ASSESSMENT OF INDICATORS OF THE ECONOMIC IMPACT OF UNIVERSITIES

6th International Conference on World-Class Universities

2 NOVEMBER 2015
Thomson Reuters Provides Data to Global & Regional Rankings

- Shanghai Jiao Tong University - ARWU
- US News and World Report Best Global Universities
- CWTS – Leiden Ranking
- U-Multirank
- Reuters News Most Innovative Universities Ranking
- Other rankings “powered by TR data”:
  - EC-3 – University de Granada (Spain)
  - RUR - Moscow Institute of Physics and Technology
  - URAP - Middle East Technical University (Turkey)
Broad Missions of World Class Universities Lead to Diverse Impacts

- **Education & Training**
  - Students
  - Faculty
  - Skills and Knowledge

- **Services (consultancy)**
  - Faculty
  - Expertise

- **Basic & Applied Research**
  - Faculty Researchers
  - Acquired Knowledge

- **Tech Transfer & Commercialization**
  - Staff
  - Spin-offs & Products

**Conducted by the Academic Sector**

**Impact on Industry, Government, etc.**

- Trained workforce, professional development, future academics
- Policy development, process improvement, public engagement
- Journal articles, books, patents, legislation, etc.
- Licenses, Products, etc.

Source: Thomson Reuters
A Conceptual Model to Map the Impacts of University R&D

- **Inputs**
  - Public sector scholarships
  - Industry/commercial
  - Investment/endowment
  - Tuition fees, scholarships
  - Commercialization
  - Infrastructure & facilities
  - Intellectual capacity
  - Knowledge base

- **Activities**
  - Education & Training
  - Services (consultancy)
  - Basic & applied Research
  - Tech transfer & commercialization

- **Outputs**
  - Graduates
  - Policy, standards
  - Journals, books, other
  - Patents, licensable
  - Tech transfer & spin outs
  - Trained people

- **Outcomes**
  - Skilled employment
  - Social change
  - Economic benefits
  - Health & Environments
  - Legislation & policy
  - Research advancement

Source: Thomson Reuters
## Publication-based Indicators

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Articles co-authored with industry</td>
<td>Output / Outcome</td>
<td>The volume articles that contain one or more co-authors from a commercial entity. This indicator shows the volume of research activity that is conducted in collaboration with industry and it is an indicator of potential future economic impact.</td>
</tr>
<tr>
<td>Citations affiliated with industry per article</td>
<td>Outcome</td>
<td>Article to article citations are an established indicator of influence and research impact. By limiting the citing items only to those items that are affiliated with industry it becomes an indicator of the influence and impact that basic research conducted in an academic setting has had on commercial research.</td>
</tr>
<tr>
<td>% Articles acknowledging funding from industry</td>
<td>Input</td>
<td>An indication of commercial sector investment. Although the articles themselves are a research output, the funding acknowledgment is an indication of research funding and is therefore an input measure.</td>
</tr>
<tr>
<td>Patent citations per article</td>
<td>Outcome</td>
<td>Similar to “Patent citations per patent” this indicator measures the average number of times an article has been cited by patents. This unique indicator is an indication that basic research conducted in an academic setting (as measured by articles) has had influence and impact upon commercial Research &amp; Development (as measured by patents).</td>
</tr>
</tbody>
</table>
## Patent-based Indicators

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patents</td>
<td>Output</td>
<td>The number of basic patents filed by the organization is an indication of research output with potential for commercial value.</td>
</tr>
<tr>
<td>Granted patents per application</td>
<td>Outcome</td>
<td>The proportion of patent applications that are granted shows the success rate in the patent filing process and indicates the significance of the inventions.</td>
</tr>
<tr>
<td>Patent global diversity</td>
<td>Outcome</td>
<td>The proportion of patents that have been filed in a second major country is a measure of the globally diversity of the patent portfolio. Filing a patent is an expensive and laborious process and filing in multiple countries is an indication that the invention is non-trivial and has commercial value.</td>
</tr>
<tr>
<td>Patent citations per patent</td>
<td>Outcome</td>
<td>This indicator measures the average number of times a patent family has been cited by other patents. As part of the patent inspection process the patent examiner will cite significant prior art. The number of times a patent has been cited is an indication that it has had impact on further R&amp;D.</td>
</tr>
<tr>
<td>% patents cited one or more times</td>
<td>Outcome</td>
<td>This indicator is the proportion of papers that have been cited by other patents one or more times. It is a complementary indicator to the “Patent citations per patent” indicator</td>
</tr>
</tbody>
</table>
Data Sources for Indicators

• Data on scholarly publications and citations were sourced from Thomson Reuters InCites™, which is the gold standard for bibliometric evaluation and built on Thomson Reuters Web of Science citation index.  
http://researchanalytics.thomsonreuters.com/incites/

• Patent data were sourced from Thomson Reuters Derwent World Patents Index (DWPI), which is the world’s largest and most authoritative database of patents. The Patent Citation Index was also used which is a complementary database of patent citations.  
<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Number of patents</th>
<th>Granted patents per application</th>
<th>Patent global diversity</th>
<th>Patent citations per patent</th>
<th>% patents cited one or more times</th>
<th>Patent citations per article</th>
<th>% Articles co-authored with industry</th>
<th>Citations affiliated with industry per article</th>
<th>% Articles containing acknowledgement of funding from industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of California System</td>
<td>2,796</td>
<td>49.3%</td>
<td>29.1%</td>
<td>2.34</td>
<td>53.6%</td>
<td>0.069</td>
<td>2.70%</td>
<td>0.465</td>
<td>10.1%</td>
</tr>
<tr>
<td>United States Navy</td>
<td>1,720</td>
<td>90.2%</td>
<td>5.5%</td>
<td>1.21</td>
<td>45.3%</td>
<td>0.039</td>
<td>1.28%</td>
<td>0.162</td>
<td>1.3%</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>1,357</td>
<td>58.1%</td>
<td>21.4%</td>
<td>2.86</td>
<td>63.2%</td>
<td>0.161</td>
<td>4.20%</td>
<td>0.752</td>
<td>8.1%</td>
</tr>
<tr>
<td>University of Texas System</td>
<td>1,144</td>
<td>51.3%</td>
<td>28.3%</td>
<td>1.93</td>
<td>57.3%</td>
<td>0.087</td>
<td>2.90%</td>
<td>0.441</td>
<td>12.9%</td>
</tr>
<tr>
<td>Stanford University</td>
<td>1,032</td>
<td>66.5%</td>
<td>23.2%</td>
<td>2.56</td>
<td>59.6%</td>
<td>0.096</td>
<td>3.83%</td>
<td>0.595</td>
<td>12.6%</td>
</tr>
<tr>
<td>United States Department of Energy</td>
<td>890</td>
<td>75.7%</td>
<td>14.6%</td>
<td>1.52</td>
<td>46.9%</td>
<td>0.057</td>
<td>2.59%</td>
<td>0.301</td>
<td>2.4%</td>
</tr>
<tr>
<td>State University of New York System</td>
<td>891</td>
<td>55.7%</td>
<td>21.4%</td>
<td>1.51</td>
<td>46.9%</td>
<td>0.037</td>
<td>1.94%</td>
<td>0.288</td>
<td>12.0%</td>
</tr>
<tr>
<td>State University System of Florida</td>
<td>825</td>
<td>50.7%</td>
<td>21.3%</td>
<td>1.64</td>
<td>49.5%</td>
<td>0.045</td>
<td>1.73%</td>
<td>0.230</td>
<td>6.9%</td>
</tr>
<tr>
<td>United States Army</td>
<td>791</td>
<td>88.0%</td>
<td>5.7%</td>
<td>1.28</td>
<td>46.0%</td>
<td>0.053</td>
<td>2.00%</td>
<td>0.194</td>
<td>2.4%</td>
</tr>
<tr>
<td>California Institute of Technology</td>
<td>766</td>
<td>71.1%</td>
<td>24.3%</td>
<td>2.96</td>
<td>62.1%</td>
<td>0.066</td>
<td>1.86%</td>
<td>0.269</td>
<td>3.6%</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>495</td>
<td>57.4%</td>
<td>18.6%</td>
<td>2.33</td>
<td>54.3%</td>
<td>0.070</td>
<td>2.92%</td>
<td>0.478</td>
<td>12.7%</td>
</tr>
</tbody>
</table>
Select Criteria for Assessing Indicators of Economic Impact

• *Is the indicator size-independent?* Due to the variations in the size of universities in terms of faculty, students, research activities or support for commercialization, it is important that indicators reflect the performance of the university in a size-independent way.

• *Is the indicator direct, or indirect?* Indicators should be used that reflect both the direct economic impact, as well as the indirect benefits universities may have on local, regional and national economies.

• *Is the indicator sufficiently timely to tell us something about the university’s recent impact?* The influence of universities on downstream economic activity may take significant time to accrue and therefore it is important to consider how timely each indicator may be.

• *Is a meaningful and relevant baseline available for this indicator?* Interpretation of indicators and their subsequent value in rankings are enhanced by relating a discrete value to a relevant baseline. Common baselines include location-based or global averages, disciplinary averages, or institutional classification averages (e.g. Carnegie Classification of Institutions of Higher Education).
Assessment of Publication-based Indicators

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>SIZE-DEPENDENCY</th>
<th>DIRECTNESS</th>
<th>TIMELINESS</th>
<th>BASELINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Articles co-authored with industry</td>
<td>Normalized to total number of articles</td>
<td>Indirect</td>
<td>Current - same as existing publication-based indicators</td>
<td>Possible</td>
</tr>
<tr>
<td>% Citations affiliated with industry per article</td>
<td>Normalized to total number of citations</td>
<td>Indirect</td>
<td>Moderate to slow - requires time for article to be incorporated into industry research</td>
<td>Possible</td>
</tr>
<tr>
<td>% Articles containing acknowledgement of funding from industry</td>
<td>Normalized to total number of articles</td>
<td>Indirect</td>
<td>Current - same as existing publication-based indicators</td>
<td>Possible</td>
</tr>
<tr>
<td>Patent citations per article</td>
<td>Normalized to total number of articles</td>
<td>Indirect</td>
<td>Slow - requires time for article to be incorporated into industry research and patent application process</td>
<td>Possible</td>
</tr>
</tbody>
</table>
## Assessment of Patent-based Indicators

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>SIZE-DEPENDENCY</th>
<th>DIRECTNESS</th>
<th>TIMELINESS</th>
<th>BASELINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patents</td>
<td>Size-dependent</td>
<td>Indirect</td>
<td>Moderate - it takes time to prepare patent application</td>
<td>Possible</td>
</tr>
<tr>
<td>Granted patents per application</td>
<td>Normalized to the number of patents applied</td>
<td>Indirect</td>
<td>Moderate - the patent evaluation process takes years at most authorities</td>
<td>Possible</td>
</tr>
<tr>
<td>Patent global diversity</td>
<td>Normalized to the number of patents</td>
<td>Indirect</td>
<td>Moderate to slow - patent filings in multiple jurisdiction may take years</td>
<td>Possible</td>
</tr>
<tr>
<td>Patent citations per patent</td>
<td>Normalized to number of patents</td>
<td>Indirect</td>
<td>Moderate to slow - patents take some time to accrue patent citations</td>
<td>Possible</td>
</tr>
<tr>
<td>% patents cited one or more times</td>
<td>Normalized to number of patents</td>
<td>Indirect</td>
<td>Moderate to slow - patents take some time to accrue patent citations</td>
<td>Possible</td>
</tr>
</tbody>
</table>
Using These Indicators to Inform University Strategy

• The following can serve as timely indicators of faculty engagement with industrial partners
  – % Articles co-authored with industry
  – % Articles containing acknowledgement of funding from industry

• The following indicators may provide a mid- to long-term view of the performance of that engagement or the visibility of the institution to industrial partners:
  – Number of patents
  – Granted patents per application
  – Patent global diversity
  – % Citations affiliated with industry per article
  – Patent citations per article
  – Patent citations per patent
  – % patents cited one or more times
What Can These Indicators Reveal About University Performance?

• The use of these publication-based and patent-based indicators may tell us something different about the mission of a university compared to other indicators.
  – Northwestern University placed 6 in Reuters News Top 100 Most Innovative Universities Rankings as compared to:
    • 47 in THE World University Ranking,
    • 32 in the QS World University Ranking,
    • 27 in the ARWU World University Ranking, and
    • 25 in US News Best Global Universities Ranking

• Future work to include:
  – Time windows and baseline development
  – Incorporation of direct measures of economic impact
Economic Impacts of Other University Missions
## Assessment of Alumni-based Indicators

###INDICATOR ACTIVITY DESCRIPTION

| Officers & Directors (F&R) | Output | Officers & Directors are senior executives in global companies. This indicator counts the number of executives per organization. This is long term indication of a university’s ability to create industry leaders and the university’s ability to train an elite workforce. |

###INDICATOR SIZE-DEPENDENCY DIRECTNESS TIMELINESS BASELINE

| Officers & Directors (F&R) Alma Mater | Size-dependent | Indirect | Moderate to Slow - it takes time to for these alumni to progress in their career | Not possible with existing data |
THANK YOU