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Alignment of Public/Private Institutions in the Biotechnology Revolution

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1. Introduction

1.1 Public Policy

— 1st half of century

— 2nd half of century

1.2 R and D Incentives in the Private Sector

1.3 R and D Incentives in the Public Sector

— Pre Bahy-Dole-Act (1980?)

— Post Bahy-Dole-Act

1.4 Position of Land Grant Universities

— Old vs. new knowledge

— Science and practical knowledge

— Evolution of research universities from pure scholarship, to science to entrepreneurship (Peter David, Etzkowitz)

1.5 Structure of Technology Transfer

— Secrecy and the role of transparency

— Role of modern economics and finance

— Core of real options

1.6 Future Scenarios in US Agriculture

1.7 Organization of Paper

— Public policy

— Current position in future scenarios for US Agriculture

— Science and technology

— New vs. old paradigm

— Challenges and concluding remarks

1.8 Role of Information in Public Decision-Making: Secrecy and the Role of Transparency (see page 9 of R)

2. Public Policy

2.1 Intellectual Property Right Protection (Wright; Koo)

— Patent license

— Material transfer agreement

— Bag label contracts

— Technology use agreement

— Trade secret

2.2 Bahy-Dole Bill

— The promotion of economic growth: capturing market value

— Assignment of property rights

— Recent government accounting office review

— April 1998 House hearing on irreplaceable Federal role in funding basic scientific research

— Jensen & Thursby survey

2.3 Land Grant University Private Research Partnerships

— Just-Rausser findings

— Option design

— Policy evolution

— Crowding out of public good research

2.4 Public Good vs. Private Good research

— Provision vs. Use (heterogeneity of users of Public Good knowledge)

3. Current Position of US Agriculture

3.1 Technological opportunities

— Biotechnology

- Input traits
  - Insect resistance
  - Herbicide tolerance
  - Fungal resistance
  - Viral resistance
  - Nematode resistance
- Output Traits
  - Delayed ripening
  - Modified oils
  - Modified proteins
  - High solids
  - Phyto-manufacturing of antibodies, enzymes…

— Information technologies

— Natural technologies

— Globalization

— Population & economic growth

— Demand for environmental quality

— Consolidation of industry & resulting controversy

— Societal concerns

3.2 Roadblocks to Capturing Value (see chart of Larry Jansen)

3.3 Structural Changes in US Agriculture; the New Core Concepts

3.4 Major Implications

— Critical role of science & technology (concerns & threats, see pages 10-11, 13

— Science will become a critical driver of structural change

— Evolution from commodity-based business to a differentiated-product-based business

— Evolution of value-differentiation patterns **(Value Differentiation)**

— Off-farm control of value differentiation and quality. Here we've only seen the tip of the iceberg with the grower license agreements (see page 13 of Rausser Q&A)

4. Science & Technology

4.1 Economic Growth and the Results of the CEA study

4.2 Private Good Research (movement toward life-science companies)

— Complementarities, contractual hazards and legal disputes)

— Longer-term planning horizons

4.3 Public and Private University Research

— Jensen & Thursby Overview

— Etzkowitz

— Land-grant University Experience

— MIT Experience

— Integration of scientific and practical knowledge

— Peter David : Evolution from pure scholarship to science to entrepreneurship

4.4 Land-Grant University

— Page 10 of Peter's paper on democracy

— Need for transparency; must avoid secrecy

— Quote from Ruby Green-Smith

— Tragedy of Commons paper in Science: role of interdisciplinary work and the pursuit of societal problems (see Q & A of Rausser)

4.5 Implications

— Democracy and the need for public transparency (Rausser, Stiglitz)

— Complementarities

— Multidisciplinary research (Hardin)

— Beneficiaries of public good research

— Integrity of public institutions

4.6 Game-Pieces in the Future of Biotechnology and Bargaining Power

5. Existing vs. Alternative Paradigm

5.1 Existing Paradigm

— Linear evolution from public good to private research

— To achieve tractable representations for which analytical results can be generated innovation is often specified to follow a straight line from basic research (conducted mainly in Universities) through applied R and D (conducted mainly by firms) and hence into the wider economy.

— As argued in the report prepared by the Council of Economic Advisers, October 1995 (Supporting Research and Development to Promote Economic Growth: the Federal Government's Role)

> "Ideas flow from basic research, through pre-competitive development to concrete applications producing new products and developing new, better, and lower cost production processes. Government has a vital role in sustaining this infrastructure – from supporting scientists and engineers to promoting basic research to assisting in the development of new, high-risk technologies with significant spill-overs.

— For policy-makers and University researchers this paradigm is very attractive and some would argue, self-serving.

— Does this paradigm admit the fundamental complementarities that form the foundation for the biotechnology revolution?

5.2 Alternative Paradigm – Non-linear, Chaotic R & D Processes

— Many analysts have documented the meandering flow of innovations into the economy.

— Casual observation and many case studies demonstrate that innovations emerge through a circuitous path.

— This path cannot be codified and, many would argue, is impossible to measure.

— An extreme variant of this view has been proposed by Terrance Kealey ("The Economic Laws of Scientific Research", McMillan Press, London, 1996 and Science Magazine, February 7, 1997, page 750)

— Kealey argues that innovation tends to drive basic science, not the other way around.

— This alternative paradigm blurs the distinction that governments often make between basic and applied science.

— As a result, it also blurs the boundary between the University and the outside world.

6. Challenges

6.1 Creating Institutions that Align Incentives

— Exploiting complementarities and structured fairness in sharing "the Gains from Trade"

— Appropriate mechanism design, recognizing core option values

— Design of exit options, as well as call and put options

6.2 Concrete Example of Novartis/Berkeley Research Alliance

— Through this alliance, we gain access to information technologies, databases, and gene sequences that exist nowhere in the public sector. This access allows us to fulfill our commitment to first-rate graduate education.

— We recently established a new program in Microbial Biology where extraordinary opportunities exist for fundamental discoveries over the course of the next century. Even though the college was able to secure the faculty positions for this new program, no infrastructure support or, more importantly, support for graduate fellowships and research assistantships were available from

any source, including the campus, the state, or other public institutions.

— We desired access to intellectual capital that would not only complement our own, but allow us also to preserve and enhance our values and our culture. This commitment resulted in our insistence on the unrestricted funding provided by the NADI agreement.

— We wanted to establish a public-private relationship which would allow the campus to capture a more significant portion of the value that is created by public research university/private company research agreements. As a result, we incorporated competitive economic principles, constrained by our public values and culture, in our selection of a partner.

— We wanted to structure a collaboration that provided the private partner with no more effective rights than they would have if this agreement did not exist. The University must own the patents – the Intellectual Property. As a public research University, whatever we generate in the

way of discoveries should be broadly available to the general public, including NADI. For this reason, the agreement allows NADI a first right to negotiate and then only for a portion of the discoveries that might emerge. Even without the agreement NADI would have a right to negotiate on all discoveries, just not the first right.

6.3 Value Added : Unique Intellectual Capital and the Direction of Complementarities Toward the Public Interest

6.4 Monitoring and Controlling Unintended Consequences

— Openness and transparency

— Checks and balances through neutral peer review and evaluation

6.5 Potential Role of Public/Private Institutions in Aligning Interests to Exploit Complementaries

— Prisoner's-dilemma problems arising in technology stacking

— Can patents deter innovation: The Anticommons in Biomedical research

— Resent events: Merck's gift to Washington University

— Joint venture between UC Berkeley, D.O.E., and Celera Genomics Corporation

— Commodity interests: what game pieces, what intellectual capital, and what strategic position might they take in the unfolding research and development process.

- One example is the role of US Corn Commodity Association in lobbying for a Congressional appropriation to plant genomics