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DIAGNOSING CLUSTER COMPETITIVENESS USING FIRM-LEVEL DATA IN THE PROFIT–GROWTH NEXUS FRAMEWORK

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Competitiveness is defined at the level of firms, clusters, regions, and nations. Although researchers have extensively explored the concept of competitiveness in each of these respective categories, an understanding of the relationship between levels of competitiveness is lacking. The simple aggregation of indicators to approximate broader categories of competitiveness is challenged as a robust solution. This paper proposes an alternative solution to aggregating firm-level competitiveness, based on the profit–growth nexus. Using data collected from SMEs in two ICT clusters, the size–profit–growth relationships were tested. Based on 83 Hungarian and 71 Australian responses, positive relationships were found in both samples, demonstrating high cluster-level competitiveness. It is argued that this outcome better represents cluster-level competitiveness based on firm-level data, than other – linear and additive – aggregation methods. However, a comparative examination of the data across the clusters showed significant differences between the results of the two samples, ascertaining limitations for the generalisability of the results.

Keywords: profit–growth nexus, firm size, firm growth, profitability, competitiveness, SME, clusters

JEL classification indices: D21, L21, L26, M21

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1. INTRODUCTION

The profit–growth nexus is a conceptual framework that integrates firm performance (profitability), potential (growth), and other firm characteristics (size). The trade-off between profit and growth, and the independence of firm size and growth implied by theory in the profit–growth nexus presents the conceptual boundaries to firm competitiveness. This paper sets out to explore whether the profit–growth nexus can provide a basis for aggregating firm competitiveness indices to approximate aggregate competitiveness. Answering this question provides a conceptual basis to fill the gap in the body of knowledge spanning between the different levels of competitiveness.

The paper is structured as follows. Section 2 provides the theoretical background of the study, including competitiveness and the profit–growth nexus. Section 3 develops the research propositions and hypotheses, Section 4 gives account of methods and analysis. The empirical component of the study described in Section 5. The summary, conclusions, and limitations of the study are presented in Section 6.

2. THEORETICAL FRAMEWORK

2.1. Competitiveness

Buckley et al. (1988), Stojcic (2012), and Wach (2014) provide in-depth reviews of the field of competitiveness, including the theoretical basis of conceptualisation spanning from evolutionary and institutional economics, the resource-based view, and international trade and economic growth. Conceptually, there are two distinguishable schools measuring competitiveness. One is based on the practice of using global performance measures and deriving complex indicators of competitiveness from these. Examples of this include the Global Competitiveness Indicator of the World Economic Forum (Porter – Schwab 2009), the IMD World Competitiveness Yearbook (2009), or the structural model based competitiveness study of Ju – Sohn (2014). The other school is based on the competitiveness models of Porter (2003) and constructs competitiveness from the firm level up to the international level (Cho et al. 2008; Cho – Moon 2013).

This paper follows the conceptualisation of Chikán (2008) in addressing the gap between empirically linking competitiveness at different levels, and focuses on the issue of using firm-level competitiveness data, as implied by the Porterian view of competitiveness. Huggins et al. (2014) suggest that firm-level factors are the most important drivers of competitiveness when comparing competitiveness internationally, at regional (mezzo) and national (macro) levels. Stojcic et al.

(2013) also share this view, and highlight that firm-level factors can be aggregated into national- (macro-) level competitiveness. Cho et al. (2008) and Ju – Sohn (2014) further attest to the link between firm (micro) and higher aggregation levels of competitiveness.

Competitiveness can be understood at micro, mezzo, and macro levels. Competitiveness at a national (macro) level was understood as the ability of a national economy to conduct foreign trade at a surplus by creating more value than other countries (Cho – Moon 2013). Stojcic (2012) and Wach (2014) argue for the merit of studying competitiveness at a regional (mezzo) level, as it provides the basis of a more refined level view on the competitiveness phenomenon. Porter (2003) stresses the importance of distinguishing between regional and cluster competitiveness. Regional competiveness delineates firm population based on the spatial dimension, while clusters are additionally defined by the dimensions of industry (Sölvell et al. 2008), and the existence of company-level networks (Zettinig – Vincze 2012). Ketels (2013) confirms the rationale for the investigation of mezzo-level competitiveness within clusters by arguing that firms in clusters share several key characteristics leading to competitiveness and that clusters are thus the natural units of regional policy initiatives.

Buckley et al. (1988) define firm competitiveness as consisting of three dimensions: performance, potential, and process. Craig et al. (2008), Laureti – Viviani (2011), and Gao et al. (2013) conclude that performance is an important dimension of firm-level competitiveness. Kivilouto (2013) asserts that firm performance itself consists of multiple dimensions, and is characterised by the co-existence of growth (potential) and profitability (performance). The third dimension of firm competitiveness as defined by Buckley et al. (1998) is process, referencing the specifics of the firm management.

The operationalisation of competitiveness measures is extensively discussed by Buckley et al. (1988), Stojcic (2012), and Wach (2014) at all levels of analysis. Laurenti – Viviani (2011) constructed a composite measure of firm competitiveness using financial return indicators (as a measure of profitability), labour productivity (as a proxy to productivity), firm age (as a proxy of firm survival ability), and firm size (indicating a firm's ability to advance on economies of scale). Craig et al. (2008) use self-reported scales measuring firm performance and two different dimensions of competitive orientation in pursuit of measuring competitiveness. Gao et al. (2013) also implemented self-rated measures of competitiveness, consisting of product competitiveness, technological capacity, and the product position on the value chain. A fourth aspect of firm competitiveness was included in the modelling by Gao et al. (2013), namely firm size, in order to incorporate a measure of organisational capacity. These diverse ways of measuring firm competitiveness are aligned with the three categories of measures anchored in literature (Buckley et al. 1988): performance, potential, and process.

Aggregating dimensions or creating/identifying proxies of competitiveness cannot resolve the issue of comparability. However, the relationships between the dimensions/proxies of competitiveness within a population of firms may be able to inform a comparative analysis across populations. In order to build an understanding on how this can be achieved, a suitable conceptual framework was sought to provide a theoretical foundation for the expectations regarding the relationships between the various dimensions/proxies of competitiveness.

2.2. The profit–growth nexus

Cowling (2004) defines the profit–growth nexus as the relationship between firm size, growth, and profitability. Firm performance measures highlighted in the review of Kivilouto (2013), also used as dimensions of firm competitiveness, are empirically tested by Assaf et al. (2014), Choong (2014), and Acquaah (2012) to identify a temporal dimension to the relationships potentially implying causality between the different dimensions. Kivilouto (2013) asserts that competitiveness is signified by a positive relationship between profitability and firm growth. Davidsson et al. (2009) find that earlier profitability affects later firm growth. Coad (2009), on the other hand, finds that firm growth is a consequence of productivity improvement, which is positively related to profitability.

Firm size becomes an important component of the profit–growth nexus by introducing the principle of Gibrat's (1931) Law, which proposes that firm size and growth are independent. Investigating Gibrat's Law, Daunfeldt – Elert (2013) have identified significant differences between firm populations. Santarelli et al. (2006), Reid (2007), and Davidsson – Wiklund (2013) all attest to a negative size–growth relationship.

The profit–growth and size–growth relationships imply the presence of a systematic relationship between firm size and profitability. Lee (2009), Pervan – Višic (2012), and Babalola (2013) show evidence for a positive relationship between firm size and profitability in the contexts of developed, transitional, and developing economies.

Figure 1 summarises the profit–growth nexus and the anticipated relationships within it. Firm performance – measured in the profit–growth nexus – can be translated into a measure of competitiveness of the group of firms by observing the relationships between the constructs in the model. A negative relationship between growth and profitability indicates a lack of firm competitiveness, while a positive relationship signifies competitiveness (Kivilouto 2013). These find-

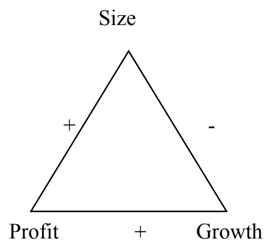


Figure 1. The profit–growth nexus

ings imply that competitiveness results in increased profitability leading to more growth, and eventually a larger firm size. Lack of competitiveness, on the other hand, pulls back profitability, which reduces firm growth results and leads to smaller firms. These relationships provide an aggregate measure of the competitiveness of the firm population at the cluster level.

2.3. Firm performance measurement

Kivilouto (2013) emphasises the multidimensional nature of firm performance. The dimensions of profit and growth – as traditional performance measures – lend themselves to the purpose of integration within the framework of the profit–growth nexus, and the exploration of the creation of an aggregation based competitiveness measure. The study of firm growth and profitability traditionally falls within the domain of entrepreneurship (Davidsson – Wiklund 2013). Mezzo-level empirical studies often deal with a wide range of firm sizes, resource configurations (Ketels 2013), and conceptual model designs (Davidsson et al. 2009), and within this context, the issue of growth and profitability of small- and medium-sized firms often coincides with entrepreneurial activity.

In particular, the subject of the evaluation of competitiveness at the firm level overlaps in its dimensionality (Buckley et al. 1988) with the measurable aspects of firm performance (Kivilouto 2013) and hence requires the integration of firm performance and competitiveness literature. This conceptual link is further augmented in relation to the design of measures discussed in the following sections.

3. RESEARCH SPECIFICATION

Our research question is empirically linking measures of competitiveness across different levels of competitiveness. In particular, the paper focuses on the issues of using firm- (micro-) level competitiveness indicators to construct cluster-

(mezzo-) level competitiveness indices, which are comparable across clusters. Based on the review of literature on competitiveness, the profit–growth nexus has been identified as a suitable conceptual foundation to investigate the research problem. Can the profit–growth nexus provide a basis for constructing competitiveness indices from firm-level data to approximate aggregate competitiveness at the cluster level? In order to answer this question, research propositions are built based on the profit–growth nexus and its ability to capture the competitiveness of the investigated clusters in a comparable manner. The propositions are operationalised into hypotheses, which are reflected upon using multivariate statistical methods.

Chikán (2008) provides the conceptual framework connecting different levels of competitiveness, which are supported by empirical evidence from Ju – Sohn (2014) and Lopez-Garcia et al. (2014) between the firm (micro) and national (macro) levels. However, the gap between firm (micro) and cluster (mezzo) levels remains unaddressed. Applying the profit–growth nexus, and the assumptions displayed in *Figure 1,* allow testing competitiveness of firms within a cluster. Relationships between the dimensions of firm competitiveness in turn will provide comparable indices of competitiveness at the cluster level, free from the previously identified accessibility and comparability issues (Lopez-Garcia et al. 2014), and tackling the non-linear nature of the measures of competitiveness (Laurenti – Viviani 2011).

The first proposition establishes the relationships between the dimensions of the profit–growth nexus as measures of competitiveness at an aggregate (cluster level). This is a necessary condition of the interpretation of relationships in the profit–growth nexus as aggregate indicators of competitiveness:

Necessity proposition: Firm profitability, growth, and size are positively related, indicating cluster- (mezzo-) level competitiveness.

The necessity proposition implies three separate hypotheses, namely:

H1.1: Profitability and firm growth are positively related.

H1.2: Profitability and firm size are positively related.

H1.3: Firm size and growth are negatively related.

The second research proposition concerns the issue of cross-population comparability as highlighted by Lopez-Garcia et al. (2014), thereby querying the sufficiency of the profit–growth nexus to provide an indication of aggregate competitiveness. Several efforts that have been reviewed to establish linear (Craig et al. 2008; Gao et al. 2013) or non-linear (Laurenti – Viviani 2011) aggregates/proxies have shown that the issue of information accessibility and comparability are inherited to the higher level of competitiveness index aggregation. Comparability can be ensured using standardised absolute measures; however, Harzing et al. (2013) argue that such cross-country comparisons can be difficult and potentially misleading. In particular, such differences are more severe in the case of self-reported, survey-based data. The second research proposition is based on the relationships between the components of the profit–growth nexus, reflecting dimensions of competitiveness. It contests whether the relationships between these dimensions are comparable between different clusters.

Sufficiency proposition: Relationships between the components of the profit–growth nexus are comparable across cluster-specific samples and this comparison is meaningful in terms of indicating cluster-level competitiveness.

The sufficiency proposition implies four separate hypotheses that are necessary to diagnose comparability of competitiveness across clusters:

H2.1: Measures of firm size, growth, and profitability are invariant across clusters.

H2.2: The profitability to firm growth relationship significantly varies across clusters.

H2.3: The profitability to firm size relationship significantly varies across clusters.

H2.4: The firm growth to size relationship varies across clusters.

4. METHODS AND ANALYSIS

The empirical investigation of the research hypotheses and propositions is conducted on cluster-based (industry- and country-specific) samples. The industry focus of the investigation has been essential in that it eliminates industry-specific variation. Becchetti – Trovato (2002) find such cross-industry variation substantial, especially when evaluating measures of firm growth and profitability. Cluster-specific studies of competitiveness (Lopez-Garcia et al. 2014; Ju – Sohn 2014) underpin the practical relevancy of constraining the investigation to geographical regions and industries. The Hungarian ICT cluster of Central Hungary (Lengyel 2012; Lopez-Garcia et al. 2014) and the Australian ICT cluster of the state of Victoria (Hall 2006) provide the testing context for these research hypotheses and propositions. Firm-level data was collected in these two clusters, in 2009, and used to provide an analysis of the profit–growth nexus.

4.1. Model configuration

Figure 1 provided an overview of the profit–growth nexus framework, based on the review of the literature. The literature implied that profitability precedes growth (Davidsson et al. 2009), and that growth rates are not related to firm size

(Gibrat's Law). This presents the empirical investigation into the profit–growth relationship with the issue of endogeneity (Greene 2007), namely that the assumption of independent error terms for using multivariate methods is potentially violated between firm size and growth.

Instrumental variables independent of the dependent variable (size), but related to the endogenous variable (growth) were sought. For the purposes of examining the profit–growth nexus, expansion planning was introduced as an instrumental variable, meeting these requirements. The presence of endogeneity and the necessity of an instrumental variable can be ascertained by means of the Durbin-Wu-Hausman test (Wooldridge 2009), which compares the original OLS model with the instrumental model to identify the presence of a systematic relationship between the error term of the endogenous variable and the dependent variable. Details of these calculations are available from the author upon request.

4.2. Measurement design

Based on the conceptualisation of the dimensions of competitiveness (Buckley et al. 1988; Stojcic 2012; Wach 2014) and the components of the profit–growth nexus (Cowling 2004), measures for firm growth, profitability, and size were constructed. Coviello – Jones (2004) point out in their review that employee number and annual sales are the two most frequently used measures. Further to these, Delmar (2006) in his extensive review of the literature confirms the use of firm asset size as a dimension of growth measurement.

Self-reported, perception-based measures were selected instead of using datasets from specific government or commercial databases. Mckinley et al. (1996) suggest that perception-based measures are appropriate, while Achtenhagen et al. (2010) point out the lack of studies building on how practitioners actually perceive growth. Kaplan – Pathania (2010) find that perception-based measures are influenced by the broader economic environment, providing a strong argument for the use of soft measures within a specific context. A further advantage of using self-reported measures was that it reduced the issue of business confidentiality and enhanced the response rate to the survey. The detailed list of survey items used to collect data for this paper is available from the author upon request.

Firm growth was conceptualised with two different metrics. Respondents were required to rate their firms' performance in comparison to other companies (which is a perceived relative measure) and to their potential (which is a hypothetical absolute measure). Information on the perceptions of owners, managers, and key decision-makers was sought of the current situation at the time of data collection. Firm size measures were developed following the classifications of

Eurostat and were cross-referenced with the recommendations of the Australian Bureau of Statistics (Trewin 2005; EC 2008). Similarly to firm growth measures, information was sought from owners, managers, or key decision-makers of the firm size at the time of data collection.

Scales measuring perceived profitability were constructed in a similar way to deliver potentially good psychometric properties and align with the measures of growth. As suggested by the literature (Davidsson et al. 2009), the endogeneity of firm growth to past profitability was captured by placing profitability among the dependent variables. A four-year time period was found adequate by researchers investigating retrospective bias of perception-based surveys (Golden 1997) to serve as a retrospective time period in which respondents were requested to assess the profitability of their firm. Furthermore, the endogeneity of firm growth to firm size was remedied by the introduction of an instrumental variable.

Past planning was introduced into the conceptual framework as a suitable instrumental variable. Pistrui (2003) identified firm expansion plans with the growth intentions of a company. Scales developed and empirically validated in Romania (Pistrui et al. 1997) and several other countries were adapted in this study. Scales of market and operations expansion planning were introduced into the survey.

4.3. Data collection

Data collection was conducted in Australia and Hungary. In order to reflect on the research hypotheses and propositions, and to validate the findings, two cluster samples were necessary. In order to augment the expected difference between the samples, similar clusters in two substantially different economies were selected. The selection of the ICT sector is of interest, as substantial ICT clusters are present in both countries (Hall 2006; Lopez-Garcia et al. 2014), and is an industry which has suffered substantial loss of productivity and competitiveness in developed countries since the dotcom boom of the millennium (Rohman 2013).

Specific analyses into the competitiveness of the clusters explored in Australia (Hall 2006) and Hungary (Lengyel 2012; Lopez-Garcia et al. 2014) testify the globally significant competitive positions of these clusters, providing an argument for exploring the research hypotheses and proposition on firm-level data in these clusters.

Specific information on comparing competitiveness of the Central Hungarian and Victorian ICT clusters is not available, but rankings of global nature allow some approximation of the expected comparative outcomes. The Global Competitiveness Index of the World Economic Forum places Australia at the rank of 18, while Hungary is ranked 62 (Porter – Schwab 2009) out of 134 countries. According to the IMD World Competitiveness Yearbook (2009), Australia ranked 7th and Hungary 45th. In both rankings, Australia outperformed Hungary in 2009, potentially implying the expected result of the comparative analysis in this study. In particular, the investigation of Lengyel – Szakálné Kanó (2014) into the role of clusters in regional economic development has found that cluster specialisation does not affect regional growth, which is primarily driven by the presence of large, foreign companies. This implies that actual competitiveness measured based on SMEs-level data in the respective clusters may show even larger differences in competitiveness compared to the national-level indicators. Hence, a decision was made to focus on SMEs to further increase the homogeneity of the cluster-specific samples.

Table 1 provides details of survey distribution and response characteristics in Australia and Hungary. In Australia, a web-based survey distribution approach was taken, and the survey was distributed in 3 waves. Wave 1 was a distribution of the questionnaire in the newsletters of the Australian Computer Society and the Australian Information Industry Association. The newsletters are received by over 10,000 members of these associations. Wave 2 was distributed to an email list of ICT SME owners and managers acquired from a licensed direct marketing list provider. This was the best available contact list also containing email addresses in Australia at the time, and contained 3,083 addresses. Wave 3 distribution was to ICT SMEs registered with Multimedia Victoria, a state-level government agency in Australia, and AusTrade exporter database, a Federal agency in Australia. These databases are based on self-registration of firms and contained 2,291 addresses of predominantly small- and medium-sized IT companies. The invitation letter to the survey instructed recipients only to commence responding if they were ICT SMEs as specified in this paper. Of the initial invitations sent out, 1,157 email addresses have been proven invalid, and of the remaining 4,222 invitations, 550 have proceeded to commence the survey. 167 responses were submitted, out of which 141 were usable due to a high amount of missing data. 71 of the 141 respondents reported to be located in the Victorian ICT cluster. The country-wide total response rate was 3.96%, and the effective response rate based on the number of surveys commenced in the on-line survey system was 25.64% in Australia. 50.35% of the respondents were from the Victorian ICT cluster.

In Hungary, a paper-based distribution approach was used. Two address lists were used in the mail distribution. List 1 was provided of registered ICT SMEs by the Hungarian Central Statistical Office (CSO). This list was comprised of ICT SMEs considered active by the CSO and with registered employees of 20 or more, and contained 1,503 addresses. During the mailout, 186 addresses were reported invalid by the Hungarian Postal Service. List 2 was compiled based on web-based business registries (such as the yellow pages), in which firms self-

Table 1. Sampling characteristics

		TOTAL	Wave 1	Wave 2	Wave 3	Response rates
Australia	Medium	Web: email & newsletter				
Australia	INVITES sent	5,379		3,083	2,291	3.10%
Australia	VALID addresses	4,222				3.96%
Australia	TOTAL commenced	550	30	247	273	30.36%
Australia	Number of responses received	167				
Australia	Number of usable responses received	141	7	68	92	25.64%
Australia	Number of usable responses from Victoria	71				12.91%

		TOTAL	List 1	List 2	Response rates
Hungary	Medium	Paper: regular mail and fax			
Hungary	SURVEYS sent	2,507	1,503	1,004	5.23%
Hungary	VALID addresses	1,870	1,317	553	7.49%
Hungary	Number of responses received	140			
Hungary	Number of usable responses received	131	116	24	7.01%
Hungary	No. of usable responses from Central Hungary	86			4.60%

identified as ITC companies. Of the 1,004 new company contacts identified in this way, 451 were reported invalid by the Hungarian Postal Service. A total of 1,870 surveys distributed yielded 140 responses received, of which 131 were usable, and 86 reported to be located in the Central Hungarian region. A 7.01% country-wide response rate was reached in Hungary, of which 65.65% reported to be in the Central Hungarian region.

Missing data in the final sample was insubstantial (less than 5%), and was found to be missing completely at random (MCAR). Missing values were replaced using mean-based imputation (using SPSS v23) as recommended by Hair et al. (2006). The respondents in the nationwide samples were concentrated in the Central Hungarian region (65.65% of the respondents in this cluster) and the State of Victoria (50.35% of respondents in the cluster).

The representativeness of the data requires further validation based on respondent characteristics, as the total population of respondents was not available and sampling was self-selective with potential non-response biases. Respondent firm size was somewhat skewed towards larger companies within the population of SMEs, but encompassing the full range of firm size possibilities. The sample in the Australian cluster consisted of more wholesale and development, the

Hungarian contained more retail, data-related, and consultancy services. These indicators suggest no strong biases between the samples, although due to the lack of the characteristics of the cluster populations, representation cannot be demonstrated.

4.4. Data analysis

Cluster level analysis of the respective sub-populations was performed for the profit–growth nexus. Multivariate statistical techniques were employed (using SPSS and AMOS V23 software package) to analyse the data. (A list of variables used in the analysis are available from the author upon request.) In order to eliminate potential biases caused by the use of self-reported, reflective measures, the scales have undergone psychometric analysis. Once the scales measuring the constructs were confirmed using confirmatory factor analysis (CFA), factor average scores were calculated, which were used to analyse differences between the clusters. Validity of the scales was confirmed by evaluating measurement model fit, loadings, and cross-loadings of indicators, variance extracted by scale aggregates, and invariance of loadings between the cluster samples. Inter-rater reliability was assessed by means of Cronbach's Alpha. The following section gives details on the confirmation process of the scales used, providing empirical evidence to support the psychometric qualities of the measures, and the elimination of systematic biases caused by self-reporting.

Relationships between the constructs were investigated using path modelling. Metric equivalency of the measures was tested using invariance testing and the model paths were compared between the two cluster samples based on the confidence intervals of the respective coefficients (Hair et al. 2006). *Table 2* shows the basic descriptive statistics for both clusters.

Table 2. Cluster level descriptive statistics of the sample

HU (N = 86)	Mean	Std. Dev.
Growth_Pot	2.7634	.89524
Growth_Comp	2.4854	.92570
SIZE	2.4457	.61672
PROFIT	2.7227	1.09043
MARKET	3.2008	.96545
OPERATION	3.3012	1.12452

AU (N = 71)	Mean	Std. Dev.
Growth_Pot	3.5685	.84615
Growth_Comp	2.7137	.95833
SIZE	2.5818	.80020
PROFIT	2.5631	1.03057
MARKET	3.9765	.76495
OPERATION	3.8122	.92364

Table 3. Reliability and discriminant validity

AU & HU (N = 71 + 83)	Cronbach's Alpha	AVE	Growth_Pot	Growth_Comp	SIZE	PROFIT	MARKET	OPERATION
Growth_Pot	0.81	0.471	0.686					
Growth_Comp	0.75	0.6	0.09	0.775				
SIZE	0.813	0.658	–0.015	.317**	0.811			
PROFIT	0.822	0.619	–0.036	.375**	0.135	0.787		
MARKET	0.657	0.399	.249**	.189*	0.101	–0.025	0.632	
OPERATION	0.724	0.477	.221**	.332**	0.113	0.09	.319**	0.691

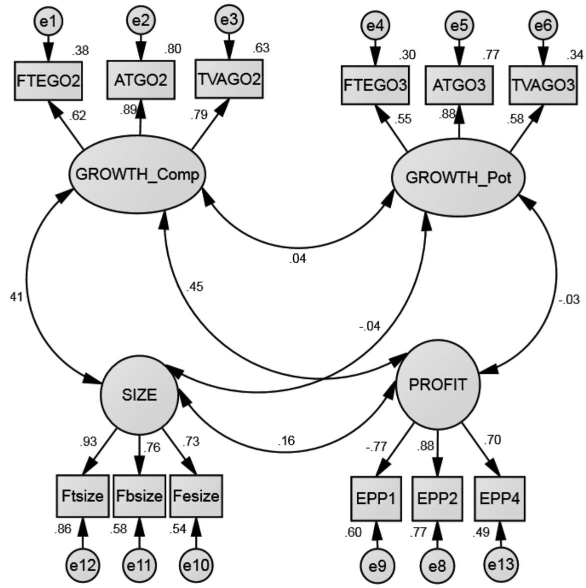
* Correlation is significant at $p < 0.05$. ** Correlation is significant at $p < 0.01$.

The validation and invariance testing of the measures was conducted using confirmatory factor analysis (Hair et al. 2006). The scales were proven to be valid and reliable, based on the absolute (p, GFI), relative (TLI, CFI), and incremental (SRMR, RMSEA) fit indices, AVE, and Cronbach's Alpha indicators (Hair et al. 2006). Convergent validity is assured by the fit indices, and discriminant validity is ensured by the Fornell-Larcker (1981) criterion. *Table 3* demonstrates discriminant validity and scale reliability for the combined dataset.

Configural invariance of the profit–growth nexus measures was demonstrated by the multi-group confirmatory factor analysis. Acceptable levels of measurement model fit and metric invariance were also demonstrated by the tests (see *Figure 2*), showing a significant χ^2 difference test between the unconstrained and metric equivalent model variants (Hair et al. 2006). This result provides support for H2.1.

Similarly, the instrumental variable Planning was identified to consist of two factors: market planning and operations planning. Confirmatory Factor Analysis demonstrated the validity and reliability of both proposed factors of planning (see *Table 3*). Configural and metric invariance were demonstrated by the significant χ^2 difference test between the unconstrained and metric equivalent model variants (calculations available upon request from the author).

For further analysis, construct level average scores were calculated, and reverse-scaled items were inverted to ensure appropriate aggregation. The conceptual framework was adopted to incorporate the two factors of planning as instrumental variables. The Durbin-Wu-Hausman test results indicate that the residuals are not significantly related to the dependent variable, dismissing the issue of flawed results caused by endogeneity in the model.



(Fully constrained model results)*

* Model fit characteristics available upon request from the author.

Assuming Unconstrained model to be correct:

Model	DF	CMIN	P
Measurement	8	16.114	.041
Structural	18	35.276	.009
Fully constrained	30	95.273	.000

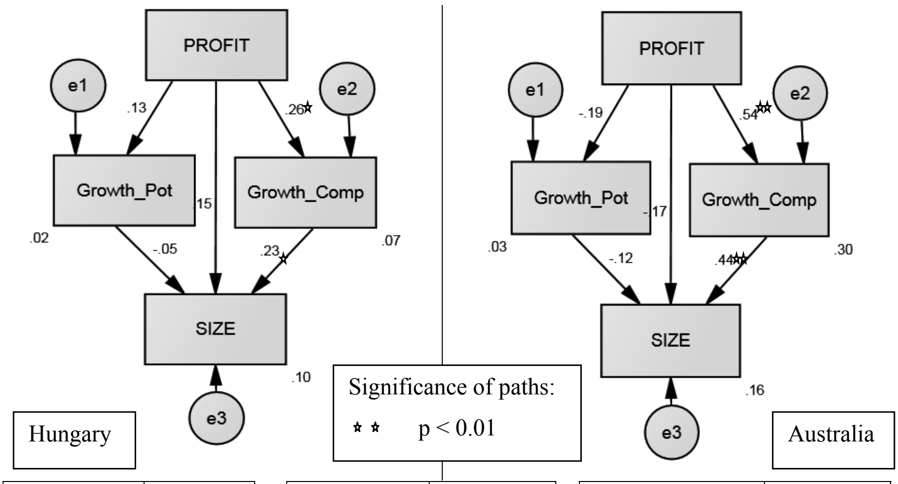
Assuming Measurement weights constrained model to be correct:

Model	DF	CMIN	P
Structural	10	19.161	.038
Fully constrained	22	79.159	.000

Assuming model Structural paths constrained model to be correct:

Model	DF	CMIN	P
Fully constrained	12	59.998	.000

Figure 2. Profit–growth nexus measurement model confirmation and invariance testing



Fit indicator	Value
p	0.581
χ^2	1.085
df	2
$\chi 2$ / df	0.543

Fit indicator	Value
GFI	0.996
AGFI	0.965
NFI	0.980
TLI	1.128

Fit indicator	Value
RMSEA	0.000
RMR	0.020
SRMR	0.0106
Bollen-Stine p	0.621

Figure 3. Australian and Hungarian cluster model solutions

Figure 3 displays the model paths in the profit–growth nexus framework, in both the Australian and Hungarian cluster sample. The unconstrained model displays a strong simultaneous probability fit for both samples. Profit is significantly related to comparative growth, which is significantly related to firm size in both cluster samples. The strength and significance of the relationships between profit, comparative growth, and size differed across the two samples.

Table 4 displays the unstandardised regression coefficients and their significance in the model. The results provide support for H1.1 (profit–growth relationship) and H1.3 (profit–size relationship) by displaying significant path coefficients in the Australian ($p < 0.01$) and the Hungarian ($p < 0.05$) cluster samples, respectively. However, based on the results, H1.2 is rejected, as the profit–size relationship is not significant in either sample.

Growth potential, however, does not significantly correlate with the other factors in either sample. Whilst these particular correlations are not significant, it needs to be highlighted that in the Hungarian cluster sample, potential growth shows a positive correlation with comparative growth and profit, and a zero correlation with firm size. On the other hand, in the Australian cluster sample, po-

Table 4. Unstandardised regression coefficients and their significance

Australia (Victoria) N = 71			Estimate	S.E.	C.R.	P
Growth_Pot	←	PROFIT	–.153	.096	–1.592	.111
Growth_Comp	←	PROFIT	.506	.093	5.424	***
SIZE	←	Growth_Pot	–.116	.106	–1.095	.274
SIZE	←	Growth_Comp	.365	.109	3.335	***
SIZE	←	PROFIT	–.135	.103	–1.303	.193

Hungary (Central Hungary) N = 83			Estimate	S.E.	C.R.	P
Growth_Pot	←	PROFIT	.109	.090	1.214	.225
Growth_Comp	←	PROFIT	.220	.091	2.433	.015
SIZE	←	Growth_Pot	–.037	.074	v.497	.619
SIZE	←	Growth_Comp	.156	.073	2.134	.033
SIZE	←	PROFIT	.086	.062	1.391	.164

Table 5. Differences between significant correlations

		Standardised path coefficients	
		Growth_Comp	PROFIT
		SIZE	Growth_Comp
HU (N = 83)	Direct effect	0.234*	0.260*
AU (N = 71)	Direct effect	0.436**	0.544**
Difference	z-score	–1.3875	–2.0838
	p value	0.1653	0.0372

* Correlation significant at the p < 0.05 level (2-tailed).

** Correlation significant at the p < 0.01 level (2-tailed).

tential growth displays negative correlations with the other factors in the profit–growth nexus.

Based on the path coefficients that were found significant, differences between the relationships in the profit–growth nexus were evaluated. As the model path between profitability and firm size was not significant in either sample, it was not possible to reflect on H2.3. *Table 5* shows the comparative statistics of the two significant path coefficients in the profit–growth nexus model, in both samples. No significant difference ($p > 0.1$) was found between the Australian (0.436) and Hungarian (0.234) results regarding the relationship between comparative firm growth and firm size. This implies the rejection of H2.4. However, the path from profitability to comparative firm growth was significantly higher ($p < 0.05$) for the Australian cluster sample (0.544) compared to the Hungarian cluster sample (0.260). Hence, H2.2 was supported.

5. DISCUSSION OF THE RESULTS

The research propositions encompass the issue of aggregation and comparability between competitiveness indicators at different levels. The review of the literature highlighted three specific issues potentially inhibiting aggregation of firm- (micro-) level measures to construct cluster- (mezzo-) or national- (macro-) level competitiveness indicators. The lack of availability (1) and comparability (2) of firm-level data was emphasised by Lopez-Garcia et al. (2014), and aggregation between the levels of competitiveness lacking consensus was identified based on the variety of methods used by researchers (Craig et al. 2008; Laurenti – Viviani 2011; Gao et al. 2013).

5.1. The necessity proposition

Necessity proposition: Firm profitability, growth, and size are positively related, indicating cluster- (mezzo-) level competitiveness.

In order to respond to the first research proposition, the relationships between the components of the profit–growth nexus were investigated *(Table 6)*. A positive profit–growth relationship was implied by prior research on SMEs. This was supported by the significant, positive paths found between profit and comparative growth variables in the study (H1.1 supported), in both the Australian and the Hungarian sample. A positive relationship was also identified between comparative growth and firm size in both cluster samples (H1.3 supported) in both sam-

Table 6. Differences between significant correlations

Hypotheses:	Test results	
	AU	HU
H1.1: Profitability and firm growth are positively related.	Supported ($p < 0.01$)	Supported ($p < 0.05$)
H1.2: Profitability and firm size are positively related.	Not supported ($p > 0.1$)	Not supported ($p > 0.1$)
H1.3: Firm size and growth are negatively related.	Supported ($p < 0.01$)	Supported ($p < 0.05$)
H2.1: Measures of firm size, growth, and profitability are invariant across clusters.	Supported (see *Figure 3*)	
H2.2: The profitability to firm growth relationship significantly varies across clusters.	Supported ($p < 0.05$)	
H2.3: The profitability to firm size relationship significantly varies across clusters.	Not tested	
H2.4: The firm growth to size relationship varies across clusters.	Not supported ($p > 0.1$)	

ples. These results align to prior research on SMEs, but contradict some aspects of the theory that implied a trade-off between firm size and growth. Finally, the path coefficients between profitability and firm size were not found to be significant in either sample (H1.2 not supported).

The findings in the investigated clusters support the positive relationship between past profit and subsequent firm growth, but reject Gibrat's law of the independence of firm size and growth. The simultaneous existence of high profit and growth in both samples signals the high performance and, consequently, competitiveness of the respective clusters. This implies partial support to the necessity proposition concerning the relationships in the profit–growth nexus.

The relationship between firm size and profitability was not shown to be significant. Growth potential – as reported by the respondents – was also not shown to have a significant relationship with the other variables of the study. The lack of a significant direct size–profit relationship in both samples implies that smaller businesses are not systematically advantaged or disadvantaged in terms of the performance dimension of their competitiveness. The lack of significant relationships of potential growth to other variables probably implies that respondents' judgement on growth potential varied to such an extent that it is not possible to meaningfully integrate it into the profit–growth nexus, hence this indicator is not usable in assessing competitiveness. In terms of the necessity proposition, these outcomes mean that the relationship between past profit and current firm size cannot be subject to further analysis in terms of comparing cluster competitiveness.

Both clusters – as shown by prior researches – are globally noted and hence to some extent competitive. It was implied from prior results that the Victorian ICT cluster may exceed the Central Hungarian ICT cluster in terms of competitiveness. In order to explore how well the relationships between size, growth, and profit reflect competitiveness, the sufficiency research proposition was investigated.

5.2. The sufficiency proposition

Sufficiency proposition: Relationships between the components of the profit–growth nexus are comparable across cluster-specific samples and this comparison is meaningful in terms of indicating cluster-level competitiveness.

In order to establish the equivalency of the measures, invariance testing was conducted by means of multi-group confirmatory factor analysis. As *Figure 2* shows based on the χ^2 difference test, the metric invariance of the models can be assumed, based on the two cluster samples (H2.1 supported). In other words, the scales used to measure the variables of the study are not only of a similar structure, but actually display identical loadings on the variables. This makes the variables of the study statistically comparable across the cluster groups.

The two significant paths identified in the model were compared. As the third (profit to firm size) path was not found to be directly significant in either cluster sample, the comparative analysis of their relationship across clusters was not necessary (H2.3 not tested). *Table 5* shows the statistical significance of the difference between the paths. The relationship between growth and profitability shows a significant difference between the Australian and the Hungarian cluster samples. Responses in the Australian sample displayed a significantly stronger positive relationship between profitability and firm growth than the responses in the Hungarian sample (H2.2 supported). However, the relationship between growth and firm size showed no significant difference (H2.4 not supported).

This leaves one indicator – namely the path between profit and growth – to be compared across the investigated clusters to reflect on the sufficiency proposition. A stronger correlation of growth and profit reported by the Australian respondents can be interpreted as the presence of higher levels of competitiveness in the examined cluster compared to the Hungarian cluster of firms. A stronger positive relationship between profit and growth is an indicator of improved firm performance, which in turn is a measure of competitiveness. This implies partial support to the second research proposition, as one of the two significant correlations showed a significant difference between the two groups. This difference is reflected in the macro-level competitiveness indicators quoted earlier in the study.

5.3. Implications for competitiveness research

Support for the necessity proposition implies that the relationship between the components of the profit–growth nexus characterises the competitive character of firms in the population included. The previously used, linear aggregation methods (Cho et al. 2008; Cho – Moon 2013; Ju – Sohn 2014) were reliant on representativeness of sampling at the firm level, and a certain degree of standardisation of metrics across a variety of companies. By using correlation as an aggregate indicator of competitiveness, the standardisation of the inputs is automatically conducted without having to fulfil underlying assumptions behind the nature of the data.

An example of support for the necessity proposition in the case of the two clusters validates the potential usability of the correlation-based aggregate competitiveness indicator. The necessity of such an indicator is pointed out by Lopez-

Garcia et al. (2014) in a context where primarily macro indicator-based competitiveness measures have been employed (such as the Global Competitiveness Index, see Bowen – Moesen 2011).

Finally, the operationalisation of a mezzo-level aggregate competitiveness indicator faces a number of obstacles such as availability of information specific to mezzo-level categorisation and the measures influencing competitiveness beyond location, suggesting that a purely regional aggregation may fail due to unobserved heterogeneity. However, the cluster-level example integrates the dimensions influencing firm performance (Craig et al. 2008; Laureti – Viviani 2011; Gao et al. 2013), and the performance dimensions identified by Kivilouto (2013) are coherent with the firm-level competitiveness factors proposed by Buckley et al. (1998).

6. CONCLUSIONS, LIMITATIONS, AND FURTHER RESEARCH

6.1. Research outcomes

Multivariate statistical analysis was conducted on a sample of 86 Hungarian and 71 Australian SME ICT firms in Central Hungary and the state of Victoria, respectively. The necessity and sufficiency propositions are both supported by the findings of the study, suggesting that the profit–growth nexus provides an appropriate framework to aggregate and compare the competitiveness of clusters using firm-level data. The necessity proposition demonstrated that there are significant positive relationships between the components of the profit–growth nexus, which – contradicting the profit–growth trade-off – in the data analysed shows a self-enhancing growth–profit spiral, demonstrating the competitiveness of the businesses in the cluster. This positive relationship measures the performance dimension of competitiveness. The positive relationship between firm growth and size furthermore accounts for the process dimension of competitiveness. The sufficiency proposition demonstrated that the relationships between the profit–growth nexus can be compared (invariance of measures) and actually show some significant differences (profit–growth path). Secondary information indicated that although both investigated clusters are present on the global competitive landscape, the Victorian ICT cluster is more competitive compared to the Central Hungarian ICT cluster. The significant link between firm size and growth showed no difference between the clusters. The significant difference of relationship between firm growth and profit reflected the competitiveness differences between the two clusters. This result allows for the performance dimension of competitiveness to be reflected in the correlation coefficients between the components of the profit–growth nexus.

The potential dimension of competitiveness was not measurable by correlations between the components of the profit–growth nexus model, as potential growth was not significantly correlated with any other component of the model. The process dimension of competitiveness was measurable by the correlations between firm growth and size. This showed no significant difference between the clusters, leaving only the performance component of competitiveness to be comparable and different.

It can be concluded that:

- The profit (past) and growth (comparative) components of the profit–growth nexus are positively related, reflecting a cluster-level aggregate of firm-level competitiveness.
- Differences are present between cluster-specific firm samples in terms of the strength of the relationships between the components of the profit–growth nexus (profit–growth relationship).
- Relationships in the profit–growth nexus provide indicators for assessing and comparing cluster-level competitiveness, which reflect competitiveness difference validated by secondary sources.
- These indicators eliminate the issue of aggregation (between firm and cluster levels) and population-specific biases (particularly in terms of response patterns).

6.2. Implications for theory and practice

The theoretical implications of the outcomes pertain to the profit–growth nexus and firm competitiveness. The findings highlight that the relationship between firm profit and growth needs to be revisited. The results of this research suggest that there is a dynamic relationship between profit (past) and growth (comparative), which also implies the absence of this trade-off between firm profit and growth. SMEs are assumed to be operating under conditions of competitive markets. Exploring the structural competition distorting effects of various factors may provide new insights into anticipating under what circumstances the trade-off is to be expected or not. These factors are likely to become antecedents of competitiveness at multiple levels of analysis. Further theoretical implications regarding Gibrat's Law need to be observed in light of the research results. The positive relationship between firm size and growth suggests that economies of scale are important and present in the ICT industry for SMEs. It also implies the progressive concentration in the sector progressing towards maturity. It would be interesting to explore the origins and impact of this phenomenon, in particular with regard to the structural causes and implications of progressive industry concentration.

The practical implications of the research support public policy. Comparative competitiveness indicators reliant on firm-level information from within particular sub-populations of firms (such as clusters) can support policy decision-making by means of providing tracking indicators over time for one cluster, as well as comparative indicators across different firm populations, clusters, or countries. Sub- and supra-national economic policy decisions can be supported, and their impact assessed based on the availability of such indicators improving regulatory quality and effectiveness.

In particular, regional economic development policies can greatly benefit from enhanced means of comparative assessment of cluster competitiveness. Clusters – as building blocks and connecting entities within and across regions – can be subjected to more specific and thus effective policy initiatives, which can be informed by this aggregation method of competitive performance.

6.3. Limitations and further research directions

There are several limitations to the generalisability of the results.

- Limitations of representativeness have been identified as a barrier to generalising the outcomes of the study. In particular, representative sampling is required to construct a competitiveness indicator that accurately measures cluster-level competitiveness based on firm-level data. Although the components of the profit–growth nexus potentially provide measures for every dimension of competitiveness (performance, potential, and process), it was not possible to test measures for all three. Potential growth was not found to significantly correlate with any of the other components, and failed to provide a competitiveness measure. Size – as a proxy to the process component of competitiveness – significantly correlated with growth, providing a measure for the process dimension of competitiveness. However, this measure showed no significant difference between the Australian and Hungarian cluster sample. The correlation of profit and growth provided a measure for the performance dimension of competitiveness. The significant difference between the correlations of growth and profit across the two samples demonstrated a measure of difference in competitiveness, corresponding to the results implied by secondary data.
- The measures chosen were self-reported, limiting the replicability of the study and the extension of the scope of data collected between clusters. Nightingale – Coad (2014) draw attention to the shortcomings and biases of research on firm growth, identifying that the biases of the samples studied can imply erroneous conclusions. Addressing this concern may require a choice of alternative measures of the profit–growth nexus, in which competitiveness can be evaluated. In

the absence of access to cluster-specific comprehensive databases, this may be a challenging task for future research.

- The availability of comprehensive data in relation to the profit–growth nexus may enable aggregating and assessing competitiveness not only to the mezzo, but also the macro levels. However, such a study would need large and up-to-date datasets and comprehensive statistical testing, and runs risks of being inconclusive on account of the heterogeneity of firm samples.
- The link between mezzo- and macro-level competitiveness remains unexplored, providing room for further empirical investigations augmenting the current findings.

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