Skoltech
Skolkovo Institute of Science and Technology

Thesis Changes Log (minor corrections)

Name of Candidate: Maksim Malyy

PhD Program: Engineering Systems

Title of Thesis: The data-driven model of technology-based new ventures growth

Supervisor: Associate Professor Zeljko Tekic, HSE University

The thesis document includes the following changes in answer to the external review process.

Comments of Prof. Fred Phillips

The reviewer's comment:

Deal with the question of hype. Not necessarily with the hype curve itself, which is justifiably outside the scope of the dissertation. But with a discussion of the limitations of using VC valuation (which is essentially hype) as a proxy for firm growth. This would include his answer, shown in the change log, to my question about page 36 of the dissertation. The bibliography I sent him yesterday is a sampling of the big literature on hype.

Response to the reviewer:

Thank you for the comment. The following text was added to Chapter 5, paragraph 6: "Another question worth discussing here is that venture capitalists are also known to create "hype" around their investments sometimes, which may be supported by the founders and, thus, may lead to the overestimated TBNVs' assessments. There are a number of well-known cases that were highly valued during the early and growth series of VC funding but demonstrated an inability to appropriate value properly during the later stages, e.g., Theranos or MoviePass. Since in this study VC valuations were heavily utilized as a TBNVs' growth proxy, can I be sure that I do not base the conclusions on the artificially inflated growth as an indicator of hype? Indeed, the exceptional media coverage (in other words, hype) demonstrates a higher probability of being a unicorn with valuations "might be prone for overreactions" (Zorgiebel, 2016, p. 21); however, without a proven causal link (Zorgiebel, 2016). Answering this question, I assume that within the developed framework, the influence of VC hype is low if exists at all. First, if the VC hype would have had a strong influence, we probably would have seen significantly low correlations for at least 135 cases in Study 1, which were identified as non-unicorns and, thus, notably less subjected to hype than unicorn ones (Fan, 2016; Gornall and Strebulaev, 2017; Zorgiebel, 2016). In opposite, 83% of TBNVs presented a high correlation level between VC valuations they achieved during the funding series and related to them GT search query data with a significant skew of correlation distributions toward higher values. Moreover, some unicorns demonstrated low correlation coefficients, which would not be possible if their valuations would have been purely inflated. Second, it should not be forgotten that high correlation levels were observed during the whole TBNVs lifecycles. In other words, even when a fast-growing company has not been highly evaluated by VCs, the search query data related to it were still strongly associated with its series of funding. If this link would have been driven by the VC hype, I most likely would have observed the changing correlation levels during TBNVs' growth and, as a result, the low average correlation across the sample. Third, if to consider the unfiltered TBNVs data and the valuation events, it can be seen that some of these happenings can be related to the clear peaks of search queries while not influencing (or influencing to an insignificant degree) the main growth trend, which is of the major interest of this thesis (Fig. 5.2). If the rise in search queries would have been highly influenced only by VC hype, probably, we would not have seen the main growth trend since when this hype has ended, users' interest not supported by anything except hype would have been decreasing to zero until the next VC series of investment and the accompanying marketing campaign. So, I assume that the number of search queries, in this case, would oscillate around its average,

and growth in valuations would have not been correlated with the TBNVs' growth in GT data. This conclusion is also backed by the logic presented in the previous paragraph about the drivers and proxies of new ventures growth: since TBNVs' GT data reflect their value appropriation dynamics, the long-term growth or decline trends of this measure cannot be only driven by the sudden increase of the public interest. More rigorous conclusions on the role of VC hype in TBNVs' growth dynamics are aimed to be developed in the additional study with preliminary results to be published in close future (Ganz, 2022)."

The reviewer's comment:
In the later part of the dissertation, insert qualitative discussion, including speculation, on context and causes of firm growth. This will provide context for the dissertation's model, preventing it from being a pure exercise in math or computer science.

Response to the reviewer:
Thank you for the comment. The following text was added to Chapter 5, paragraph 5: "Considering the drivers of TBNVs growth, there are several factors, which were evidenced in literature to influence this process. For instance, one set of drivers is connected to an entrepreneur's personal characteristics such as level of education, prior related industry and entrepreneurial experience of founders, and integral team experience (Gilbert et al., 2006; McKelvie and Wiklund, 2010). Another set of characteristics accounts for resources available to companies and includes such drivers as internal and external funding available for a new venture (i.e., financial resources), the company's employee capabilities (i.e., human resources), and networking capacity, which is assessed by the existence and quality of a new venture's external business ties, like relation to incubators or industrial partners (Colombo and Grilli, 2010; Gilbert et al., 2006). Next, growth is also understood to be influenced by a company's geographical location, pursued growth strategy, industrial context, and the structure of an organization (Gilbert et al., 2006; Wright and Stigliani, 2013). These and other, still not observed factors, are evidenced to drive TBNVs growth in one or another direction. At the same time, to identify the influence of these growth drivers, four proxy measures are commonly applied by scholars (Gilbert et al., 2006; Gornall and Strebulaev, 2017; Malyy et al., 2019): growth in employees, growth in VC valuations, increase of a market share, and sales growth. From a venture capital perspective, during the investment decision-making process, VCs obviously cannot apply growth in valuation (since they aim to evaluate the companies of interest by themselves (Moro Visconti, 2020)) and rarely pay attention to the growth in employees (in fact, a particular interest to a new venture from VC drives growth in employees but not the other way around (Davila et al., 2003)). In their turn, VCs more focus on the last two measures even if they can be only projected by various financial methods (e.g., Discounted Cash Flow, DCF or Net Present Value, NPV (Moro Visconti, 2020)) in the cases of early-stage TBNVs or ones working in the specific industries like biotech. Despite the clear differences between the increase in market share and sales growth (Gilbert et al., 2006), these measures are very similar in logic and meaning: both aim to mirror the inbound cash flow generated by a company while attempting to appropriate the value from its operations (Di Gregorio, 2013; Fjeldstad and Snow, 2017). I assume that the source of data proposed in this thesis (i.e., related to a company's Google Trends search queries data) also has a strong relation to the value appropriation process while being connected to future sales (Choi and Varian, 2012; Jun et al., 2018) and market share if considered under the competitive context (Bong and Lee, 2020; Szczech and Turetken, 2018). This measure demonstrates the level of public interest toward the product and, thus, is similar to other sales-related indirect metrics, like application downloads, website unique visitors, registered accounts, or pre-order numbers. At the same time, it has more potential than these measures: (1) it is much easier to obtain GT data for an outside observer than, for instance, the number of registered accounts; (2) it is not subjected to speculations and exaggerations by a company; (3) it can be directly compared between the competitors. So, to conclude, TBNVs growth is understood to be driven by many factors whose influence is measured by a few more. Venture capitalists, in their turn, are known to be ultimately focused on growth (Zider, 1998) and on growth-connected metrics of value appropriation dynamics even when they can be only projected. Since GT data was evidenced to predict future sales of various products and assess their market share, which is known as one of the direct measures of value appropriation dynamics (Lieberman et al., 2017; Tower et al., 2021), it can be inferred that web search query statistics are a valid descriptor of a company's value appropriation process and, thus, mirror the assessment of this process by VCs that was demonstrated in Study 1 of this thesis. Therefore, the proposed source of data can be used as a proxy for studying TBNVs growth dynamics that were implemented in Study 2 of this research."

The reviewer's comment:
Maksim might also mention that in his model of a single firm, "q" does not indicate "imitation," as it does in Bass' model of multiple buyers.
Response to the reviewer:
Thank you for the comment. I believe I was not clear enough about this issue and this fact, probably, caused this question. The key thing I missed to mention is related to the fact that for TBNVs it is common to have one product and one brand name and market their product under this name. So, in fact, if the product was put on the market, the related GT data reflects public interest not toward the company itself but toward this product which has the same name, and this interest further results in sales as it was shown in previous studies (e.g., *Choi, H., Varian, H., 2012. Predicting the present with Google Trends. Econ. Rec. 88, 2–9. https://doi.org/10.1111/j.1475-4932.2012.00809.x, Goel, S., Hofman, J.M., Lahaie, S., Pennock, D.M., Watts, D.J., 2010. Predicting consumer behavior with web search. Proc. Natl. Acad. Sci. U. S. A. 107, 17486–90. https://doi.org/10.1073/pnas.1005962107*). Taking this into account, it can be said innovation/imitation paradigm is still applicable and the q-point can be considered as the influence of imitators. Moreover, as it is seen from the new discussion on the growth drivers and measures, it can be reasonably assumed that VCs are also heavily interested in company's value appropriation dynamics and, thus, in sales what together fit the results of the thesis and explain the achieved correlations. I've corrected respectively the text on page 122 of the attached new thesis version: "That is to add, for TBNVs it is common to have the main product name similar to the name of the company (at least in the analyzed sample) and, even if they differ, GT still aggregates search query statistics under the one company-related search term (e.g., the Facebook term was included by GT into the related term Meta, which recently became the name of the Facebook parent company). So, it can be said that the company-related GT search term demonstrates, in fact, a public interest toward a company's product if it was already put on the market and not toward the company itself. Therefore, considering the innovation/imitation paradigm, it comes out that a company starts to grow exponentially when imitators add their value to the TBNV's product adoption process and, thus, signal on the beginning of the "viral" effect (Leskovec et al., 2007)."

Comments of Prof. Vincent Mangematin
The reviewer's comment:
After having read again the revised version of Maskim's thesis, I would be happy if Maskim can add in the introduction and conclusion what I mention as a limitation of the thesis:

- as the dataset includes only companies funded by VCs, it is difficult to argue in a general way on growth of start-ups. The thesis analyses the expectations and ways to grow anticipated and framed by VCs more than growth of the start-ups in the economy. VCs have frames and theories when they decide to finance start-ups, they have models when they advise CEOs and they have a strong model of behavior regarding Top Management Teams. Then it strongly influences the growth pathway of start-ups.

Response to the reviewer:
Thank you for the comment. The following text was added to Chapter 1, paragraph 15: "It also should be noted that, due to the character of the employed sample and research method, the results achieved in this thesis, so far, are applicable only to TBNVs backed by VCs for at least three times. VCs are known to be heavily focused on the fast growth of the portfolio companies that influence their investment decision-making process, the strategies advised by them to founders, and the assessment of companies' growth dynamics, for instance, when a portfolio new venture is not profitable by any common financial measure but is still highly valuated by VCs. The growth of the non-VC funded TBNVs, in their turn, may not be reflected by the related to it GT data and may present a trajectory and evolution phases different from the ones proposed in the current research. However, due to the similarity of the underlying TBNVs' evolution logic (which will be discussed in more details later in this thesis) I believe that the obtained findings hold for all growth-oriented TBNVs regardless of receiving funding or not."
And to Chapter 10, paragraph 5: "It also should be noted that, due to the character of the employed sample and research method, the results achieved in this thesis, so far, can be only applicable to TBNVs backed by VCs for at least three times. VCs are known to be heavily focused on the fast growth of the portfolio companies that influence their investment decision-making process, the strategies advised by them to founders, and the assessment of companies' growth dynamics, for instance, when a portfolio new venture is not profitable by any common financial measure but is still highly valuated by VCs. The growth of the non-

VC-funded TBNVs, in their turn, may not be reflected by the related to it GT data and may present a trajectory and evolution phases different from the ones proposed in the current research. However, I have many reasons to believe that non-VC-backed TBNVs will follow a similar growth curve since the underlying logic of TBNVs evolution stays the same. Why? All new ventures start from a vision or idea while carrying out small steps for bringing this idea to a viable business (some may start from R&D or invention, some from identified opportunity, but still all will need to put it in the market to become a TBNV). According to the view of practitioners, TBNVs also face similar problems and have similar ways of solving them. For instance, based on the widely-recognized Lean Startup methodology (Ries, 2011), any TBNV first should perform a customer development process (Cooper and Vlaskovits, 2010): identify the customer, define the problem, create a minimum viable product, and try to find a problem/solution fit. Next, in case of success, practitioners advise all TBNVs to reach the product/market fit, which is the situation when a "customer pulls the product out of their hands" (Rachleff, 2019), and, after that, to start scaling and growing until possible. These steps form particular stages, which reflect TBNV's states and are commonly called in VC terms, even if a company has not attracted VC funding, e.g., Pre-Seed, Seed, Scale-up, etc. (Dahiya and Ray, 2012). Of course, TBNVs may fail at one or another stage – actually, they do that more often than succeed (Cantamessa et al., 2018) – but this is a natural situation, specific to any competitive environment. Nevertheless, according to the definition of a TBNV developed for this thesis3, it aims to sustain a venture level of growth (which can be reached with or without external VC funding) and, therefore, should have a specific growth trajectory, which was discussed here for VC-backed companies. The growth trajectory of non-VC-backed TBNVs requires an additional study and is planned for the future."

The reviewer's comment:

- Regarding the strong positioning of the thesis on organisation Life Cycle approach, it would be necessary to discuss the extent to which the recent evolution of the economy challenges the boundaries of companies: multisided markets, platform companies, new intermediation

Response to the reviewer:

Thank you for the comment. The following text was added to Chapter 5, paragraph 7: "Another important discussion that should be addressed in this section is related to the boundaries of new ventures. One may see a contradiction between the well-defined and limited organizational boundaries typical for the OLC theory and the recently developed view of commercial organizations as boundless and flexible. Indeed, the majority of the OLC concepts grounded their logic on understanding the new ventures as having the same set of features and changing in a similar predetermined sequential manner, thus, forming a lifecycle (Gilbert et al., 2006; Mosca et al., 2021; Muhos et al., 2010; Phelps et al., 2007; Tam and Gray, 2016). However, the up-to-date managerial frameworks, like Open Innovation (Chesbrough, 2003), and recently emerged phenomena, like digital platforms, multisided markets, and new ways of intermediation (Nambisan, 2017; Veisdal, 2020), consider the boundaries of these organizations to be fluid, permeable, and blurred due to the significant influence of ecosystems, open global market, and other factors (He et al., 2020; Santos and Eisenhardt, 2005). In my understanding, the evolution trajectory proposed in this thesis is not influenced by one or another position on this question. Any new venture, employing any business model, starts from birth and has to pass through various stages while, according to the definition of a business, attempting to create value for the market, appropriating it, and, thus, generating a revenue stream (Di Gregorio, 2013; Fjeldstad and Snow, 2017). And in any particular business model setting – open or closed, b2c or b2b, R&D heavy or not, monetizing through a service or a product, developing a digital platform or a traditional product, etc. – the moving from zero to some amount of earnings results in changing the several growth-related measures like market share or amount of sales, which overall reflect the company's value appropriation dynamics and are tracked by a company's stakeholders including investors if there are some (Fjeldstad and Snow, 2017; Gompers et al., 2016; Zider, 1998). In other words, growth is a characteristic of any TBNV (that is also accounted in the definition of a TBNV taken for this research, p.16), and, from the perspective of describing its growth, it does not matter, which business model with which features lie in its basics. Even if a TBNV works in some R&D-intensive setting or, on the opposite, aims to launch an open multisided digital platform, it still aims to grow fast (otherwise it will stay at some moderate level and, thus, cannot be called a TBNV by the definition employed in this thesis). In this research, on the example of VC-backed TBNVs, it was demonstrated that this growth is most accurately described by the S-curve models, one of which can also provide a mechanism for a precise division of phases. Since this growth exists (or is aimed to happen) by the definition of a technology-based new venture3, the proposed model can be employed for revisiting any conceptual model, like ones related to OLC, teleology, or other theories (Van De Ven and Poole, 1995), any practitioners view on the companies' evolution, like Lean Startup (Ries, 2011) or VC funding stages (Dahiya

and Ray, 2012; Gompers, 1995), and any other managerial phenomena like Open Innovation or emergence of digital multisided platforms. This thesis does not argue that the OLC or any other growth-describing theory is the most correct one. In opposite, I believe there may be several valid approaches for explaining the new ventures' growth from various positions, accounting for the previous and recent theoretical developments. But the goal of this thesis was to provide a rigorous methodological basis able to be applied for revisiting and aligning the existing theories (on the example of the OLC theory) and developing new ones."

Other minor corrections

Also, with the goal to increase the comprehensibility of the research, I applied the minor text corrections in the body of the thesis and excluded contributions, conclusions, limitations and further studies parts in Appendix D (starting from p. 206 of the previous thesis version and further), which are not influencing the main thesis structure and results.