Abstract

Title: Exploring Entrepreneurial Support Performance in Institutions: A Data Envelopment Analysis

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Existing State-of-the-art: Institutions play a critical role in innovation and venture development in regional economies. Institutions deliver valuable human capital as graduates, intellectual capital as patent and research outcomes, and industrial outputs as research commercialization led ventures. Further, the role of institutions has evolved over the last two decades to comprise promotion of entrepreneurship and/or support the entrepreneurial ecosystem. Therefore, the performance of institutions in driving both entrepreneurial activity, and traditional research and educational outcomes could be studied as a multi input and multi-output phenomenon.

Research Gap: Institutional role and performance in entrepreneurial ecosystems are not adequately explored in extant literature with quantitative methods. Educational, industrial and entrepreneurial outcomes are generally not considered simultaneously when comparing the performance of institutions. The role of institutions in supporting entrepreneurship is important to understand, considering the global growth of investments into support structures like incubators and TTOs for venture creation. The research question is: How can we compare entrepreneurial support performance of institutions, as a contributor to overall institutional efficiency?

Theoretical Arguments: Firstly, ambidexterity exists between education/research outcomes vis-a-vis commercial/entrepreneurial outcomes. This can be seen at an institutional or personal level (Perkmann et al., 2013). Secondly, there is path dependence (as influence of pre-existing structure and interests) with respect to actions that institutions take, and this depends on age and legacy of the institution.

Method: Based on National Institutional Ranking Framework (NIRF) (2016-18) disclosures, we obtained data on applied science and research institutions across two key states in India. We compare venture emergence and support intensity of these institutions using non-parametric data envelopment analysis. This type of analysis does not assume a functional relationship between inputs and outputs (Charnes, Cooper, & Rhodes, 1978).

Results: We were able to identify and rank efficient institutions by explicitly considering input expenditures to produce various outputs. We were able to ascertain the relative contribution of
entrepreneurial support to the overall institutional efficiency. The results indicated that resource endowment did not matter for the overall institutional efficiency.
From the analysis we suggest how institutions can improve their overall efficiency by promoting entrepreneurial support outputs and by scaling or mixing other outputs. Further, such an improvement can be achieved without impacting the traditional outcome contribution to the overall institutional efficiency.

References
Exploring Entrepreneurial Support Performance in Institutions: A Data Envelopment Analysis

Name: Muralidharan Loganathan
Affiliation: Research Scholar (Ph.D. Student), Indian Institute of Science, Bangalore, India
Year of enrolment: 2016
Expected final date: 2021
Email address: muralidharan@iisc.ac.in

Name: MH Bala Subrahmanya
Affiliation: Professor, Indian Institute of Science, Bangalore, India
Email address: bala@iisc.ac.in

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Introduction
Investments made into research and higher education is a significant percentage of GDP across several countries (UNESCO, 2014). Institutions have become critical source and support of entrepreneurship in ecosystems, as they deliver new technologies/change from research oriented activities that have potential to be commercialized and the human capital necessary to develop new ventures. Such support may be operationalized through various policies like incentives, sponsored research or organizational forms like incubators and technology transfer offices. Thus role of institutions in an entrepreneurial ecosystem is multi-fold. The outcomes from institutions can be seen as traditional human capital, knowledge capital in the form of research and consultancy for industries, intellectual capital as formal patents or other intellectual property rights. With the emergence of the notion of “entrepreneurial university” it becomes imperative to consider the role of university in development of entrepreneurial ecosystems. In order to compare performance of institutions, we have to consider the traditional and entrepreneurial outcomes simultaneously against the various inputs that these institutions receive as financial and human capital.

In this article we examine 15 institutions in 2 states of India for their efficiencies in driving outcomes including entrepreneurial support and their traditional outputs. We rely on statutory disclosures and data under the National Institutional Ranking Framework of the Government of India and take forward a non-parametric data envelopment analysis to study the efficiency of these institutions.

The rest of the article is structured into five sections. Following this introduction we briefly draw on literature around studies on institutional efficiency and place our research in the context of institutional studies. Here we focus our attention on institutional ambidexterity managing both traditional outcomes on the one hand and entrepreneurial outcomes on the other. We clarify our research objective, scope and methodology in the section three. Following this we explain the analysis that we conducted on the institutional data. In section five, we interpret our results for opportunities at institution level to improve efficiency. And finally we conclude our study by noting policy implications and future research directions based on this study.

Literature Review
The role of institutions has evolved to become more entrepreneurial as a stated objective in entrepreneurial ecosystems (Bala Subrahmanya, 2017). Thus it is necessary to look at traditional outcomes along-side entrepreneurial outcomes when studying effectiveness of institutions. Institutional effectiveness is the capability to achieve stated mission objectives, whereas efficiency denotes the ability to produce outputs given a set of inputs. Thus efficiency may be subsumed within effectiveness. Effectiveness includes other hard to estimate factors like quality of research whereas efficiency does not include such factors (Sherman & Zhu, 2006). We structure the literature review along two distinct research themes, first is the notion of “entrepreneurial university”, second is the methods that are generally adopted to evaluate efficiency of organizations and draw broad research gaps that we intend to address.

Entrepreneurial University and Ambi-dexterity
Institutions are complex organizations that take in multiple inputs in the form of human, financial and physical capital and produce various outputs traditionally human and knowledge
capital. Recently entrepreneurial activities at universities have become garnered attention on both policy makers and researchers, considering the potential for regional development from such activity.

Entrepreneurial activities in an university can take many forms, for example academic entrepreneurship of scientists, technology commercialization, entrepreneurial support organizations like incubators, spin offs are common. Entrepreneurial activities at university may emerge primarily through 3 routes, firstly through “academic entrepreneurship” of faculty and students who are engaged at the institution, secondly through the licensing route when external entrepreneurs may take up research outputs and commercialize them to develop new products, and thirdly institutions setting up quasi internal organizations like incubators and research parks to support ventures that emerge from the institution (Rothaermel, Agung, & Jiang, 2007).

Such entrepreneurial activities have become more a norm among institutions than an optional side activity of institutions (Etzkowitz, 2002). This stems from the basic tenet that research and higher education are related to economic growth outcomes (Hayter, 2013). In addition institutions have taken steps to derive and generate economic value from research activity that happens at the university (Phan & Siegel, 2006).

As with any organization that is balancing multiple outcomes, for example between exploration and exploitation, doing well on both becomes imperative (Bartlett & Ghoshal, 1991). Thus the notion of ambi-dexterity of doing two or more things equally well emerges (Simsek, 2009). At an institution level, given the need for balancing traditional outcomes of research and education against industrial and entrepreneurial outcomes, the interest in studying institutional ambi-dexterity emerged (Ambos, Mäkelä, Birkinshaw, & Pablo, 2008). There have been various studies at individual or organization level, examining tensions with varied antecedents, achieving the balance and the conceptual view (simultaneous/structural) that is adopted (Simsek, 2009).

Ambi-dexterity at institutions can be studied at an individual level as tensions balancing academic and commercial activity or at an organizational level structurally. The structural approach to studying ambi-dexterity involves resolving tensions and responsibilities at individual level by creating “dual structures” like technology transfer offices and incubators, that separates the scientist level individual tensions but actively supporting the commercial aspects of institutional outcomes. Simsek (2009) proposed a model for ambi-dexterity considering organizational, inter-firm relations, and environmental variables and their interactions affecting organizational performance. We believe performance of such dual structures supporting ventures that emerge and develop at the institution, should be accounted and included in the efficiency analysis of an institution.

We focus our next sub-section in reviewing methods that are generally adopted for evaluating efficiency of service organizations.

Methods in efficiency studies

The standard costs systems approach which minimises costs based on a certain standard and engineer to reduce inputs. This approach relies on historic standards that are deemed adequate, to target reductions. This leads to two issues firstly the availability and efficacy of the historic standard and secondly the false confidence of having achieved efficiency based on the standard (Sherman & Zhu, 2006).
Ratio analysis is also common, that in absence of a standard, we could simply improve efficiency for example by improving costs per unit or output produced per unit of resource consumed. Such ratio analysis is helpful only when there are limited number of ratios that adequately represent the overall organizational efficiency. When organizations are compared against each other with ratios, there is no threshold above which it can be deemed efficient. Ratios may not adequately capture the complexity of performance of organizations. One particular form of ratio viz. ROI or return on investment is particularly meaningful to compare performance of organizations, but it comes with the bias for short run, i.e. performance in the short run may be improved by sacrificing the long run efficiency (DiSalvio, 1989).

Program based planning and budgeting have long been used when groups of services can be evaluated within an organization. This method involves comparing departments as programs and each are tracked for costs and outputs, and continuously monitored for productivity. When efficient standards are not available, and we have to deal with multiple inputs and outputs for comparable organizations, best practice review and analysis methods have been suggested in literature. Best practice review are labour intensive and involves significant judgement and understanding contextually and does not in any way help organizations locate the sources of inefficiency (Sherman & Zhu, 2006). Other methods like Balanced Score Cards (BSC) are adopted for tracking performance criteria and targets across different dimensions for organizations. Even in BSC approaches, the targets are arbitrary unless objectively determined and may lead to false convictions of having achieved best practice efficiency. Large number of studies measure organization efficiency to monitor performance, and evaluate policy changes in institutions. Many of these studies consider an efficient frontier or the best practice frontier approach, simply because of the closer correspondence to the production function in economics (Worthington, 2001).

Usually 3 different efficiencies are considered in such studies, first is technical efficiency considering maximum possible output given a set of inputs, second is allocative efficiency considering the optimal weight of inputs in combination to improve the outputs produced and thirdly the productive efficiency that is a combination of both technical and allocative efficiencies. As long as certain technical and allocative inefficiencies exist, the organization cannot be deemed fully productive efficient and opportunities to improve exist.

Data Envelopment Analysis (DEA) emerged as an important quantitative performance evaluation method, after the seminal work by Charnes et al., (1978). DEA establishes a best group of units among the compared decision making units (DMUs) and objectively identifies units that could improve productivity to match efficiency of the best practice units. It directly allows for having multiple inputs and outputs. It allows to easily find amount and type of changes but does not come with the effort burden in methods like peer reviews or best practice analysis.

DEA has been used to study institutions in several contexts. Johnes (2006) notes the ease with which DEA has been applied for measuring efficiency of higher education incorporating multiple inputs and a variety of outputs. Liu et al. (2013) note that DEA application to education field ranks among the top 5 application domain of the method in an extensive review of DEA applications. While several studies like Sagarra, Mar-Molinero, & Agasisti (2017) consider a plethora of variables, do not consider entrepreneurial support as an outcome at institution level. Therefore, from this brief literature outline we can address, firstly the evaluation of ambi-dexterity at institutions and secondly using DEA for such analysis.
The novelty in our study is the inclusion of entrepreneurial support in the performance, and such studies have not been conducted to the best of our knowledge on Indian institutions.

**Objective, scope, data source and methodology**

Our primary research question is “how can we evaluate institutional efficiencies including entrepreneurial support outcomes alongside traditional outcomes?”. The data for this analysis is derived from secondary sources, primarily the institution level disclosures to the National Institutional Ranking Framework (NIRF) under the Ministry of Human Resource Development, Government of India. The parameters in NIRF broadly cover “Teaching, Learning and Resources,” “Research and Professional Practices,” “Graduation Outcomes,” “Outreach and Inclusivity,” and “Perception” (Ministry of Human Resource Development, 2018). We rely on this data for conducting our analysis. We augment the data with number of ventures supported at the respective institutions from the incubator online archives (https://web.archive.org/). Further our data set is only a subset of the NIRF data of only 2 states (Karnataka and Tamil Nadu) where we are examining the performance of institution based entrepreneurial support organizations.

DEA as noted from literature, is powerful when comparing service organizations or the Decision Making Units (DMUs) like institutions when there are multiple inputs and multiple outputs. DEA does not directly tell what institutions are the absolute best, but only the best among the lot that is being analysed. Further in the analysis it assigns the best possible efficiency to the DMUs which is a strength of the method. This allows us to compare efficiencies across the DMUs and derive meaningful actionable insights that can be used by institutions. During such comparison the weakly efficient DMUs are compared against a set of efficient institutions referred as the Efficiency Reference Set (ERS). The degree to which the weakly efficient DMUs are away from the efficient frontier are identified and weights are assigned to make each DMU as efficient as possible. These weights themselves are meaningful to institutions in both taking managerial action and analytic value. We chose DEA as our preferred method of analysis as it has the added advantage of not assuming any functional relationships between the inputs and outputs.

**Selection of inputs and outputs**

DEA Specification is provided in table 1. Although operational expenditures were disclosed we did not consider them as a separate input, as it was correlated with the number of full time equivalent faculty. Age as an input for pre-existing infrastructure and processes for the institution is considered at this liminal stage. Human capital and financial capital as inputs employed for producing outputs that are research output measured as a ratio of citations to publications, human capital as total number of graduates, industrial revenue and number of entrepreneurial ventures supported during the period. All inputs were normalized and transformed adequately for conducting the efficiency analysis.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Age</td>
<td>1 Research Citation/Publications</td>
</tr>
<tr>
<td>B Full time equivalent faculty</td>
<td>2 Graduates</td>
</tr>
<tr>
<td>C Capital Expenditure</td>
<td>3 Industrial revenues</td>
</tr>
<tr>
<td></td>
<td>4 Entrepreneurial ventures supported</td>
</tr>
</tbody>
</table>

*Table 1: DEA Specification*
Analysis

We adopt an output oriented model with constant returns to scale (known as CCR-O) (Charnes et al., 1978), to analyse the efficiency of institutions, that can be defined as an envelopment model below.

\[
\max \phi + E \left( \sum_{m=1}^{2} S_m^- + \sum_{r=1}^{4} S_r^+ \right)
\]

Subject to
\[
\sum_{j=1}^{15} v_j x_{ij} + s_i^- = x_{i0}, \quad i = 1, 2
\]
\[
\sum_{j=1}^{15} u_j y_{rj} - s_r^+ = \phi y_{r0}, \quad r = 1, 2, 3, 4
\]
\[
\lambda_j \geq 0, \quad j = 1, 2, \ldots, 15
\]

Equation 1: Envelopment Model

\(\phi\) is the output oriented efficiency score, that is maximized for every \(j^{th}\) institution given \(m\) inputs and \(r\) outputs that we defined previously and \(E\) is the non-Archimedean that could be any positive real number. \(S_m\) and \(S_r\) are the input and output slacks respectively. \(u, v\) represents the weights for the inputs and outputs. \(\lambda\) are the lambda weights.

The same model may be defined as a multiplier version as below,

\[
\min \sum_{i=1}^{2} v_i x_{i0}
\]

Subject to
\[
\sum_{i=1}^{2} v_i x_{ij} - \sum_{r=1}^{4} u_r y_{rj} \geq 0, \quad j = 1, 2, \ldots, 15
\]
\[
\sum_{r=1}^{4} u_r y_{r0} = 1
\]
\[
u_r, v_i \geq \epsilon > 0
\]

Equation 2: Multiplier Model

We prefer the output oriented model due to the fact that institutions do not have control over their inputs, as much as they have over the outputs. Hence for our analysis we will interpret the output slacks and weights while comparing weakly efficient with the efficient institutions.

Results and Discussion

In this section, we operationalize the efficiency model for the 15 institutions data, and sequentially interpret the efficiency scores, followed by the output slacks and weights of the weakly efficient institutions. We used the DEA-Solver Software version 8 for the calculations provided along with Cooper, Seiford, & Tone (2007).

Ranks of efficiency

Out of the 15 institutions that we included in the analysis we had Six efficient DMUs and nine inefficient DMUs. Our initial model included Age, but the rankings were unchanged, even with
the consideration of Age as an input to account for institutional path dependence. Hence we drop Age as an input from the final DEA model. The institutions were ranked as in table 2.

Firstly, we notice that DMUs that are indicated as efficient were best among the lot in different aspects. For example IISc in research and industrial output, IITM in industrial and entrepreneurial outputs, Amritha in entrepreneurial and graduation and TNAU in just entrepreneurial support are among the efficiency reference set (ERS) or an exemplar set of institutions against which other weakly efficient units could be compared against. Secondly, inclusion of Age as an input of historical resource endowment or path dependence of institutions did not matter in their overall ranking, hence we drop Age from our further analysis.

<table>
<thead>
<tr>
<th>Inst</th>
<th>Score</th>
<th>Rank</th>
<th>(I) Faculty</th>
<th>(I) CapEx</th>
<th>(O) Research</th>
<th>(O) Industrial</th>
<th>(O) EntSupport</th>
<th>(O) Grad</th>
</tr>
</thead>
<tbody>
<tr>
<td>IISc</td>
<td>1</td>
<td>1</td>
<td>1.056</td>
<td>1.000</td>
<td>2.000</td>
<td>2.000</td>
<td>1.200</td>
<td>1.024</td>
</tr>
<tr>
<td>JSS</td>
<td>1</td>
<td>1</td>
<td>1.143</td>
<td>1.972</td>
<td>1.640</td>
<td>1.000</td>
<td>1.644</td>
<td>1.285</td>
</tr>
<tr>
<td>IITM</td>
<td>1</td>
<td>1</td>
<td>1.114</td>
<td>1.058</td>
<td>1.582</td>
<td>1.692</td>
<td>1.700</td>
<td>1.171</td>
</tr>
<tr>
<td>Amritha</td>
<td>1</td>
<td>1</td>
<td>1.476</td>
<td>1.369</td>
<td>1.186</td>
<td>1.205</td>
<td>1.889</td>
<td>2.000</td>
</tr>
<tr>
<td>UoM</td>
<td>1</td>
<td>1</td>
<td>1.000</td>
<td>1.934</td>
<td>1.812</td>
<td>1.022</td>
<td>1.022</td>
<td>1.050</td>
</tr>
<tr>
<td>TNAU</td>
<td>1</td>
<td>1</td>
<td>1.185</td>
<td>1.681</td>
<td>1.000</td>
<td>1.147</td>
<td>2.000</td>
<td>1.150</td>
</tr>
<tr>
<td>PSGTech</td>
<td>0.987</td>
<td>7</td>
<td>1.132</td>
<td>1.927</td>
<td>1.009</td>
<td>1.018</td>
<td>1.867</td>
<td>1.016</td>
</tr>
<tr>
<td>Sastra</td>
<td>0.856</td>
<td>8</td>
<td>1.183</td>
<td>1.831</td>
<td>1.484</td>
<td>1.030</td>
<td>1.178</td>
<td>1.158</td>
</tr>
<tr>
<td>VIT</td>
<td>0.855</td>
<td>9</td>
<td>1.484</td>
<td>1.669</td>
<td>1.208</td>
<td>1.018</td>
<td>1.200</td>
<td>1.663</td>
</tr>
<tr>
<td>Thiagaraja</td>
<td>0.853</td>
<td>10</td>
<td>1.023</td>
<td>2.000</td>
<td>1.233</td>
<td>1.003</td>
<td>1.000</td>
<td>1.010</td>
</tr>
<tr>
<td>NITSu</td>
<td>0.850</td>
<td>11</td>
<td>1.013</td>
<td>1.922</td>
<td>1.164</td>
<td>1.028</td>
<td>1.078</td>
<td>1.000</td>
</tr>
<tr>
<td>SRM</td>
<td>0.827</td>
<td>12</td>
<td>2.000</td>
<td>1.137</td>
<td>1.137</td>
<td>1.014</td>
<td>1.044</td>
<td>1.249</td>
</tr>
<tr>
<td>Anna</td>
<td>0.752</td>
<td>13</td>
<td>1.227</td>
<td>1.882</td>
<td>1.267</td>
<td>1.192</td>
<td>1.000</td>
<td>1.069</td>
</tr>
<tr>
<td>Manipal</td>
<td>0.743</td>
<td>14</td>
<td>1.772</td>
<td>1.517</td>
<td>1.075</td>
<td>1.122</td>
<td>1.078</td>
<td>1.595</td>
</tr>
<tr>
<td>KLE</td>
<td>0.727</td>
<td>15</td>
<td>1.264</td>
<td>1.618</td>
<td>1.052</td>
<td>1.048</td>
<td>1.233</td>
<td>1.113</td>
</tr>
</tbody>
</table>

Table 2: Efficiency Ranks and inputs/outputs of Institutions

Output slacks in entrepreneurial support

The analysis provided the output slacks across the weakly efficient institutions, as provided in table 3. We have excluded institutions that were in the efficiency reference set as their slacks are zero, i.e. they are already efficient. For weakly efficient institutions, slacks indicate scope to improve their outputs using the same level of inputs and thus reaching the efficient frontier.

Our outputs included the traditional (research and graduation), industrial and entrepreneurial support of the institutions. We can compare these outputs across weakly efficient institutions outputs against the efficient institutions. Such difference manifests as output slacks in our analysis. The output slacks are not seen across research and graduation across many institutions, indicating that they are already efficient in producing these outputs. Further, this indicates that the traditional outcomes of the institutions did not provide a large enough lever for the weakly efficient institutions to become efficient. Whereas both industrial revenues (3 institutions) and entrepreneurial support (5 institutions) outputs provide a significant lever for improving their efficiency.
In our second stage of analysis we interpret the weights given to each of the outcomes of weakly efficient institutions against the efficient ones. This will give us clues on how the weakly efficient ones may improve by mixing or prioritizing the different outputs. The weights comparison among the different institutions is provided in table 4.

### Table 4: Output weights from the DEA

<table>
<thead>
<tr>
<th>DMU</th>
<th>Score</th>
<th>Rank</th>
<th>Research slacks</th>
<th>Industrial revenue slacks</th>
<th>Entrepreneurial support slacks</th>
<th>Graduates slacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IISc</td>
<td>1</td>
<td>1</td>
<td>0.2862</td>
<td>0.3564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JSS</td>
<td>1</td>
<td>1</td>
<td>0.1575</td>
<td>0.0203</td>
<td>0.0639</td>
<td>0.4797</td>
</tr>
<tr>
<td>IITM</td>
<td>1</td>
<td>1</td>
<td>0.1817</td>
<td>0.0763</td>
<td></td>
<td>0.4806</td>
</tr>
<tr>
<td>Amritha</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>0.5000</td>
<td></td>
</tr>
<tr>
<td>UoM</td>
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<td>1</td>
<td>0.2296</td>
<td>0.1311</td>
<td></td>
<td>0.4288</td>
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<td>TNAU</td>
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<td>1</td>
<td>0.3435</td>
<td>0.2721</td>
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<td></td>
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<td>0.1309</td>
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<td>0.1779</td>
<td>0.0230</td>
<td>0.0722</td>
<td>0.5418</td>
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<td>0.1493</td>
<td></td>
<td></td>
<td>0.4930</td>
</tr>
<tr>
<td>Thiagaraja</td>
<td>0.8533</td>
<td>10</td>
<td>0.2025</td>
<td>0.0444</td>
<td></td>
<td>0.6984</td>
</tr>
<tr>
<td>NITSu</td>
<td>0.8495</td>
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<td>0.2092</td>
<td>0.0270</td>
<td>0.0849</td>
<td>0.6371</td>
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<td>SRM</td>
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<td>0.5926</td>
</tr>
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<td>0.7515</td>
<td>13</td>
<td>0.1918</td>
<td>0.0420</td>
<td></td>
<td>0.6615</td>
</tr>
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<td>0.1920</td>
<td></td>
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<td>0.4918</td>
</tr>
<tr>
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<td>0.0488</td>
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</tbody>
</table>
Among the efficient institutions we can see that IISc, and TNAU were weighing heavily on entrepreneurial support outputs. In the extreme case of TNAU, even without weighing on industrial and research outputs, the institution has been able to commercialize large number of technologies developed and support entrepreneurs. PSGTech was weighing on the entrepreneurial outcomes heavily, even a marginal increase in this would make it efficient as its ERS institutions viz. IITM and TNAU.

The ratio of weights among the outputs can be interpreted as substitution potential among the outputs. Among the efficient institutions we can see that there is wide heterogeneity in the ratios of weights between entrepreneurial/research, entrepreneurial/graduation and entrepreneurial/industrial. Further, the degree to which research and industrial outputs can be mixed leading to entrepreneurial support output can be seen as the ratio of these weights within an institution. This lends support to the varying degrees of knowledge spill-over between research and industrial outputs to entrepreneurial outputs. When we compare the entrepreneurial support output weights of the weakly efficient institutions, we see that Sastra, NITSu and KLE are showing one sixth, one fifth and one third of what PSGTech’s entrepreneurial support contribution to its overall efficiency.

Although it is the institutions’ prerogative to improve its efficiency, we note a few suggestions and stylized facts from existing practices that could aid in such improvement. Institutional level policies to address slack in entrepreneurial support can lead to improved outcomes in this area. Reducing barriers to translation of research in the ‘dual structures’ and encouragement of graduates to pursue entrepreneurship as a career option, although progressive would lead to increased entrepreneurial outcomes.

This can take forms of incentives to commercialize technology that emerged from research. We see evidence of incentives on technology commercialization as direct financial benefits to principal investigators improving the level of licensing in a central agriculture institution. In another instance, where the institution was limited by both basic research infrastructure as well as human capital had shifted focus to inter-disciplinary research in close collaboration with industry. We saw another institution that had set up a large research park tracking (as credits/hours of involvement) both industry involvement and faculty involvement in developing new entrepreneurial ventures that have emerged from the institution. And finally, we noted differentiated norms across several institutions for commercializing research to established firms vis-à-vis new ventures/ startups as defined by the government based on age and sales turnover.

Conclusions

Our study, looking at the institution data from India, evaluated efficiency including the entrepreneurial support outcomes and the traditional outcomes of institutions. We were able to rank the institutions; locate and quantify inefficiencies among them. The output slacks based interpretation provided the quantum of improvement in entrepreneurial support possible at these institutions. We further looked at the output weights to interpret mix/scale possibilities for the weakly efficient institutions against the institutional practices of efficient ones. We then provided certain managerial implications on how this could be achieved.

The data that is necessary to perform such analysis are generally hard to acquire, due to changing governmental regulations on institutional disclosures. While our analysis was based on the 2016-18 data, the trailing three years 2017-19 the same data is not made available.
So continuing this research to include such panel data is not feasible. Other future research avenues, could be to extend the analysis to include the external environment conditions, either as venture investment/credit growth measures, GDP growth measures, number of incorporations at a relevant geographic unit level.

References


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