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EXECUTIVE SUMMARY OF THE THESIS

An empirical analysis of EU Framework Programmes financing HTEVs in the drone industry

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1. Introduction

Innovation has now become the industrial religion of the late 20th century (The Economist, 1999).
Among the plurality of themes that gravitate around the kaleidoscopic nature of innovation, this research focuses on how innovative firms can benefit from policymakers' intervention. In this landscape, there are two different perspectives, the firms' one where they want to profit from innovation, and the policymakers' one in which they are eager to support innovation for growing their economies. As was proved by Schumpeter, innovation leads to economic development in terms of both dynamic efficiency, related to better use and allocation of resources in an economy over time, and economic growth, leading to an increase in wealth generated by innovation over time in the economy (Schumpeter Joseph A., 1961). This latter regards why policymakers want to support innovation and innovative firms. A distinction regarding the type of innovation needs to be made. Sustaining innovation is an improvement of something already existing, while disruptive innovation refers to a process by which a new product or service creates an entirely new market, eventually displacing established competitors (Bower, Joseph L.; Christensen, Clayton M., 1995). According to Christensen, disruptive innovations are critical to long-term competitive advantage and success in business (Christensen, Clayton M.; Raynor, Michael E.; McDonald, Rory,2015). Disruptive innovation is the most impactful in terms of benefit in society, so aiming to create something new or improved, technology is fundamental. In this sense, we can introduce the high-tech entrepreneurial ventures (HTEVs), small young organizations operating in technology-intensive industries (D.J. Storey, B.S. Tether, 1998), meant as connectors between the industry and research world (Colombo, 2010). These latter are the key players in performing the Schumpeterian creative destruction, where their small sizes and lack of experience are offset by innovation sources (Audretsch and Acs, 1994). As a result, HTEVs

boost the country's economic growth by exploiting previously developed knowledge converting them into value-added knowledge (Braunerhjelm et al., 2010). HTEVs have the potential to bring innovations and economic growth. But their potential is limited. The barrier on external finance depicts a crucial point. Firstly, HTEV suffers from substantial information asymmetries between HTEVs' managers and external investors, primarily due to short track of records and uncertain innovation processes. Furthermore, this latter is characterized by complex technical projects and difficulties in monitoring the R&D investments, distinguished sometimes by an unwillingness to disclose information because of the rivalry in the R&D race (Valérie Revest and Alessandro Sapio, 2010). Also, there are higher transaction costs due to the conversely proportional relation between banks' market power and borrower size. All these factors lead to difficulties in accessing external finance for HTEVs.

So, policymakers have to intervene to solve this failure. Direct funding allows governments to target specific innovation activities driving the efforts towards business areas that are interesting for specific projects (OECD, 2010b). Grants and subsidies are used as seed funding for startups and innovative SMEs. Granted on a competitive basis and in some cases based on private co-funding.

So, the point is to analyze how the European policymakers distribute subsidies, particularly grants, towards the most deserving innovative projects

2. Literature background and gaps

The EU framework programs are one of the main instruments available to policymakers for awarding grants to the best innovative companies that present worthy projects aimed at sustaining the knowledge-based economy. On the other hand, despite the long history of European Framework programs, where the first was adopted in 1982, the grants' policies concerning innovation did not receive significant attention from the scientific community.

Broekel T., Fornahl D., and Morrison A. (2015) investigated firms' potentialities in specific clusters to get access with a greater likelihood to grants than others, finding positive evidence.

Aguiar L. and Gagnepain P. (2017), after having identified that these programs are targeted to firms with specific social and economic concerns, clarified their impact on founded firms in terms of performance improvement which turned out to be mainly in labor productivity (at least +44,4%) rather than on profit margin. Teirlinck P. and Spithoven A. (2012) discovered the creation of installments of industry-science research cooperation when funds are provided by regional governments, while there is no impact on EU framework programs because targeted firms are already cooperating with scientific research centers. The significant contribution brought by Massimo G. Colombo, Diego D'Adda, and Lorenzo H. Pirelli (2015) led us to understand the positive impact of VC backing, differentiated based on VC types, over the participation of young innovative firms in EU framework programs. Finally, Børing P., Fevolden A.M., Mark M.S. and Piro F.N. (2020), by considering the recent Framework programme, Horizon 2020, analyzed three dimensions of Scandinavian organizations: firm's size, industrial sector, and strong connection with research institutions to find correlations with participating and winning companies of such programme. As a result, the firm's size has some positive effects in terms of participation rather than grants' size. Little support has been found related to research-intensive industries and connection with research institutes with programme participation and grant size. However, despite the good intentions of the authors, the research takes into consideration firms coming from Scandinavian countries, leading to an unbalanced analysis due to the greater maturity level of certain industries. Furthermore, the cluster of factors considered as main winning drivers are too narrowed, do not allow firms to understand what affects their success. Then, this paper does not consider the role of HTEVs in FPs and the features that with a more significant likelihood match FP's expectations. Therefore, Børing P. et al. (2020) started real work to assess the firms' performance in framework programs. Nevertheless, this paper favors policymakers' point of view, giving them insights on how to involve and coordinate organizations, rather than help firms to familiarize themselves with the success factors of such programs. Moreover, the paper suggests that an ad hoc analysis of SMEs could boost their participation. In this sense, an overall analysis of different traditional industries,

like the one of Børing P. research, could result too scattered. While concentrating on new rising industries could be an exciting research topic since it would guarantee to keep an eye open on SMEs while involving broader advanced technology topics that are gradually catching on in almost all industries

3. Research demand 1

Given the existence of limited studies regarding the assignment of funds to HTEV, this research aims to analyze *which are the factors that play a decisive role in order to obtain a call?*
The first step regards the identification of the potentially available industries to focus on the analysis. Once the industry is chosen, an in-depth study of such a market might be necessary to grasp all the peculiarities affecting that context. Subsequently, we can map and describe the results gained by chosen industry firms in Horizon 2020 framework programme. Finally, an econometric model will guarantee us the chance to catch a proper answer to our research question, namely the firms' features that influence FP's tenders' outcomes.

4. The drones industry

To overcome the Børing P. et al. (2020) geographical constraints, this study will consider the entire European countries. While regarding the centralization of HTEVs, it is easier to find a larger portion of such firms in new rising industries predominantly grounded on latest-generation technologies, where there is still plenty of room for innovating. Regarding the industry chosen, it is advantageous to consider a typical field of activities that characterizes the European Union's economic system. Thus, the industry we will pick as the unit of analysis should be comprised within the manufacturing sphere since it represents the sector, in terms of GDP generated, in which the EU ranks first among all the developed nations.
In this respect, PwC consulting corporation has developed a crucial framework, called The Essential Eight technologies. Among these, the drones industry resulted as the most suitable represents the most suitable candidate to perform further analysis regarding the potentialities of HTEVs in EU framework program tenders. First of all, it is plunged into a fast-developing environment, and the drones market is significant in terms of market value and growth rates worldwide with a homogeneous geographical expansion. In the European area, the significant fragmentation enables us to benefit with a higher likelihood from a pool of innovative small enterprises. Last but not least, the vast diversity of applications in different fields makes it possible to achieve a greater generalization of the research's outcomes.

5. Research demand 2

Before entering into the core research question of our thesis, we need to describe the framework program environment in which firms compete. In this sense, an ad-hoc mapping and assessment of firms' and projects' features are required to feed the fundamental knowledge adequate for answering the main thesis research question. Thus, another research question comes up:
Which are the drone industry firms participating in Horizon 2020 landscape?

6. Framework programmes and Horizon2020

Our analysis concerns the European Union and the drone industry, as is stated above. There is the necessity to understand the dynamics that gravitate around the European firms that operate in the drone industry and that applied and obtained funds for their drone-related projects.
This is not a new topic the involvement of the European Union in research activities began in the 1970s through the adoption by the Council of the first Community research program. The first real framework programme covered three years from 1984 to 1987, from FP1 to Horizon2020 seven FPs have been made, but Horizon was the turning point. It run until the end of 2020 and it was the most extensive EU Research and Innovation program with a total budget of nearly 80 billion euros of funding available. Horizon 2020 aims to develop a society based on knowledge and innovation while addressing the important priorities suggested by the European Agency for 2020: *smart*, *sustainable,* and *inclusive growth.*

7. The census

Methodology

A census of all the drones' related projects that won a Framework Programme's tender has been made. The source of reference was CORDIS, Community Research, and Development Information Service. All the projects containing the keyword "drone" have been downloaded and screening has been made to eliminate the out-of-scope projects. As a result, from this screening process, 320 projects have been found and could potentially be used for the census. This is built around three main pillars (i) descriptive introductive part that is automatically extracted from the platform; (ii) characteristics of budget and coordinator; (iii) classification of the project type. The most important part is the project mapping. The projects are classified into macro-categories that are *Product, Service,* and *Others.* These macro-categories are branched into the *Proposal category*, *macro project field*, *micro-project field*, and *project field details*. The product macro category is divided into Hardware and Software. The Hardware macro project field is divided into Drone platform, Payload, Components, and Counter-drone solutions. The Software is branched into Flights Planning & Fleet Operations Management, Data analysis, and Navigation. The Service macro category is divided into the following macro projects fields, Search and rescue, Inspections, Security and surveillance, Inventory, Transport, Distribution, Media, arts, and entertainment, and Maintenance. The last macro category Other contains all the projects that are not specifically related to the previous classes, so, Collaborative Platforms, Unmanned Traffic Management, Advanced Air Mobility (AAM), Research Activity & Training. (ANNEX 1)

Census analysis

There has been run a dual analysis with different levels of detail. On one hand, a country-oriented analysis has been executed looking at the common features of winning nations. As a result, most developed countries from a manufacturing and educational points of view, such as Germany, Italy, the UK, or Spain, turned out to be the most active and successful in terms of the number of projects and funds raised. Furthermore, an in-depth focus allowed us to become aware of the presence, in such countries, of a large number of projects with small budgets, probably deriving from an HTEVs environment. On the other hand, the product-oriented study led us to experience the major rewarded topics of winning projects. The most recurrent macro-categories refer to products and services, where in the first case the two sub-categories, Hardware and Software, show differences. Hardware products are mainly dominated by Drone Platforms and Payload in terms of projects, even if promising products such as Counter Drone Solutions exhibit higher EU contributions. Whilst Software products: Flights Planning, Navigation, and Data Analysis share similarities both in terms of projects' volumes and funds raised. The second most recurrent product is Service which finds few well-established fields, such as Inspections that are widespread in various business environments ranging from public, with public infrastructure inspections, to private with energy infrastructure ones. Nevertheless, the vast majority of service types, such as Erogation and Maintenance, are considered innovative with few current applications in businesses nowadays, but with promising growth prospects. The third macro-category, Other, has not fully evolved yet, but it has been able to gain, in relative terms, greater contributions thanks to the presence of Advanced Air Mobility (AAM) and Unmanned Traffic Management (UTM) that represent the future of drones' industry. (ANNEX 2)

8. The econometric model

This chapter constitutes the backbone of our thesis, where we would like to reach an evolved knowledge regarding the most impactful features that companies competing into EU FP should develop. Indeed, this represents the final answer to the initial research question set.

Methodology

Another dataset, containing the core characteristics of drones companies has to be adopted. This latter relies on the information of Crunchbase and CORDIS. It depicts the specificities of almost all worldwide innovative small firms for drones, which account for 5283, founded over a temporal horizon that spans from 2011 to 2021. However, the dataset reported many missing parts, due to the non-compulsory need to publish financial reports for several countries in which these firms reside (ANNEX3). After having understood the weaknesses of such a dataset, we are ready to

assess the correspondence with the one previously censused about Drones' FP. Firstly, a selection of the interesting firms' features has been made, and unfortunately, only 552 firms were suitable for attempting the matching between the two datasets. With the Fuzzy Lookup function on Excel, 54 matches were found. This satisfies the 8% threshold of winners imposed to give validity to our work. Having to assess the statistical relationship of the variables that characterize the drone-related firms that obtained a grant and those that have not, the most suitable regression model for our study is the *probit* one. The dependent variable can take only two values, in our case victory or loss of the tender, and the independent variables considered are the characteristics of the firms. Before running the Probit model, a variables operationalization has to be carried out. Firstly, the variables were tested for collinearity adopting the *Variance Inflation Factor* (VIF) (ANNEX4). A critical threshold that states the presence of collinearity is set to values greater or equal than 10 (Vittinghoff E, 2001), twelve variables were affected by multicollinearity, and so removed from the model, whilst the vast majority exhibit VIF lower than 5. Then, robustness was assessed applying a threshold of 10% on the P-Value. To avoid heteroscedasticity, the firms were clustered considering belonging to a financial center. So, the assumption that belonging to a financial center would favor HTEV, has been established. As a result, the model will split observations into two diverse clusters, where within the same cluster errors share the same variance. This ensures a lowering in the P-Value of several independent variables, boosting their significance.

Econometric results

The econometric analysis has been executed based on two different levels. Firstly, there is the description of the regression results coming from the main model. Secondly, has been examined how the main model reacts to different independent variables' group exclusions. This step is aimed at verifying the goodness of the main model questioning whether changes could be done towards the achievement of better results.

Main model results

Running the Probit model, we defined the statistical relationship between the binary dependent variable, obtainment or not of the grant, and the independent variables that characterize the firms (ANNEX5). The Location variables are impactful variables; southern and eastern European countries are advantaged, especially residing in a financial center can lead to a higher likelihood of receiving FP funds for HTEV.

Nowadays social media are becoming an important instrument of corporate communication strategy (Carim, Warwick, 2013). On the contrary, the model shows that the EU Commission had also privileged those newborn companies that probably just came up with a great idea, but that is still not structured enough to have a website and a social media account. There can be seen that applying only in the b2b or b2c sector is better perceived than operating in both of them. Also, looking at the application fields, we can state that specializing in one or at least less than four application fields is positively related to the winning of the tender. Also, regarding the specialization, focusing only on hardware or software is better perceived than doing both of them.

Considering, the development and size of the companies, the newborn companies, the HTEVs with small innovative projects, and large and well-established companies are the ones that were advantaged in the funds' assignment. In addition, being specialized and focused is better perceived than being differentiated.

Models comparison

The objective of this analysis was to understand the variation of the main model's variables, excluding the seven groups of variables one by one (ANNEX6). Excluding Website & Social Media independent variables, results in a minor reduction of the pseudo-R-squared (0,447). The main change is the shift of the Financial Center variable from significant towards not significant. This, indeed, would undermine the assumption made about the importance of financial centers for HTEVs to gain funds. Another meaningful change regards the turnaround, from positive to negative, of the b2b variable. This latter, even if not significant, implies, given b2c variable significant, that being only in the b2b business environment is not preferred to being in both anymore. Then additional changes, of a lower relevance, concern the exceeding of 0,1 p-value threshold for certain variables, such as software product type, utility as client field, and medium & large companies' size.

The second variables' group exclusion regards companies' Locations, which leads us to a huge impact in terms of econometric model robustness. as a result, pseudo-r-squared dropped from almost 0,5 to 0,28. Furthermore, it has a massive shock on industry type and product's features. Most of the industries that were significant in terms of p-value, such as G4, I7, and M6, are not compliant anymore with the threshold set. Furthermore, software product type becomes again not significant and there is no preference between a specialized and a focused solutions provider. Other large impacts are registered in the different client and application fields, where most of the variables significant for our main model get tipped over. In the end, no significance is encountered also in the company size's group of variables.

The exclusion of Industry Specificities variables can be interpreted as the least impactful among all the steps we are going through. The main variables touched consist of the specialization needed by HTEVs, the software product types, and a few applications and client fields. All the mentioned variables experienced an increase of p-values over the predefined threshold.

Afterward, stepping into solutions' variables opt-out, we can notice that the Financial Center variable is once again not significant. The combination of missing company's specialization and client fields grouping variables do not allow to identify how HTEVs should strategically behave. Then, it is worthwhile to analyze the independent variables' groups of application and client fields both at the same time. Both exclusions bring to a non-significance of Financial Centers variables. Whilst, despite the significance of variable b2b in the no Application Fields model, this latter experiences a greater impact in terms of non-significant variables among the industry types compared to the no client fields model. Looking at the product type and specialization, we find conflicting results since the no application fields model keeps specialization variable as relevant, while no client fields model has product types of variables in line with the main model. Then the two groups' exclusions react similarly, with the only difference that no application fields do not have medium & large companies significant.

Finally, Company Size variables exclusion leads to almost the same results as the main model, with the major exception for the company's specialization and product types details that are now non-significant. The number of variables and their importance is fairly reduced compared to the previous groups' exclusions analyzed above.

9. Conclusions

Limitations

The drone industry is still a developing industry, characterized by uncertainty, partially caused by the legislation. Firms are afraid to invest in large projects. So, we are still in a moment of initial market development, many startups and small ventures are developing, riding the wave of unexpressed possibilities that may emerge in the near future. To build a complete model, there should be a full insight into the financial information of these small and medium-sized companies, which unfortunately are not legally required to provide this information. All this leads to a limitation of our model, which suffers from the lack of data caused by low transparency. Another important limitation of our model relies on the fact that we have visibility only over the calls' winners, while all the other participants are unknown. This could bring additional and valuable information to understand the dynamics behind the assignment of tenders in the EU FP. So, our model can be limited to providing general guidelines and quantitative indications regarding the observable basilar variables.

Future developments

These limitations open up great possibilities in the next future for additional developments and research. There is space for future research considering other industries in the same area, to understand if our results can be generalizable. Another possible evolution regards enlarging the geographical boundaries, expanding the interest area outside the Euro-zone. There can also be interesting to consider the B2C market of drones and their applications in our daily lives. Drones have already been used by the industrial sector, by governments, etc., but the applications for the consumers' use of drones are still growing, and we can only imagine what the future will bring.

With this thesis, we had only scratched the surface of a possible branch of analysis, to fully grasp and understand the dynamics that progress around the grants' assignment. This work could be beneficial for those young companies that were born with a great idea and that were able to make it valuable and profitable, that need to be financed. That is

why EU Framework Programmes exist, to foster and support innovation and development, and so, firms, startups, and HTEVs with innovative projects. Having guidelines and being aware of how they could exploit their strategic assets, could lead and favor them to outperform Framework Programme's calls obtaining funds, and at the end bring value to the whole society.

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