
The new technology-based firm profile required for a delimitation of its definition in empirical studies

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Abstract: The main objective we pretend to reach is to obtain a conclusive final definition and the characterisation of new technology-based firm (NTBF). This quest for an integrative and commonly recognised profile gains even more force when focused on its application within the field of social and economic empirical studies. Within the social and economic empirical research, the formulation of the definition and full profile becomes highly relevant, because we cannot gather data without previous identifying and conceptualising the object of the research. That is, as the own proximity to the data access impregnates and clarifies the proper definition, at some NTBF studies. This paper debates existing approaches as well as defines the key factors needed to delimitate the definition and the parameters of the NTBF.

Keywords: technology-based firm; definition; key parameters; entrepreneurship; technology intensity; NTBF; new technology-based firm; engineering; economics; technology management.

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1 Introduction

In any empirical research there is a fundamental piece to be considered and that is an exact term/definition that delimits and identifies the object of a study. This requirement, in case of research on the new technology-based firm (NTBF), presents a double challenge. This dual prism of the NTBF concept should, on one hand, contemplate the new entrepreneurship as an active agent in the creation and funding of the NTBF. On the other hand, it must pick up the results of the attempt of delimiting the object of study in the field of the NTBF held in the scientific literature reviews. This lack of consensus in the conceptualisation of NTBF restricts the adequate applicability of the term or a comparison possibility between different existing studies. In undertaking such a review, it is important to define what is coined as a term 'new technology-based firm'.

At this point, we will proceed further a survey approach to important empirical studies in order to extract descriptions and characteristics useful to any researcher at NTBF field.

2 State of the art

In accordance with Autio (1997), the NTBFs are formed on a fundamental ground of being the driving force of the economic development and an essential piece of the reindustrialisation processes. Regarding to the relationship between R&D and economic growth, we note that the importance placed on 'high-tech-high-growth' firms in economic development policy is due to a prevailing assumption that R&D directly leads

to growth. NTBFs can be considered as important means of technological invention commercialisation. Other authors have, however, applied the term NTBF to a much broader population of enterprises; however, in some instances it is unclear whether the word 'new' applies to the firm, or to the technology, or both. New technology-based firms can influence economic growth both directly, by their number and their own growth, or indirectly by providing specialised input to other firms.

The leading player of the NTBF is a technological entrepreneur, who funds these companies, as well as becomes the key element of the organisational processes, because of the main role assumed in the birth, launching and consolidation of this type of business profiles.

As mentioned by the authors Torrecilla et al. (2014a), originally stated by Salas (2010), the entrepreneur is a key figure in the process of knowledge transfer and use. Become the nexus between the science and the market. It is the starting point for the technological advances that will lead to the product development and subsequent commercialisation.

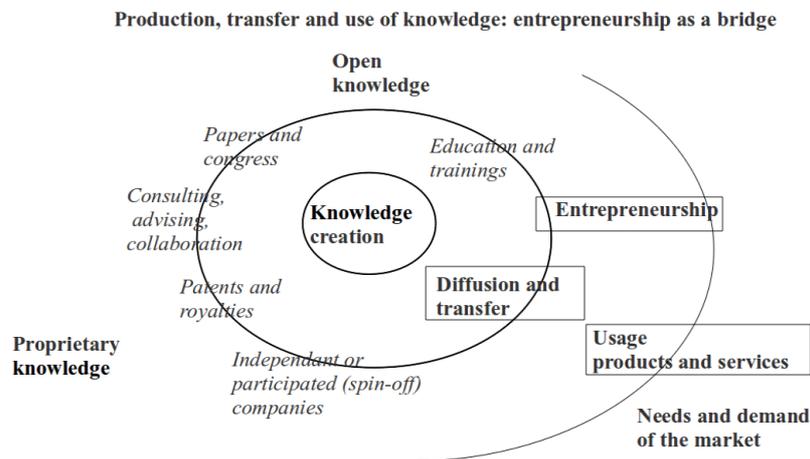
The technical and scientific knowledge is usually complex to understand and apply outside the academic environment. These characteristics can constitute a serious obstacle to the commercial exploitation. The micro- and macroeconomic potential – the technological advances and innovations provide to the development of new products, improvement of existing ones and its market entry – presents a challenge and an opportunity to be explored in due to accelerate the socioeconomic growth.

The market requires persons capable to – by undertaking the entrepreneurial initiative – translate the language of science into business concepts, and in this way, to take the role of the nexus/bridge between both parts, generally with some unique skills of risk undertaking and communication. As it is well known, not always the scientific progress, or even knowledge advances, has an immediate impact on the market. That gap of R&D results' commercialisation causes lower economic productivity, possible lack of acceptance by the market, or requirements of additional innovations or improvements; reasons introduced by Fagerberg and Srholec (2005) and cited by Souto (2013). This author places a historical example to illustrate the previous findings: Leonardo da Vinci and his sketches about the possibility men could fly. This innovative idea was not materialised until the new materials and modern means of mechanical traction were developed. Reason why there is a need for highly qualified people who serve as a link between the scientific knowledge generation and its commercial application. People who are able to design and produce goods and/or services that can be placed on the market, as at Figure 1. These qualified people able to interpret the knowledge, are precisely entrepreneurs, the key pieces of the economic dynamism.

The principal aim of this paper, based on survey evidence, is to establish a bunch of operative concepts related to the NTBF that could help us obtain conclusive and comparable results in the empirical field studies. At some point, a new definition should explicitly link technology entrepreneurship to the theory of the firm, entrepreneurship theory and management theory. There is a general consensus among different authors on the perception of shortage of studies focused on the NTBF in Spain (also widely in Europe). As we face the limited and insufficiently studied group of firms (Díaz et al., 2013); of which we cannot gather enough differential characteristics, nor reveal their relative importance in the neither productive structures, nor which industries they operate (Fariñas and Lopez, 2006). It would be necessary to propose in-depth studies on the behaviour of the NTBF from the economic analysis prism (Trenado and Huelgo, 2007);

as far as the enquiries about difficulties related to the fundraising and the explorations on the optimal entrepreneur profile (Fernandez and Hidalgo, 2011).

Figure 1 Entrepreneurship as a bridge



Source: Torrecilla et al. (2014a) based on Salas (2010)

3 The proposed NTBF definition

However, at international scope the surveys on the NTBF are far more, addressing the broad range of factors and determinants (Fernandez and Hidalgo, 2011) numerous in comparison to those realised in Spain (Quintana and Benavides, 2012); we observe the disabling lack of homogeneity. Already Storey and Tether (1998) recognised that a consistent narrow definition of NTBFs was not feasible, nor able to provide comparisons between countries or even same nation regions.

Trenado and Huergo (2007) consider the methodological problems common to the majority of studies on NTBFs. These methodological questions are, moreover, materialised within the following three points:

- the NTBF term defining
- the lack of official data on the NTBF performance
- the lack of a general theoretical and analytical frame of the NTBF.

In the different theoretical and empirical studies on NTBF, referred in the literature, both national and international, it does not appear there is a universally accepted definition of NTBF (Delapierre et al., 1998; March et al., 2010; Fernandez and Hidalgo, 2011); even the unique concept comprehension has not been reached yet (Trenado and Huergo, 2007); presenting ambiguities and blurred limits (Díaz et al., 2013); reason why it is distinguished by imprecision and methodological vagueness (Trenado and Huergo, 2007). Thus, Storey and Tether (1998) speak of the difficulty to specify when a company can be considered as the NTBF; also Palacios et al. (2005) emphasises that this complexity is mainly due to the variety of companies and industries that can cover this concept.

According to Fontes and Coombs (2001) NTBF definitions can be devised for the purpose of field studies, as “young independent firms involved in the development and/or diffusion of new technologies”. So from the empirical point of view, it is crucial to handle a NTBF term that would be able to satisfy the qualitative and quantitative research requirements. The restrictions, previously imposed, will trigger the inclusion or exclusion of some companies into/of the study, and in this way, expose the results to be distorted. Thus these restrictions will impose the new limits to the field study research. Consequently, it will make methodologically unfeasible to compare the empirical results obtained by different authors.

The different terms used in the literature induce misunderstanding, denoting the absence of an integrated and coherent theoretical framework (Torrecilla et al., 2014b). Coping with the lack of a universally accepted theoretical frame that could serve as a reference point, different research studies in the academic or institutional field choose one of existent definitions or construct own one to deal with the NTBFs’ data used in the study or according to the specific aspects of the research to be carried out (Trenado and Huergo, 2007).

We can observe the multitude of existing definitions, coined by different authors, become the results of the difficulty of formulating clear and distinctive characteristics that this type of enterprises represents. Authors as Fariñas and Lopez (2006), Trenado and Huergo (2007), Beraza and Rodríguez (2012), assume that many researchers apply the most general term available into the empirical studies, in due to establish *ad hoc* criteria applicable to the data previously gathered. On the contrary, the case studies related to concrete geographic areas or institutions, or based on much reduced samples; tend to use narrow or the strictest meaning of the term, in which the requirements of difficult quantification are included. So we can say that it is the availability of data that subordinates the term conceptualisation.

Despite the economic importance of NTBFs, there are diverse approaches (Storey and Tether, 1998; Delapierre et al., 1998; Grinstein and Goldman, 2006) that discuss the NTBF definition’s complexity and assume the term does not reflect homogeneous economic realities, with so many authors proposing variable concepts. However, four principal factors are to be considered when defining NTBFs: technology newness and new industry emergence, age of the firm, size of the firm, and finally capital independence.

Given the wide survey on the term of NTBF, coined by many theorists and after an in-depth study of the different definitions contributed to the mentioned authors, and in face of the lack of academic consensus, as well as the crying need to establish analytical limits of the concept, we consider as a NTBF:

“all independent companies that incorporate some kind of invention, technological advance or noteworthy innovation based on technology to their internal processes or/and products within less than 42 months since their creation (recognising them as companies consolidated on the market after this period, and becoming then just Technology-based Firms).”

It is really significant to take into account because the researchers frequently do not have precise notion what NTBF means (Autio, 1997; Storey and Tether, 1998). As wide range of different concepts are included into the survey of new technology intensive firms realised by Cunha et al. (2013) as well as also widely mentioned nomenclature of a NTBFs, small technology intensive firms, small and medium technology-based firms, small technology-based firms or high technology SMEs.

For that reason, we are going to specify the following aspects of our proposal of NTBF definition:

- independent firm property
- technology-based strategy
- new or recent creation.

4 Independent firm property

Most studies assume that a NTBF is independent, which means it is not a part or subsidiary of an existing company. However, there are evidences of very extended practice among stakeholders (or firms owners) in Spain, to fund a new company in due to operate outside of the core business activities, merely to avoid the mainstream of competitiveness of given industry. It means that at NTBF's the principal shareholder of the social capital is mainly the entrepreneurial team (Fontes and Coombs, 2001). However, it is important to take into consideration the different options for technology commercial exploitation from the prism of capital property:

- Gather the necessary resources to fund a new business activity within the same legal entity that developed the invention, technological advance or innovation. In this case, all kind of synergies are generated to maximise the results of the commercial exploitation of this new activity.
- Constitution of a new company with independent legal entity but owned by the parent organisation. This new company will operate on the market as a 'new business', but with the capital participated by the parent organisation. Including a Joint Venture, where two or more companies unite their efforts to launch new business (legally independent but co-owned by the principal firms), that fits here as a common option of high-tech industries (Ganzarain et al., 2006).
- Technology sale, cession under contract, licensing or patenting, that implies that a third party will acquire final rights for technology exploitation, assuming higher risk as at previous options. To Ganzarain et al. (2006) it means "granting the rights to create, use and/or sell a product, a design or a process".

We acknowledge that the NTBF must operate as an independent entity, not participated by third parts. If its capital is shared by any other organisation, certain degree of transfer of experiences, knowledge, abilities and resources takes place, the reason why this new firm would be referred just as a 'technology-based firm'. Within the category of 'newness' should be included those companies that constitutes themselves without being the continuity of an existing one.

5 Technology-based strategy

There is no general consensus among the authors about how to define 'technology-based' firms. It does not exist a common agreement on the precise classification of firms operate within the context of technical innovation processes. We understand that the concept

refers to all type of invention, technological advances or significant innovation applied, either in the internal processes, or in developed products, or both simultaneously. Including the companies that carry on internal R&D and those that exploit the technological innovation generated by third parties, generally with no consideration if that technology is in the early stages.

From a functional perspective, for the purpose of discerning this group of companies, it is crucial to define those parameters and characteristics that distinguish the technology-based firm from other 'advanced' industries. Some authors go for classifications based on industry that the company belongs, usually classifications reign by the criteria of technological level or intensity. We consider that these classifications can be used as elements or tools, mostly created by public institutions, to facilitate the research tasks within the primary or secondary source information processing. Thus, these official classifications allow carrying out the first filtering of companies, based on the type of activity or assigned code of activity, and so to focus our attention on the muster of technology-based firms.

It is quite obvious, the question that arises to the researcher, in his/her approach to the criteria of classification of companies: who determines the inclusion of a company to one industry or another? And what level of rigour that involves? The inclusion of the company to one sector or another based on non-rigorous procedure can substantially contaminate the selection of the NTBF muster.

Additionally, it is necessary to consider that these classifying tools are not invariable in time. Since the degree of technological content/capital can have diverse development within the enterprise activity and can vary in time, being this industry included or excluded in/from a concrete category. It is to say, the technological evolution has an inseparable variable, the time, and that can cause that concrete activity, in specific temporary segment, more or less expanded, can be defined as high, upper-medium, medium, low-medium or low technology. And, after a revision subsequent to the end of this period of time, the classifications can throw elements of judgement that will induce to reorganise the multiple industries/sectors, in focus to include or exclude them into/from superior or inferior level of technology.

There is a clear example of what we assumed in the modification carried out by OECD in 2001. (We intentionally rule out the OECD ISIC Rev.4 as lead by more organic methodology of industries aggregation). For example, the activity denominated as "Manufacture of medical, optical or precision instruments" happens to be incorporated to the category of high-tech due to its evolution since 1980. However, this example and remark do not reduce validity, functionality and operability of these classifications. They are still very useful as a support in the empirical studies. Therefore, the proper scientist is the one that must decide which classification take into account to reach the study objectives.

At international level, authors as Almus and Nerlinger (1999), in the empirical study carried out in Germany, conceptualise to the NTBF as an independent organisation of recent creation, and, to establish the denomination of technology-based, rely on the concept of 'technology intensity' picked up from the OECD, as segregation criteria.

At the moment, the classification- in force since 2001, materialised in Organisation for Economic Cooperation and Development (OECD), of technology-based industries, with its corresponding codes (International Industrial Standard Classification of All Economic Activities, Rev.3), is the aggregated collection, as in Table 1.

Table 1 Manufacturing industries based on technology codes, OECD¹

<i>Manufacturing industries based on technology</i>		<i>ISIC rev.3</i>	
<i>High-technology industries</i>		<i>Medium-high-technology industries</i>	
Aircraft and spacecraft	353	Electrical machinery and apparatus, n.e.c.	31
Office, accounting and computing machinery	30	Motor vehicles, trailers and semi-trailers	34
Radio, TV and communications equipment	32	Chemicals excluding pharmaceuticals	24 excl. 2423
Pharmaceuticals	2423	Railroad equipment and transport equipment, n.e.c.	352 + 359
Medical, precision and optical instruments	33	Machinery and equipment, n.e.c.	29
<i>Medium-low-technology industries</i>		<i>Low-technology industries</i>	
Building and repairing of ships and boats	351	Manufacturing, n.e.c.; Recycling	36–37
Rubber and plastics products	25	Wood, pulp, paper, paper products, printing and publishing	20–22
Coke, refined petroleum products and nuclear fuel	23	Food products, beverages and tobacco	15–16
Other non-metallic mineral products	26	Textiles, textile products, leather and footwear	17–19
Basic metals and fabricated metal products	27–28		

¹Classification in force since (2001).

Source: OECD

The OECD outline of classification of industries based on the technological intensity is not, however, exempt from limitations. These limitations are important to know as to be able to structure correctly the collection of data within the empirical studies. These restrictions, that entail and clarify the research depth because the methodological criteria established by the OECD to define if a company belongs to one industry or produces a concrete category of technology (high, upper-medium, medium, low-medium or low technology), suppose the sieve criteria we adopt *a priori* for our approach. That means that an external agent, in our case the OECD, filters the perception of the subject, object and centre of our analysis; as much as it segregates the reality on the basis of its proper vision of what should be the technological degree of the company to belong to one industry or another.

On the other hand, in Europe, Eurostat¹ is based on the classification of the OECD to divide industries into groups according to the technology intensity, without any consideration of intensity of R&D activities, EUROSTAT (1999). We assume that EUROSTAT classification, far from contributing to the improvement of the methodological criteria of the OECD, is carried on by the inertia of already established criteria. It seems to be just a proposal of framework for the EU Member States to develop more exact and conclusive concepts and methodological structures.

The actual aggregation classification of the industries suggested by EUROSTAT is in force since 2008, and uses the set of codes called NACE². Table 2 shows the aggregation group of technology-based industries.

Table 2 Technology-based industries codes, EUROSTAT¹

<i>Technology-based industries</i>	<i>NACE</i>
High-technology manufacturing	
Pharmaceuticals	21
Computers, electronic and optical products	26
Medium-technology manufacturing	
Chemicals	20
Electrical equipment	27
Machinery	28
Motor vehicles	29
Transport equipment excluding ships, boats, excluding air and spacecraft	30
<i>High-tech knowledge intensive services</i>	
Motion picture, video and television program production, sound recording and music publishing activities	59
Programming and broadcasting activities	60
Telecommunications	61
Computer programming, consultancy and related activities	62
Information service activities	63
Scientific research and development	72

¹Classification in force since (2008).

Source: Eurostat

Another example of an empirical study, carried out in Europe, is the research on Technology-based Firms conducted by authors Fariñas and Lopez (2006). When they approach the question of the association and counting of the number of TBF population, the main problem becomes to discriminate firstly the technology-based firms from others that use the technology intensively. So the authors confer to implement the INE³ classification set on the degree of technological intensity of the industry that TBFs belong to. Selecting those companies whose CNAE⁴ is classified among the industries described as high and high-medium technology, guarantees the very first sieve.

With the intention of picking out only technology-based companies, they apply the discriminating additional criteria of positive expenses on internal R&D, and/or that the company core activity is related to the productive or commercial exploitation of any technology-based innovation. This last parameter is fulfilled when 25% or more of company sales volume is linked to a product innovation.

The aggregation of technology-based industries extract from the present (2009) INE classification, pertinent to the criteria of the technology intensity, as in Table 3.

The table of high and high-low technology-based enterprises, elaborated by INE is clearly based on the OECD classification structure, as well as the divisions of EUROSTAT.

The first hand conclusion is that the attempt to harmonise criteria of NTBF selection or classification is not yet culminated. It still allows the new research generation, however, the comparison between countries and regions should deal with some correction factors to be considered as relevant and methodologically robust. This fact will probably delay the general consensus of scientists on the creation of a unifying theoretical body of the NTBF area.

The second conclusion for the researchers that initiate field studies on the NTBFs is that there are multiple options to choose or even propose new ones, the discriminating tool for the identification of this group of companies in front of the general set operating in a country or geographic area. The academic literature exhibits the moderate use of classifications of industries due to the technology intensity, can facilitate in certain degree field study of the scientist. And also it can initiate the incipient academic consensus on the approach and interpretation of this model of business organisation.

Table 3 Technology-based industries CNAE codes, INE¹

<i>Technology-based industries</i>	<i>CNAE 2009</i>
High-technology manufacturing	
Manufacture of pharmaceuticals	21
Manufacture of computers, electronic and optical products	26
Manufacture of air and spacecraft and related machinery	30, 3
Medium-technology manufacturing	
Manufacture of chemicals	20
Manufacture of weapons and ammunition	25, 4
Manufacture of electrical equipment	27
Manufacture of machinery	28
Manufacture of motor vehicles	29
Manufacture of transport equipment excluding ships, boats, excluding air & spacecraft	30–30, 1–30, 2
Manufacture of medical and dental instruments and supplies	32, 5
High-Tech Knowledge intensive services	
Motion picture, video and television program production, sound recording and music publishing activities	59
Programming and broadcasting activities,	60
Telecommunications	61
Computer programming, consultancy and related activities	62
Information service activities	63
Scientific research and development	72

¹Classification in force since 1 January 2009.

Source: INE

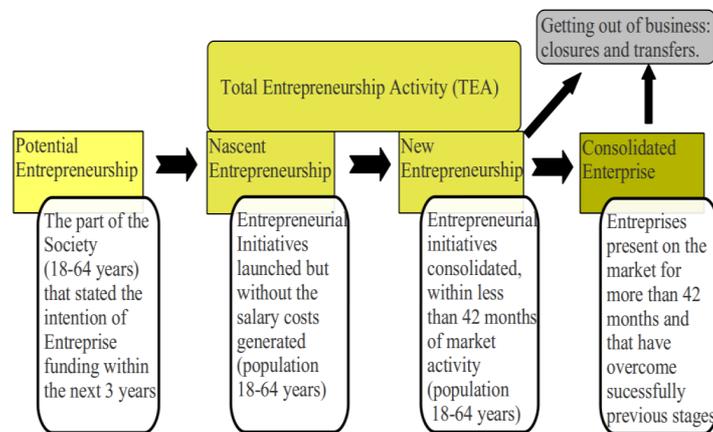
6 New or recent creation

New or recent creation is also defined as an age of the firm by some authors. We share the idea of Hernández and Corduras (2013) proposed in “global entrepreneurship

monitor (GEM) Report. Spain 2012". This report elaborated annually for 16 years and participated by more than 70 countries of all continents, is considered as a milestone in entrepreneurial survey by numerous international institutions, such as the UN, the OECD, EU Commission, World Bank, etc.

In this report, the entrepreneurial activity is delimited as "all business undertaking that lead to the creation of a company developed from its birth *to no more than 3 years and a half (42 months)*". Beyond 42 months on the market, no entrepreneurial consideration can be associated. The critical moment is the barrier of 42 months, considered as a 'survival and adaptation to the market' point, as presented at Figure 2. We embrace this period as a differential criterion adopted to qualify an enterprise as a NTBF or not. In sum, NTBFs are all technology-based firms that lie between the constitution and posterior 42 months.

Figure 2 Entrepreneurship cycle (see online version for colours)



Source: Hernández and Coduras (2013)

On the other hand, in other countries, however, the insight into the 'newness' could enclose different perspectives. Some studies consider the 'new' term as the synonym to 'youth of the firm' and 'technological newness', potential grade of the development or developed and under-developed market economies, in addition to an alternative comprehension of 'new' adjective in the context of the emergence of 'new industries'. Therefore, the concept delimitation of NTBFs may cover not just the 'newness of the firm' or of the technology but also of the industry.

7 Conclusions

Although the related literature has revealed awareness of the relevance of NTBFs, there is somewhat confusion at the term conceptualisation for the use of empirical analysis. There are approaches that have reached several, alternative definitions of NTBFs, but without clarify or operationalise the concept for a general application. NTBFs are subjects of definitional discrepancies (no standard definition is applied) and, therefore, panel dataset are problematic and expensive to compile.

However, after studying the different partial definitions and considering the urgency of term delimitation and conclusive profile building, we consider as a NTBF:

“all independent companies that incorporate some kind of invention, technological advance or noteworthy innovation based on technology to their internal processes or/and products within less than 42 months since their creation (recognising them as companies consolidated on the market after this period, and becoming then just Technology-based Firms).”

Even so, as stated, it will probably depend on the existing classifications of technology-based industries in different countries or regions.

We consider that a NTBF must be an independent company, whose capital should not be participated by third organisations. Thus, capital shares can produce certain degree of co-dependence due to transfer of experiences, knowledge, abilities and resources.

As far as this survey could examine, the NTBF is directly linked to technology, including all its operative types, such as: invention, technological advances/developments or any noteworthy innovation within the internal processes, its products, or both. Including the companies that carry on internal R&D and those that exploit the technological innovation generated by third parties, generally with no consideration if that technology is new.

The academic literature survey carried out shows the alternatives that some authors settle in their empirical studies, in focus to confront the question related to the correct and conclusive NTBF identification, including the precise selection of these companies from the general group of enterprises. The solution proposed by different authors, among them Almus and Nerlinger (1999) or Fariñas and Lopez (2006), is to use the already elaborated classifications of industries on base of the technology intensity within their productive processes.

Choosing the technology intensity factor to classify the enterprises or industries is still only a methodological ‘shortcut’ tool, with certain degree of effectiveness that can simplify the delimitation of the study objects. Thus, this tool is not exempt from a methodological controversy and regional, or even political, biases. However, all this attempts can be considered as a big step forward towards a delimitation of the heterogeneous enterprise group based on technology.

As published at “Global Entrepreneurship Monitor (GEM) Spain 2012” report, the entrepreneurial activity, defined as “all business undertaking that lead to the creation of a company developed from its birth to no more than 3 years and a half (42 months)”, induce deeper comprehension of the emergence of the entrepreneurial activity. As said, beyond this time, if the company endures on the market, it will be classified as a consolidated one, and no more as an entrepreneurial entity. So, we consider this delimitation as correct for the data collecting within any empirical study.

This paper leaves open many questions related to precise consequences of the NTBF term delimitation for the accuracy of field studies, as well as the potential impact on policy makers (such as university spin-offs, science parks, incubators, local government). This would also require broadening of further characteristics of NTBF founders and factors facilitating or inhibiting the creation and development of NTBFs within the more detailed, in-depth concept delimitation.

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Notes

¹Eurostat (Statistical Office of the European Community).

²Statistical Classification of Economic Activities in the European Community (NACE) rev.2.

³Instituto Nacional de Estadística (INE): The National Statistics Institute is a legally independent administrative Autonomous institution assigned to the Ministry of Economy and Competitivity via the Secretary of State for the Economy and Business Support.

⁴Clasificación Nacional de Actividades Económicas (CNAE): Spanish Statistical classifications are structures prepared for the purpose of being able to group homogeneous units, according to a defined criterion, in a single category