.3m	-£.5m	-£1.4m
	Radical Radiotherapy- Brachytherapy	£.0m	£.0m		£8.3m	£8.8m	£34.2m
	LHRH analogue (short course)	£100.0m	£111.7m		£241.2m	£235.0m	£3809.5m
Intermediate/high risk localised	Radical Radiotherapy- Conventional external beam	-£.1m	-£.2m		£.0m	£.0m	-£3.4m
	Radical Radiotherapy- 3DCRT	£.0m	£.0m		£71.7m	£72.3m	£366.5m
High risk localised/ locally advanced	LHRH analogue (long course)	£41.5m	£46.3m		£100.1m	£97.5m	£1580.2m
	Nonsteroidal antiandrogen	£.0m	£.0m		£35.2m	£23.2m	£175.7m
Advanced/Metastatic	Bilateral Orchiectomy	£.0m	£.0m		£.0m	£.0m	£.0m
	Diethylstilbestrol	£.0m	£.0m		£.0m	£.0m	£.0m
	LHRH analogue	-£136.4m	-£152.4m		-£329.2m	-£320.6m	-£5197.8m
	Nonsteroidal antiandrogen	£.0m	£.0m		-£83.5m	-£54.9m	-£708.4m
Castration resistant	Prednisolone	£.0m	£.0m		£.0m	£.0m	£.0m
	Mitotaxtrane and prednisolone	£.9m	£1.0m		£.6m	£.6m	£23.0m
	Docetaxel	£.0m	£.0m		-£6.4m	-£6.8m	-£35.6m
	Total annual NMB	**£6.3m**	**£6.9m**		**£42.7m**	**£59.0m**	**£66.0m**

Assumptions, limitations and caveats

- Our base case valued of a QALY is £25 thousand
- The total net monetary benefit for interventions not covered is zero
- The total net flow of knowledge between disciplines is zero
- All health gain from treatments is captured in the estimates of the health gain from specific interventions

Assumptions, limitations and caveats *(cont'd)*

- We made various assumptions about the baseline treatment against which we were looking at research-based developments
- There is a risk that we may have double counted the NMB for individuals who are treated as a result of screening

Calculating the Internal Rate of Return (IRR)

- A method for comparing the value of the return on an investment in a way that means it can be compared with the return on other quite different investments of different sizes timings and uses
- Specifically important here as the literature on “spillover benefits”(the GDP benefits of medical research) presents results as IRRs
- It combines our stream of investment costs (research investment) and our lagged stream of net monetary benefits to calculate…

Calculating the Internal Rate of Return (IRR) *(cont'd)*

- …the "rate of return" that makes the net present value (NPV) of the combined stream equal to zero
- An IRR of 10% means that the profile of investments and returns are equivalent to receiving a 10% return in perpetuity on the capital investment
- If we used NPV the standard discount rate for appraisal of government investments would be 3.5%, so an IRR of 3.5% can be seen as the minimum required

The estimated IRR for cancer related-research is 10%

	Cancer
Total annual research investment between 1976-1995* (in constant 2011/12 prices)	£5b
Total net monetary benefit 1991 – 2010 (in constant 2011/12 prices)	£124b
Attribution (proportion of papers that cite a UK address from the papers cited on guidelines)	17%
Time lag (average time between publications of cited paper and clinical guideline, plus period between funding and publication and guidelines and implementation)	15 years
Internal Rate of Return (for health gain)	10%

*Note this is a subset of the £15b estimated for 1970 to 2009 to take into account the time lag

One-way sensitivity analyses of IRR against base estimate of 10%*

Variable	Scenario	IRR
Research Funding	High	10.8%
	Low	8.7%
Value of QALY	£20k	8.0%
	£30k	11.7%
	£50	16.0%
	£70	18.9%
Time lag	10 years	14.5%
	20 years	7.4%
Attribution to UK research	10%	6.1%
	25%	13.3%
Smoking cessation	Decrease NMB by 25%	8.7%
	Increase NMB by 25%	11.2%
	Omitting benefit of smoking reduction	2.4%

**Best estimate for research funding and net monetary benefit, QALY value of £25k, time lag of 15 years, and attribution to UK research of 17%)*

If we include our previous best estimate of the "spillover" gain then the total IRR is in the order of 40%

Spillover or GDP gain

c 30%

+

Net health gain

c 10%

Strengths of economic approaches

- Convincing to those who do not start from an inherent belief in the value of medical research – Departments of Finance or Treasury
- In principle, can be compared with estimates for investing in other (research) sectors
- Emphasises the necessary linkages to changes in medical practice, the time-lags involved and the long-term nature of the returns
- Reflects actual previous returns not potential for the future

Weaknesses of economic approaches

- Complex analyses requiring substantial long-term data and significant assumptions
- Cannot be related to individual steams of research funding
- Emphasises the international nature of the evidence-base for innovations in health care

Learning activity

- In your country, which influential audience might be most persuaded by measures of economic returns?
- Which specific economic focus would be most relevant?
- What do you think might be the greatest challenges to undertaking such a study?

Key messages

- Major GDP and health-related returns have been and can in future be demonstrated
- They involve substantial data, analysis and significant assumptions
- They demonstrate the (past) returns to the aggregate of medical research (in a particular area) at a national (or regional) level

Key messages *(cont'd)*

- Such studies have been shown to be influential in the protection of medical research funding streams
- Analysis of net health gains provides additional insights as to how and where greater benefit of research could be achieved and emphasise that to have net value interventions have to be cost-effective
- But the past may be a poor indicator of the future

Recommended readings

Refer to the handout *Further Reading on Economic Returns* in your binder

Thank you!

Martin Buxton

Brunel University

Martin.Buxton@brunel.ac.uk