Analyzing the relative efficiency of internationalization in the university business model: the case of Germany

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ABSTRACT

Internationalization impacts universities and changes their core missions. Consequently, many western universities adopted a business model approach to deal with opportunities and challenges internationalization poses to their missions. Resulting from increased scrutiny from the public and policy makers on the ability of universities to efficiently utilize public resources to achieve institutional missions, interest is growing to analyze this development and its effects upon the university business model. This paper's purpose is to examine and evaluate how internationalization within the university mission impacts the university business model. Using a sample of German universities, this study develops a unique, three-stage, mathematical analysis to investigate this connection. By determining the internationalization and overall efficiencies of each institution relative to peers in the dataset, it is found that no direct correlation between the relative internationalization and overall institutional efficiencies exists, while also evidencing the usefulness of efficiency analysis in allocating resources for internationalization and overall university mission achievement. These results show that while the relative efficiency of internationalization may contribute to a university's overall relative efficiency, other components in the university business model may also be critical in determining overall relative efficiency, and the interplay of these components should be investigated in future research.

KEYWORDS

Higher education; internationalization; efficiency; business model; university mission; performance evaluation

1. Introduction

Universities face changes driven by multifaceted environmental factors, including changes to funding structures and increased competition for resources between universities at national and global levels (Valero and Van Reenen 2019). This impacts overall university business models; institutional strategies and operations employed to achieve missions and respond to stakeholders through value creation (McAdam, Miller, and McAdam 2017; Zott, Amit, and Massa 2011). Internationalization influences university missions of teaching, research and service to include a global perspective in response to a world becoming more complex – with more competitive environments in which a university must position itself (Hudzik 2011; Knight 2003; Valero and Van Reenen 2019). Consequently, universities alter their business model by focusing, refining and expanding pre-existing internationalization of higher education to better achieve their missions (Soliman, Anchor, and Taylor 2019; Tadaki and Tremewan 2013). This is shown by the increasing number of

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affiliations and activities of universities domestically and across the globe. Attracting students and grants from abroad may increase access to resources in some of these competitive environments and also strengthens relationships to key external stakeholders by creating knowledge spillovers.

Business model performance is based on two measures, effectiveness ('doing right things') and efficiency ('doing things right'). This paper focuses on the latter, evaluating relative efficiency of internationalization in university missions as part of overall university business models. Using internationalization to improve positioning is increasing in an environment of more scrutiny over budget allocation (since universities are competing nationally and globally for resources to achieve their missions), serving to make relative efficiency a useful metric for analyzing internationalization and overall mission performance.

Are universities relatively efficient in pursuit of internationalization? What is the relationship between relative internationalization efficiency and overall relative efficiency? What does this mean for developing university missions and university business models? This study explores these questions and contributes to literature by investigating internationalization as a university business model component, and by employing a Data Envelopment Analysis (DEA) of institutional-level data from German universities to evaluate relative efficiency of internationalization within the context of relative efficiency of the overall university business model in mission achievement.

This study begins by detailing the definition and motivation for internationalization in university missions, placing internationalization within university business models and justifying methodology. Then quantitative methodology is explicated, describing data collection from a sample of German universities and how a three-stage process, based on DEA and correlation/regression analyses, is used to determine internationalization and overall performance relative efficiencies while controlling for extraneous factors. Next, the methodology is applied, showing German universities are relatively efficient in internationalization and overall, but findings do not indicate a direct relationship. Lastly, findings are linked to key questions, implications for decision-makers and future research are discussed and limitations are described.

2. Literature and theory

2.1. Internationalization

For higher education institutions (HEIs) prioritizing internationalization to achieve missions, the practice is linked to improved teaching, research and service to society (Agasisti and Pohl 2012; Hudzik 2011; Lehmann et al. 2018). As internationalizing higher education and its missions develops over time, so too does its study. This necessitates an evolving definition of higher education internationalization to reflect its intention/usage (de Wit 2002; Knight 2004; Vestal 1994). While discussion amongst scholars reveals a desire to update the modern understanding of internationalization to become more specific and inclusive by focusing on ethical engagement and relational equity amid power imbalances (Buckner and Stein 2020), the commonly accepted definition within literature was posited by Jane Knight (de Wit 2020):

> Internationalization at the national, sector and institutional levels is defined as the process of integrating an international, intercultural or global dimension into the purpose, functions or delivery of postsecondary education. (Knight 2003)

Thus, higher education internationalization is understood as an ongoing effort developing over time and dimensions, intentionally injected in strategies and activities throughout higher education and its missions (Knight 2004). While broad, Knight's definition positions internationalization as an umbrella term accommodating Buckner's (2019) finding that types of internationalization pursued by an institution, and how internationalization is experienced, is connected to locational, historical and cultural contexts of institutions.

Knight's framing provides a separation from globalization, describing a wider phenomenon. Altbach and Knight define globalization as 'economic, political and societal forces pushing twenty-first century higher education toward greater international involvement' (2007). This allows for conceptualization of internationalization as the education sector's response to globalization (Altbach and Knight 2007). This clarifies the relationship between changes in international relations/affairs/paradigms and changes in university internationalization.

Comprehensive internationalization is the operationalization implicated by Knight's definition (Hudzik 2011). Distinguishing from conceptual ideas, Hudzik (2011, 2015) focuses on institutional action, asserting:

> Comprehensive internationalization is the means by which higher education institutions respond to widening and more complex expectations to connect globally across all missions to better serve students, clientele and society in a twenty-first century context.

Ensuring an HEI's mission recipients are exposed to transnational/intercultural/global themes, comprehensive internationalization seeks improved overall service quality (Hudzik 2011). Internationalization is integrated throughout missions and operations to produce international outcomes in teaching, research and student programming (Hudzik 2015). This improves outcomes for HEI stakeholders, including economic beneficiaries of activities spawned through comprehensive internationalization (Knight 2004).

In many higher education systems, internationalization impacts university business models by improving university missions while potentially bolstering prestige (e.g. international reputation and influence on rankings) and revenues (e.g. research/programmatic grants, international student fees) (Altbach and Knight 2007). Since theory states internationalization improves overall university performance, understanding if internationalization efficiency is correlated to overall university mission efficiency is important. There is little scholarly work investigating university internationalization efficiency and this paper addresses this gap.

2.2. University business models

Sustained change and increased competition effects university business models and their missions (Cunningham, Menter, and O'Kane 2018; Miller, McAdam, and McAdam 2018; Morphew, Fumasoli, and Stensaker 2018). Business model perspectives in higher education research are recent, deriving from strategic management/entrepreneurship literature (McAdam, Miller, and McAdam 2017). Business models as units of analysis enhance understanding of how organizations create, deliver and capture value (Cavalcante, Kesting, and Ulhøi 2011; Zott, Amit, and Massa 2011). This paper takes an active system perspective, with business models explaining how universities create value for stakeholders through their missions (Zott and Amit 2010; Zott, Amit, and Massa 2011). Changing environments and stakeholder needs force universities to adjust their business models, such as increasing internationalization (de Wit 2002). Competition for funding and international scholars/students necessitates efficient resource allocation. Thusly, HEI management needs to evaluate university business model efficiency in this area.

Analyzing increased stakeholder interaction is broadly adopted in university business model research (Lehmann et al. 2020). Miller, McAdam, and McAdam (2014) use a stakeholder perspective to explore university value creation through their missions. This focuses on 'entrepreneurial universities,' including technology transfer offices, industry collaborations and internationalization (Fitzgerald and Cunningham 2016; Guerrero and Urbano 2012; Lehmann et al. 2020; McAdam, Miller, and McAdam 2017). Thus, universities seek to refine their business model and engage with stakeholders through a reframing of missions, principles and operations (Hudzik 2011, 2015; Zott, Amit, and Massa 2011).

The literature mostly overlooks internationalization within the expanded university business model (Soliman, Anchor, and Taylor 2019; Tadaki and Tremewan 2013). Studies on the consequences

of mission expansion are lacking (Morphew, Fumasoli, and Stensaker 2018; Yang 2017). Efficiency-based business model themes gained less attention. Debate continues on the fit/relevance of measurement tools to assess university business models (Perkmann, Neely, and Walsh 2011). Understanding relative efficiency within a university business model component reveals insights for efficiencies of the new university business model as a whole. This study contributes to literature on university business models and internationalization by demonstrating how the concepts are linked together in working towards improved university mission achievement. This contribution helps policy-makers and university managers to evaluate aspects of business models and mission achievement and make appropriate changes.

2.3. Efficiency

Measuring relative efficiency of internationalization in university missions, and the university business model itself, requires proper mathematical techniques. Analyzing relative efficiency, Charnes, Cooper, and Rhodes (1978) introduced the basic Data Envelopment Analysis (DEA) model, CCR. CCR uses inputs and outputs ratios, and their proportional changes, to measure relative efficiency for each Decision-Making Unit (DMU) among peers. However, organizations exist where not all inputs (or outputs) operate proportionally, as some inputs and outputs are substitutional – as in this study. Radial models suffer from neglecting slacks in estimating efficiency. The remaining non-radial slacks impact relative efficiency evaluation (Tone 2001). Those models may misinform decision making when used to assess DMU performance. Locational differences may influence educational outcomes and play a role in heterogeneity across universities. HEIs in affluent areas may be benefitting from environmental spillover effects. Measures taken in this study's three-stage analysis account for such factors and therefore fill a methodological gap.

University mission efficiency research established DEA as preferred methodology (Agasisti and Pohl 2012; Ahn and Seiford 1993; Civera et al. 2018; Johnes 2006; Lehmann et al. 2018). DEA is applied in global HEI contexts, with McMillan and Datta (1998) applying to Canadian universities, Abbott and Doucouliagos (2003) for Australian universities, Warning (2004) for German universities, Afonso and Santos (2005) for Portuguese universities, Agasisti and Pérez-Esparrells (2010) for Italian and Spanish universities, and Chu Ng and Li (2000) for Chinese Universities, among others (Carrington, O'Donnell, and Prasada Rao 2018; Papadimitriou and Johnes 2019). Studies evaluated relative university efficiencies across borders (Agasisti and Haelermans 2016; Agasisti and Johnes 2009; Agasisti and Pohl 2012) and for departments, functions and units within universities (Agasisti et al. 2012; Arcelsus and Coleman 1997; Beasley 1990; Giraleas 2019; Lehmann and Warning 2002; Leitner et al. 2007).

This study builds upon literature with a three-stage approach accounting for nuances affecting DEA results, as previous studies implement models without further homogenizing samples and without accounting for locational/geographic spillovers (Civera et al. 2018). First, DEA is sensitive to outliers, addressed here by detecting outliers through a super-efficiency DEA model. Next, SBM DEA as a non-radial model is used to measure relative efficiency account for non-proportional changes in inputs/outputs and handles slacks. Lastly, typical DEA models consider only inputs with quantities controlled by management; however, contextual variables can affect relative efficiency calculation; addressed in this study through regression/correlation analysis. Uniquely applying DEA to university mission internationalization is another contribution.

3. Methods

To investigate interplays of theoretical aspects of internationalization in university missions and university business models, in addition to applying relative efficiency as a performance metric for HEIs, German universities are analyzed. As an educational and economic leader within the European Union (EU) that has introduced a competitive funding scheme to alter and assess university

mission performance (Excellence Initiative), Germany proves an interesting case for analysis (Jungblut and Jungblut 2017). Because German higher education policies, structure and culture are specific (Warning 2004), study generalizability is limited.

Public, doctoral-granting universities were isolated from total HEIs in Germany using German Rector's Conference (2019) data. This homogenizes DMUs for better analysis and eliminates HEIs less similar to doctoral-granting universities in other country contexts. German universities with medical schools have a special structure for financing them (Warning 2004), and since they are not ubiquitous, this study excludes medical school/faculty data from individual universities in the sample. After exclusions, 73 universities constitute the sample. Since two levels of analysis (internationalization and overall performance) were conducted, inputs and outputs were gathered for both. Environmental variables were collected for post-processing checks for spillover influences from the location on relative efficiencies. Data is from 2016, the most recent year where data for all variables are available, at the time of writing. While previous DEA work has also used data on these inputs and outputs within a single year (Agasisti and Pohl 2012), it is impossible to eliminate all potential influence from inputs from previous years upon outputs of the year in question. This limits this study's explanatory power, and for previous studies analyzing inputs and outputs from one year.

Because efficiencies in university settings are sensitive to the number and selection of inputs and outputs (Ahn and Seiford 1993), the selection is grounded in literature. As the first DEA study to analyze the relative efficiency of internationalization in university missions, additional detail is given for choosing these inputs and outputs. Because DEA for overall university mission relative efficiency is common and variables are established (Civera et al. 2018; Lehmann et al. 2018; McMillan and Datta 1998), those descriptions are condensed.

3.1. Data collection

Inputs for the relative efficiency of university mission performance stem from human/financial resources invested by government and institutions to pursue their missions (Agasisti and Pohl 2012; Civera et al. 2018). Total annual expenditures (Budget) and total academic staff (Ac Staff) were collected from the German Federal Statistics Office ('DESTATIS') (2020). These account for capital (fiscal and human) allocated to achieve these broad institutional goals (Lehmann et al. 2018, 2020). While these inputs have been utilized by previous DEA studies (Agasisti and Pohl 2012; Civera et al. 2018), they are potentially correlated since academic staff salaries are included in budgets, limiting explanatory power for this analysis.

For outputs, it is important to consider traditional university missions: teaching, research and service to society (Lehmann et al. 2018). While these are accepted in prior DEA studies, it is important to note work from Jungblut and Jungblut (2017) who found for German universities that focus distribution and alignment between these missions varies depending on self-categorization, discovered in their mission statement documents. Outputs for missions in DEA are established in prior studies (Agasisti and Pohl 2012; Civera et al. 2018; Lehmann et al. 2018, 2020; Warning 2004). Teaching is accomplished by educating society, represented by total graduates (Graduates) and collected from DESTATIS (German Federal Statistics Office 2020). Research is accomplished by producing high-quality publications, represented by total citations (Citations) and collected from Web of Science (2020). Web of Science citations favor publications from some disciplines, potentially affecting results for universities specializing in other areas – therefore influencing the results' impact. Service to society through knowledge transfer takes form through patenting, represented by total patent filings (Patents) and collected from the German Patent and Trade Mark Office (2020). Patenting has served as a proxy in previous DEA studies in university contexts (Civera et al., 2018; Lehmann et al. 2018), but this choice may impact results for universities pursuing societal service through knowledge spillovers not involving patenting (Hudzik 2015); a limitation for this study.

In determining internationalization inputs, comprehensive internationalization literature proves useful. Hudzik (2011, 2015) details how international strategies are operationalized by university administrators, represented by total international office staff (Int Off Staff), collected from respective university websites. Total funding from the EU and other international organizations (Int Funding) was collected from DESTATIS (German Federal Statistics Office 2020), showing financial inputs for international research and programmatic efforts in university mission pursuit. While there is a debate in literature considering these funds, they are generally recognized as inputs (Agasisti and Pohl 2012; McMillan and Datta 1998). One could argue receiving international funding through an application process constitutes an output, but because relevant outcomes of internationalizing university missions (below) are produced through administrative/programmatic institutional efforts relying on the type of financial support external funding provides, this study follows literature considering third-party funding as an input.

Outputs were identified representing outcomes of university internationalization, produced by the inputs. Total international professors (Int Profs), professors that are not German citizens, collected from DESTATIS, display diversity recruitment efforts and internationalization in teaching (German Federal Statistics Office 2020) (Beelen and Jones 2015). Recruitment of degree-seeking international students and incoming exchange students provides internationalization domestically, represented by total full-time international students (Int Students) and total incoming students from the EU's ERASMUS exchange program (Erasmus In) (Beelen and Jones 2015) and collected from the German Academic Exchange Service ('DAAD') (German Academic Exchange Service 2019). Sending domestic students abroad for programming constitutes a major internationalization effort (Stebleton, Soria, and Cherney 2013). This is represented by total outgoing students from ERASMUS (Erasmus Out), collected from the DAAD (German Academic Exchange Service 2019).

The last output at this level concerns HEI international partnerships (Partnerships), collected from the German Rector's Conference (2019). International partnerships, contractual relationships creating alliances and collaborations between an HEI and other institutions, organizations and governments around the globe, expand international reach, engagement, influence, networks, resources, capacities, capabilities and programs towards university mission achievement (Banks, Siebe-Herbig, and Norton 2016; Sandström and Weimer 2016). Total international partnerships reflect administrative effort allocated to numerous international objectives universities undertake (e.g. research, exchanges, double/dual degrees, practical training, development projects, etc.) (Banks, Siebe-Herbig, and Norton 2016). A limitation exists, as depth and breadth for each partnership is unknown; therefore, variation in partnership value is not captured or represented.

Environmental variables were collected for regression and correlation analyses of efficiencies in the post-processing phase. Accounting for environmental factors, efficiency analysis is strengthened, showing if relative efficiency is significantly impacted by location (Banker, Natarajan, and Zhang 2019). Hence, gross domestic product per capita (GDP/Capita), total population (Pop) and total land area (Area) for university municipalities were collected from DESTATIS (German Federal Statistics Office 2020). Table 1 provides the sample's descriptive statistics and shows locational variance through minimums and maximums in each category.

3.2. Three-stage process

Illustrated in Figure 1, this study develops a three-stage procedure with super-efficiency and standard DEA models to determine relative efficiencies, followed by regression and correlation analyses to estimate impacts of selected environmental variables.

Conventional DEA models contain drawbacks e.g. sensitivity to outliers (Simar and Wilson 2015). Proposed approaches in studies address drawbacks (Dyson et al. 2001). Building upon literature, this study uses a super-efficiency DEA model in the first stage (pre-processing) to identify and exclude outliers. Then, standard DEA modeling is used to estimate relative efficiencies for internationalization

Table 1. Descriptive statistics of 73 public universities in Germany.

Variable category	Variable	Mean	Median	St. D.	Kurtosis	Skewness	Minimum	Maximum
Internationalization	Int Off Staff	22.9	20.0	13.7	0.4	1.0	4.0	61.0
	Int Funding	6165.6	4319.9	6229.6	4.4	2.0	9.4	29933.2
	Int Profs	27.9	24.0	22.6	2.0	1.3	1.0	112.0
	Int Students	3035.5	2323.0	2232.3	0.4	1.1	235.0	9343.0
	Erasmus In	211.3	163.0	185.3	2.9	1.6	8.0	900.0
	Erasmus Out	371.1	329.0	250.3	0.4	0.9	45.0	1178.0
	Partnerships	283.1	252.0	153.1	−0.8	0.4	36.0	626.0
Overall	Ac Staff	3449.8	2923.0	2310.2	0.3	0.9	299.0	10112.0
	Budget	274502.6	247831.4	178064.3	1.3	1.0	31484.9	885354.1
	Citations	27285.3	17451.0	27968.3	1.2	1.3	296.0	116445.0
	Patents	22.9	11.0	33.2	9.1	2.8	0.0	182.0
	Graduates	3868.1	3426.0	2128.6	0.3	0.8	718.0	9930.0
Contextual	GDP/Capita	48860.9	42430.0	17768.6	−0.4	0.8	23066.0	91531.0
	Pop	452379.5	209751.0	739541.9	10.7	3.2	15736.0	3520353.0
	Area	228.7	147.6	237.0	6.4	2.5	43.7	1262.6

Notes: Int Off Staff: International office staff; Int Funding: International Funding; Int Profs: International professors; Int Students: International students; Erasmus In: Incoming students from the EU-driven ERASMUS; Erasmus Out: Outgoing students from the EU-driven ERASMUS; Ac Staff: Academic staff; GDP/Capita: gross domestic product (GDP) per capita; Pop: total population; Area: total land area.

and overall performance (processing). Finally, the study explores the environmental factor influence through regression and correlation analysis (post-processing).

4. Results

4.1. Outlier detection

Due to sensitivity in DEA models to outliers, Banker and Chang (2006) use super-efficiency DEA to detect and exclude them, producing more accurate estimates. Following this, a super-efficiency, input-oriented, SBM DEA (Tone 2002), assuming constant returns to scale, is performed excluding the considered DMU from the reference set. Efficiency values higher than 1.0 are attainable. This study considers 2.0 as the screen level for outlier identification, established by existing literature (Banker and Chang 2006). More stringent screen levels deteriorate discriminatory power, excluding more institutions. Less stringent screen levels fail to remove contaminated observations (Banker and Chang 2006). Universities with super-efficiency scores over 2.0 are excluded (see Figure 2). *Universität Erfurt* is an outlier with a score of 15.03. Low international funding could be responsible for this score (Table 2). This may be due to the DEA assumption that inputs and outputs are monotone, that is, when a specific output level is produced by a certain input level, the same output level or greater should be reachable if additional inputs are used, conforming to ratio scales (Dyson et al. 2001). Other super-efficient units are not conspicuous, having values less than 2.0, and *Universität Duisburg-Essen* just makes it under.

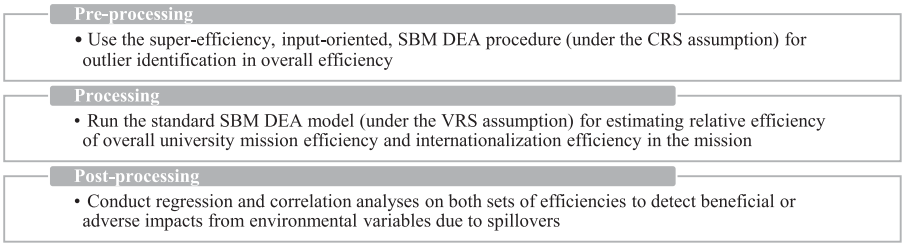

Figure 1. Proposed procedure.

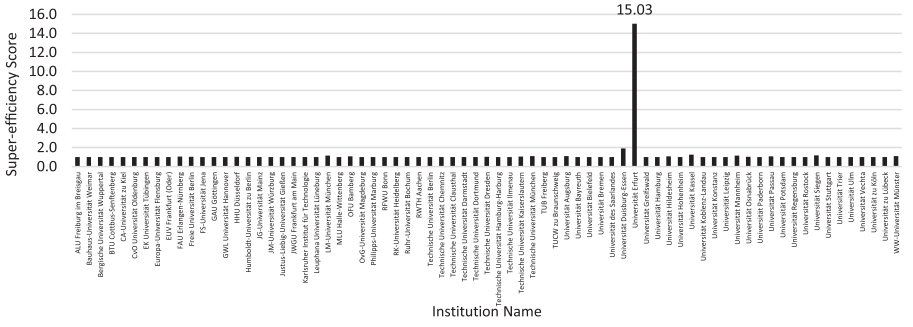

Figure 2. Super-efficiency scores.

Table 2. Input and output variables of *Universität Erfurt* compared to the other analogous universities.

Institution name	Int off staff	Int funding	Int profs	Int students	Erasmus in	Erasmus out	Partnerships
Universität Erfurt	4	9.38	7.8	428	37	85	101
Universität Greifswald	11	1945.23	6.08	666	51	103	133
Universität Hamburg	39	15427.51	71.379	5254	288	472	426
Universität Hildesheim	8	566.55	0.946	511	113	194	250

Notes: Int Off Staff: International office staff; Int Funding: International Funding; Int Profs: International professors; Int Students: International students; Erasmus In: Incoming students from the EU-driven ERASMUS; Erasmus Out: Outgoing students from the EU-driven ERASMUS.

4.2. Efficiency estimation

The resulting university efficiency scores from both perspectives are shown in Figure 3. Table 3 reports the relative efficiencies' descriptive statistics. On average, the universities have a higher relative internationalization efficiency score than the overall efficiency score. Relative efficient universities in internationalization (29) are more than double those in relative overall efficiency (13). DEA models describe a production to an abstraction level necessary for decision-makers and exclude an internal activity description, treating sub-technologies as a 'black-box' since there is no information about how they work. That more universities are relative internationalization efficient than relative overall efficient indicates that their sub-technologies function differently. This may come from a heightened focus from universities to internationalize missions, resulting in directed input allocation (Hudzik 2011; Knight 2004; Soliman, Anchor, and Taylor 2019). Because

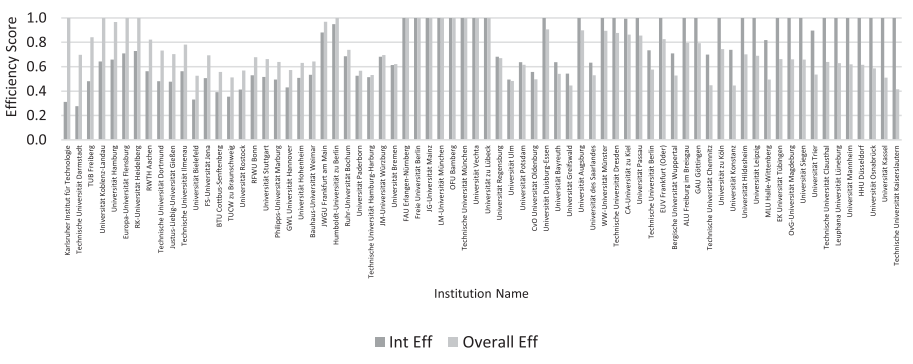

Figure 3. Relative internationalization and overall efficiencies scores.

Table 3. Descriptive statistics of the relative efficiency score.

Statistic	Internationalization efficiency	Overall efficiency
Mean	0.7573	0.7221
No. of Efficient DMUs	29	13
Median	0.7313	0.6838
Mode	1	1
Standard deviation	0.2377	0.1823
Kurtosis	−1.4087	−1.1865
Skewness	−0.2885	0.2857
Minimum	0.2771	0.4138
Maximum	1	1

many DMUs achieve high marks in one or both areas, it suggests German universities utilize resources relatively efficiently in both respects of mission achievement.

Results show 8 universities (*FAU Erlangen-Nürnberg*, *Freie Universität Berlin*, *JG-Universität Mainz*, *LM-Universität München*, *OFU Bamberg*, *Technische Universität München*, *Universität Vechta*, and *Universität zu Lübeck*) are relative efficient from both perspectives. Both large and small universities are included, suggesting size is not a predictor. Accuracy in these results is demonstrated by comparing with previous studies on mission achievement relative efficiency in German public universities (Kempkes and Pohl 2010). In both, the same universities contribute to the overall relative efficiency frontier. Efficiency score correlation analysis indicates a statistically significant ($\alpha = 5\%$) value of 0.36, but not a strong relationship. It is concluded that as relative internationalization efficiency changes, relative overall efficiency does not necessarily change in a specific direction, and vice versa.

4.3. Evaluating environmental variable effects

Regression models are estimated with efficiency scores as dependent variables and environmental factors as independent variables. This checks for locational spillover influences on internationalization and university mission achievement efficiencies. Table 4 reports the results. OLS

Table 4. Results of regression analyses.

	Regression Models			
	IntEff ∼ *GDP/Capita* + *Pop* + *Area*		*OverallEff* ∼ *GDP/Capita* + *Pop* + *Area*	
	OLS	Tobit	OLS	Tobit
	1	2	3	4
GDP/capita	−0.00000	−0.011***	0.00000**	−0.297***
Standard error	0.00000	0.00000	0.00000	0.00000
Marginal effect	–	−1.29e−06	–	2.81e−06
Pop	0.00000**	0.0003***	0.00000	0.019***
Standard error	0.00000	0.00000	0.00000	0.00000
Marginal effect	–	9.65e−08	–	7.78e−08
Area	−0.0003*	−1.553***	−0.00002	−53.751***
Standard error	0.0002	0.0004	0.0001	0.0003
Marginal effect	–	−3.02e−04	–	−5.00e−05
Constant	0.851***	0.000	0.567***	0.000
Standard error	0.090	0.000	0.067	0.000
Observations	72	72	72	72
R^2	0.068		0.124	
Adjusted R^2	0.027		0.086	
Log-likelihood		−14,400.0		−14,000.0
Residual std. error (df = 68)	0.235		0.174	
F statistic (df = 3; 68)	1.658		3.216**	
Wald test (df = 3)		82,119,013.0***		127,942,350,466.0***

Notes: *$p < .1$; **$p < .05$; ***$p < .01$. GDP/Capita: gross domestic product (GDP) per capita; Pop: total population; Area: total land area.

model results for relative internationalization efficiency, that is, regression model 1, ($IntEff \sim GDP/Capita + Pop + Area$) note negative signs exist on *GDP/Capita* and *Area* variables, but they are not statistically significant at the 5% level. *Pop* has a statistically significant but weak relationship to internationalization efficiency. For the Tobit model (regression model 2), *GDP/Capita* and *Area* variables have negative statistically significant relations to internationalization efficiency. Only *Pop* has a positive statistically significant relation to internationalization efficiency. However, no strong relationship exists between variation in environmental features and internationalization efficiency. For relative overall efficiency, only *GDP/Capita* has a statistically significant relation to efficiency in OLS regression model 3. Regression model 4 indicates all non-discretionary inputs are statistically significant and *GDP/Capita* and *Area* variables are negatively related to relative overall efficiency.

Results indicate the contextual variables for university location do not show a strong relationship between variations at either analysis level.[1] This is supported by Warning (2004): 'German universities do not vary significantly in their financial inputs, because the overwhelming majority of financing is provided by the government, which does not differentiate among universities.' In Germany, policy measures alleviate locational discrepancies in university inputs. This limits the results' generalizability, since Germany varies from many other higher education systems, like those in several Anglo-Saxon countries producing significant revenues through student fees and tuition – with higher rates for international students (Altbach and Knight 2007; de Wit 2002; Hudzik 2015).

5. Discussion and conclusion

Internationalization is a component of modern university missions and business models but the effects of this component have not been fully investigated in previous studies (Soliman, Anchor, and Taylor 2019; Tadaki and Tremewan 2013). Internationalization permeates throughout university missions (Altbach and Knight 2007; Hudzik 2015), yet its efficiency and the relationship between relative internationalization efficiency and relative overall efficiency within the university business model has so far been unknown (Morphew, Fumasoli, and Stensaker 2018; Perkmann, Neely, and Walsh 2011). Increased competition for funding and recognition necessitates efficient resource allocation, thus HEI management stands to benefit by understanding university business model efficiency in this area (Hudzik 2011; Knight 2003; Soliman, Anchor, and Taylor 2019; Tadaki and Tremewan 2013; Valero and Van Reenen 2019). This study addresses these gaps and contributes to the literature on university internationalization and university business models by implementing a unique, three-stage mathematical process, based on DEA methods and regression/correlation analyses, to find relative internationalization and relative overall efficiencies of German universities and to show these are not significantly correlated to certain locational factors. While German universities proved to be relatively efficient at both analysis levels in general, a direct relationship between those levels was not found.

Key questions posed can now be assessed. Are universities relatively efficient in pursuit of internationalization? Results show universities in the sample range in relative efficiency scores, indicating there is no universal answer. Results show a majority pursue internationalization relatively efficiently, though only a subset are high performers. This suggests German universities in this study have mostly been efficient at allocating resources for internationalization, when compared with their peers in the sample.

If universities are relatively efficient in internationalization, are they also relatively efficient in overall performance? Results for this sample show this is not a direct relationship, with only eight universities receiving top scores in both dimensions. Many universities were deemed relatively efficient in one respect, but not in both. When testing correlation between efficiencies, results suggest a relationship may exist, but it is not direct/strong in nature.

What might these answers mean for developing other aspects of university missions and business models? This study shows evidence that relative internationalization efficiency cannot predict

relative overall efficiency in the sample, implying relative efficiencies of other components of the university business model contribute to relative overall efficiency in mission achievement. This suggests the relative efficiency of other components may also be unable to predict relative efficiency of overall university performance in mission fulfilment, hinting this may only be understood when all components are taken into account together.

The study bears implications for practitioners throughout higher education. Policy-makers and grant-makers now have a tool for tracking resource allocation efficiency to better achieve university missions through internationalization. University leadership can adjust their inputs and understand what efficient mission outcomes should resemble, better informing decisions and goal setting in university business models, in particular with an eye towards internationalization and overall university mission achievement. Universities can look to peers on either relative efficiency frontier and identify potential adjustments within their mission-oriented business model to improve returns on resources, otherwise known in DEA literature as utilizing the 'reference set' of efficient units to improve one's own efficiency (Charnes, Cooper, and Rhodes 1978). Governments could use this framework to identify universities needing more resources to achieve mission outcomes in either dimension. Governments could use this to leverage competition in university systems, rewarding efficient institutions and by distributing public funds consistent with efficiency scores.

This study's limitations reveal areas for future research working towards expanding external validity. This analysis's major limitation is its single country context with specific funding mechanisms, culture, policies, historical background, etc., confining the generalizability of findings from the model. Future studies could include other countries to test this theoretical work and broaden methodological impact for comparative purposes. Analyses could include data from multiple years to determine trends over time and reduce limitations introduced by timing effects. Studies could utilize different measures of the service mission accounting for spillover activities other than patents. Future research could analyze the relative efficiencies of other university business model components and explore relationships between components. Potential studies could focus on relative efficiencies for the three university missions individually and investigate internationalization's impact on each of them. This study only controlled for certain locational factors, leaving possibilities to control for other outside factors potentially influencing both efficiency scores.

Note

1. The value of environmental factors is based on data from The Federal Returning Officer (source: https://www.bundeswahlleiter.de/en/bundestagswahlen/2017/strukturdaten.html).

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