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Abstract — This paper builds upon the widely-used resource-based approach to explaining survival of new technology-based firms (NTBFs). However, instead of looking at the NTBF’s initial resource configuration, a process-oriented perspective is taken by focusing on the entrepreneur’s ability to transform resources in response to triggers resulting from market interactions.

Transaction relations reflect these interactions and are thus operationalized with a suggested method for measuring the status of venture emergence (VE) applicable to early-stage NTBFs.

NTBFs’ value network maturity is reflected in the number and strength of their transaction relations in the four market dimensions customer, investor, partner, and human resource. Business plans of NTBFs represent the artifact that contains this data in the form of transaction relation descriptions.

Using content analysis, a multi-step combined human and computer coding process has been developed to annotate and classify transaction relations from business plans in order to empirically determine NTBFs’ status of VE.

Results of the business plan analysis suggest that the level of transaction relations allows to draw conclusions on the VE status. Moreover, applying the developed process, first analysis of a business plan coding test shows that the transaction relation based VE status significantly relates to NTBF survival capability.

Keywords — venture emergence, measurement methods, business plan, content analysis, transaction relations

I. INTRODUCTION: INCREASING INNOVATION INTERMEDIARIES’ DECISION-MAKING EFFICIENCY

Economic exploitation of technology capabilities lags behind in Europe due to a lower efficiency of the innovation system [1]. New technology-based firms (NTBFs) accelerate knowledge-spillovers [2], [3], create jobs [4], [5] and thus foster economic growth. Funded by public authorities to provide supporting services, innovation intermediaries such as consultants, investors and incubators are nurturing the NTBF landscape [6-11]. Their efficiency in allocating scarce resources to the most promising ventures can be improved by supporting their decision-making processes. Knowing the NTBF development status could help them prioritizing support measures and thus increase the number of surviving NTBFs.

Existing research on the NTBF suggests that, to exploit business opportunities based on new technological advances in science and engineering, a combination of resources and skills is needed [12]. Thus, having access to resources does not sufficiently explain why some NTBFs manage to survive, while others do not [13]. Prior research exploring how NTBFs come to exist has suggested to adopt the venture emergence (VE) perspective to better understand this phenomenon [14]. The VE construct [15] provides a reference point to study how a change in NTBF status could inform on its future survival.

This research proposes a novel measurement method for this venture emergence construct. It builds on the transaction relations NTBFs build in various market dimensions. These transaction relations allow for an alternative operationalization of the VE construct. NTBF business plans are used as a valid source of information on transaction relations. Applying a human and computer coding process, measures for the transaction relation based venture emergence status are extracted. Preliminary results provide support to further develop the measurement method and some first insights on the influence of specific dimensions of the transaction relations on NTBF survival.

The paper starts with a literature review on the venture emergence construct and an outline of the related hypotheses. Then, a multi-stage process for measuring the VE status using content analysis is described. This is followed by a description of the coding process combining human and computer-based coding of business plans. Based on the coding results, NTBF survival capabilities are assessed. Finally, implications and next research steps are discussed. Practical implications for innovation intermediaries as well as other entrepreneurship and innovation management stakeholders are also provided.
II. LITERATURE REVIEW: TRANSACTION RELATIONS AS INDICATORS FOR THE STATUS OF VENTURE EMERGENCE

New technology-based firms are newly founded businesses focusing on the economic exploitation of technology-based innovations [16]. NTBFs have been targeted as the primary objective of policy makers and investors alike [17]. Prior research findings suggest that despite the interest in promoting this specific profile of entrepreneurship, most of policy actions have not achieved the expected results [18].

As observed in recent research [19-21], the network interactions of entrepreneurs, in particular if oriented towards market creation, are seen to have a significant impact on venture creation and survival. Transactions relations are indicative of antecedents of future market interactions or as evidence of the network position of the new venture and the entrepreneur [19], [22], [23]. We would expect that the more mature (developed) the value network of a venture, the more likely is its survival and full emergence.

The transformation of science and engineering advances into technology-based innovations requires a combination of technological knowledge, innovation management, and entrepreneurial skills [12], [24-26]. Accordingly, technology entrepreneurship is a rather complex phenomenon [27]. The combination of the usual entrepreneurial challenges and the specific challenges related to technology development process create a complex phenomenon where the actions of multiple actors can influence the outcomes [28].

NTBFs’ focus on the technological product is a plausible reason why most of them struggle to unlock the “product-market fit” [29]; technology-based entrepreneurs often work with products and services without a predefined market or clear application [30]. NTBFs’ “main problem is not so much invention but commercialization” [31 p.333]. The successful commercialization is not only dependent on the novelty of the technology, but also on the ability to understand the technological market environment and position their product accordingly [32], [14].

NTBFs might need to go through a transformation process where interactions with their context help to shape a market for their products [22]. As a result, research approaches that solely rely on the NTBF’s tangible resources to explain its future evolution would overlook the influence of the market creation actions [24], [14].

As an attempt to look beyond static resources, a more process oriented view to identify potential determinants of the NTBF evolution is proposed. Prior research has suggested that a process perspective should help to better capture the activities and changes that would go unnoticed with more traditional causal and static approaches [24], [33]. This process view also implies a change in the object of attention in the research [34], moving the locus of attention to the changes (if any) that occur in the NTBF as an evolving organizational form.

Consistent with the process view on the early-stage development of NTBFs, scholars observed that most of their initial organizing activities might go unnoticed to the market and would not be captured by standardized formal metrics used to measure established ventures [15]. The search for alternative conceptualizations that could capture the activities and dynamics of early-stage ventures, thus providing a better understanding on how organizations come to exist, brought scholars to conceptualize venture emergence (VE) [15], [35].

The VE concept combines venture, as a purposeful activity system [36], and emergence, as the interaction process with agents and their environment [35]. The VE construct provides a perspective allowing to capture and reflect on the process of evolutionary change of the new venture, even if it is not yet a fully operational venture. To explain the changes that occur in an NTBF using the VE perspective, attention is given to four different dimensions helping to capture the changes [35]: intentionality, resources, boundaries, and exchange.

The intentionality dimension suggests that emerging organizations are expected to be created by an individual actor with the purpose to create a new organization. The resources dimension is used to characterize the different building blocks that constitute the new organization. The boundaries are used to explain that new organizations use contracts and spaces to establish their presence. The exchange dimension is used to illustrate how getting involved in transactions, across the organizational boundaries, describes the progress of the new venture emergence. These properties provide a more granular view on the evolution of the NTBF in the early-stage, combining resources and actions in the new firm as potential measures [15].

The operationalization of the venture emergence construct in entrepreneurship research has often relied on the data available on existing datasets such as PSED [37]. As a result, prior research has been able to measure factors related to the resources dimension (e.g. human or financial capital). It has so far remained more difficult to measure properties such as the exchange dimension. Past research has had to rely in proxy measures such as whether the firm had customers or whether it had been able to generate revenues [19], [23]. As a result past research measures have rarely been able to capture the theoretical underpinnings of the venture emergence construct, either due to the lack of theory oriented measures or limited existing data in available datasets [38].

Reviewing the conceptualization of VE as a construct that captures the status of the new venture in the process of getting organized and becoming a viable new firm, we focus our attention to how, regardless of the initial starting configuration of resources, organizations are able to transform and use their resources to create and capture value. The shift on the attention locus in the process of venture emergence, from the resource access to the use that entrepreneurs do of it [13], open the possibility to give a specific weight to the exchange dimension of VE.

Therefore we propose to further study how the transactions relations can be an indicator of venture emergence for NTBFs, and of their future survival. The following hypotheses are thus addressed in this work:

**H1:** The level of transaction relations of NTBFs indicates a status of VE.

**H2:** A transaction relation based VE status significantly relates to survival capabilities of NTBFs.
III. METHOD: STRUCTURED CONTENT ANALYSIS FOR CODING TRANSACTION RELATIONS IN BUSINESS PLANS

In order to explore the above mentioned hypotheses, a data source that would provide information on the status of the NTBF, and in particular on its transaction relations, was needed. In this sense, NTBFs’ business plans deliver stable information on the business and its intended value generation strategy [39]. An elementary part of a business plan is the description of the firm’s value network [40], [41]. The herein depicted transaction relations are the anchor connecting the business plan to reality [42], [40]. Prior work has confirmed that transaction relations can be identified and evaluated in business plan texts [42]. Business plans are thus a real artifact of early-stage venturing activity [43]-[45].

Moreover, a written business plan is the most frequently produced artifact of early-stage technology ventures [46], [47]. The community for institutional entrepreneurship support claims that NTBFs should have developed a business plan [43], [48], [49]. Innovation intermediaries demand a written business plan from NTBFs as a means to decide upon support prioritization [43], [44].

Hence, business plans of early stage NTBFs are considered an artifact allowing for measuring the VE status of an NTBF. When using the content of business plans as a source of data, the analysis is performed on unstructured text which in exchange offers access to a rich context, i.e. relatively richer as compared to the number estimations contained therein [42]. Thus, the unstructured text has to be transformed into structured data in order to enable data analysis. This is done using structured content analysis [50].

Structured content analysis is a method condensing information from analyzing text documents in a systematic and replicable way to make inferences on the data context [51]. In order to conduct structured content analysis of business plan texts, a code book [52], a formal coding procedure, and coders are required.

Transaction relation descriptions build the basis for the code book, as they are argued to be a suitable construct to provide an alternative operationalization of the VE construct that can be used to determine the VE status of NTBFs.

To operationalize this construct, the relations that an NTBF has built to transaction partners along the dimensions of customer, investor, partner, and human resources [42], as documented in their business plan, are evaluated. Relations identified in each of these dimensions are rated according to their maturity on a 5-point-Likert-scale [53]. The level of transaction relations is herein reflected in both the number of relations and the highest rating in each of the four dimensions.

Prior work has confirmed this operationalization based on testing the construct on a subsample of 40 business plans selected via convenience sampling from 800 business plans of early-stage technology ventures representative for the NTBF founding activity in the German regional State of Baden-Württemberg [42]. In order to test the reliability of the coding scheme applied therein, a human coder experiment [54] has been executed [55].

For that experiment, a group of non-experts to the domain (41 final term undergraduate students, Industrial Engineering) received an initial coding training using the code book and subsequently carried out four rounds of coding performed on the above-mentioned convenient sample of 40 business plans. Based on that, each business plan had been coded 22 times on average in order to test relative inter-coder agreement amongst the non-experts. The non-expert human coders annotated a total of 4,782 transaction relations in the convenient sample. These were categorized into the four market dimensions mentioned above and classified into the 5 maturity categories.

In parallel to that, the same convenient sample was coded by three experts (researchers), which was intended to result in a “gold standard” of annotated transaction relations to serve as a reference for absolute coder agreement.

Coder agreement was determined (a) within the group of non-expert coders and (b) comparing the group of non-expert coders to the group of expert coders. The latter revealed that the non-experts’ average highest rating in each of the four dimensions had 63% agreement with the expert coders. On average, the individual non-expert coder agreement with the expert coders was 46% [55].

The main finding of the reliability test though was that the gold standard in fact did not qualify as reference since the non-expert coders (correctly) annotated a significant number of transaction relation that had not been annotated by the group of expert coders.

To improve this not yet satisfying reliability of the coding scheme and in particular based on the findings of a detailed outlier analysis, three measures have been introduced:

(1) The human coder test design has been re-designed as described in König et al. [55]. For example, now the non-expert coders would be coding while being supervised by researchers instead of coding in private.

(2) The code book has been further formalized in order to provide more precise code definitions and examples, leading to a purifying of the coding instrument [55].

(3) To increase the recall (i.e. percentage of transaction relations being correctly annotated from all transaction relations present in the document), the human coding has been supplemented with computer-based coding using computer-linguistic translation of the improved code book

In the following, we address findings from working on measure (3), which is increasing the recall to obtain a reliable measure for the status of VE, while findings on measures (1) and (2) are discussed in detail in König et al. [55].

The translation builds on abstract grammar templates that transform the code book rules into computer-linguistic coding rules for annotating and classifying transaction relations. The code book for example defines a rule that if a business plan text passage indicates that the NTBF operates with functional specialization (i.e. exhibiting explicit functional areas such as R&D, sales etc.), a transaction relation in the HR dimension is to be annotated and classified into category ‘3’.
While for a human coder one rule is sufficient here, for a computer-linguistic application the same rule is to be translated into a computer-linguistic grammar template that specifies (in this example) a list of potential words that imply individual leadership responsibility (e.g. leader, head...) and a list of areas of functional specialization (e.g. marketing, R&D...). The grammar template is further supplemented with rules on word order, tense, and relative distance of words present in a sentence, e.g. [synonym of “revenue”] followed by five arbitrary words then [numeral], which implies [revenue size of (numeral)]. Identifying a sentence matching that template results in an annotation.

Consequently, as the example above shows, a human coder easily identifies numerous sentence variations as relating to one code book rule, whereas a computer linguistic application needs exact rules encompassing all of these potential variations. Thus, based on the library of annotations and classifications of the initial reliability test, an extensive, rather comprehensive list of grammar templates has been created. Initially, this has been done using computer linguistic expert’s heuristics. The resulting base set has been fed into an iterative relevance feedback process using the above-discussed convenient sample in order to

(a) create a refined library of annotations & classifications as the computer linguistic coding was assumed to identify even more annotations than the total of the human coders and

(b) create a refined list of grammar templates for the future application on further business plans.

As a first filter in this feedback process, computer-linguistic experts refused or refined grammar templates that either obviously did not annotate valid transaction relations (but instead something else – precision too low) or did only annotate one specific transaction relation and thus were over-optimized (not likely to represent a general rule applicable also to other business plans – precision to high). Overall, this first filter rather aimed at prioritizing recall over precision in order to increase chances of arriving at annotating as much transaction relations as possible as an entry point for the second filter.

This second filter used the refined grammar templates resulting from the first filter and applied these on batches of business plans from the convenience sample. After each batch, the annotated and classified transaction relations would be reviewed by experts (researchers). Their feedback would be used to further refuse and refine the grammar templates. From the convenient sample’s 40 business plans, 33 were used in four batches for this training of grammar templates, 1 was in English language and thus not applicable, 6 were left over in order to test the finally refined set of grammar templates.

The initial library obtained from coding the convenient sample with human coders comprised 1,134 annotated and classified sentences. This library resulted from a reviewed combination of expert coding and non-expert coding outcome. It was thus considered as a ground truth suitable for training the grammar templates. This two-step training outlined above resulted in 367 computer-linguistic grammar templates. These grammar templates were trained to annotate the sentences comprised in the ground truth (recall compared to ground truth: 100%). As intended, applying these templates further resulted in 1,240 additionally annotated transaction relations not having been part of the ground truth. These additional annotations are currently in the process of being reviewed by experts. However after reviewing ~75% of these, it can be estimated that ~45% of them have been correctly annotated leading to a refined library of approximately 1,700 annotated and classified sentences.

Based on these findings, the refined and reviewed library is considered as a reference for further analysis. This gold standard results from initially applying the refined human coding scheme, feeding the results into a computer linguistic 2-step training process aiming at 100% recall of human annotations, and finally expert-reviewing the results plus, if applicable, adding valid computer-coded transactions that had not been coded by human coders before.

IV. RESULTS: FEASIBILITY OF THE METHOD

It has been outlined that venture emergence (VE) describes the process of evolutionary change of the new venture, reflected by the interaction process with its environment. Based on this, the first hypothesis proposed that the level of transaction relations may serve as an indicator for measuring that venture emergence.

This proposition is based on mirroring VE with an NTBF’s value network maturity. Following that, VE status may be determined by capturing evolutionary change in the level, i.e. number and maturity of transaction relations build by an NTBF over time. The outlined literature review supports this proposition by relating empirical findings from recent VE research to this network theory based construct. Thus, the first hypothesis seems to be supported by normative conclusion. Accordingly, transaction relations are further suggested herein for measuring the VE status of NTBFs in order to be able to confirm in further empirical tests that they are indicative of NTBFs’ VE status.

The suggested construct has been further operationalized and applied to NTBFs’ business plans by using structured, automated text analysis. This method is assumed to enable measuring the VE status of a NTBF based on the respective level of transaction relations described in the business plan. In this context, the method may moreover enable determining VE status as an indicator of NTBF’s survival capabilities already at a very early stage of NTBF maturity.

This has empirically been tested using a combined human and computer-based structured content analysis. Computer-based coding was found to be necessary for complementing initial human coding as human coders did not reliably annotate a sufficient percentage of transaction relations contained in a business plan (recall). Further, human coder agreement was found to be only moderate. Thus, a multi-step combined human and computer coding process has been developed that seems to overcome human coding flaws such as capacitive limits, low recall and other random mistakes.

The grammar templates resulting from training on 33 of 40 business plans of a convenient sample have subsequently been
tested on six business plans that had not been used for the training. Computer-based coding of these six business plans led to adding further 133 valid transaction relations to the human coder ground truth, thus resulting in a reference library of 271 annotated and classified sentences for this sub-sample of six business plans.

The computer coding annotated between 30% to 60% additional transaction relations that had neither been annotated by non-experts, nor by experts. As intended, computer-coding significantly increased recall. Further, taking human coding results as the reference, expert review of the computer-based annotations exhibited a precision of >80% in each of the four dimensions customer (80.6%), investor (81.6%), partner (82%), and human resource (88.1%). Precision in classification was somewhat lower, namely 69.9% in customer, 50% in investor, 45.9% in partner, and 80.1% in the human resource dimension.

Taking the resulting combined, reviewed coding outcome (gold standard) as a reference, human coders overall reached:
- In the customer dimension, the human coders reached 46.3%, compared to 62% (53.7% with correct classifications) from computer coding
- In the investor dimension, the human coders reached 50%, compared to 73.8% (45.2% with correct classification) from computer-coding
- In the partner dimension, human coders reached 62.3%, compared to 82% (45.9% with correct classification) from computer-coding
- In the human resource dimension human coders reached 48.9%, compared to 78.8% (72.3% with correct classification) from computer-coding

These results demonstrate the intended higher recall of the computer-coding while precision of human coding seems higher. Nevertheless, correlation between human and computer coding is 0.86. Hence, the suggested operationalization of the construct under investigation, namely determining the level of transaction relations by automated structured content analysis of business plan texts seems to prove as a suitable method for collecting data from NTBF business plans. Thus, the multi-step combined human and computer coding process was confirmed and the resulting reference, the gold standard, was subsequently used for testing the second hypothesis.

This testing was performed on the gold standard resulting from combined coding of a subsample of 39 business plans from the convenient sample, one dropped out due to its English language. From that sub-sample, 19 business plan were from surviving 20 from non-surviving NTBFs (after 5-10 years). As a first analysis, survivor with non-survivor data was compared based on the total number of transaction relations annotated and classified per business plan using a two-tailed t-test. Assuming independent samples and a confidence interval of 95%, a p-value lower than 0.05 determines statistical significance for the difference in mean values. The difference proved to be highly significant (p=0.0069): On average, business plans of survivors exhibited 71.11 annotations while non-survivor on average exhibited 42.

When testing the single dimensions, surviving NTBFs compared to non-surviving exhibited significantly higher number of annotations in the dimension of human resources (p=0.007), customers (p=0.0062), and less in partner dimension (p=0.0736), but not in the investor dimension (p=0.2278).

In addition, a threshold value for number of annotations was derived for each dimension: This estimation exhibits that NTBFs with a number of
- human resource dimension annotations greater than 8 have a survivor chance of 81.2%, while with less than 8 the chance for non-survivor is 78.3%
- investor dimension annotations greater than 13.5 have a survivor chance of 71.4%, while with less than 13.5 the chance for non-survivor is 59.4%
- partner dimension annotations greater than 18 have a survivor chance of 73.9%, while with less than 18 the chance for non-survivor is 93.8%

For additionally testing maturity, the highest classifications in each dimension has been compared between the survivor and non-survivor group. Here, the total sum of the highest rating in each respective dimension is significantly higher for surviving NTBFs (p=0.0057): The highest rating was significantly higher in the dimension of customer (p=0.0155) and human resources (p=0.024), less in investor dimension (p=0.0478) but not significant in the partner dimension (p=0.5253).

While more elaborated statistical test still need to be applied to the data, these initial tests seem to confirm the second hypothesis: Assuming that the status of venture emergence positively correlates with venture NTBF survival and, based on VE status being measured with the herein introduced network theory based construct, the level of transaction relations as measured from an NTBF’s business plan positively correlates with NTBF survival. More than that, the suggested data gathering method, combining multi-step human and computer-based business plan coding, seems to provide enough significance to represent a feasible method for testing NTBF survival capability on the basis of its business plan.

V. DISCUSSION & IMPLICATIONS: INCREASING METHOD PRECISION

This work suggested a measurement method for defining the VE status of NTBFs. The computer coding feasibility was confirmed and a correlation of VE status and NTBF survival capability was shown.

Limitations of these results apply due to the convenience sampling method and the use of basic statistics for the data analysis part. No variables other than VE status have been
taken into consideration as force influencing on NTBF survival capabilities. The suitability of the proposed method for innovation intermediaries has to be further investigated with empirical tests.

Basic data analysis has shown that number and maturity of annotated transaction relations differ significantly between surviving and non-surviving NTBFs, however, not in the investor dimension. When analyzing the maturity of transaction relations, again significant differences were found, but not in the partner dimension. In the human resource and customer dimension both number and maturity of annotations differ with statistical significance between the groups.

These findings also point to next steps in this research. Firstly, the code book may need refinement. This is not only due to the results from the statistical test but also emphasized by the observation that the code book rules in the partner dimension seemed to be ambiguous for the human coders. To take account for this, a purification of the human coding approach is addressed [55].

Secondly, determining the NTBF maturity stage with a combination of the number and maturity of transaction relation is likely to provide significant results. Therefore, a statistical model should be elaborated that recognizes patterns compatible with the level of transaction relations defined by number and maturity of such relations.

The multi-stage computer coding method will be further improved by using the available sample of 800 NTBF business plans to continue extending the number of computer-linguistic rules. This should result in an increased gold standard library and an increased number of refined grammar templates. The latter however is expected to grow into saturation where a relatively small growth in number of templates compared to the growth in number of sentences annotated with adequate recall and precision would indicate that the library of grammar rules becomes sufficiently complete.

This work also aims to generate valuable practical insights. First findings suggest that business plans of NTBFs can be a valuable source of information on the new venture potential, in particular when observing the market readiness of the new venture and the ability to transform existent resources into profitable and sustainable businesses. These insights could be of value to investors and other private and public stakeholders involved in the venture emergence process of NTBFs.

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