



Measuring the Impacts of Open Access to Research Findings

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Background

Background to Open Access

Concern about access to research findings:

- Including data and publications (*e.g.* Genome, Hubble).
- Influence of the private sector and IP control (*e.g.* patenting).
- Turns tragedy of commons into a tragedy of anti-commons.
- Efforts to re-establish science commons (*e.g.* CODATA/GICS).

Publishing – concern about journal prices:

- Prices well ahead of CPI and evidence of monopoly.
- Many institutions & countries can't afford to access journals.
- Also reduces availability of books (*e.g.* substitution), and opportunities to publish books.

Public pay for R&D, results given away, then buy it back?

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CSES work for DEST in 2003

(1) Changing Research Practices in the Digital Information and Communication Environment

- We looked at emerging research practices and research infrastructure needs.
- Found new research communication needs, and new possibilities.
- Recommended review of infrastructure – including establishing Open Access Institutional Repositories.
- Recommended review of incentives – including aligning research evaluation and access.
- Subsequently – DEST announced an Accessibility Framework and linked it to the Research Quality Framework.

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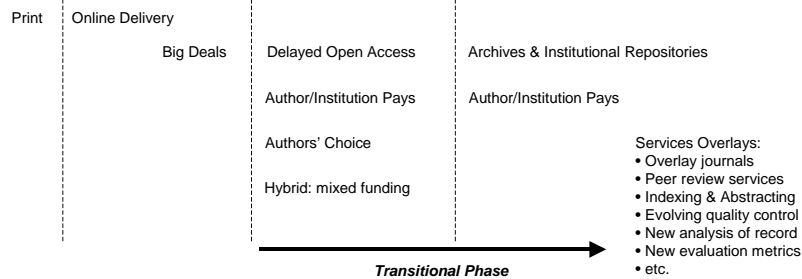
Evolution of research communication

Infrastructure Platform

Paper | Internet | High Bandwidth / HPC | E-science Grid →

Publishing Business Model

Subscription | Hybrids | Open Access →



Mode of Knowledge Production

Disciplinary (Mode 1) | Transdisciplinary (Mode 2) →

Knowledge production contained in specialist institutions (e.g. Universities).
Linear notion of invention, innovation and diffusion.
Evaluation internal (e.g. peer review).
etc.

Knowledge production diffuse and collaborative.
Invention, innovation and diffusion involve complex feedback loops.
Problem oriented.
Evaluation external (e.g. quality, impact, etc.).
etc.

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CSES work for OECD in 2005

(2) Digital Delivery of Content: Scientific Publishing

- Part of a series of reports by the OECD on "Digital Delivery" of services and content (online delivery and globalisation).
- Issues paper – to bring the issue of access to the attention of policy makers at the international level.
- Followed the OECD Ministerial Declaration on Open Access to Scientific Data.
- Ran in parallel to the UK House of Commons Inquiry "*Scientific Publications: Free For All?*".
- Preceded European Commission work on Scientific Publishing "*Scientific Publishing in the European Research Area*".

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CSES work for OECD in 2005

(2) Digital Delivery of Content: Scientific Publishing

- Put scientific publishing in context (*i.e.* importance of dissemination in innovation systems).
- Presented an outline of the scientific publishing industry and the scale of activities.
- Explored publishing value chains for each of the main players (*i.e.* commercial, society and institutional publishers).
- Examined the impacts of “digital delivery” on both publishers and the research producers and users of the content.
- Identified major business models (*e.g.* subscription “big deals”, “author pays”, open access archives/repositories, and hybrids), and examined the pros and cons.

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CSES work for DEST in 2006

(3) Research Communication Costs: Emerging Opportunities and Benefits

- Seeks to identify and quantify all costs associated with research communication in Australia *and* explore the potential benefits of enhanced access to research findings.
- Costs – based on a systems perspective (*e.g.* Don King).
- Impacts – based on an impacts framework and a modified growth model.
- Benefit/costs – based on additional costs and benefits from a national system of institutional repositories in Higher Ed.
- Subsequently – DEST put a further \$25 million into establishing institutional repositories.

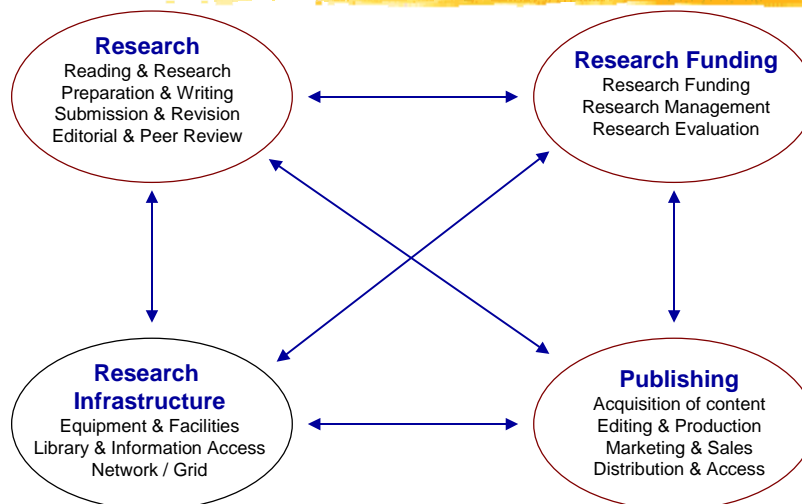
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The cost model

- Developed an 'activity cost model' based on a literature review, with activity costs and times cited used as the basis for calculating of local equivalents.
- These were supplemented and refined through local data collection and a series of interviews with stakeholders.
- Two approaches in literature: (i) focus on publishing process, and (ii) systems perspective putting publishing in a wider context.
- Inevitably, a number of simplifying assumptions must be made in the construction of such a model, and the costings should be taken as no more than indicative.

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Scholarly communication costs



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Mean activity cost estimates for Higher Education, circa 2004 (AUD)

- Reading: academic staff ≈\$4.6 billion, published staff ≈\$2.7 billion pa.
- Writing (HERDC publications only) ≈ \$480 million pa.
- Peer review (scaled to HERDC) ≈ \$100 million pa.
- Editorial activities (scaled to published staff) ≈ \$33 million pa.
- Editorial board activities (scaled to published staff) ≈ \$3.5 million pa.
- Preparing grant applications (ARC & NHMRC) ≈ \$115 million pa.
- Reviewing grant applications (ARC & NHMRC) ≈ \$22 million pa.
- Publisher costs (scaled to HERDC) ≈ \$150 million pa.
- Library acquisition costs (CAUL) ≈ \$180 million pa.
- Library non-acquisition costs (CAUL) ≈ \$316 million pa.
- Cost per download (sample of CAUL subscriptions) \$3.60 – \$4.50
- ICT infrastructure (estimated total expenditure) ≈ \$1 billion pa.
- Sum of core activities ≈ \$3.6 billion (30% of HE expenditure).

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Researching OA impacts

Policy issue:

- Are there new opportunities and new models for research communication that could enhance the dissemination of research findings and, thereby, increase returns to public investment in R&D?

Research issues:

- What methodological approaches might be used to explore the potential impacts of open access?
- What sort of evidence is required to examine impacts?
- What sort of evidence might be compelling for stakeholders and influence policy?

Impacts Framework based on a literature review.

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An Impacts Framework

Additionality:
Access for all, research participation based on merit, not means.

Potential benefits:
Speeding up discovery.
Increasing rate of accumulation of the stock of knowledge.
Reduction of duplicative R&D.
Fewer blind alleys.
Better educational outcomes & enhanced research capabilities.

Additionality:
Access as needed, informed consumers (e.g. health and education).

Potential benefits:
Contribution to the 'informed citizen' and 'informed consumer', with implications for better use of health and education services, better consumption choices, etc. leading to greater welfare benefits, which in turn may lead to productivity improvements.

OPEN ACCESS
Potentially serves all

RESEARCH
Most/Many served,
but not all

**INDUSTRY/
GOVERNMENT**
Part served,
but not much

SUBSCRIPTION PUBLISHING
Current reach

**CONSUMERS/
SOCIETY**
Few served

Additionality:
(1) Access as needed, more informed producers.

(2) New businesses add value to content (e.g. Weather Derivatives).

Potential benefits:
Accelerate and widen opportunities for adoption and commercialisation.
The potential for much wider access for GPs/nurses, teachers/students, and small firms in consulting, engineering, biotechnology, nanotechnology, etc.
The potential for the emergence of new industries based upon the open access content.

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Modified Growth Model

Impacts model

The neoclassical (Solow) growth model starts from the production function

$$(1) \quad Y = A^\eta K^\beta L^\alpha$$

From this can be derived:

$$(2) \quad \dot{Y}/Y = \eta \dot{A}/A + \beta \dot{K}/K + \alpha \dot{L}/L$$

Where \dot{Y}/Y is the rate of change in Y .

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Impacts model (cont.)

This can be used to estimate the contribution of K , L and technology or to measure total factor productivity (TFP)

$$(3) \quad \text{TFP} = \dot{Y}/Y - \beta \dot{K}/K - \alpha \dot{L}/L$$

Extend (1) to allow for knowledge (R) and other factors affecting growth (Z). That is,

$$(4) \quad Y = K^\alpha L^\beta R^\gamma Z^\eta$$

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Impacts model (cont.)

which becomes

$$(5) \quad \dot{Y}/Y = \alpha \dot{K}/K + \beta \dot{L}/L + \gamma \dot{R}/R + \eta \dot{Z}/Z$$

The rate of return to knowledge ($\delta Y/\delta R$) is that continuing percentage increment in output resulting from a one per cent increase in knowledge

$$(6) \quad \partial y/\partial R = \gamma \cdot (Y/R)$$

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Impacts model (cont.)

Using a perpetual inventory method to create the stock of knowledge (R_t)

$$(7) \quad R_t = (1 - \delta) R_{t-1} + R\&D_{t-1}$$

where δ is the rate of obsolescence of the knowledge stock, and

$$(8) \quad R_t = (1 - \delta)^t R_0 + \sum_{i=0}^{t-1} (1 - \delta)^i R\&D_{t-1}$$

where R_0 is the opening knowledge stock.

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Impacts model (cont.)

Some key assumptions of this approach:

- (i) Efficiency: all R&D generates useful knowledge
- (ii) Access: all useful knowledge is equally available to all firms/agencies that could use it
- (iii) Homogenous and disembodied: all capital units benefit equally from improvement in technology

Much literature on (iii). Concentrate here on (i) and (ii).

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Impacts model (cont.)

Rewrite (4) as

$$(9) \quad Y = K^\alpha L^\beta (\phi\varepsilon R)^\gamma Z^\eta$$

Where ϕ and ε are the proportions of R&D that are efficient and accessible. Assume for the moment that they are constants, and that the opening stock of useful knowledge $R^*_0 = \phi\varepsilon R_0$.

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Impacts model (cont.)

Then

$$(10) \quad R_t^* = (1 - \delta)^t \phi R_0 + \phi \varepsilon \sum (1 - \delta)^t R\&D_{t-1} \\ = \phi \varepsilon R_t$$

The rate of return to useful knowledge is given by

$$(11) \quad \partial y / \partial R^* = \gamma \cdot (Y/R^*) = \gamma / \phi \varepsilon \cdot (Y/R) = \gamma \cdot (Y/R) \cdot 1 / \phi \varepsilon$$

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Impacts model (cont.)

Thus if ϕ and ε are less than one, the rate of return to R^* is greater than that to R by $1 / \phi \varepsilon$.

If ϕ and ε are constant over the estimation period, the estimated returns to R^* or R will not be biased.

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Impacts model (cont.)

Assume now that, beyond the estimation period, there is a change in ϕ and ε , perhaps because of open access. Then the return to R^* will remain fixed

$$(12) \quad \partial y / \partial R^* = \gamma \cdot (Y/R) \cdot (1 / \phi_0 \varepsilon_0)$$

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Impacts model (cont.)

But the return to R will increase

$$\begin{aligned} (13) \quad \partial y / \partial R &= \gamma \cdot (Y/R) = \phi_1 \varepsilon_1 \partial y / \partial R^* \\ &= \gamma \cdot (Y/R) \cdot (\phi_1 \varepsilon_1 / \phi_0 \varepsilon_0) \\ &= \gamma \cdot (Y/R) \cdot (1 + \delta_\phi) \cdot (1 + \delta_\varepsilon) \end{aligned}$$

That is, the rate of return R will increase by the compound rate of increase of ϕ and ε .

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Results

Impact estimates

- We calculate the annual gain in returns to R&D for a given level of research expenditure across a range of rates of return for given percentage changes in both 'access' and 'efficiency'.
- We looked at rates of return of 25%-75% and impacts of 1%-10% (used 25% and 5% in examples).
- To keep it simple we assumed:
 - The increase in both access and efficiency is the same;
 - That a move to OA has no *net* impact on the rates of accumulation and obsolescence of the stock of knowledge; and
 - That the information to which access is provided is discoverable.

Calculating potential impacts

Rates of return vary considerably, but:

- With public sector R&D expenditure at \$5.9 billion a year and a 25% return to R&D, a 5% increase in access and efficiency would be worth \$150 million pa.
- With higher education R&D expenditure at \$3.4 billion and a 25% return to R&D, a 5% increase in access and efficiency would be worth \$88 million pa.
- With RC administered competitive grants funding at \$830 million and a 25% return to R&D, a 5% increase in access and efficiency would be worth \$21 million pa.

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Calculating cost-benefits

- Compared the estimated incremental cost of institutional repositories in higher ed., with the potential incremental benefits from enhanced access to higher ed. research (*ceteris paribus*).
- Assumptions about depreciation, expenditure growth, lags, etc.
- Over 20 years, a national system of institutional repositories costing \$10 million a year would cost around \$130 million (NPV).
- Enhanced access to higher education research, with impacts at \$88 million a year, would realise benefits of around \$4 billion (a benefit/cost ratio of 30).
- Enhanced access to RC competitive grants funded research, with impacts at \$21 million a year, would realise benefits of around \$925 million (a benefit/cost ratio of 7.2).

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The Easi-OA Research Program

(Economic and Social Impacts of Open Access)

- Meeting of researchers, held in March at OSI New York.
- To discuss how best to research the impacts of open access and, if possible, develop a research program identifying *and* estimating those impacts.
- The aim is to examine the costs and benefits of various scholarly communication models *and* the distribution of those costs and benefits throughout the scholarly communication system.
- We prepared a paper on potential impacts of OA in OECD countries.

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Potential impacts in the OECD

(4) Estimating the potential impacts of open access to research findings

- Paper suggests that there are access and efficiency limitations, and uses the modified growth model.
- At 2004 levels of R&D expenditure and assuming a 25% rate of return:
 - For OECD GovERD, a 5% increase in access and efficiency would have increased annual returns by around USD 2.3 billion.
 - For OECD HERD, a 5% increase in access and efficiency would have increased annual returns by around USD 3.2 billion.

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Developments

Possible developments

- Specific developments of the approach used.
- Using alternative approaches (*e.g.* New Growth, Evolutionary, Other?).
- “Bottom-up” approaches:
 - Detailed exploration of the articulation of funds around the system.
 - Detailed examination of journal publishing business models (*e.g.* subscription, “author pays”, hybrids, overlay services).
 - ...?

Possible developments (from paper)

- Finding direct measurable links between access, use and efficiency (*e.g.* citations, but difference is great).
- Working out what proportion of 'the stock of knowledge' is publications and/or data (*e.g.* 20% time spent reading).
- Trying to find measures of non-research use (*e.g.* IR downloads by domain).
- Looking at the issue of national 'leakage' of returns.
- Looking in detail at returns to different categories of R&D (*e.g.* medical R&D has high returns, history?).
- Looking at marginal returns to R&D, rather than average.
- Question of possible impacts of OA on rates of accumulation and/or depreciation of 'stock of knowledge'.

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Other possible developments

Using alternative approaches (*e.g.* New Growth, Evolutionary, Other?):

- Suggest that the answer would be bigger?

"Bottom-up" approaches:

- Detailed examination of journal publishing business models (*e.g.* subscription, "author pays", hybrids, overlay services) and their implications for higher education.

(Likely to be the topic of a major JISC study this year).

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Some Broader Comments

Strong estimated returns to R&D (30-60% and more) is a robust finding in economics. How should we interpret such results in the context of the impact of knowledge on growth?

Comment briefly on matters:

- The nature of R&D
- The efficiency of R&D
- Access
- obsolescence

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The Nature of R&D

Many different types of R&D

- Basic development/approval
- Public and private; different character in different industries

Not just creating globally new knowledge

- Making existing knowledge relevant
- Role of national and global knowledge stocks

R&D as the process of creating locally relevant knowledge

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The Efficiency of R&D

How efficient is R&D in producing useful knowledge?

- Varies over time (e.g. pharma), over industries and countries
- May need different things in different situations (knowledge frontier/catch-up)
- For example, has China been efficient in using global knowledge stocks to drive growth?

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Access

How readily can those who could use knowledge gain access to it?

Again different aspects

- Access to research results, e.g. internet and OA
- Role of patents in limiting access
- Shift from public to private control over knowledge
- Dissemination issues – e.g. developing countries

Broader aspects of access (AJ) – need for appropriate intangible capital to allow use of new technology

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Obsolescence

Normally a fixed rate of obsolescence, but the rate varies over time, industries and countries

- IT and obsolescence
- Globalisation, changing cost profiles and obsolescence in different countries
- Greater efficiency and access to R&D might speed up obsolescence, or vice versa

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