"Green" Technology and IP: A Diverse Landscape

Arti K. Rai, Duke Law School

Collaborators:
Chatham House (UK)
Richard Newell, Duke
Jerome Reichman, Duke
Jonathan Wiener, Duke

Background problem of "double" market failure

- Positive externalities of innovation (partly addressed through IP)
- Price signals (even as bolstered through IP) don't reflect carbon externalities (up to \$80/ton) (vs. \$2/ton)
- So IP only a (small) part of problem
- In virtually all green sectors, government "push" through R&D subsidies
- But see example of Integrated Gasification Combine Cycle (IGCC) for coal
 - Lots of patents (several hundred that mention IGCC)
 - Lots of push (in U.S., half the capital cost of 2 facilities)
 - But no further adoption

Diverse Technologies

- Power generation (wind, solar, biofuels, IGCC (with and without CCS)
- Industrial processes (e.g. less carbon intensive products of cement)
- Energy efficient consumer goods (e.g. lightbulbs)
- Transportation: hybrid cars; fuel cells
- Building efficiency

At Different Stages

"Theoretical" R&D

- 4G solar (nanotech)
- 3G biofuels (synbio)

"Applied" R&D

- thin-film solar
- 2G biofuels (enzyme-based cellulosic biofuels)

"Commercial" stage

- low-carbon cement production
- IGCC without CCS
- low-carbon consumer goods
- hybrid cars

Diversity even within three early-stage "power generation" technologies

- Thin-film solar
- 2nd generation biofuels
- Third generation biofuels

Thin-Film Solar

- First generation: silicon-based
- 2nd generation: consists of improvements that result in cheaper PV cells (thin films of semiconductors applied to glass)
- 4 or 5 firms hold majority of market
- Each firm uses slightly different technology (which is subject of patent portfolio)
- Unclear whether there are informal patterns of xlicensing (like semiconductors)
- Will patent portfolios pose barriers to entry for new entrants?

2nd generation biofuels (better enzymes for turning cellulose into fuel)

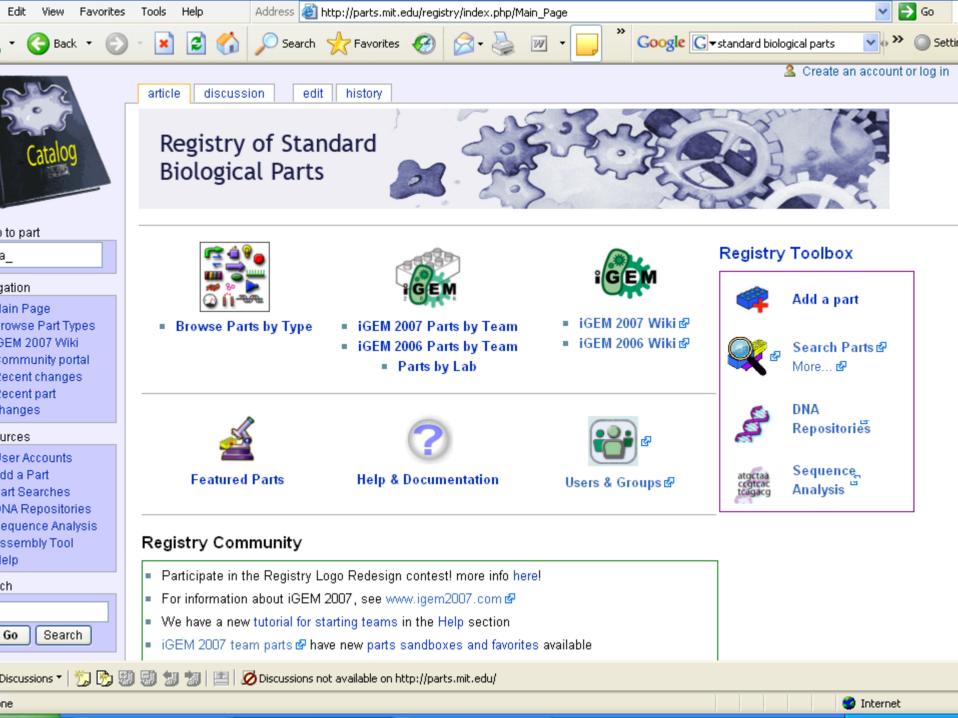
- Some similarities with medical biotech
- Partnerships between small (patent-based)
 R&D firms and large product makers
 - Diversa/Cellulol with Syngenta/Dupont/Khosla Ventures
 - logen with Shell, Goldman Sachs
 - Genencor with Cargill/Dow/Khosla Ventures

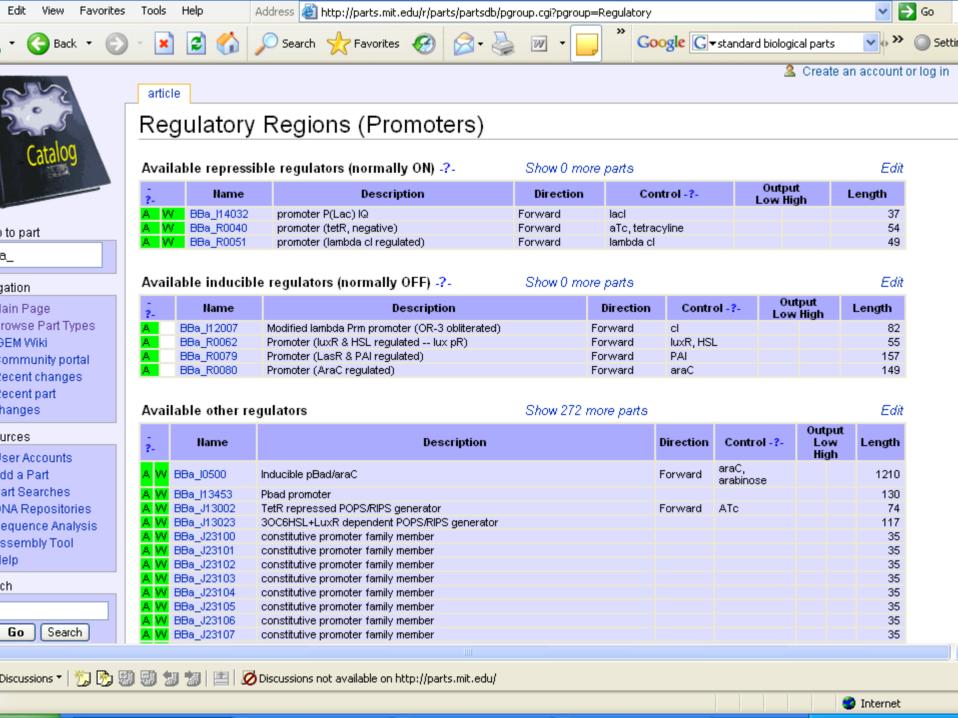
Economic Structure

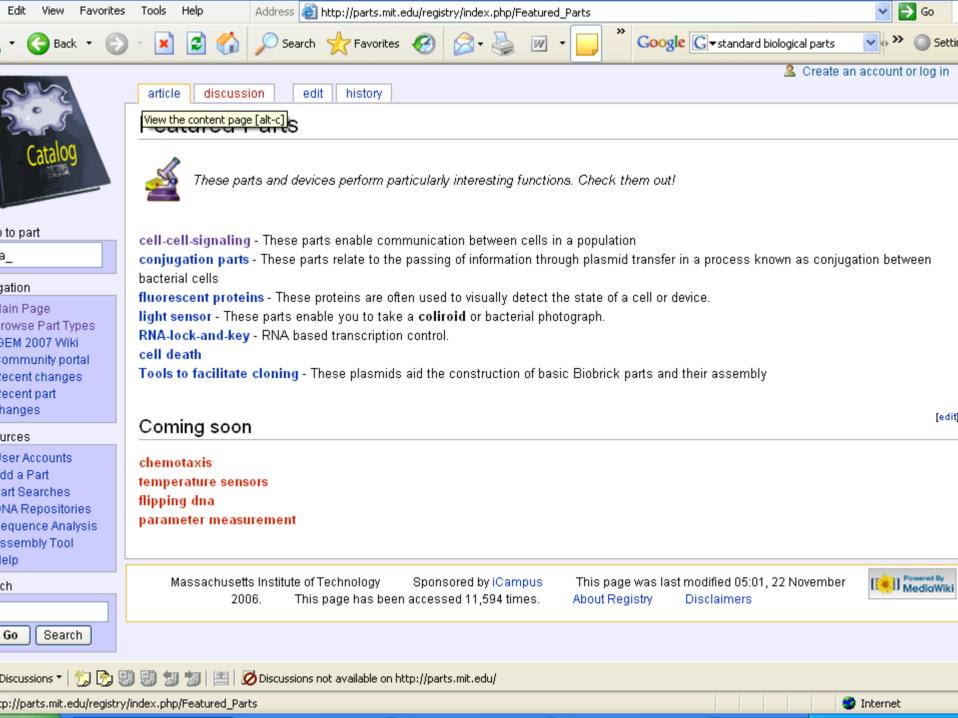
- Different from biomedicine
- End product (fuel) may not be patentable
- So upstream patents (e.g. on enzyme) may be more important for market differentiation
- OTOH, FDA regulatory hurdles won't be there either

3rd generation biofuels (syn bio)

- Micro-organisms that use DNA "parts" (e.g. promoters, repressors, inverters) assembled into "systems" to produce different chemicals, including fuels
- Systems put into micro-organism "chasses"







Different Types of Patents

- Different types of patents (apparently important for VC funding)
 - Patents on "part" components (inc. ordinary gene sequence patents) (e.g. Sangamo)
 - Patents on large scale gene synthesis (Codon Devices, Blue Heron)
 - Patents on "chasses" (Craig Venter of Synthetic Genomics)

Patents on Parts

- Role may depend on whether standardization of parts is achieved
- If achieved, secret infringement (currently a routine strategy for avoiding thickets by firms that produce products in biopharm) may not be possible

Patents on Gene Synthesis: Analogies to Open Source?

- Some companies that have strong patent positions in large scale gene synthesis (e.g. Codon Devices) want "parts" to be free available
- The more demand for "parts," the more demand for the gene synthesis tech
- Lawsuits over gene synthesis patents (Codon vs. Blue Heron)
- Monopolist in gene synthesis? (exceptions to one monopoly profit principle)

Patents on Chasses

- Patent app on "minimal genome" chassis (Craig Venter)
- This particular chassis may not work
- But a good patent on a chassis might be similar to a patent on an operating system (with concomitant push towards standardization)
- Social welfare effects?

Conclusion

- Very complex economics
- Huge diversity of tech
- Even within early-stage biotech, new puzzles and diversity