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THE EFFECTS OF HIGH-SPEED CONNECTIVITY ON FIRM CREATION AND SELF-EMPLOYMENT IN SPAIN

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Abstract

This paper aims to examine whether the expansion of high-speed digital connectivity has contributed to stronger entrepreneurial dynamics across Spanish municipalities. More specifically, it analyses the relationship between digital infrastructure and both firm creation and self-employment dynamics in a context marked by persistent territorial disparities between urban and rural areas in Spain. The study focuses on three key technologies: FTTH, 5G mobile coverage and broadband coverage of at least 100 Mbps, to assess whether different forms of connectivity generate different economic effects.

To address this question, the work combines descriptive and spatial analysis with panel data estimations based on fixed effects models. The results suggest that the impact of connectivity is not uniform across technologies or across forms of entrepreneurship. FTTH shows a positive association with firm creation, while 5G is linked not only to higher firm creation but also to lower firm and self-employment exits. Overall, the findings indicate that digital connectivity can support local economic dynamism, although its impact depends heavily on the pre-existing characteristics of each territory and should therefore be understood as a complementary enabler rather than as an automatic driver of growth.

Keywords: digital connectivity, firm creation, self-employment, municipalities, Spain, FTTH, 5G

Resumen

Este trabajo tiene como objetivo analizar si la expansión de la conectividad digital de alta velocidad ha contribuido a reforzar la dinámica emprendedora en los municipios españoles. Más concretamente, estudia la relación entre la infraestructura digital y tanto la creación de empresas como la evolución del trabajo autónomo en un contexto marcado por persistentes disparidades territoriales entre las zonas urbanas y rurales en España. El estudio se centra en tres tecnologías clave: la FTTH, la cobertura móvil 5G y la cobertura de banda ancha de al menos 100 Mbps, con el fin de evaluar si distintas formas de conectividad generan efectos económicos diferentes.

Para abordar esta cuestión, el trabajo combina análisis descriptivo y espacial con estimaciones de datos de panel basadas en modelos de efectos fijos. Los resultados sugieren que el impacto de la conectividad no es homogéneo ni entre tecnologías ni entre formas de emprendimiento. La FTTH muestra una asociación positiva con la creación de empresas, mientras que el 5G se vincula no solo con una mayor creación de empresas, sino también con una menor salida tanto de empresas como de trabajadores autónomos. En conjunto, los hallazgos indican que la conectividad digital puede favorecer el dinamismo económico local, aunque su impacto depende en gran medida de las características preexistentes de cada territorio y, por tanto, debe entenderse como un factor habilitador complementario más que como un motor automático de crecimiento.

Palabras clave: conectividad digital, creación de empresas, trabajo autónomo, municipios, España, FTTH, 5G

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1. Introduction

Digital transformation has become one of the central drivers of economic change in advanced economies. Over the past decade, high-speed broadband infrastructure has been increasingly recognised not only as a technological upgrade, but as a fundamental component of regional competitiveness, productivity growth and territorial cohesion. In the European context, digital connectivity has been framed as a strategic priority under initiatives such as the Digital Agenda for Europe and the Digital Decade targets, which explicitly links broadband deployment with economic changes and equal access to opportunities across regions.

Spain represents a particularly interesting case within this framework. Spain continues to face persistent territorial disparities in economic activity, demographic structure and entrepreneurial dynamism between urban and rural municipalities. This apparent contrast with the big fiber deployment in the country raises a relevant empirical question:

Does the expansion of digital connectivity translate into higher levels of business creation and local economic dynamism, or does it simply overlap with pre-existing structural inequalities?

The relationship between digital infrastructure and entrepreneurship has been widely explored in international literature. Several studies, which are examined later, suggest that broadband expansion reduces transaction costs, facilitates access to information, enables new digital business models and strengthens firms' productivity and resilience (i.e., Traxler & Luger, 2000; McCoy et al., 2018; Maude, 2020; Espinosa et al., 2022). However, empirical findings are not uniform.

Some studies find that broadband expansion has a positive effect on firm creation and employment. For example, McCoy et al. (2018) show that broadband availability supports new business formation in Ireland, while Maude (2020) finds that very high-speed broadband in France increases the creation of establishments and sole proprietorships. However, other studies emphasise that these effects are heterogeneous and depend on local conditions such as sectoral composition, education, population density and absorptive capacity. In the French case, Maude (2020) shows that the gains are stronger in some sectors and in municipalities with a more educated population, while Briglauer et al. (2022) argue more broadly that the economic returns of broadband depend on adoption levels and regional digital maturity. In the Spanish case, Arronte Ledo and Holl (2022) also find that better connectivity is associated with higher firm and employment growth, especially where favourable local conditions are already in place.

This work aims to contribute to this debate by analysing the relationship between digital connectivity and entrepreneurial dynamics across Spanish municipalities. Specifically, it addresses the following empirical question:

To what extent does the expansion of high-speed digital connectivity affect business creation and self-employment dynamics at the municipal level in Spain?

To answer this question, the study combines descriptive spatial analysis with panel econometric estimations. The empirical strategy exploits within-municipality variation over time using fixed effects models, allowing the analysis to control for time-invariant local characteristics and common macroeconomic shocks. Three measures of connectivity are examined: fiber-to-the-home (FTTH), 5G mobile coverage and broadband coverage at 100 Mbps. Entrepreneurial dynamics are captured through four dependent variables: firm entries, firm exits, self-employed entries and self-employed exits.

By distinguishing between technologies and between different forms of economic activity, the analysis seeks to provide an understanding of how digital infrastructure shapes local economic ecosystems. Rather than assuming a uniform growth effect, the thesis evaluates whether connectivity acts as a catalyst for entrepreneurial expansion, a mechanism for business resilience, or simply a complementary factor that reinforces existing territorial patterns.

The structure of the paper is as follows. First there is a review of the literature on broadband infrastructure and economic development, with a focus on entrepreneurship and territorial cohesion. Next, the data and descriptive analysis of connectivity and business dynamics across Spanish municipalities. Thirdly, outline of the empirical strategy and econometric methodology. Fourth, discussion of the main results and comparison of the effects of different connectivity technologies. Finally, conclusion by summarising the findings, discussing policy implications and identifying avenues for future research.

Through this analysis, the thesis aims to shed light on the economic role of digital infrastructure in Spain and to assess whether connectivity can effectively contribute to strengthening local entrepreneurial activity and reducing territorial disparities.

2. Literature review

2.1. Global context

Over the past decades, society has been shifting from industrial model towards a more digital economy. This transformation has not only changed our day-to-day lives, but also the way we work and interact within professional environments, making it easier to work from anywhere in the world. As Traxler and Luger (2000) note, "operating a business from home (or any location) has become increasingly feasible with advanced ICTs". There is no doubt that most jobs have benefited from the creation of the internet, and even more now with the existence of Generative Artificial Intelligence.

The Internet is considered a general-purpose technology, which its availability is almost expected everywhere we go. It has created a dependency on its existence, because it improves productivity and efficiency. Nowadays, it is key to have a reliable Internet access, especially in the workplace, and to understand what this connectivity really means for businesses.

Advances in Information and Communication Technologies (ICTs) have transformed the spatial organization of economic activity. Although rather than eliminating the importance of location, digital connectivity has redefined how distance, mobility, and proximity influence firm behaviour and performance. Geography is key for enterprises, although global research highlight that ICTs are reshaping, rather than erasing, the role of space. This means that firms continue to depend on their locations but now combining physical and virtual dimensions.

Building on this idea, the following section explores how digital connectivity and spatial mobility reshape economic and firm dynamics from a global perspective before moving to Europe and finally Spain.

2.1.1. The digital transformation of space and mobility

ICTs have redefined the way people and firms interact within space and time. When the Internet first appeared, many experts believed that digital communication would eliminate, or at least reduce, the importance of geography, allowing workers to operate from anywhere (Traxler & Luger, 2000). This determinism assumed that physical distance would become irrelevant and that the need for mobility and face-to-face interaction would disappear. However, the importance of physical presence has not disappeared, instead, it has been reshaped by digital infrastructure, as ICTs create new virtual forms of interaction without eliminating the relevance of physical agglomeration and face-to-face contact (Schwanen et al., 2006).

The existence of the Internet and online connectivity makes communication faster and more efficient, they do not remove the need of physical presence. In fact, most work-related interactions such as those involving trust, collaboration or negotiation, still rely heavily on face-to-face contact. Digital communication can even create additional mobility. "There is also increasing empirical evidence that Internet use on balance generates more travel than it replaces" (Schwanen et al., 2006), this is because thanks to connectivity, people have a wider network of contacts all over the world, not just the ones near them. These initial virtual interactions often lead to meetings, partnerships and other business opportunities that still require human contact.

From an economic perspective, this coexistence between virtual and physical interaction reinforces the idea that connectivity changes the form of space but not its importance (Galkina et al., 2023). Firms continue to depend on both: physical proximity to markets and clients, and digital proximity through high-quality broadband and mobile networks. When this digital infrastructure is not available, especially in rural areas, opportunities for collaboration and business growth are limited.

2.1.2. From digital infrastructure to firm reorganization

The expansion of high-speed Internet has redefined how firms organize themselves internally and how they choose their location. Due to this type of connectivity, some costs are reduced as there is more operation flexibility and a good interaction with suppliers, clients or partners, giving no importance to distance. These changes are what Traxler and Luger (2000) describe as a process-oriented technological revolution, where communication becomes the key to competitiveness.

Broadband and a good mobile network are now an important part of firms, and what facilitates that communication and coordination. Businesses can now decentralize some activities, have remote teams or even operate fully online. This has made the number of network-based firms increase, these ones do not depend exclusively on location for operations, but they do on location where there is good quality connectivity.

As a result, the locations of firms have been determined by the places in which there is broadband or mobile network. This change means that those large metropolitan areas with the best connexion attract many firms, while rural areas do not have the capacity to maintain those digital business models. These inequalities in fiber access produce a division based not on roads or airports, as it usually happens, but an "invisible" break due to data transmission speed. Indeed, "even e-commerce businesses continue to locate in attractive, established high-tech centres" (Traxler & Luger, 2000)

But not only that, also urban centres are the most populated by businesses because they combine digital and physical advantages: good infrastructures, skilled labour force and access to markets. Therefore, connectivity has provoked an even more selective agglomeration where firms want to locate themselves where there are physical accessibility and advanced connectivity. For rural areas, this means a barrier to attracting or retaining firms, especially in those sectors that depend heavily on connexion.

2.1.3. Spatial mobility and firm performance

We live in a globalized and connected world, firms are not fully independent, they need their connections with suppliers, clients and other companies, so they are not fully on their own. Moving from one place to another could change these relationships temporarily. "These findings provide evidence that relocation is a critical event that can disrupt interorganizational relationships and, as a result, affect the performance of firms" (Knoben et al., 2008).

If we talk about the digital connections, firms relocate to get better access to those, so they can improve their activity and be more efficient. Connexion has therefore become a new key aspect to take into consideration when choosing a location for companies.

However, is not that easy, there are more things to consider, relocations depend also on the distance from your first location, the direction and reasons for the move. Going from a rural to an urban area with better infrastructure, leads to long-term benefits, while going to a less connected area can reduce competitiveness. Studies also show that companies deal with balancing stability and adaptation, which means staying in a familiar environment or in a better area where new connections have to be built.

Once again, spatial mobility is not disappearing in this new era, it is in fact being redefined. Firms move not only to reduce transport costs, but also to improve their digital integration. Access to fiber and 5G has become as important as the existence of roads or airports when choosing a place to settle a company.

2.1.4. Firm diversity and location outcomes

Not all firms benefit equally from digital connectivity, and not all relocations end up giving the same results. Knoben and Weterings (2008) emphasize that the performance effects of relocation depend on what is the firm about. For example, moving to a more urbanized area can help with innovation but also increases operational costs, so, the impact of digital infrastructure depends on industries and firm sizes.

For companies more focused on knowledge and services, high-speed Internet is crucial. These types of companies depend on data, online platforms and even virtual meetings, therefore, being in strong digital areas gives them good outcomes. In contrast, manufacturing or logistics firms benefit less from broadband, as their activity is more related to supply chain or transporting. This differentiation between industries creates new patterns of digital needs (McCoy et al.,2018).

Lastly, these findings reinforce the idea that connectivity improves companies with different outcomes, it makes stronger advantages of already competitive regions and leaves the others which less connectivity even more behind. This idea will become more relevant in this study when analysing how connectivity affects firm creation and relocation across Spanish municipalities.

2.2. American evidence on connectivity and firm location

The relationship between firm location and digital connectivity in the workplace, has been really studied in the United States and Canada, where broadband roll-out began earlier than in Europe (continent which we will also see in this paper) and data availability has been strong and useful since the 1990s. All of this makes sense, as North America seems to be one step ahead with technology, if we compare it to Europe.

Earlier studies (some mentioned above), explored the effect that the Internet had on the spatial organization of firms. Traxler and Luger´s (2000) work was one of the first studies to link ICT development with changes in business locations. They argued that because all types of communication became easier and more efficient through these new technologies and connectivity, companies experienced an improvement on how they interact with clients, suppliers and the market. This change decreased the dependency on physical proximity and increased the collaboration and online exchange through the Internet.

This evolution was crucial for understanding how technology began to redefine what businesses used to look for when searching for the best location to settle in. In the U.S., the expansion of broadband network during the late 1990s and early 2000s allowed smaller and more knowledge-intensive firms (consultancy, R&D businesses…) to operate outside major cities, where everything is more expensive. Traxler and Luger highlighted that ICT-intensive sectors, particularly information-based and service-oriented businesses, were most likely to benefit from this new spatial flexibility. However, they also noted that while the Internet enabled firms to become more “footloose”, digital infrastructure itself remained highly uneven, with rural areas getting significantly behind. This geographical division laid the foundations of what later literature called the digital division in firm relocation.

Building on this, Tranos and Mack (2016) provided one of the clearest analyses of the U.S. context by examining whether broadband development affects the presence of knowledge-intensive firms. Using spatial econometric models for all American metropolitan areas, they found a causal relationship between fiber availability and the concentration of these kinds of firms (KIBS). In other words, areas with better connectivity infrastructure not only attract, but also retain firms whose activity depend on data and digital interaction. Their study showed that broadband has become a new form of invisible infrastructure that substitutes things like transport accessibility. This finding confirms that in the U.S., digital connectivity has become a key driver of economic clustering, particularly in metropolitan regions where knowledge exchange and innovation are key.

Moreover, recent studies from Canada have provided more insights into how fiber access affects local economies and firm dynamics. Espinosa et al. (2022) analysed Quebec municipalities and found that broadband availability is associated with both firm creation and business survival, but with different effects in urban and rural areas. They demonstrated that areas with better Internet access have higher rates of business establishment creation. They compared different municipalities that gained broadband access with similar ones that did not and discovered that digital infrastructure reduces transaction costs and expands market access, making these connected areas more attractive for new businesses.

Beyond helping firm entry, the study also observed a lower rate of firm closures in connected areas. The authors saw this as evidence that connectivity makes firms lives stronger. Faster internet allows small businesses to reach bigger and more extended markets, access digital tools that improve efficiency and competitiveness or adopt e-commerce platforms, for example. In regions like Quebec, where many municipalities are small and isolated, this digital integration helps with the disadvantages of distances and helps firms remain alive.

Together, these studies demonstrate that fiber access reshape firm geography in different ways. In the U.S., broadband infrastructure boosts the concentration of digital and knowledge-based activities, while in Canada, it increases resilience and firm creation in smaller municipalities. Both cases put emphasis on the idea that digital connectivity is not a neutral factor, it reinforces competitive advantages in already good areas but also opens opportunities for more rural areas with good human capital.

2.3. European perspective and situation

2.3.1. European agenda

Across Europe, broadband expansion has been an important factor in European Union´s strategy to promote regional competitiveness and territorial cohesion. Both, the digital agenda for Europe 2016 and the latest one for 2030, have the objective of achieving universal access to very high-speed Internet for economic improvement. In the European context, fiber networks are not only seen as technological advancements, but also as a tool for reducing the big division between urban areas and peripheral or rural ones. By ensuring equal access to high-speed Internet, the EU tries to increase productivity, attract investment and encourage entrepreneurship in some areas were does not happen often. However, some research reveals that the relationship between connectivity and local economic outcomes remain complex.

A big number of studies within Europe have studied whether broadband development translates into tangible economic benefits such as firm creation, relocation or increase in productivity. As said earlier, this is complex. For example, Briglauer et al. (2022) highlight that broadband expansion has had a positive macroeconomic impact across Europe, especially in productivity and innovation. However, they also mention that these benefits are not uniform, as economic effects also depend on the level of broadband adoption and the digital maturity of the region. Their analysis shows that investments in high-speed Internet have stronger outcomes when combined with good human capital and innovation capacity.

Adding to these findings, broadband expansion has become a key driver of regional competitiveness, although countries remain very different and have heterogenous economic effects. Some research on Ireland, France, Italy and the Netherlands show that while better connectivity increases firm creation and relocation, the size of this impact depends on the regional context.

For instance, fiber availability in Ireland (McCoy et al., 2018) and in France (Maude, 2020) has created new businesses. However, these positive effects are less visible in rural areas, where additional infrastructure and human capital are limited. Studies from the Netherlands (de Bok & Sanders, 2005; Knoben & Weterings, 2013) really emphasize that while accessibility plays an important role in firm relocation decisions, internal firm factors and agglomeration dynamics often are more important than connectivity alone. Finally other evidence from Italy (Cambini & Sabatino, 2022) suggests that the expansion of very fast broadband can even accelerate business turnover, which is a benefit for technological firms, but perhaps an extra disadvantage for more traditional ones.

Altogether, these studies conclude that broadband infrastructure is a conditional enabler rather than an automatic engine for development. Its effectiveness depends on the existence of other things, such as skilled labour and innovation capacity, which determines whether digital connectivity helps with improvement or reinforces the divisions within Europe.

2.3.2. Infrastructure and firm creation

Exploring now the cases of the Irish and French, which are detailed analyses of how connectivity influence business creation within the European context. Both case studies confirm that connectivity alone does not generate entrepreneurship, its effectiveness depends on how it interacts with local assets.

In the case of Ireland, where small towns coexist with a highly educated workforce, the spread of broadband made new possibilities for business creation. McCoy et al. (2018) found that “both initial DSL and middle-mile fiber broadband have had a positive impact on firm formation, particularly in the high-tech sectors”, they analysed the relationship between broadband availability and the location of new business using a large dataset within several years and municipalities.

Their study includes fiber infrastructure as one of the important explanatory variables, with more traditional ones such as road accessibility, labour force skills, and proximity to urban centres. The results show that broadband availability is a significant positive determinant of new firm creation, but its influence is conditional on complementary factors. In areas with high levels of education and access to transport, broadband access increases entrepreneurial activity, whereas in areas with weaker human capital or limited connectivity, the effect is much smaller. As McCoy et al. (2018) note, "areas with preexisting high levels of human capital and knowledge-intensive firms may be better equipped to reap the rewards of broadband roll-out than other areas less endowed with these attributes.".

It is argued that this pattern suggest that broadband facilitates the attraction of firms that rely heavily on digital communication, while its impact on traditional sectors remains limited. The Irish case underlines that digital infrastructure works best as part of an integrated regional development strategy, rather than as an isolated technological investment.

Similarly, Maude (2020) investigates the effects of very high-speed connectivity expansion in France, focusing on the roll-out of connections exceeding 30 Mbps. Using a model with econometric framework, the author compares municipalities that received very high-speed broadband with similar ones that did not, estimating the impact of a new network. As it is explained, "Given the type of data available, a count model is implemented to address the main question, which is whether very high-speed broadband networks have a causal effect on the creation of new establishments" (Maude, 2020). The findings reveal a positive and significant effect on firm creation.

The availability of high-speed Internet reduces transaction costs, improves market access, and enhances communication efficiency, making these areas more attractive for new entrepreneurs. However, Maude (2020) also finds that the impact is uneven depending on the areas, urban municipalities experience strong growth in new business formation, while rural areas show limited effects. This suggests that the benefits of broadband depend on pre-existing socioeconomic and demographic structures. As the author notes, "There is no significant effect of the presence of a very high-speed broadband network on company creation in areas with a low-skilled workforce. [...] Educational attainment plays an important role in the appropriation of the benefits of faster broadband technologies" (Maude, 2020).

While the Irish case highlights the role of human capital and accessibility, the French shows that network speed and quality are key for attracting new digital businesses. Overall, these two cases show that broadband fosters business creation only when aligned with each country's specific regional characteristics and assets.

2.3.3. Relocation and accessibility

Across Europe, companies face the same question at some point in their life cycle: should they stay where they are or move elsewhere? In the Netherlands, where cities are close together and infrastructure is highly developed, this question takes on a very practical dimension. Firms tend to move, but not far. As mentioned by de Bok and Sanders (2005), "firms appear to move over relatively short distances, plausibly because firms depend on existing spatial relations with employees and customers or suppliers, also referred to as keep factors.". Relocations are usually short and motivated by internal changes, such as needing more space, better accessibility, or updated facilities, rather than a search for entirely new markets. Dutch evidence shows that most companies prefer to remain within the same region, balancing the benefits of physical and digital connectivity with the comfort of proximity to their established networks. In such a context, broadband and transport act less as forces of change and more as conditions that allow flexibility when growth or adaptation make it necessary.

Longer moves are rarer and often reveal another side of firm behaviour. As Weterings and Knoben (2013) found:

> "Short distance relocations (within municipalities and labour markets) are triggered by growth and the corresponding need for more space, while longer distance relocations are mainly influenced by regional characteristics. The spatial concentration of similar or related firms, a higher level of urbanization and R&D intensity keep firms from leaving their labour market region, but firms are more inclined to leave regions with a higher share of innovative firms".

When companies relocate over greater distances, it is usually because their surroundings have stopped fitting their ambitions. An area that once offered advantages like good connections, skilled workers or local suppliers, may become saturated or too competitive. In those cases, the search for a more favourable environment takes over. Interestingly, firms embedded in innovative, knowledge-intensive areas are less likely to leave, as the exchange of ideas and collaboration acts as an anchor. Others, with fewer ties to such networks, are more mobile and more sensitive to regional opportunities.

Italy presents a somewhat different picture. There, the introduction of high-speed broadband has not simply encouraged firms to move or expand, it has transformed the rhythm of business life itself. Studies on Italian municipalities show that the arrival of fiber-optic infrastructure increases both the creation and disappearance of firms. In regions where digital development is high, the new network opens opportunities for innovation and growth; but in more traditional sectors, it also raises competition and highlights weaknesses. The result is a faster economic turnover: firms that adapt success and those unable to digitalize tend to exit the market. Connectivity, therefore, acts as both a catalyst and a filter, rewarding those ready to operate in a more digital environment.

Taken together, the Dutch and Italian experiences illustrate two sides of the same story. Connectivity, whether through transport or broadband, does not dictate where firms go, but it shapes how they evolve. In the Netherlands, it supports gradual, adaptive movements within an already integrated landscape. In Italy, it accelerates transformation, forcing a reorganization of the local business fabric. Both cases show that infrastructure alone is not the protagonist; it is the interaction between technology, geography, and the capacity of firms to adapt that ultimately defines who moves, who stays, and who grows.

2.3.4. European synthesis

Looking across Europe, the evidence on broadband and firm dynamics reveals a picture that is quite different depending on the country. The continent's diversity in geography and infrastructure, makes connectivity a story with many local versions. What makes them follow a similar path is the growing recognition that digital networks shape the economic map, just as roads and airports once did.

In Ireland and France, broadband expansion clearly encouraged entrepreneurship, although only where the local context of the area allowed it. Ireland's experience showed that connectivity works best when combined with education and accessibility, broadband in this case acts as a bridge between skilled labour and new digital opportunities. France, on the other hand, demonstrated that the quality and speed of infrastructure matter as much as its presence. Very high-speed broadband boosts firm creation in cities, but the benefits fade in rural areas, revealing how digital divisions can persist even within developed economies.

The Netherlands offers a different perspective, focused on how firms move rather than where they begin. There, physical and digital accessibility influence relocation decisions, but they rarely drive them alone. Companies tend to stay close to their original networks; their clients, suppliers, and workers, suggesting that good infrastructure enables movement without necessarily encouraging it. Mobility becomes a sign of adaptation rather than disruption.

Finally, Italy shows a different outcome altogether. The arrival of ultra-fast broadband did not simply attract new businesses; it transformed the rhythm of local economies. In areas where new technologies are ready to be adopted, connectivity became a tool for innovation and growth. Elsewhere, it increased competition and forced less adaptable firms out of the market.

Taken all together, these European experiences show that broadband's influence on firm geography is conditional, context-specific, and often paradoxical. Connectivity can encourage decentralization, helping smaller regions to attract investment, but it can also reinforce existing hierarchies, strengthening urban centres that already hold the skills and institutions to exploit it. The lesson is that digital infrastructure alone cannot rebalance the economic map; it needs to go hand in hand with policies that develop human capital, support innovation, and ensure that all regions have the capacity to make technology work for them.

2.4. Focus on the Spanish perspective

Spain represents one of the most interesting European cases when analysing how broadband infrastructure has changed regional economic development. Despite being one of the countries with a more advanced fiber deployment over the last years, its geography and historical territorial differences have made the relationship between digital connectivity and firm activity not easy. The potential of broadband transforming local economies and the challenges of ensuring that this transformation reaches rural and less dynamic areas can be perfectly seen in this case.

During the early 2000s, the first big broadband plans were launched, but the actual good implementation came later with the *"Plan de extensión de banda ancha de nueva generación (PEBA-NGN)"* and the objectives were similar to the European ones. These initiatives looked to provide coverage even in remote municipalities and reduce that invisible wall between disconnected rural areas and more digitalized ones. In recent years, Spain has achieved one of the highest rates of fiber-to-the-home (FTTH) coverage in Europe, being in 92% of households according to official broadband coverage report published by the Spanish Ministry (*Ministerio para la Transformación Digital y de la Función Pública*, 2024). However, as highlighted by González-Val (2023), improvements in connectivity have not directly ended into economic growth or population stability. The expansion of broadband has helped with increasing productivity and access to services, but the effects it should have on business creation and rural repopulation are still dependent on other factors, such as the quality of human capital and pre-existing economic specialisation.

The Spanish context has a lot of contrasts between large urban areas such as Madrid, Barcelona, Valencia or Bilbao, and a big number of small and medium municipalities that have difficulties to attract or retain economic activity. Broadband has partly ended these differences, although the studies reveal that technology alone cannot reverse decades of uneven development. In his analysis of more than 8,000 municipalities, González-Val (2023) finds that broadband penetration is positively associated with population growth and employment, but only in the most dynamic regions. In rural areas or in those with weaker industrial bases, the same infrastructure often fails to produce significant demographic or entrepreneurial effects. In other words, the digital division has shifted from a question of access to one of capacity to benefit.

Moreover, broadband has also begun to influence firm dynamics in Spain. Using detailed municipal data, Arronte Ledo and Holl (2022) investigate how broadband coverage affects local economic performance. Their findings show that municipalities with better fiber connectivity experience higher growth in the number of firms and in employment, especially in sectors where digital interaction and information processing are key to daily operations. However, their study also says that the economic impact of broadband is not automatic, the benefits happen when the new infrastructure interacts with favourable local conditions such as innovation capacity, education levels, and accessibility to urban markets.

This interaction between broadband and local characteristics reinforces the idea already observed in the European literature, that digital infrastructure acts as a conditional enabler. In Spain, the expansion of fiber networks has certainly created opportunities for entrepreneurship, remote work, and territorial diversification, but these opportunities are more easily implemented by regions that already had a good human capital and institutional support. As Arronte Ledo and Holl (2022) note, the presence of high-speed networks has a positive effect on business growth only when accompanied by complementary assets that allow firms to innovate and scale.

At the same time, broadband development has played an important role in reshaping the geography of opportunities in Spain. While large cities have consolidated their dominance in digital-based activities, several medium-sized urban areas, such as Zaragoza, Valladolid, or Málaga, have emerged as secondary areas of attraction thanks to improved connectivity.

In contrast, more peripheral provinces continue to face structural barriers that limit the benefits of fiber access, including lower human capital, weaker local productive structures, ageing populations and poorer accessibility to urban markets (González-Val, 2023). This author underlines that broadband expansion has often been seen as a strategy to fight depopulation, but some evidence shows mixed results. Some municipalities have managed to slow population decline thanks to remote work or e-commerce opportunities, while others, have not registered any significant demographic change.

Overall, the Spanish experience is a paradox: the country is top in Europe in fiber coverage, although regional inequalities in economic outcomes continue existing. Broadband has become a prerequisite for competitiveness, but its capacity to stimulate sustainable growth depends on how it interacts with the social and economic background of each area. In urban regions, fiber has strengthened innovation ecosystems and allowed the proliferation of technology-based firms. In rural Spain, however, the same networks have not been enough to counteract depopulation or generate new business ecosystems on their own.

2.5. My perspective and research hypothesis

After analysing the existing literature, it becomes clear that broadband has reshaped the geography of opportunities across the world. However, the Spanish case still presents a paradox: while the country leads in fiber coverage, rural areas continue to face persistent demographic and economic stagnation. This contrast motivates the analytical focus of this study. My perspective is that digital infrastructure in Spain, particularly fiber deployment, has not yet reached its full potential as an equaliser of regional differences. Instead, it seems to have made the division between territories stronger.

The studies reviewed, particularly those of González-Val (2023) and Arronte Ledo & Holl (2022), provide a solid foundation for this argument. They show that high-speed broadband is positively related with local growth and firm creation, but only when accompanied by favourable local conditions. This conditional effect raises a central question:

Is connectivity truly driving new economic opportunities in rural municipalities, or is it simply reinforcing the strength of already developed urban ones?

Spain's territorial structure makes this question especially relevant. The country is composed of more than 8,000 municipalities, many of them small and ageing, which face difficulties attracting or retaining businesses. Fiber deployment has been one of the main tools, although its actual economic impact at local scale remains very little. Previous research tends to focus on aggregated regions or provinces, which does not show the differences that exist between small and large municipalities. This paper analysis aims to fill that gap by taking the smallest territorial unit, the municipalities, as the core of observation.

The empirical strategy will therefore rely on two complementary data sources provided by the *Ministerio de transformación digital*. The first dataset includes, from 2010 to the present, annual information on broadband technology (especially fiber-optic coverage) by municipality, including when each area got access to high-speed connectivity. The second dataset contains the number of new firms created each year in those same municipalities. Together, they provide an opportunity to explore whether the arrival of fiber correlates with an increase in local entrepreneurial activity.

From this perspective, I see broadband not just as part of technology, but as a possible tool to boost and modernise rural areas. For it to truly help local development, its benefits must go beyond having Internet access and lead to visible economic results, for example, the creation of new businesses, more jobs, or a stable population. With the data available, it will be tested whether rural municipalities that got fiber earlier have seen more firms being created than those that received it later, while considering differences in population and economic structure.

Lastly, my hypothesis is that the expansion of fiber broadband has had a positive but uneven effect on firm creation across Spanish municipalities, being stronger in urban or intermediate areas and weaker in the most rural ones. In other words, the digital division in Spain may no longer lie in access to technology, but in the capacity to transform connectivity into economic opportunity.

This leads to a broader research question that will guide the empirical part of this study:

To what extent has the arrival of fiber-optic connectivity and 5G contributed to business creation in Spain's municipalities, and under what conditions can digital infrastructure become a key driver of territorial cohesion?

3. Descriptive Analysis

3.1. Introduction

This chapter dives into the descriptive analysis of the dataset used in the empirical part of the thesis. After reviewing the international, European and Spanish evidence on connectivity and business activity in the previous section, the goal here is essential: to understand how digital connectivity and new business activity is across Spanish municipalities between 2013 and 2022.

Before estimating any causal relationship, it is important to check how the variables behave, how they have changed over time, and whether there are visible territorial patterns that are consistent with the expectations created from the literature and from my own research question.

The analysis combines two main groups of variables. On one hand, I used several indicators of high-speed broadband coverage at municipal level: fiber-to-the-home (FTTH), coverage of at least 100 Mbps, and 5G availability. These indicators come from the Spanish Ministry for Digital Transformation and provide annual information on the percentage of households covered by each technology. On the other hand, I used two measures of local economic dynamism: the rate of new self-employed registrations and the rate of new firm creations per 100 inhabitants, from the national Statistics Institute. Working with these variables at municipal level allows to explore more than usual national or regional averages and explore the internal diversity of the Spanish territory.

The rest of the chapter is organised as follows:

First, a description of the main variables, including basic statistics (mean, median and mode) and simple histograms for both connectivity and business activity.

Second, I study the relationship between connectivity and new business creation through a correlation matrix and a set of scatter plots, which provide an initial and descriptive view of the relation between both dimensions.

Third, I examine the evolution of the different broadband technologies over time and across Spain, identifying groups of municipalities that are clearly ahead or behind in terms of digital infrastructure.

Finally, I use several maps to visualise the spatial patterns of self-employment, firm creation and connectivity, and to highlight those areas that remain structurally disconnected. All these visual graphs will help to understand the heterogenous landscape that Spain has.

3.2. Data description and variable exploration

The descriptive analysis provides an overview of the main variables included in the study. The objective of the thesis is to understand how digital connectivity is related to business activity in Spain, since it has more than 8,000 municipalities, the distributions reflect the strong heterogeneity that exists across territories.

Here is a table that sums up the important information about these variables:

Figure 1 - Variables summary table

Variable	Description	Value range	Period	Source	Average	Median	Mode
5G	Percentage of households covered by 5G technology	[0-1]	2021-2022	Ministerio de Transformación Digital	0.042	0	0
5G_dummy	Binary indicator= 1 if municipality has any 5G, and 0 otherwise	[0-1]	2021-2022	Ministerio de Transformación Digital	0.086	0	0
Cob_100Mbps	Percentage of households covered by broadband of at least 100 Mbps	[0-1]	2013-2022	Ministerio de Transformación Digital	0.244	0	0
FTTH	Percentage of households covered by Fiber-to-the-Home (FTTH)	[0-1]	2013-2022	Ministerio de Transformación Digital	0.221	0	0
Autonomos_Tasa_Altas	Rate of new self-employed registrations in the municipality	[0-200]	2020-2022	INE	3883	0	0
Empresas_Tasa_Altas	Rate of new firms created in the municipality	[0-400]	2020-2022	INE	7799	0	0
Gross household income	Average gross household income in a municipality	[13454-116308]	2015-2022	INE	26670	25653	28286
Total population	Total resident population in a municipality	[4-3334730]	2013-2022	INE	5690	557	106
Population aged 65+ share	Share of population aged 65 or above in a municipality	[4.8-80]	2018-2022	INE	28	27	41

Source: elaborated by the author

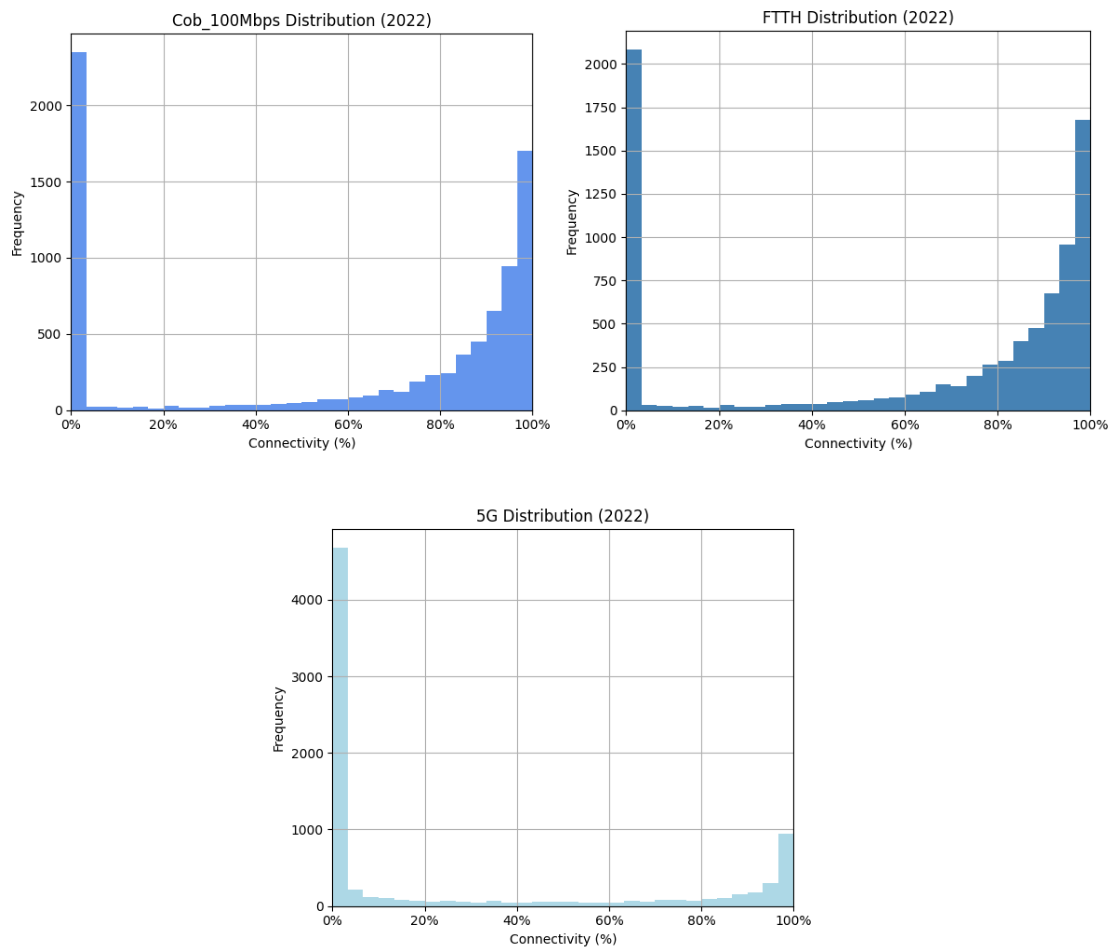
3.2.1. Connectivity variables

The dataset includes three measures of high-speed internet availability, all expressed as the percentage of households in each municipality that are covered by a given technology:

- **FTTH (Fiber-to-the-Home)**: a measure of fiber-optic deployment, available in this dataset from 2013 to 2022. FTTH is the most advanced infrastructure for long-run digital capacity, and the variable shows strong variation both across municipalities and across years.

- **100 Mbps coverage (Cob_100Mbps)**: the percentage of households that have at least 100 Mbps of download speed, regardless of the infrastructure. This indicator captures effective broadband performance and complements FTTH when fiber is not fully deployed.
- **5G coverage (5G)**: availability of 5G networks (data starts in 2021). Since the introduction is very recent (2019), many municipalities show zero coverage in the first years.

Figure 2 - Connectivity distributions in 2022



Source: elaborated by the author

Focusing on 2022, the distributions shown on the graphs, of FTTH, 100 Mbps coverage and 5G reveal substantial territorial heterogeneity across Spanish municipalities. These figures isolate the cross-sectional variation that remains in the last year of the sample. The three variables display a polarised pattern, with a significant concentration of municipalities at very low levels of coverage and another group clustered near the upper bound.

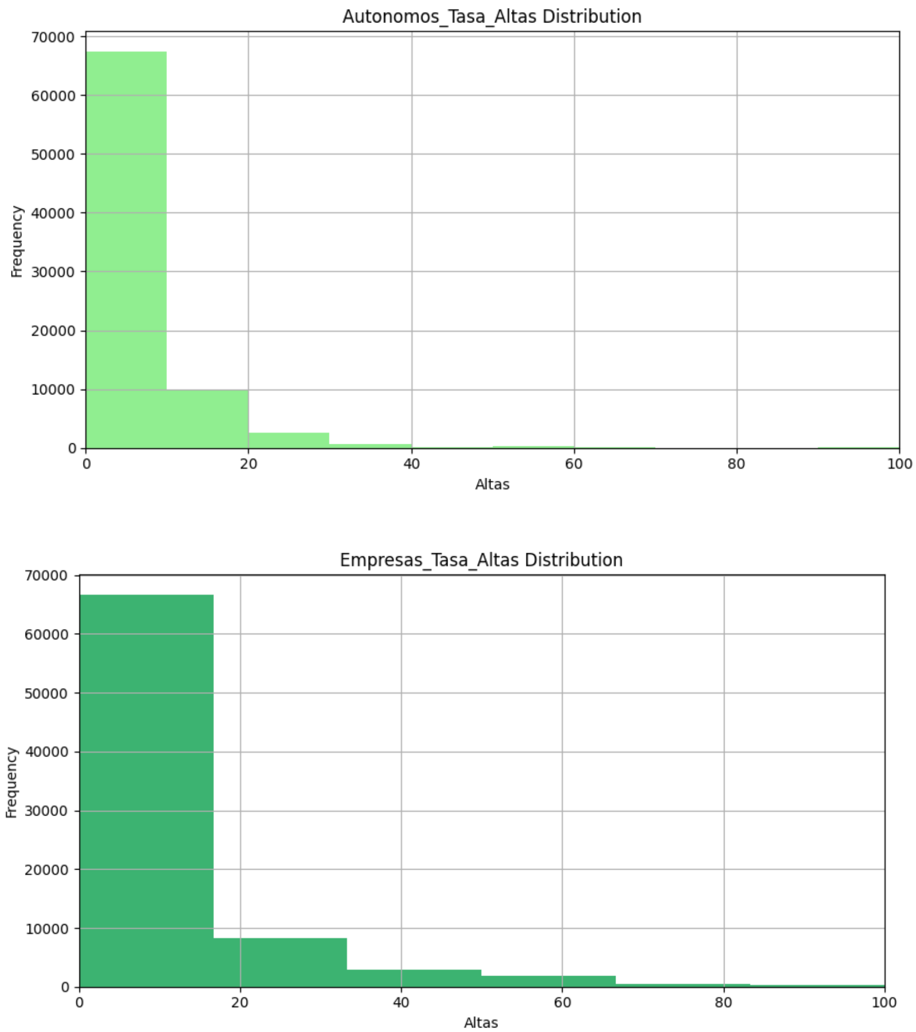
FTTH and 100 Mbps coverage show the clearest accumulation at high values, indicating that a large share of municipalities had already reached advanced stages of fixed broadband deployment by 2022, although important gaps persisted for others. By contrast, 5G coverage remains more unevenly distributed, with a greater concentration of municipalities at or near zero and fewer municipalities close to full coverage, reflecting a more recent and less homogeneous rollout. These descriptive results confirm that municipal disparities in connectivity remained relevant at the end of the period and therefore provide meaningful variation for the empirical analysis.

3.2.2. Business activity variables

There are also two indicators for the business activity:

- **Self-employment rate (Autonomos_Tasa_Altas)**: rate of new self-employed registrations per 100 inhabitants.
- **Firm creation rate (Empresas_Tasa_Altas)**: rate of newly created firms per 100 inhabitants.

Figure 3 - Entrepreneurship distribution



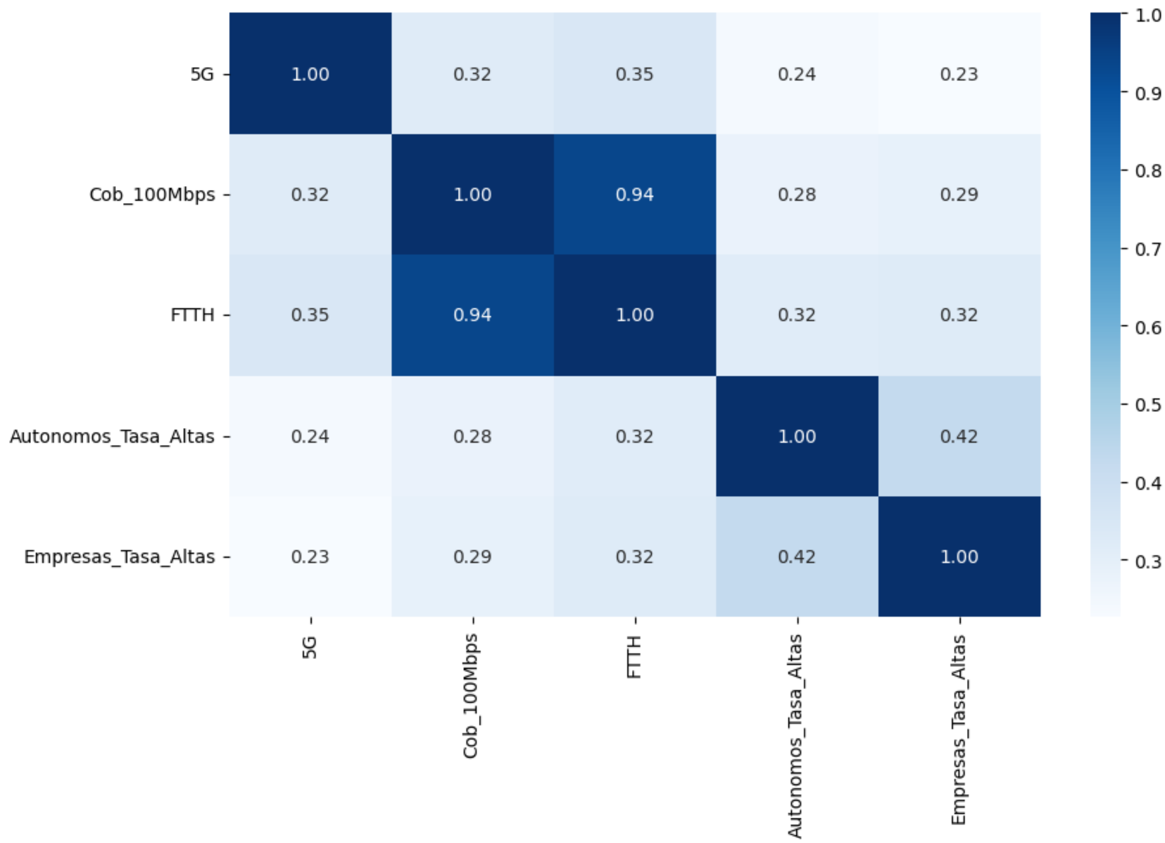
Source: elaborated by the author

These variables allow to measure entrepreneurial activity at a very granular level. Their distributions are also very different through each municipality, with many having very low values and a smaller group showing much more intense activity.

The distributions of the two business activity indicators also reveal a highly uneven pattern across Spain. In both cases, most observations are very close to zero, indicating that most municipalities register only a small number of new self-employed workers or newly created firms each year. The histograms show long right tails, with progressively fewer municipalities displaying higher values. This pattern is more pronounced for the firm-creation rate. Overall, these distributions confirm that entrepreneurial activity is far from symmetric.

3.2.3. Correlation matrix

Figure 4 - Correlation matrix



Source: elaborated by the author

To complement the analysis, a correlation matrix summarises the linear relationships between variables, with coefficients from –1 (perfect negative association) to +1 (perfect positive association). Although correlation does not imply causality, it is an initial indication of how variables behave together and helps identify patterns.

Before analysing the correlation matrix of this study, lets recall how these coefficients should be read. A correlation close to zero suggests no linear association, meaning that changes in one variable are not associated with changes in the other. Moderate correlations (e.g., between 0.2 and 0.5) already signal meaningful movements, especially when the dataset is large and heterogeneous, as is the case here with more than 8,000 municipalities. High correlations above 0.7 indicate strong linear relationships, although such values are uncommon in regional or socioeconomic data. Therefore, even small coefficients can have value when the underlying variation is wide and complex.

This matrix shows that the **FTTH and 100 Mbps indicators** are positively correlated with each other (0.94). This is an intuitive and expected pattern. Municipalities with earlier and more extensive FTTH deployment usually show higher adoption of 100 Mbps broadband. This makes sense because fiber is the infrastructure that facilitates high-speed connections. The correlation between FTTH and 100 Mbps is therefore the strongest among the connectivity area.

The correlation between **5G and the other technologies** is positive but weaker (0.32 and 0,35), which makes sense given that 5G was introduced in 2021. Many municipalities still have zero 5G coverage, and the rollout has followed a different pattern, prioritising dense urban areas. Still, even a small positive correlation indicates that places with more advanced fixed broadband networks tend to also be the first to receive mobile network upgrades.

The correlation between the **two business activity indicators** is positive and a little strong (0.42). This is consistent with the idea that these two forms of activity coexist, municipalities with dynamic business environments are likely to show higher rates in both indicators. However, the correlation is not perfect. In Spain, self-employment often reflects individual job choices in rural or service-based areas, whereas firm creation is more related to market potential. The imperfect correlation highlights their complementary nature and justifies analysing both outcomes separately.

The most relevant insight from the correlation matrix is the positive association between **broadband availability and business activity**. The coefficients linking FTTH and 100 Mbps to both self-employment and firm creation are modest but consistently positive (around 0.30 all of them). This suggests that municipalities with better digital infrastructure tend to promote slightly higher entrepreneurial activity.

The fact that correlations are not very large is not surprising. Business dynamics depend on many factors: demographics, local policies, human capital, geography…

Broadband is only one part of the equation, nevertheless, the presence of a positive association, is meaningful given the size and heterogeneity of the dataset. It provides preliminary support for the idea that connectivity and economic activity evolve together.

The **correlations involving 5G** are smaller (around 0.20), largely due to its limited rollout window. Because most municipalities acquired 5G in 2021 or 2022, the variable has little time to covary with business outcomes. Still, the positive sign of the coefficients is aligned with expectations of relationship between technological upgrades and local economic dynamism.

In summary, the correlation matrix reveals three key insights:

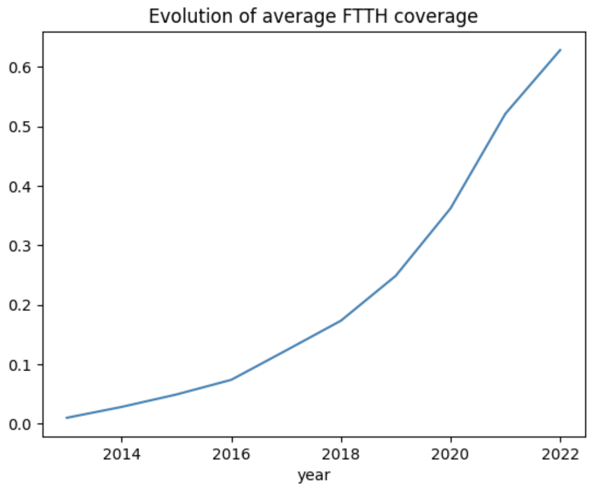
1. Connectivity technologies tend to cluster together: municipalities strong in one technology are often strong in others.
2. Business activity indicators are related but capture distinct dimensions of entrepreneurship.
3. Connectivity and business outcomes move in the same direction.

These patterns do not establish causal effects, but they highlight clear empirical regularities that justify deeper econometric modelling. The next sections explore how connectivity evolves over time and how these patterns differ across municipalities.

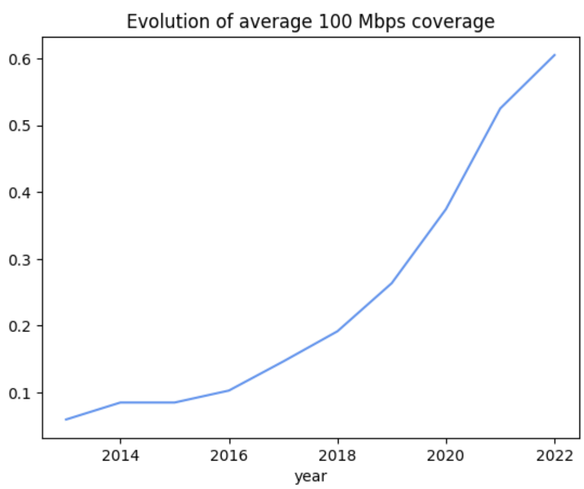
3.3. Evolution of digital connectivity (2013-2022)

To complement the cross-sectional distributions, the dataset also allows observing how connectivity has evolved over time.

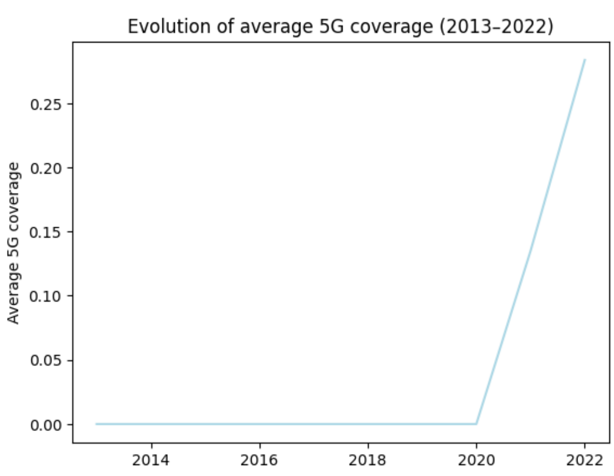
Figure 5 - Evolution of connectivity



FTTH shows the most pronounced expansion. Average coverage increased from almost zero in 2013 to more than 60% of households in 2022, following a smooth growth pattern. The curve reflects the long-term fiber rollout, investment decisions were made well in and diffusion follows a typical S-shaped trajectory described in the technology diffusion literature. The pace accelerates a lot from 2018 onwards, being the period in which large national and European initiatives supported fiber.



The **100 Mbps** indicator follows a similar pattern but starts at a higher initial level, since this performance can be reached through different technologies, not only with fiber. Even so, the general pattern is like FTTH. Slow growth until around 2017, followed by a sharp increase from 2018 to 2022. By the end of 2022, the national average is more than 60%, which suggests that upgrades occurred in parallel to infrastructure upgrades.



Finally, **5G** has a completely different shape due to its recent introduction. Between 2013 and 2020, 5G coverage is exactly zero across all municipalities. Coverage only begins to appear in 2020, and the average rises quickly in 2022 as it started in urban areas

Source: elaborated by the author

Overall, the three curves highlight that Spain experienced an improvement in digital connectivity during the decade, although not in the same way across technologies. This heterogeneity is relevant for the empirical analysis, as municipalities were exposed to connectivity at very different moments, generating variation useful for studying its relationship with business activity.

3.4. Spatial heterogeneity in connectivity

The previous sections documented the overall evolution of digital infrastructure in Spain. However, national trends need an extra dimension for understanding the role of connectivity in local development, due to its strong spatial heterogeneity. Broadband deployment in Spain has expanded rapidly, but not uniformly. This section studies how connectivity differs across municipalities.

To do so, only for these graphs, the analysis uses the municipality-level average coverage over the full period (2013–2022), and only municipalities with non-zero coverage are included in some subsections. This avoids the statistical distortion caused by the very large number of municipalities that still display zero average connectivity, especially for 5G.

Before comparing municipalities, it is important to acknowledge the magnitude of zero-connectivity areas:

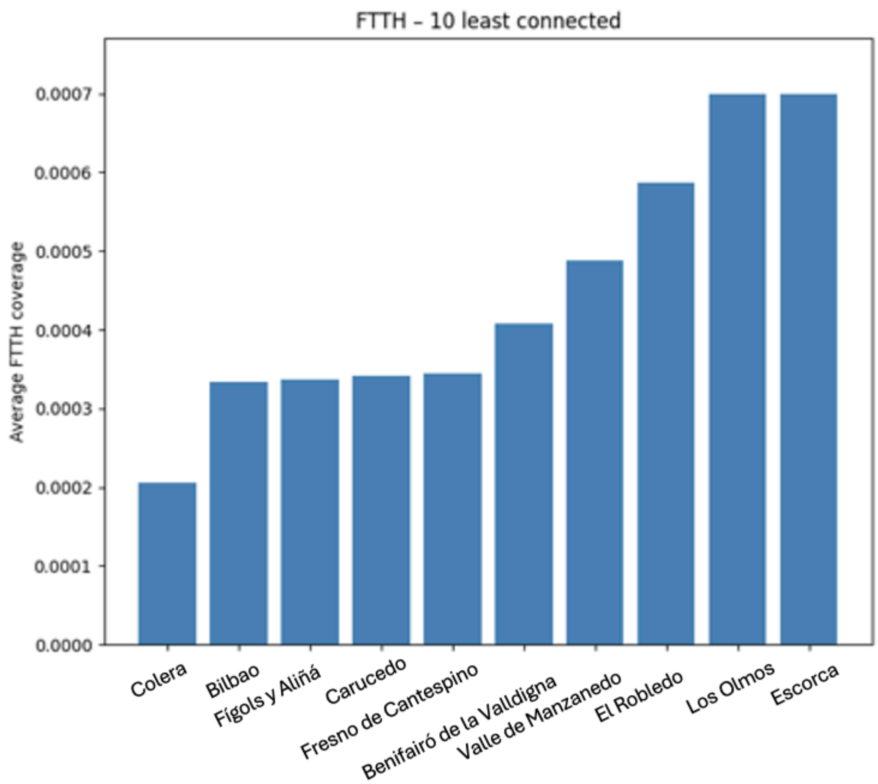
- FTTH (2013–2022): 1,949 municipalities recorded zero for their average.
- 100 Mbps coverage (2013–2022): 2,063 municipalities average coverage was zero.
- 5G coverage (2021–2022): 3,743 municipalities; nearly half of Spain, had no 5G.

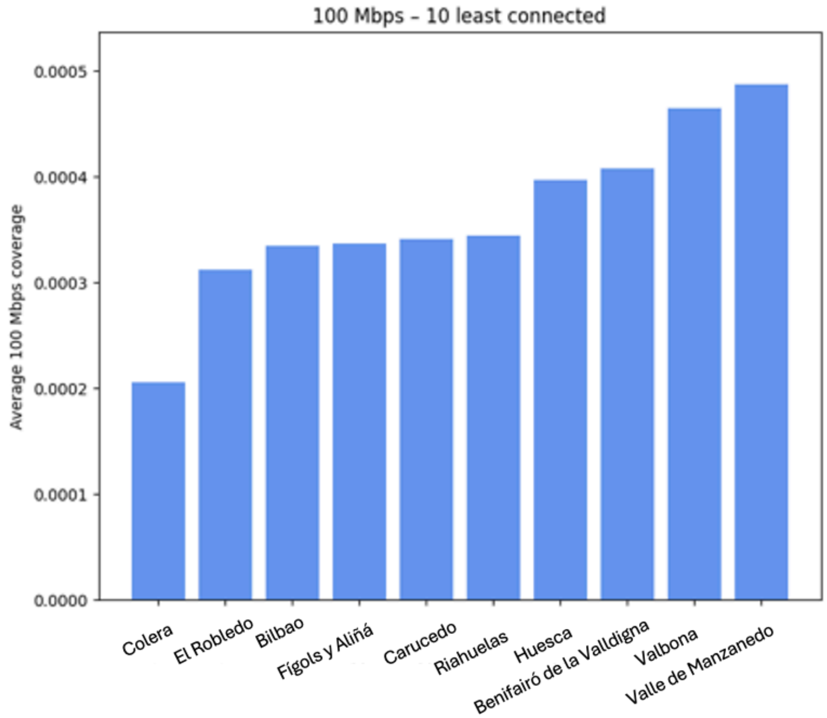
These numbers highlight the asymmetric nature of Spain's digital expansion. While major urban areas and intermediate towns exhibit near-universal high-speed connectivity, thousands of small rural municipalities remain digitally isolated.

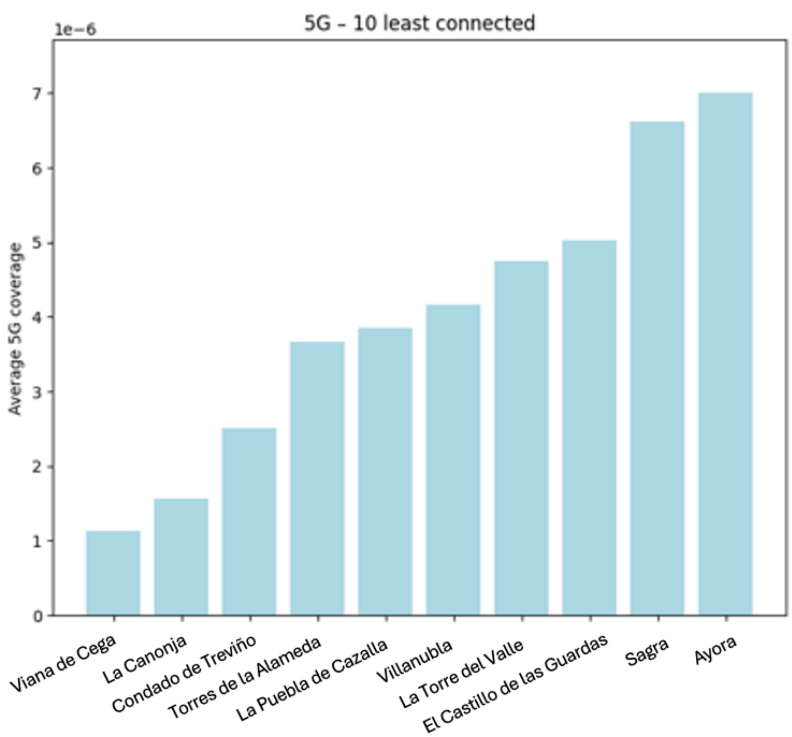
3.4.1. Top 10 least connected municipalities

Focusing only on municipalities that have experienced some connectivity (>0 average coverage), here are the "Top 10 least connected municipalities" as an average during this period.

Figure 6 - Least connected municipalities







Source: elaborated by the author

Across the three technologies, the bottom-ten municipalities reveal a consistent pattern of geographic and demographic isolation. In the case of FTTH, some of the least connected areas are: Colera (Cáceres), Fígols y Aliñá (Lérida), Carucedo (León) and Fresno de Cantespino (Segovia), and are all small inland municipalities, typically located in mountainous or not very populated regions.

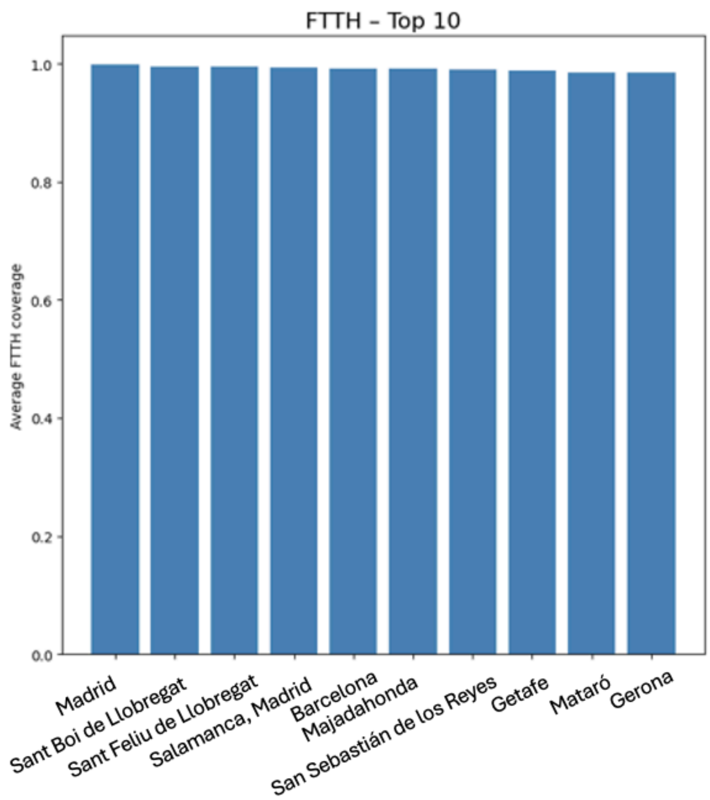
A very similar thing happens to 100 Mbps coverage: Colera (Gerona), El Robledo (Ciudad Real), Fígols y Aliñá (Lérida) and Carucedo (León) also represent rural localities far from major urban centres.

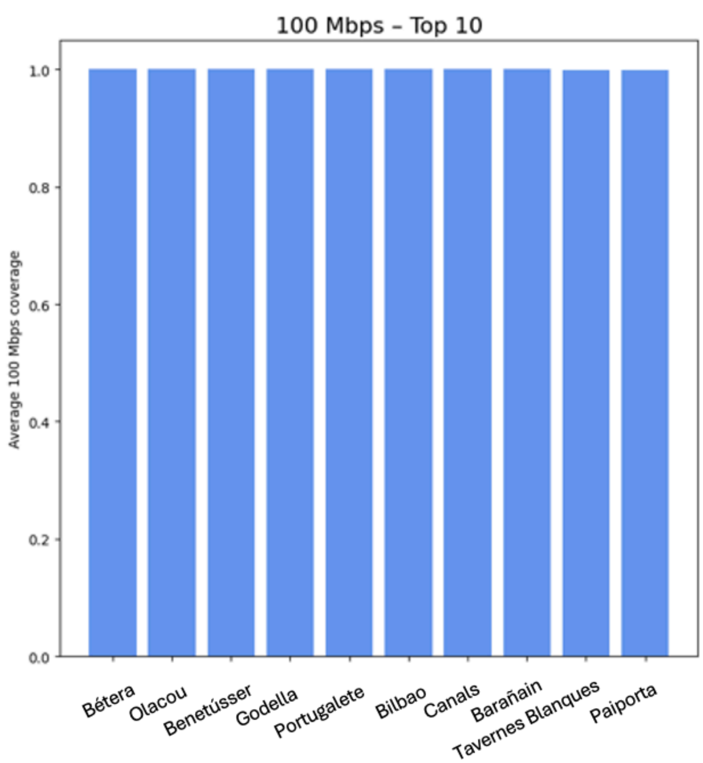
Finally, the municipalities with the lowest non-zero 5G coverage, Viana de Cega (Castilla y León), La Canonja (Tarragona), Condado de Treviño (Burgos), Torres de la Alameda (Madrid) and La Puebla de Cazalla (Sevilla), are likewise dispersed across the country and share the common feature of being small, non-coastal communities where deployment of the newest technologies has arrived later. The fact that these municipalities are in very different regions (Castilla y León, Madrid, Andalucía, Cataluña, País Vasco, etc.) suggests that low connectivity is not concentrated in a specific autonomous community but is instead associated with structural rural characteristics rather than regional policy differences.

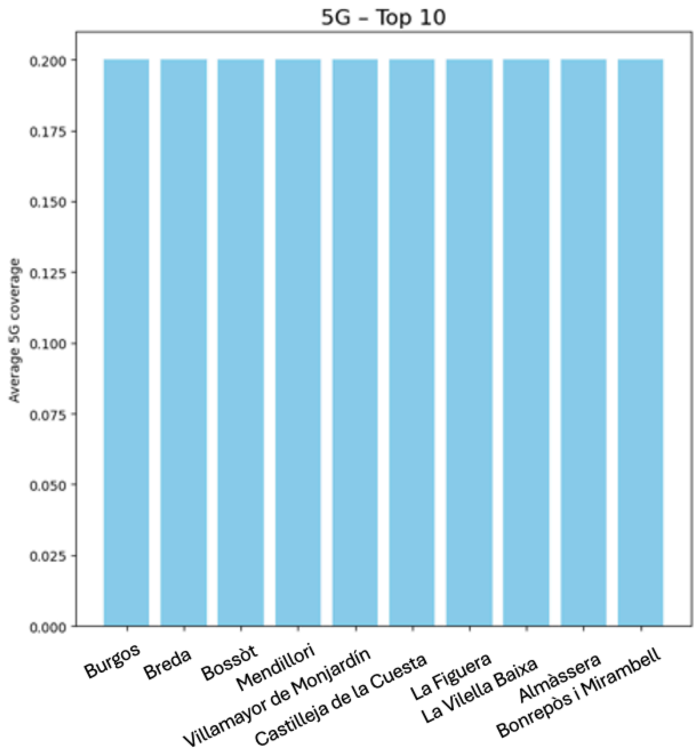
3.4.2. Top 10 best connected municipalities

On the contrary, here are the "Top 10 best connected municipalities" for each technology:

Figure 7 - Best connected municipalities







Source: elaborated by the author

For FTTH, the top municipalities include Madrid, Alcobendas (Madrid) and Barcelona, along with medium-sized urban centres such as Sant Boi de Llobregat and Sant Feliu de Llobregat, both in Barcelona. These cases fit a clear pattern: dense metropolitan areas with strong economic activity and early incentives for telecom operators to deploy fiber.

In contrast, the 100 Mbps top performers show a very different composition. Municipalities such as Bétera, Olacou, and Benetússer (all located in metropolitan areas of Comunidad Valenciana) and Portugalete (in Vizcaya metropolitan area) are not major cities but extremely dense urban municipalities where physical size is small and population concentration is high. This density reduces deployment costs, making these locations particularly attractive for operators to upgrade networks to high-speed broadband. The contrast with the FTTH list suggests that while fiber rollout follows large-city investment strategies, high-speed broadband based on mixed technologies may prioritise compact, high-density areas.

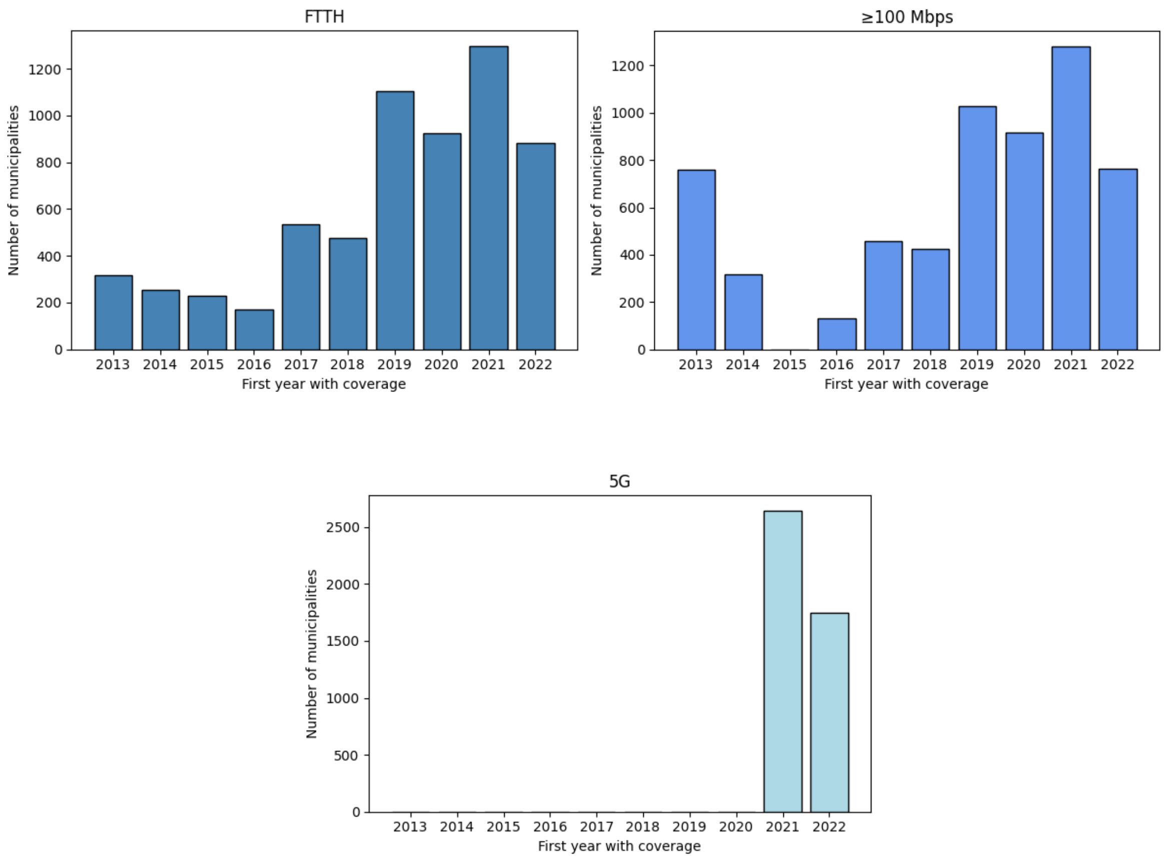
The 5G ranking has a third pattern. Municipalities such as Breda (Gerona), Bossòst (Lleida) and two municipalities in Navarra (Mendillori and Villamayor de Monjardín) are small, dispersed populated and geographically diverse, many located in mountainous areas close to borders or major transport corridors. Unlike FTTH or 100 Mbps, these are not urban areas. Their presence in the top group likely reflects strategic early-stage deployments driven by technical testing, spectrum optimisation in low-congestion areas, or regional policy initiatives rather than market size. In other words, 5G does not (yet) follow the same economic logic as fiber, appearing instead as a patchwork of targeted rollouts in small but strategically relevant locations.

Together, these patterns highlight that "top connectivity" does not mean the same thing across technologies. FTTH leaders are major economic centres; 100 Mbps leaders are tiny but very dense municipalities; and 5G leaders are small rural or semi-rural areas often located in the north of Spain. This heterogeneity reinforces the idea that each technology follows a distinct spatial logic, commercial, demographic, or strategic, and that Spain's digital landscape cannot be understood without considering these differences.

3.4.3. Timing of first coverage

The final component of this chapter considers when each municipality received connectivity for the first time. The year of first coverage charts show the rollout dynamics for the three technologies.

Figure 8 - First year coverage



Source: elaborated by the author

Deployment for FTTH begins around 2013–2014 with a small number of municipalities, accelerates sharply after 2018, and peaks around 2020–2021, when more than 1,200 municipalities received FTTH for the first time. These peaks correspond to major nationwide expansion programs and private investment cycles.

100 Mbps rollout accelerates a little after than FTTH, with major waves in 2019–2021. This is consistent with technological upgrades that leveraged both fiber and improved VDSL or cable infrastructure.

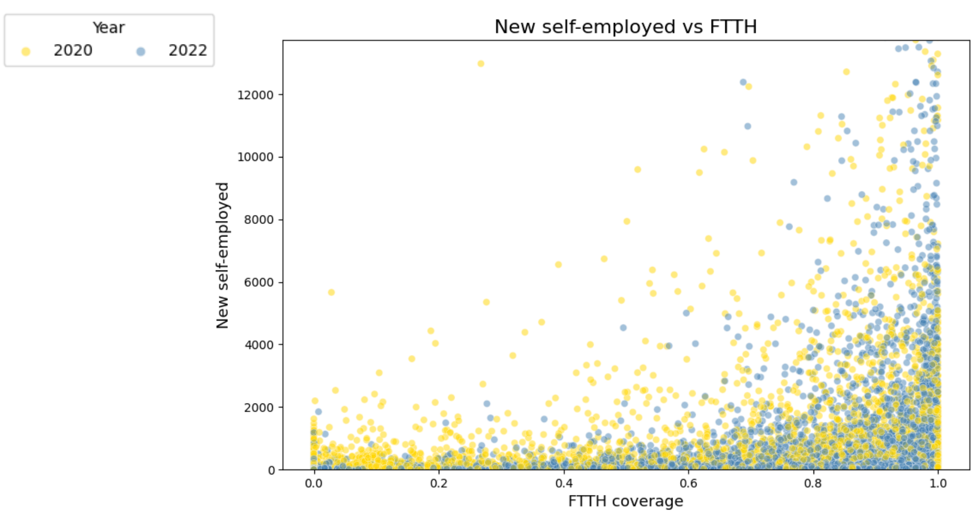
Finally, 5G adoption is compressed in time, nearly all municipalities that have any 5G coverage received it in 2021 or 2022, with a clear peak in 2021. This confirms the technology's extremely recent and rapid diffusion and explains why most municipalities show average values equal to zero.

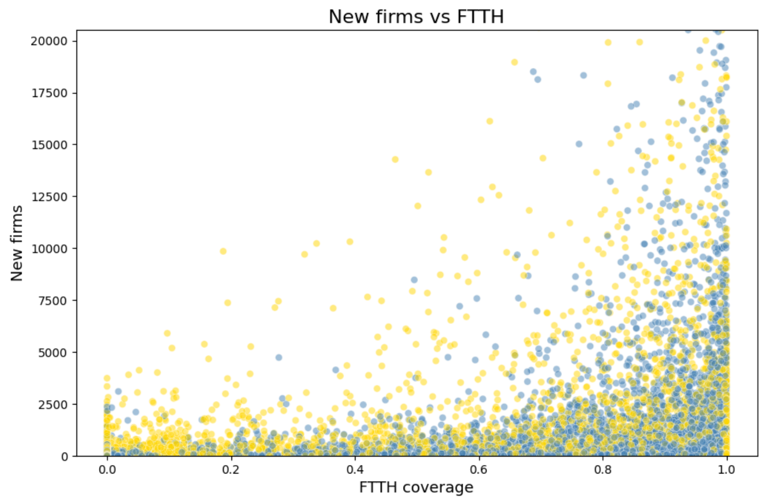
3.5. Connectivity and business activity: visual exploration

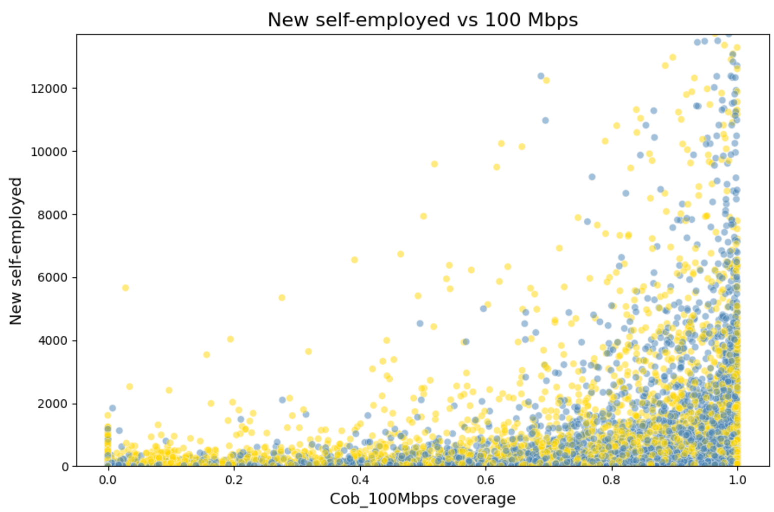
Moving on, it is crucial to visually examine how connectivity and business activity have co-evolved in the different Spanish municipalities. The following graphs will show key insights for our study and will help a lot on understanding if the empirical question is true or not.

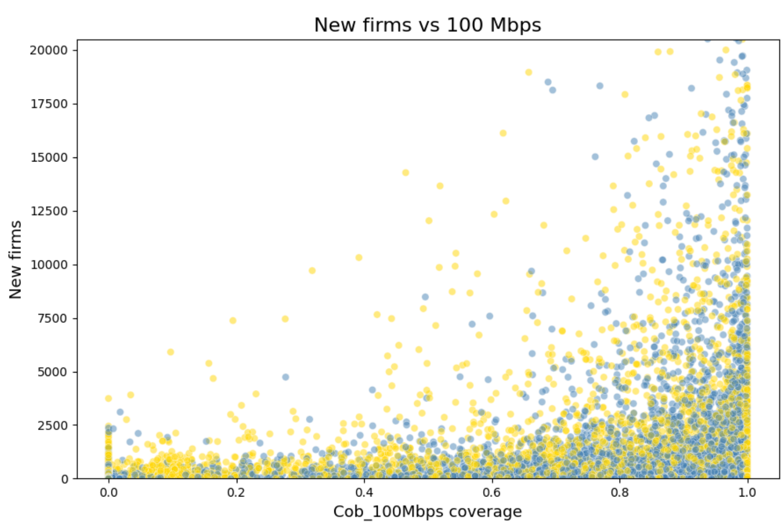
In these scatterplots, firm and self-employed rates are no longer used, instead they are transformed into absolute numbers computed with the municipal population. This change makes the cloud of points easier to interpret visually. Also, the time coverage is slightly different by technology, for FTTH and Cob_100Mbps 2020 and 2022 are compared, and for 5G 2021 and 2022, because its deployment started later.

Figure 9 - Connectivity exploration









Source: elaborated by the author

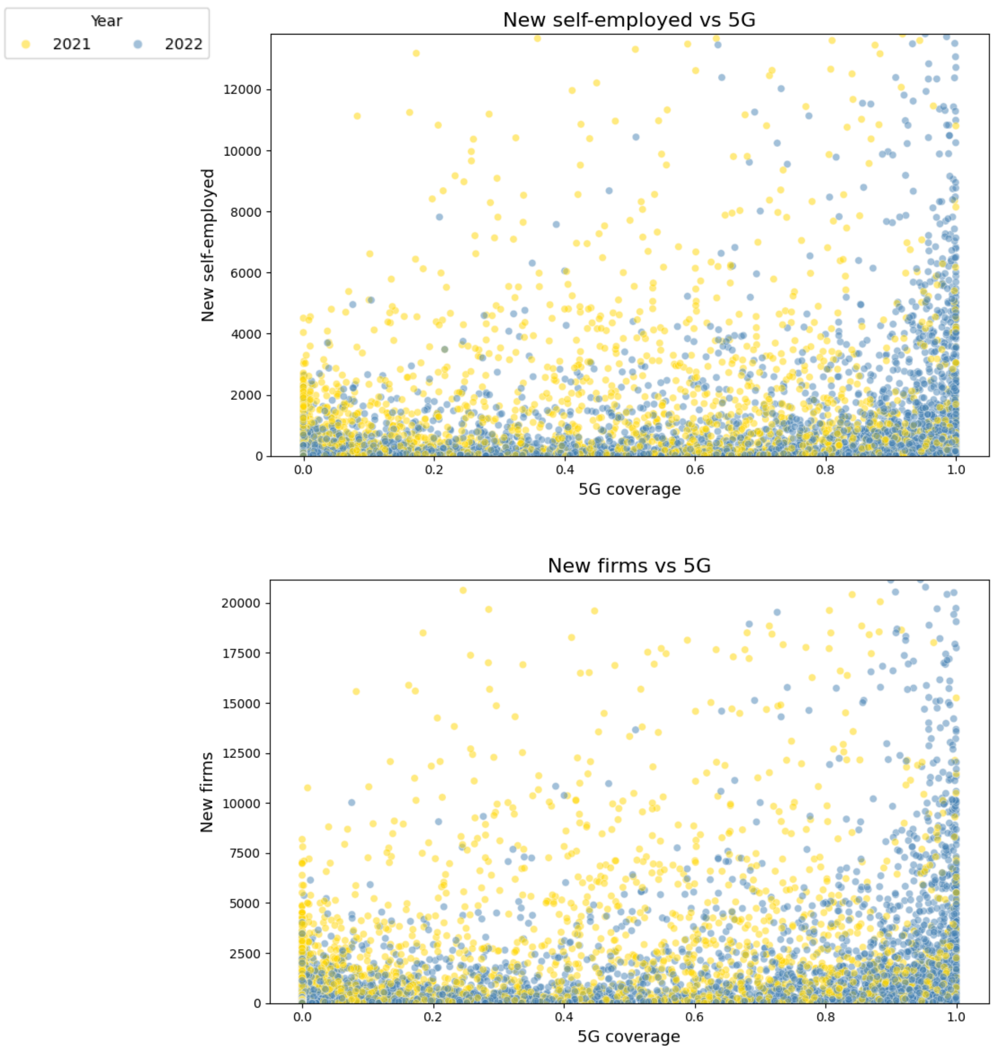
The four panels combining FTTH / Cob_100Mbps with new self-employed and new firms show a very similar pattern. On the horizontal axis, many municipalities are concentrated at very high coverage levels (close to 1) in 2022, while in 2020 the dispersion is wider, especially for Cob_100Mbps. On the vertical axis, most municipalities register relatively few new firms or self-employed, with a small group of outliers reaching several thousand registrations. **Visually as coverage increases, the maximum observed number of new firms/freelancers also increases.** Which means that when connectivity rises, so does the economic activity.

For FTTH vs new firms, the upper-right corner becomes much more populated in 2022 than in 2020. Municipalities with almost full FTTH coverage are precisely those where we observe the highest counts of new companies. At low levels of FTTH coverage there is business creation, but the vertical spread is clearly more limited. The pattern is similar for new self-employed vs FTTH. The most extreme values in terms of entrepreneurial activity appear in municipalities that are already close to 100% fiber coverage. This visual association is consistent with the idea that very high-speed fixed networks can make locations more attractive for new establishments and entrepreneurship, as found earlier for France or Quebec in the empirical literature.

The Cob_100Mbps panels reinforce this message. In 2020, municipalities are spread along the whole coverage range, and high numbers of new firms/freelancers are already concentrated to the right of the graph. By 2022, most observations collapse near full coverage, and it is again in this area where we observe the thickest tail of municipalities with many new firms or self-employed. In other words, municipalities that had already achieved very high coverage in 2020 and maintain it in 2022 are exactly those where business dynamism is strongest. This matches the narrative that modern broadband is a general-purpose infrastructure that supports local growth and entrepreneurship, especially in service activities.

At the same time, the scatterplots also show substantial heterogeneity: there are many municipalities with almost universal FTTH or Cob_100 coverage but only modest numbers of new firms or freelancers, and a few medium-coverage municipalities with relatively high entrepreneurial activity. From a descriptive point of view this suggests that good connectivity is a facilitating condition rather than a sufficient one. Factors such as human capital, sectoral structure or proximity to metropolitan areas, highlighted in the literature on broadband and local development, are likely to interact with digital infrastructure.

Figure 10 - 5G exploration



Source: elaborated by the author

The two 5G scatterplots (2021 vs 2022) look different, reflecting the much earlier stage of the 5G rollout. A large share of observations is still clustered near zero coverage, especially in 2021, and only some municipalities reach medium or high 5G coverage by 2022. This makes the cloud more compressed horizontally than in the FTTH and Cob_100 graphs.

Despite this, a similar qualitative pattern emerges. Higher 5G coverage tends to be associated with a wider range, and a higher ceiling of new firms and new self-employed. The municipalities located in the far right of the 5G axis (coverage close to 1) are also the ones with the largest absolute numbers of business creations. In 2022 the right tail of the distribution is slightly thicker than in 2021, in line with the idea that the expansion of 5G has taken place first in dynamic urban and metropolitan municipalities.

However, because 5G is still very recent, the descriptive evidence is weaker than for FTTH or Cob_100Mbps. The high concentration of points at very low coverage levels, together with the strong size effect (major cities adopting 5G first), means that the scatterplots cannot yet separate clearly whether 5G coverage is driving business creation or simply following it. This justifies treating the 5G results with more caution.

Overall, these six scatterplots provide first, purely visual evidence that municipalities with better fixed and mobile broadband coverage tend to be the ones where more new firms and self-employed workers appear. The relationship is clearest for FTTH and Cob_100Mbps, and more tentative for 5G due to the shorter time.

At the same time, the wide vertical dispersion at high coverage levels reminds us that connectivity is not the only driver of local entrepreneurship. The descriptive analysis therefore points to a new version of the main empirical question of the TFG:

Broadband and 5G deployment seem to create a favourable environment for firm and self-employed creation, but their impact is mediated by other characteristics such as size, sectoral structure and human capital.

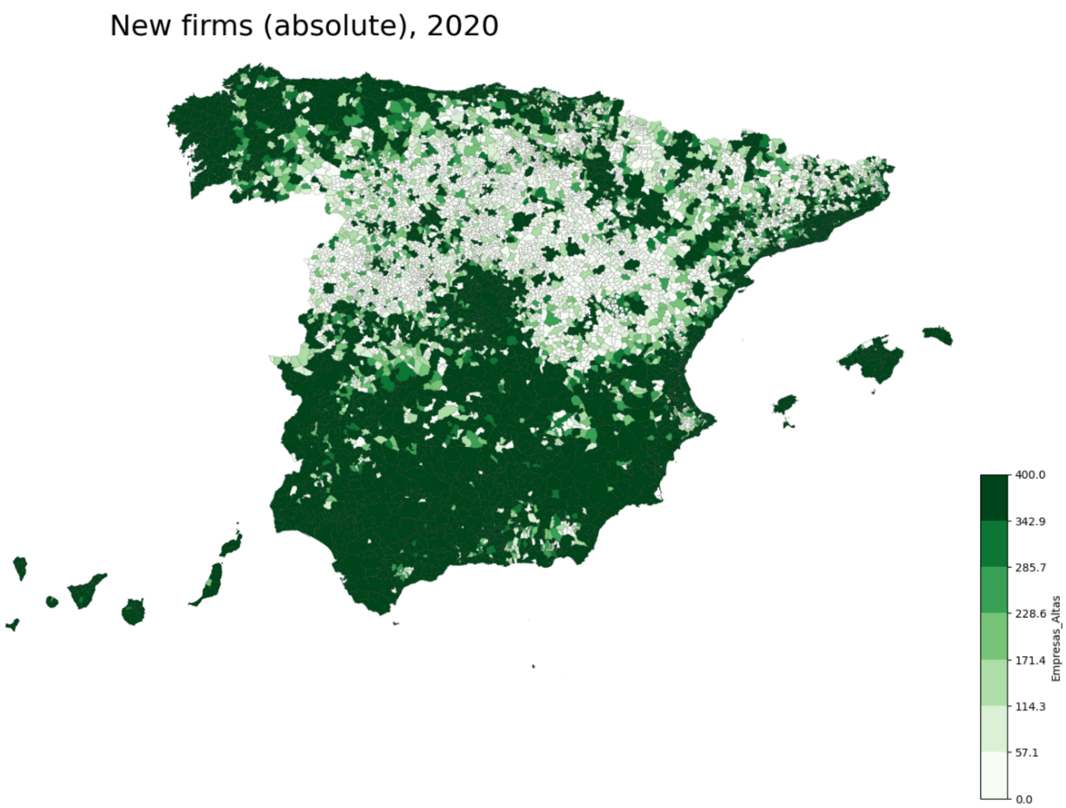
3.6. Visual spatial overview

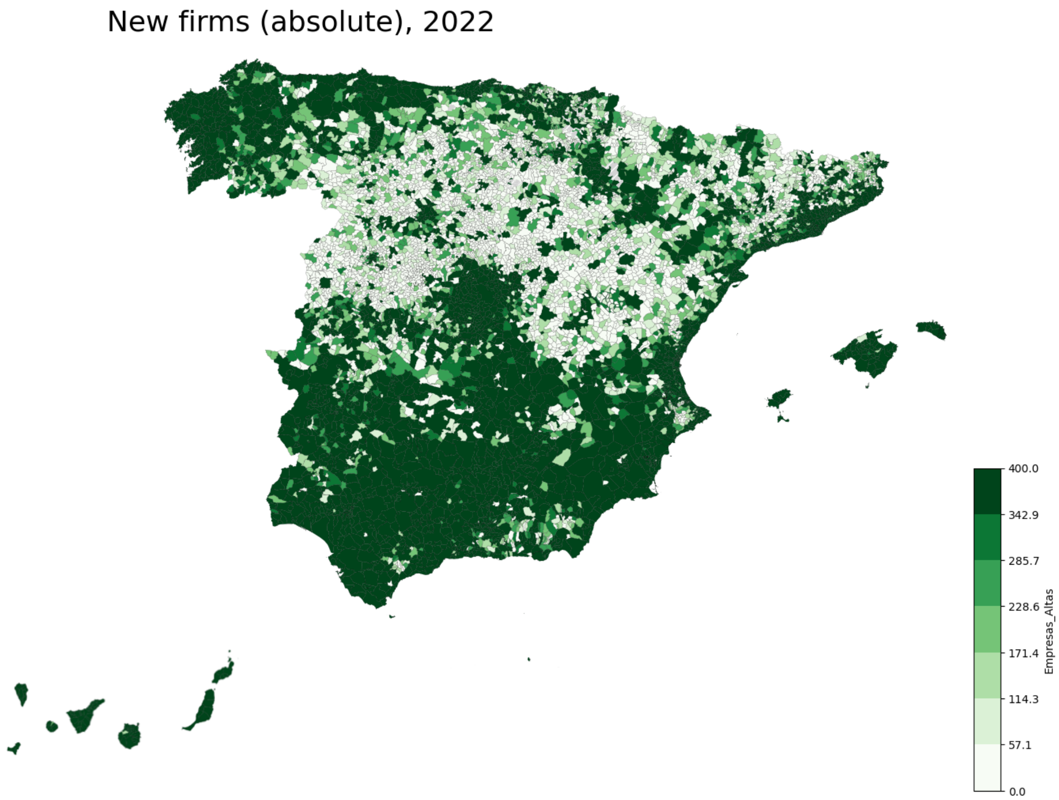
It is also very useful to visualise how business activity and connectivity are spatially distributed across Spanish municipalities. To do this, here are 10 maps showing the five different variables.

3.6.1. Spatial patterns of business activity

To keep the visual message clear, absolute numbers of new firms and new self-employed are used instead of rates. This is because when using rates per 100 inhabitants, very small municipalities appeared with extremely high values, and the maps became almost impossible to read. With absolute figures the maps reflect more realistically where business activity is concentrated.

Figure 11 - New firms: 2020 vs. 2022





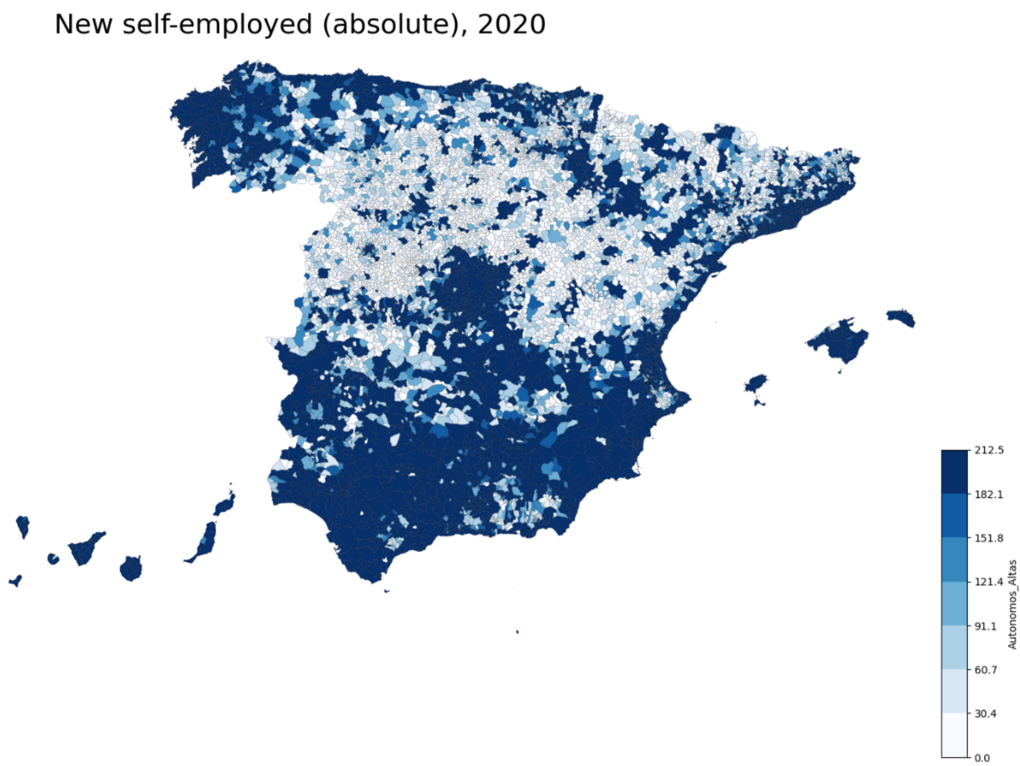
Source: elaborated by the author

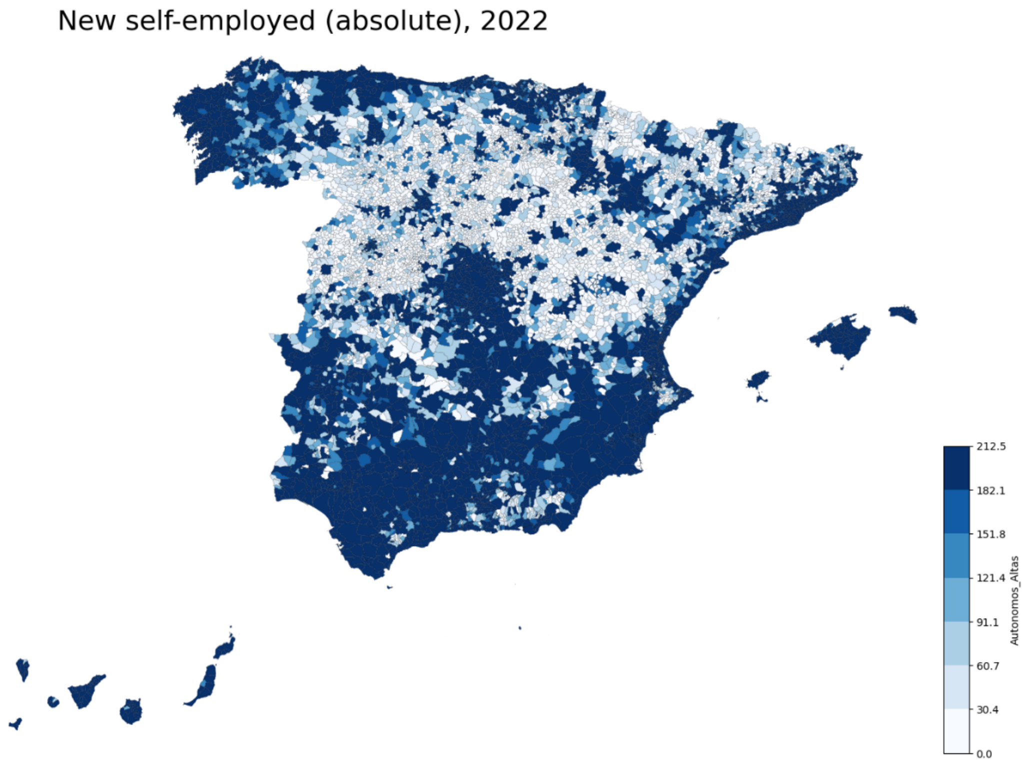
The first pair of maps displays the number of new firms by municipality in 2020 and 2022. In both years there is a very clear coastal and metropolitan pattern. Darker municipalities are mainly located along the Mediterranean arc (Cataluña, Valencia, Murcia and the Andalucia), around the main metropolitan areas such as Madrid and Barcelona, in the Basque Country and the north-west coast (Asturias and Galicia), and in the Balearic and Canary Islands, where tourism and services are very important.

By contrast, a large part of the inland northern area and some inland provinces of Aragón and Castilla–La Mancha appear in much lighter tones, indicating few firm entries. This spatial division between dynamic coastal/urban areas and the more stagnant interior is very similar to what other authors find for population and employment growth in Spain.

Comparing 2020 and 2022, the overall pattern is remarkably stable, which suggests strong path dependence, the municipalities that were already business hubs during the pandemic in 2020 are the ones where most new firms continue to appear afterwards. At the same time, the 2022 map looks slightly "darker" in many of these areas, which is consistent with a moderate recovery in firm creation after the COVID-19 shock.

Figure 12 - New self-employed: 2020 vs. 2022





Source: elaborated by the author

The maps for new self-employed workers show a similar, but not identical, structure. High values again concentrate along the Mediterranean coast, Madrid and the main urban regions, but the pattern is more dispersed than for firms. There are quite a few municipalities in southern and western Spain (for example parts of Andalusia and Extremadura) that appear in mid- to high-intensity classes for freelancers while having fewer firm entries. This fits with the idea that self-employment is relatively more important in rural and semi-rural economies, often linked to agriculture, small trade and local services.

As with firms, the comparison between 2020 and 2022 suggests continuity. The ranking of territories barely changes, but in 2022 more municipalities move into intermediate classes of new self-employed. This hints at a recovery of individual entrepreneurship in the territories that were already relatively dynamic before.

Taken together, these four maps show that business creation in Spain is highly spatially concentrated. New firms and new self-employed are not randomly spread across the territory but clustered in urban areas, coastal regions and areas with better accessibility, while many small inland municipalities barely register any entries. This is exactly the type of geography one would expect from the literature on firm location, agglomeration and accessibility, where firms tend to choose locations with good market access, infrastructure and local demand.

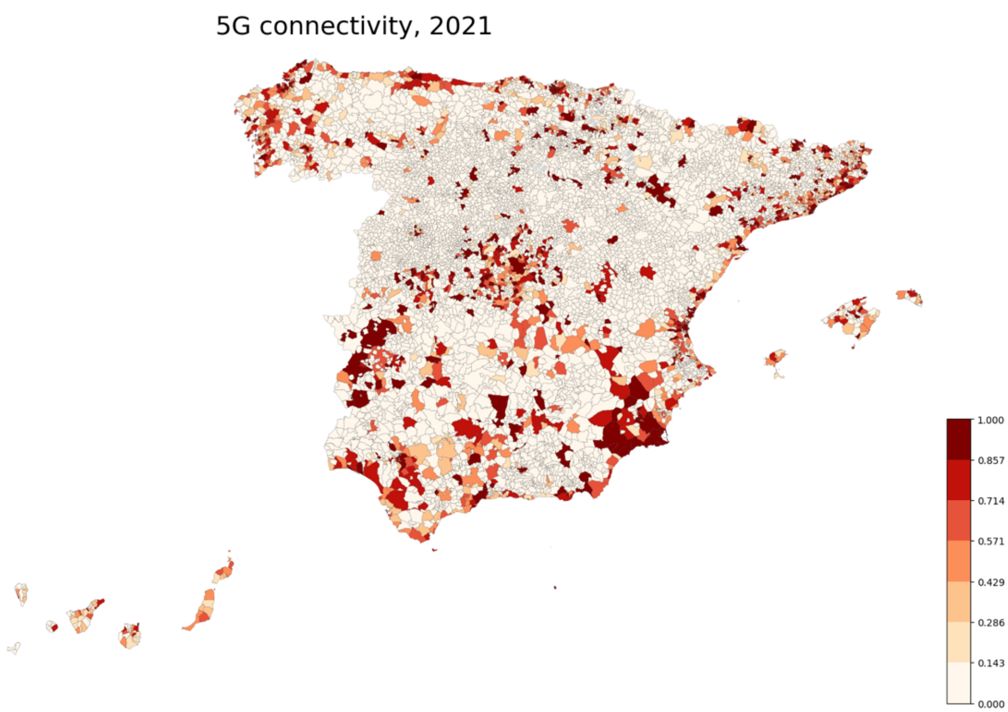
In previous sections I have already shown that high-speed broadband (FTTH, 100 Mbps and 5G) is also very unevenly distributed, with an early and almost complete rollout in many of these same urban and coastal areas, and slower progress in the populated interior. The spatial maps of business activity therefore visually anticipate a key idea of the TFG:

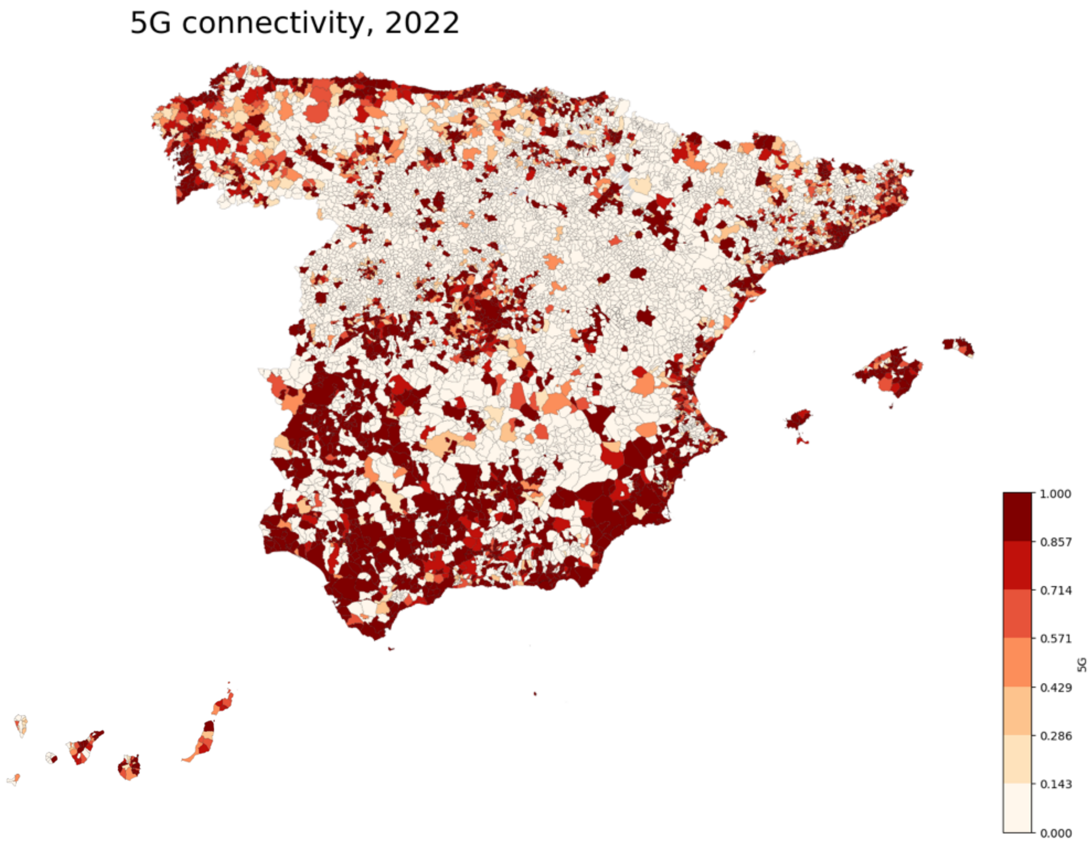
Municipalities that are better connected, in both physical and digital terms, are also the ones where more new firms and freelancers appear.

Of course, these maps are descriptive and cannot prove causality on their own. But they are a useful starting point: they reveal the geography of entrepreneurship in Spain and show how it overlaps with the geography of modern broadband, which we will see next.

3.6.2. Spatial patterns of connectivity

Figure 13 - 5G connectivity: 2021 vs. 2022





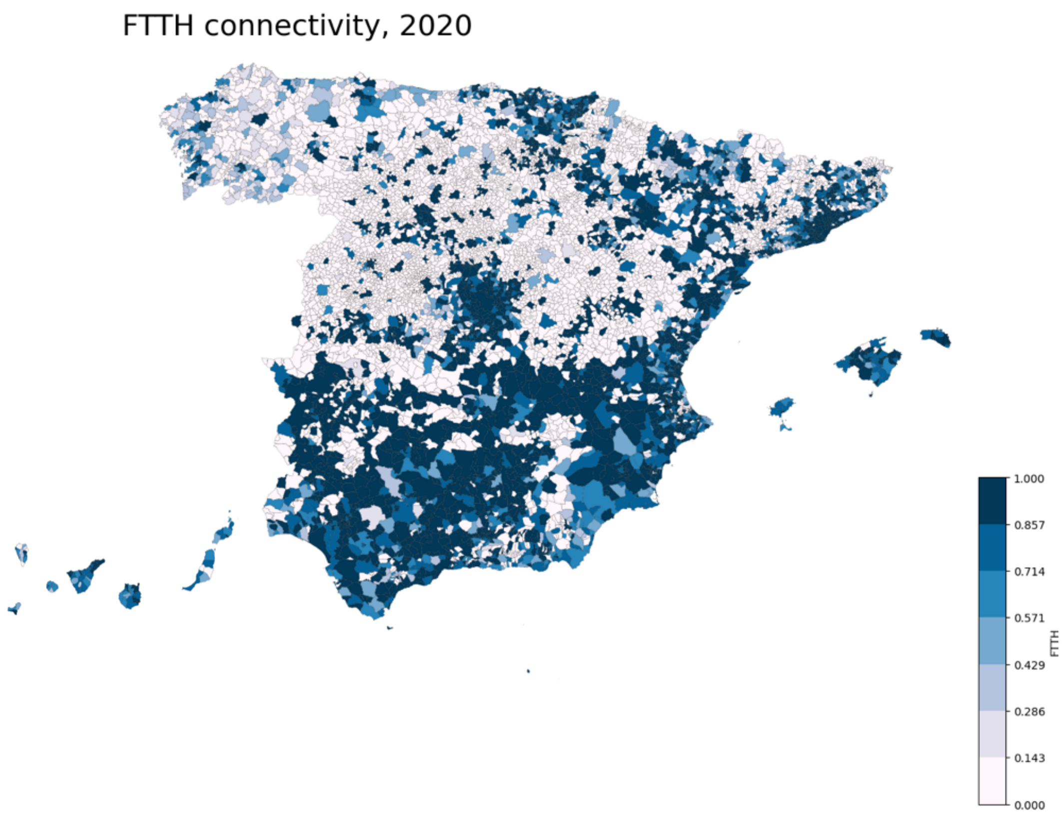
Source: elaborated by the author

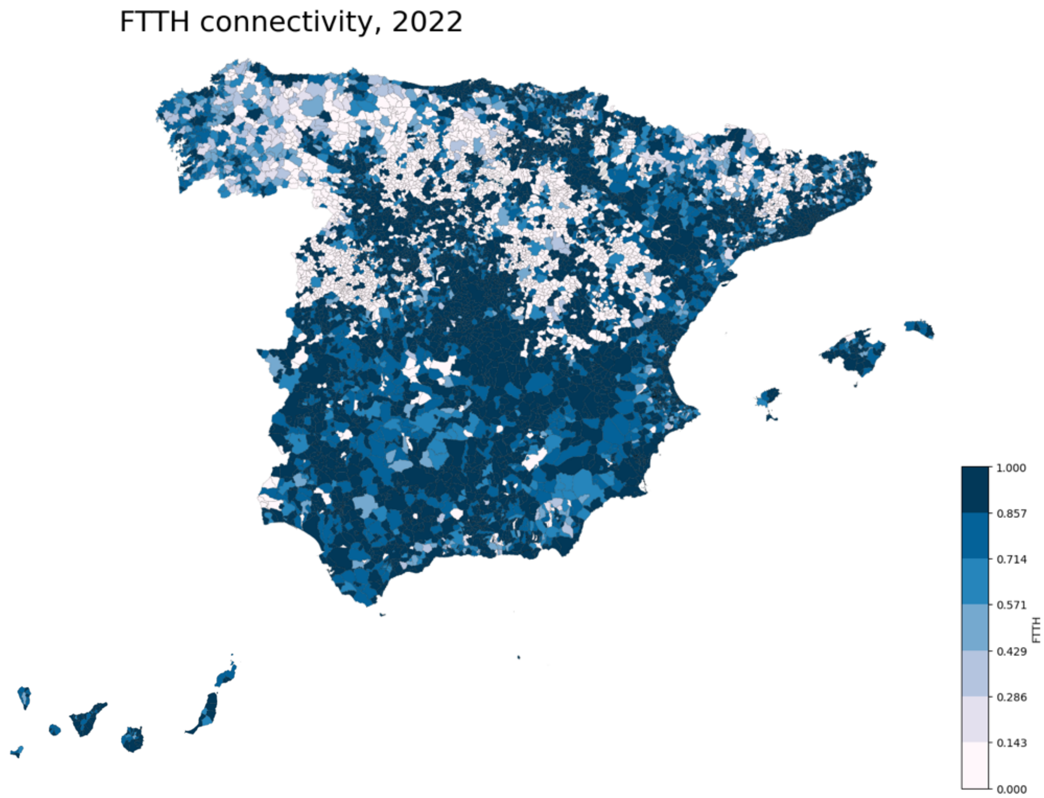
This pair of maps illustrate the early expansion of 5G across Spain. In 2021, coverage is highly uneven and clearly urban-biased. Most municipalities remain unconnected, while the darker areas concentrate around large metropolitan regions, particularly in Madrid, the Mediterranean corridor, the Guadalquivir area around Sevilla, and a few isolated urban nodes. Much of the northern interior, Aragón, and rural Galicia remain almost entirely really light, showing no deployment at this stage.

By 2022, the spatial picture changes noticeably. The darker shades spread outward from major cities into their surrounding municipalities, forming more continuous corridors along the southern coast, the eastern Mediterranean, and the Ebro axis. However, large inland rural areas, especially Castilla y León, parts of Aragón and Extremadura, still show very limited coverage. This confirms that 5G follows a clear "urban-first" rollout pattern, consistent with operators prioritising high-density areas where demand and returns are greater.

The comparison between 2021 and 2022 shows a rapid but still incomplete maturation of the technology.

Figure 14 - FTTH connectivity: 2020 vs. 2022





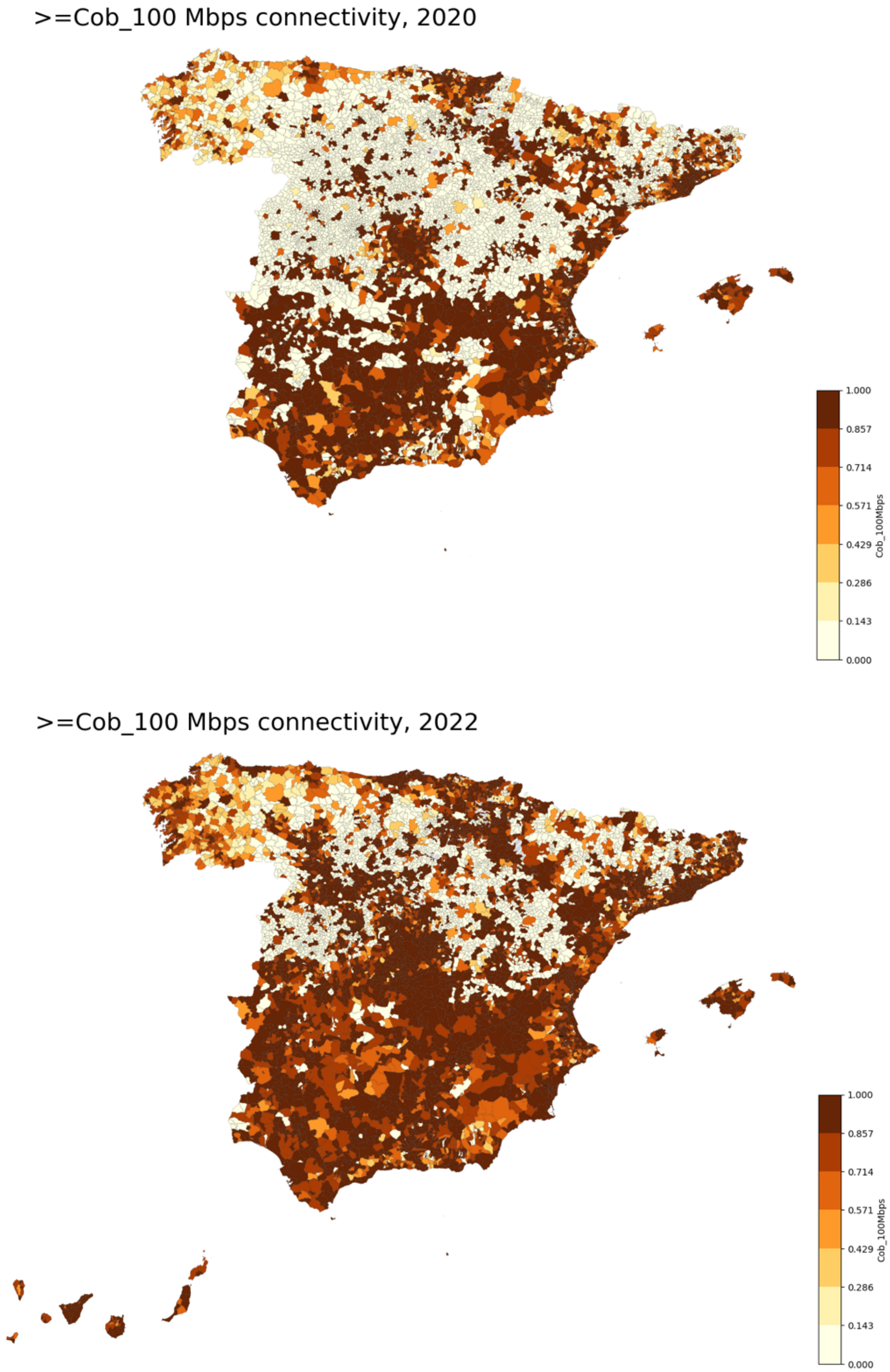
Source: elaborated by the author

The FTTH maps present a very different situation, reflective of a far more consolidated technology. Already in 2020, much of southern Spain, the Mediterranean coast, and major metropolitan areas (Madrid and Barcelona) display very high coverage levels, indicated by the darker tones. The extensive presence of fiber at this stage illustrates the cumulative effect of strong investment across the previous decade.

By 2022, FTTH has expanded even further. Regions that appeared in mid-tones in 2020, such as parts of Castilla-La Mancha, Aragón, Galicia or Andalucia, now show near-complete coverage. Only small parts in sparsely populated or mountainous areas remain lighter. In general, the FTTH map for 2022 reflects a near-universal fixed broadband infrastructure, with much smaller territorial disparities than other technologies.

The remaining differences tend to appear in rural or low-density areas, where the literature suggests broadband may have the strongest marginal effects on productivity and entrepreneurship.

Figure 15 - High-speed broadband (>= 100 Mbps) connectivity: 2020 vs. 2022



Source: elaborated by the author

The maps for Cob_100 Mbps represent an intermediate case between 5G and FTTH. In 2020, high-speed fixed broadband already covers large parts of Spain, particularly Andalucia, the Mediterranean coastline, and many provincial capitals. Some northern interior regions also display strong coverage, although gaps remain in rural areas.

By 2022, these gaps shrink considerably. Coverage expands through Castilla-La Mancha, Aragón and especially Galicia, creating a much more continuous map of high-speed access. Compared to 5G, the spatial expansion of 100 Mbps broadband is less dependent on urban density and more consistent with a gradual rural extension, likely facilitated by FTTH rollout. Indeed, by 2022 the Cob_100 Mbps pattern almost mirrors the FTTH map, which makes sense given that fiber is the main infrastructure enabling these speeds.

This suggests that 100 Mbps broadband is transitioning toward consolidation, though still retaining slightly more spatial differentiation than FTTH.

Together, these maps reveal a layered digital geography in Spain. All technologies begin in major cities and coastal areas, but their diffusion paths diverge: FTTH and high-speed broadband achieve widespread rural penetration relatively quickly, whereas 5G remains more selective and spatially concentrated.

This spatial reading is essential for the empirical part of the thesis. Technologies with broad territorial variation provide a stronger basis to study associations with firm creation and self-employment.

3.6.3. Integrated spatial insight: business activity and digital connectivity

Taken together, the ten maps provide a coherent visual narrative that brings the central question of this thesis into focus: ***do digitally connected municipalities experience stronger entrepreneurial dynamics?*** Although descriptive evidence cannot establish causality, the spatial patterns observed across Spain strongly suggest a meaningful and systematic association.

On one side of the analysis, the maps of new firms and new self-employed show a highly concentrated geography of economic dynamism. The darkest areas consistently appear along major metropolitan regions such as Madrid and Barcelona and coastal areas. In contrast, much of the northern and central interior shows structurally lower levels of business creation. This division aligns with well-documented territorial inequalities in population density, labour markets, accessibility, and economic structure.

On the other side, the maps of digital connectivity reveal a strikingly similar geography. The same coastal arcs, metropolitan belts, and urban corridors that lead business activity are also precisely where digital infrastructures are most extensive and advanced. FTTH and high-speed broadband display an almost continuous presence in these areas by 2022, while 5G also emerges in these same hubs before gradually expanding outward.

The overlap is not incidental. Instead, it suggests a strong spatial alignment between entrepreneurial concentration and digital infrastructure availability. While part of this alignment reflects underlying factors such as population density and agglomeration economies, the maps visually indicate that connectivity is consistently present wherever business creation is strongest, and that digital access improves over time in many of the areas where entrepreneurial activity is growing.

Three observations stand out:

1. The geography of FTTH and Cob_100 Mbps in 2022 closely mirrors the geography of firm and self-employed creation, indicating that high-speed fixed networks have become deeply embedded in Spain's economic centres.

2. 5G deployment, although less widespread, appears first in precisely the municipalities with the highest entrepreneurial potential, reinforcing the idea that cutting-edge connectivity expands where demand and innovation capacity are highest.

3. Areas with limited business activity almost always coincide with lower levels of digital adoption, especially in rural and sparsely populated regions of the northern interior and parts of Aragón, Extremadura, and Galicia.

In other words, the spatial patterns reveal a dual dynamic: digital infrastructure tends to follow economic density, but it may also enable the competitiveness of the municipalities that adopt it early. The descriptive evidence therefore supports the intuition behind the thesis:

Digital connectivity does not act in isolation, but it seems to form part of the broader ecosystem that enables entrepreneurship, firm entry, and local economic dynamism.

This integrated spatial perspective provides the foundation for the econometric analysis that follows. While maps cannot answer at a 100% the questions, they offer a powerful visual demonstration of where business activity emerges and how it correlates with the geography of broadband deployment. The next stage of the thesis will test whether improvements in connectivity, especially FTTH and high-speed broadband, have a measurable impact on firm creation and self-employment once population, economic structure, and other local characteristics are controlled for.

4. Empirical strategy and econometric approach

After the descriptive and spatial analysis, this section aims to formally assess the relationship between digital connectivity and entrepreneurial activity at municipal level. While maps and descriptive statistics provide valuable insights into spatial patterns, they do not allow for isolating the effect of connectivity from other structural municipal characteristics.

To address this limitation, the empirical analysis relies on panel data econometric techniques. This model is particularly appropriate in this context for two reasons: first, connectivity deployment does not occur randomly across space, municipalities differ in size, income, demographic composition and productive structure, and second, entrepreneurial activity is also strongly shaped by persistent local characteristics.

By using panel data with fixed effects, the empirical strategy focuses on how changes in connectivity within a municipality over time are associated with changes in firm and self-employment dynamics in that same municipality.

4.1. Model specification and variables

The baseline econometric specification is defined as follows:

$$Y_{it} = \beta \ x \ Connectivity_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

In the estimated models, a vector of time-varying controls X_{it} is also included and *i* denotes the municipality and *t* the year.

Dependent variable:

The dependent variable, Y_{it}, measures the number of newly created firms or self-employment in municipality *i* during year *t*. Firm creation is selected as the main outcome variable as it constitutes a direct indicator of local economic dynamism and territorial attractiveness for economic activity. New firm registrations reflect both entrepreneurial decisions and firms' location choices, making this variable particularly relevant for evaluating the potential economic impact of improved digital connectivity.

Key explanatory variable:

The main explanatory variable, $Connectivity_{it}$, captures the level of high-speed internet availability in municipality *i* during year *t*. In the baseline specification, this variable is represented by fixed high-speed broadband infrastructure (fiber), given its central role in enabling advanced digital services for firms and its relatively stable deployment process over time.

Fixed effects:

The term μ_i, represents municipality fixed effects, which control for time-invariant characteristics specific to each municipality. These include structural factors such as geographical location, historical economic structure, long-term demographic patterns, or persistent institutional characteristics. By including municipality fixed effects, the model effectively compares changes within the same municipality over time, rather than differences across municipalities.

The term λ_t, corresponds to year fixed effects, which account for common shocks affecting all municipalities in a given year. These include macroeconomic conditions, nationwide policy changes, business cycle fluctuations, or extraordinary events such as the COVID-19 pandemic. The inclusion of year fixed effects ensures that the estimated relationship between connectivity and firm creation is not driven by aggregate temporal trends.

The model also includes a vector of time-varying controls $\boldsymbol{X_{it}}$, including average gross household income, total population and the share of population aged 65 or above. These variables account for local economic conditions, market size and demographic structure, which may simultaneously influence connectivity deployment and entrepreneurial activity.

Error term:

ε_{it}, is the idiosyncratic error term, capturing unobserved factors that vary across municipalities and over time and are not explicitly included in the model.

Interpretation of the coefficient:

The coefficient $\boldsymbol{\beta}$ measures the association between changes in digital connectivity and firm creation within municipalities over time. A positive and statistically significant estimate of β would indicate that increases in high-speed internet availability within a municipality are associated with higher levels of new firm creation, after controlling for both time-invariant municipal characteristics and common yearly shocks.

4.2. Interpretation by connectivity type

4.2.1. FTTH results

The FTTH results reveal a statistically significant positive association across all four dependent variables: firm entries, firm exits, self-employed entries and self-employed exits. This pattern is particularly relevant because it suggests that fiber deployment does not operate through a single channel, but it also affects the overall dynamics of local economic activity.

From the perspective of firm creation, the positive coefficient (+0.031 and statistically significant (p=0.002) indicates that municipalities experiencing increases in FTTH coverage tend to register higher levels of new firm formation, after controlling for fixed municipal characteristics and years. This result is aligned with the hypothesis that high-speed fixed broadband facilitates access to digital markets and enables remote or platform-based business models. Fiber infrastructure may therefore enhance territorial attractiveness for entrepreneurial initiatives, especially in municipalities where digital connectivity was previously limited.

Moreover, the relationship between firm exits and FTTH shows a coefficient of –0.002, which is not statistically significant (p=0.802). Because it is a negative result, this can be seen as a decrease of firm exits, which means a greater firm survival.

With respect to self-employed dynamics, the results do not show statistically significant effects of FTTH on either entries (coefficient: -0.003; p=0.766) or exits (coefficient: -0.016; p=0.153). Although the estimated coefficients are negative, they are not statistically different from zero, which implies that association cannot be established between fiber deployment and self-employment dynamics within municipalities over time. This suggests that, unlike incorporated firms, self-employed activity may be less sensitive to improvements in fixed broadband infrastructure during the analysed period. One possible explanation is that many self-employed activities rely less on high-capacity digital infrastructure. Therefore, while FTTH appears to stimulate firm creation at corporate level, its impact on individual entrepreneurial activity remains limited in the short term. This distinction between firms and self-employed workers highlights the heterogeneous nature of digital infrastructure effects across different forms of economic organisation.

Figure 16 - FTTH panel regresion summary table

	FTTH			
	Coefficient	**Std. Err.**	**t**	**P-value**
Firm creation	0.031	0.010	3.172	0.002
Firm exits	(0.002)	0.010	(0.251)	0.802
Self-employment creation	(0.003)	0.010	(0.298)	0.766
Self-employment exits	(0.016)	0.011	(1.43)	0.153

Source: elaborated by the author

4.2.2. 5G results

The 5G results reveal a different pattern across the four dependent variables, suggesting that the economic effects of mobile connectivity are not the same across types of entrepreneurial activity.

Starting with firm creation, the estimated coefficient is positive (+0.046) and statistically significant (p=0.002). This indicates that municipalities which increase in 5G coverage tend to register higher levels of new firm formation. The magnitude of the coefficient is economically meaningful, suggesting that mobile high-speed connectivity may facilitate certain types of business activity that rely on flexibility, mobility and digital integration. 5G may enable new service-based or technology-driven firms that depend on real-time data transmission and digital platforms.

Moreover, the relationship between firm exits and 5G is negative and statistically significant (coefficient: -0.051; p=0.001). This result suggests that improvements in 5G coverage are associated with lower levels of firm closure. This result means an effect of advanced mobile infrastructure. Access to high-capacity mobile networks may enhance firms' adaptability, improve operational efficiency and allow businesses to integrate digital tools more effectively, thereby strengthening survival probabilities.

Now, with self-employed dynamics, the results are more heterogeneous. The coefficient for self-employed entries is positive (+0.013) but not statistically significant (p=0.376), indicating that no association can be established between 5G deployment and the creation of new self-employed activities. However, the relationship with self-employed exits is negative and highly significant (–0.071 and $p < 0.01$), suggesting that increased 5G coverage is associated with a reduction in self-employment closures. This might indicate that mobile digital infrastructure plays a particularly relevant role in sustaining existing small-scale activities, possibly by expanding customer reach or facilitating remote service provision.

Overall, the 5G results show that while 5G deployment seem to stimulate firm creation and reduce firm deaths, its impact on new self-employment formation is limited. The significant reduction in exits, both for firms and self-employed workers, points toward a strengthening of economic resilience rather than simple market churn. Compared to FTTH, 5G seems to combine expansionary and stabilising effects, particularly in relation to business survival.

Figure 17 - 5G panel regression summary table

	5G			
	Coefficient	**Std. Err.**	**t**	**P-value**
Firm creation	0.046	0.015	3.080	0.002
Firm exits	(0.051)	0.016	(3.28)	0.001
Self-employment creation	0.013	0.015	0.886	0.376
Self-employment exits	(0.071)	0.015	(4.77)	0.000

Source: elaborated by the author

4.2.3. Cob_100Mbps results

From the perspective of firm creation, the positive but insignificant coefficient suggests that while there may be a directional association between improved broadband availability and new firm formation, the evidence is not strong enough to establish a reliable relationship.

The same absence of statistical significance is observed in the case of self-employed dynamics. Both entries and exits show positive coefficients, but the lack of statistical significance prevents drawing firm conclusions regarding the role of 100 Mbps coverage in shaping individual entrepreneurial activity.

Overall, these findings suggest that reaching the 100 Mbps broadband threshold, while potentially important from a technological standpoint, does not appear to generate measurable short-term effects on local entrepreneurial dynamics during the analysed period. Compared to FTTH and especially 5G, the estimated effects of Cob_100Mbps are weaker and less robust, indicating that not all forms of connectivity expansion translate into immediate economic responses at the municipal level.

Figure 18 - Cob_100Mbps panel regresion summary table

	Cob_100Mbps			
	Coefficient	Std. Err.	t	P-value
Firm creation	0.021	0.024	0.868	0.386
Firm exits	0.014	0.025	0.556	0.578
Self-employment creation	0.018	0.025	0.730	0.466
Self-employment exits	0.011	0.025	0.426	0.670

Source: elaborated by the author

4.3. Interpretation by connectivity type

When the three connectivity measures are analysed, a differentiated pattern emerges that helps clarify the economic implications of digital infrastructure deployment. The results suggest that the entrepreneurial effects of connectivity are not uniform across technologies, nor across forms of business organisations.

First, advanced connectivity technologies such as FTTH and 5G show clearer associations with firm creation than general broadband coverage at 100 Mbps. This distinction is important because it indicates that the quality and technological sophistication of infrastructure may matter more than simply meeting a minimum speed threshold. In other words, the economic impact of connectivity appears to depend not only on access, but on the capacity of that infrastructure to support more complex digital integration and business innovation.

Second, the effects are more consistent for incorporated firms than for self-employed activity. This suggests that digital infrastructure may be particularly relevant for businesses operating at a larger scale, or for those requiring more structured digital processes. Self-employment, which often includes smaller-scale or locally oriented activities, may be less sensitive to marginal improvements in high-speed connectivity in the short term.

Lastly, the absence of robust effects for Cob_100Mbps indicates that infrastructure expansion alone does not automatically translate into measurable entrepreneurial change. Complementary factors such as digital skills, sectoral composition, market size or local innovation capacity may mediate the relationship between connectivity and economic outcomes.

5. Final conclusions

Once analysed everything, and knowing this works ‘empirical question:

To what extent has the arrival of high-speed digital connectivity contributed to business creation in Spanish municipalities, and under what conditions can digital infrastructure act as a driver of local economic dynamism and territorial cohesion?

The results explored allows to extract some conclusions and insights.

First, the evidence confirms that digital connectivity is not neutral with respect to local entrepreneurial dynamics. Both the descriptive spatial analysis and the econometric estimations indicate a systematic association between improved connectivity and business activity. However, this relationship varies considerably depending on the type of technology and on the form of entrepreneurship considered.

FTTH deployment shows a positive and statistically significant association with firm creation, suggesting that fixed high-capacity broadband facilitates the emergence of incorporated firms. This finding is consistent with the literature reviewed earlier, which emphasises that fiber infrastructure reduces transaction costs, enhances digital integration and supports platform-based or knowledge-intensive activities. Nevertheless, the absence of robust effects on self-employment dynamics indicates that not all entrepreneurial forms respond equally to improvements in fixed connectivity.

The results for 5G reveal a different mechanism. While 5G is positively associated with firm creation and significantly reduces both firm and self-employed exits, its impact on new self-employment entries is limited. This suggests that advanced mobile connectivity may operate more strongly through resilience and business survival than through pure expansion. In other words, 5G seems to reinforce adaptability and continuity rather than simply stimulating new entry. Given its recent rollout, these results likely capture early-stage effects concentrated in more dynamic municipalities.

By contrast, coverage of at least 100 Mbps does not exhibit statistically robust effects on entrepreneurial dynamics. Although descriptively correlated with business activity, the econometric analysis suggests that reaching a general broadband threshold may not be sufficient to generate measurable short-term changes in firm entry or exit once municipal fixed effects and common yearly shocks are controlled for. This distinction highlights that the quality and technological nature of connectivity matter: not all improvements in digital speed translate into equivalent economic outcomes.

Taken together, the findings support the hypothesis that digital infrastructure acts as a conditional enabler rather than as an automatic engine of development. Connectivity appears to strengthen local entrepreneurial ecosystems where complementary conditions, such as population density, economic structure, and prior dynamism, are already present. The spatial analysis reinforces this interpretation, the municipalities with the highest business activity are also those where connectivity was deployed earlier and more intensively. Rather than reversing territorial disparities, digital expansion often overlaps with pre-existing economic hierarchies.

In response to the main research question, it can be concluded that:

- High-speed connectivity, particularly FTTH and 5G, is positively associated with firm dynamics at the municipal level.
- The effects are heterogeneous across technologies and across types of entrepreneurial activity.
- Digital infrastructure strengthens local economic dynamism primarily where structural conditions allow it.

Ultimately, digital infrastructure should be understood as a necessary but not sufficient condition for local development. While it creates the technological foundation for entrepreneurship and business survival, its transformative potential depends on broader regional ecosystems. Policies aimed at reducing territorial disparities must therefore combine infrastructure deployment with human capital development, innovation support, and institutional strengthening. Only through this integrated approach can connectivity become a true driver of long-term territorial cohesion rather than a reinforcement of existing economic concentration.

5.1. Limitations

This study presents some limitations that should be considered when interpreting the results. First, although the fixed-effects panel approach controls for time-invariant municipal characteristics and common yearly shocks, it does not eliminate completely endogeneity concerns. In particular, the deployment of FTTH and 5G may be more likely in municipalities that already had stronger economic potential or more favorable structural conditions. Therefore, the estimated coefficients should be interpreted as robust within-municipality associations rather than as definitive causal effects.

Second, connectivity is measured through coverage indicators, which capture infrastructure availability but not actual adoption, usage intensity, or the extent to which firms and self-employed workers effectively incorporate digital tools into their activity. As a result, the analysis may not fully reflect the mechanisms through which connectivity translates into entrepreneurial outcomes.

Last, the analysis of 5G is constrained by its recent rollout, since this technology is only observed in the final years of the sample. Consequently, the estimated effects for 5G should be interpreted with caution, as they are more likely to capture short-term or early-stage dynamics than longer-term structural transformations.

5.2. Future research

This thesis opens several relevant paths for further analysis. A first natural next step would be to examine more closely how the effects of connectivity evolve over time, especially as technologies such as 5G become more consolidated across Spanish municipalities. This would make it possible to observe whether the patterns identified here remain stable, intensify, or change as digital infrastructure matures.

A second interesting direction would be to explore the heterogeneity of these effects in greater depth. The results of this work already suggest that the relationship between connectivity and entrepreneurial dynamism is not uniform across territories or across types of business activity. Future work could therefore analyse whether these effects differ depending on factors such as sectoral composition, urban-rural characteristics, local human capital, or the pre-existing economic structure of municipalities.

Finally, another valuable next step would be to broaden the range of outcomes considered. Beyond firm creation and exits, digital connectivity may also influence business survival, productivity, innovation capacity, employment quality, or the ability of municipalities to retain economic activity over time. Exploring these additional dimensions would help develop a more complete understanding of the role of connectivity in local development and territorial cohesion.

5.3. Final Remarks

In conclusion, this thesis shows that the expansion of digital connectivity is economically meaningful, but not economically self-sufficient. The Spanish evidence indicates that advanced technologies such as FTTH and 5G can reinforce business creation and local dynamism, yet their benefits are not evenly present across space. Digital infrastructure, therefore, should not be understood as a universal solution to territorial disparities, but as a strategic asset whose transformative power depends on the capacity of each municipality to embed connectivity within a broader ecosystem of opportunity, resilience and growth.

6. Declaration on the use of AI

I, María Tadea Botas Etcheverría, student of Business Administration and Business Analytics at *Universidad Pontificia Comillas*, hereby declare, upon submitting my Final Degree Project entitled “The effects of high-speed connectivity on firm creation and self-employment in Spain”, that I have used ChatGPT or similar generative artificial intelligence tools only in the context of the activities listed below:

1. **Brainstorming research ideas**: used to explore and outline possible research approaches.
2. **References**: used on a preliminary basis to guide the bibliographic search, with all final sources later checked and validated independently.
3. **Methodological support**: used to better understand possible research methods applicable to the study.
4. **Template building**: used to propose structures for sections, tables, or parts of the dissertation.
5. **Language and style correction**: used to improve clarity, grammar, wording, and academic expression.
6. **Synthesiser and explainer of complex books**: to summarise and understand complex literature.
7. **Reviewing**: used to receive suggestions for improving the structure, coherence, and presentation of the dissertation.
8. **Translation**: used occasionally to translate or revise specific passages written in English, such as the abstract.

I declare that all the information and content presented in this dissertation are the result of my own research and individual effort, except where otherwise indicated and properly acknowledged. I have included the appropriate references in the dissertation and have explicitly stated the purposes for which ChatGPT or similar tools were used. I am aware of the academic and ethical implications of submitting non-original work and accept the consequences of any breach of this declaration.

Date: 18-03-2026

Signature: 

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8. Appendix

9. FTTH – Firm entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0315
Estimator:                   PanelOLS   R-squared (Between):             -0.6039
No. Observations:                8119   R-squared (Within):               0.0315
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.6474
Time:                        09:38:22   Log-likelihood                    1105.2
Cov. Estimator:             Clustered
                                        F-statistic:                      22.057
Entities:                        4726   P-value                           0.0000
Avg Obs:                       1.7179   Distribution:                  F(5,3388)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             22.054
                                        P-value                           0.0000
Time periods:                       2   Distribution:                  F(5,3388)
Avg Obs:                       4059.5
Min Obs:                       3546.0
Max Obs:                       4573.0

                                   Parameter Estimates
===========================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                           0.0306     0.0096     3.1716     0.0015      0.0117      0.0495
Renta_bruta_media_hogar  2.113e-05  7.772e-06     2.7190     0.0066   5.893e-06   3.637e-05
Pob65                       0.0097     0.0169     0.5725     0.5670     -0.0235      0.0428
Padron_Total            -5.563e-06  3.444e-06    -1.6152     0.1064  -1.232e-05    1.19e-06
year_2021                   0.0273     0.0165     1.6597     0.0971     -0.0050      0.0596
const                       2.3680     0.4539     5.2174     0.0000      1.4781      3.2578
===========================================================================================

F-test for Poolability: 4.1008
P-value: 0.0000
Distribution: F(4725,3388)
```

10. FTTH – Firm exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.2045
Estimator:                   PanelOLS   R-squared (Between):             -0.2515
No. Observations:                8082   R-squared (Within):               0.2045
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.1610
Time:                        09:39:07   Log-likelihood                    732.14
Cov. Estimator:             Clustered
                                        F-statistic:                      173.88
Entities:                        4696   P-value                           0.0000
Avg Obs:                       1.7210   Distribution:                  F(5,3381)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             190.74
                                        P-value                           0.0000
Time periods:                       2   Distribution:                  F(5,3381)
Avg Obs:                       4041.0
Min Obs:                       3573.0
Max Obs:                       4509.0

                                   Parameter Estimates
===========================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                          -0.0023     0.0093    -0.2505     0.8023     -0.0205      0.0158
Renta_bruta_media_hogar -8.054e-06  7.168e-06    -1.1235     0.2613  -2.211e-05   6.001e-06
Pob65                      -0.0272     0.0157    -1.7384     0.0822     -0.0579      0.0035
Padron_Total            -2.848e-06  3.862e-06    -0.7375     0.4609  -1.042e-05   4.724e-06
year_2021                  -0.2237     0.0163    -13.762     0.0000     -0.2555     -0.1918
const                       4.3516     0.4274     10.181     0.0000      3.5135      5.1896
===========================================================================================

F-test for Poolability: 3.4741
P-value: 0.0000
Distribution: F(4695,3381)
```

11. FTTH – Self-employment entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0023
Estimator:                   PanelOLS   R-squared (Between):             -0.1674
No. Observations:                8311   R-squared (Within):               0.0023
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.1733
Time:                        09:39:28   Log-likelihood                    868.18
Cov. Estimator:             Clustered
                                        F-statistic:                      1.5944
Entities:                        4841   P-value                           0.1581
Avg Obs:                       1.7168   Distribution:                   F(5,3465)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             1.3460
                                        P-value                           0.2418
Time periods:                       2   Distribution:                   F(5,3465)
Avg Obs:                       4155.5
Min Obs:                       3616.0
Max Obs:                       4695.0

                                   Parameter Estimates
===========================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                         -0.0029     0.0098    -0.2976     0.7660     -0.0220      0.0162
Renta_bruta_media_hogar -1.214e-05   5.44e-06    -2.2313     0.0257    -2.28e-05 -1.473e-06
Pob65                     -0.0035     0.0161    -0.2166     0.8285     -0.0351      0.0281
Padron_Total            3.333e-06  3.871e-06     0.8611     0.3892  -4.256e-06   1.092e-05
year_2021                  0.0144     0.0138     1.0496     0.2940     -0.0125      0.0414
const                      3.0145     0.4216     7.1510     0.0000      2.1880      3.8410
===========================================================================================

F-test for Poolability: 2.9776
P-value: 0.0000
Distribution: F(4840,3465)
```

12. FTTH – Self-employment exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.1489
Estimator:                   PanelOLS   R-squared (Between):             -0.3212
No. Observations:                8347   R-squared (Within):               0.1489
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.2703
Time:                        09:39:43   Log-likelihood                    943.85
Cov. Estimator:             Clustered
                                        F-statistic:                      122.10
Entities:                        4852   P-value                           0.0000
Avg Obs:                       1.7203   Distribution:                   F(5,3490)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             135.13
                                        P-value                           0.0000
Time periods:                       2   Distribution:                   F(5,3490)
Avg Obs:                       4173.5
Min Obs:                       3660.0
Max Obs:                       4687.0

                                   Parameter Estimates
===========================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                         -0.0155     0.0109    -1.4299     0.1528     -0.0369      0.0058
Renta_bruta_media_hogar  9.318e-06   6.35e-06     1.4673     0.1424  -3.133e-06   2.177e-05
Pob65                     -0.0127     0.0175    -0.7229     0.4698     -0.0470      0.0217
Padron_Total           -3.202e-06  2.744e-06    -1.1669     0.2433  -8.582e-06   2.178e-06
year_2021                 -0.2067     0.0146    -14.140     0.0000     -0.2354     -0.1781
const                      2.6475     0.4504     5.8780     0.0000      1.7644      3.5306
===========================================================================================

F-test for Poolability: 2.5078
P-value: 0.0000
Distribution: F(4851,3490)
```

13. 5G – Firm entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0260
Estimator:                   PanelOLS   R-squared (Between):             -0.5376
No. Observations:               11484   R-squared (Within):               0.0260
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.5310
Time:                        09:40:02   Log-likelihood                   -535.94
Cov. Estimator:             Clustered
                                        F-statistic:                      27.217
Entities:                        6372   P-value                           0.0000
Avg Obs:                       1.8023   Distribution:                   F(5,5107)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             35.166
                                        P-value                           0.0000
Time periods:                       2   Distribution:                   F(5,5107)
Avg Obs:                       5742.0
Min Obs:                       5561.0
Max Obs:                       5923.0

                                   Parameter Estimates
===========================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                          0.0455     0.0148     3.0802     0.0021     0.0166      0.0745
Renta_bruta_media_hogar 1.345e-05  6.021e-06     2.2344     0.0255  1.649e-06   2.525e-05
Pob65                     -0.0037     0.0088    -0.4195     0.6749    -0.0209      0.0135
Padron_Total           -7.659e-06  5.688e-06    -1.3465     0.1782 -1.881e-05   3.492e-06
year_2021                  0.0384     0.0152     2.5248     0.0116     0.0086      0.0683
const                      3.0416     0.3072     9.9013     0.0000     2.4393      3.6438
===========================================================================================

F-test for Poolability: 3.9575
P-value: 0.0000
Distribution: F(6371,5107)
```

14. 5G – Firm exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.1273
Estimator:                   PanelOLS   R-squared (Between):             -0.2948
No. Observations:               11461   R-squared (Within):               0.1273
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.2259
Time:                        09:40:19   Log-likelihood                   -1035.4
Cov. Estimator:             Clustered
                                        F-statistic:                      147.36
Entities:                        6407   P-value                           0.0000
Avg Obs:                       1.7888   Distribution:                   F(5,5049)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             192.22
                                        P-value                           0.0000
Time periods:                       2   Distribution:                   F(5,5049)
Avg Obs:                       5730.5
Min Obs:                       5692.0
Max Obs:                       5769.0

                                   Parameter Estimates
===========================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                         -0.0511     0.0156    -3.2802     0.0010    -0.0816     -0.0206
Renta_bruta_media_hogar -4.041e-08 5.634e-06    -0.0072     0.9943 -1.109e-05     1.1e-05
Pob65                     -0.0177     0.0097    -1.8242     0.0682    -0.0367      0.0013
Padron_Total           -4.194e-06  4.705e-06    -0.8913     0.3728 -1.342e-05   5.031e-06
year_2021                 -0.1868     0.0154    -12.131     0.0000    -0.2170     -0.1566
const                      3.9929     0.3150     12.674     0.0000     3.3753      4.6105
===========================================================================================

F-test for Poolability: 3.4037
P-value: 0.0000
Distribution: F(6406,5049)
```

15. 5G – Self-employment entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0016
Estimator:                   PanelOLS   R-squared (Between):             -0.1428
No. Observations:               12201   R-squared (Within):               0.0016
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.1068
Time:                        09:40:33   Log-likelihood                   -1287.5
Cov. Estimator:             Clustered
                                        F-statistic:                      1.7194
Entities:                        6811   P-value                           0.1265
Avg Obs:                       1.7914   Distribution:                  F(5,5385)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             1.6708
                                        P-value                           0.1380
Time periods:                       2   Distribution:                  F(5,5385)
Avg Obs:                       6100.5
Min Obs:                       5984.0
Max Obs:                       6217.0

                                   Parameter Estimates
==============================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
----------------------------------------------------------------------------------------------
x                          0.0134     0.0151     0.8856     0.3759     -0.0162      0.0429
Renta_bruta_media_hogar -1.06e-05  4.344e-06    -2.4405     0.0147  -1.912e-05  -2.085e-06
Pob65                     -0.0100     0.0080    -1.2399     0.2151     -0.0257      0.0058
Padron_Total            2.952e-06  3.318e-06     0.8896     0.3737  -3.553e-06   9.457e-06
year_2021                  0.0145     0.0139     1.0398     0.2985     -0.0128      0.0417
const                      3.1981     0.2570     12.444     0.0000      2.6943      3.7020
==============================================================================================

F-test for Poolability: 3.2104
P-value: 0.0000
Distribution: F(6810,5385)
```

16. 5G – Self-employment exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0809
Estimator:                   PanelOLS   R-squared (Between):             -0.1500
No. Observations:               12475   R-squared (Within):               0.0809
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.1047
Time:                        09:40:50   Log-likelihood                   -1437.6
Cov. Estimator:             Clustered
                                        F-statistic:                      97.179
Entities:                        6947   P-value                           0.0000
Avg Obs:                       1.7957   Distribution:                  F(5,5523)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             148.95
                                        P-value                           0.0000
Time periods:                       2   Distribution:                  F(5,5523)
Avg Obs:                       6237.5
Min Obs:                       6225.0
Max Obs:                       6250.0

                                   Parameter Estimates
==============================================================================================
                        Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
----------------------------------------------------------------------------------------------
x                         -0.0710     0.0149    -4.7689     0.0000     -0.1001     -0.0418
Renta_bruta_media_hogar 9.013e-06  4.867e-06     1.8518     0.0641  -5.287e-07   1.855e-05
Pob65                     -0.0078     0.0083    -0.9392     0.3477     -0.0241      0.0085
Padron_Total           -2.252e-06  2.243e-06    -1.0044     0.3152  -6.649e-06   2.144e-06
year_2021                 -0.1510     0.0143    -10.528     0.0000     -0.1791     -0.1229
const                      2.6309     0.2734     9.6222     0.0000      2.0949      3.1669
==============================================================================================

F-test for Poolability: 2.7997
P-value: 0.0000
Distribution: F(6946,5523)
```

17. Cob_100Mbps – Firm entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0244
Estimator:                   PanelOLS   R-squared (Between):             -0.3473
No. Observations:               11484   R-squared (Within):               0.0244
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.3380
Time:                        09:41:26   Log-likelihood                   -544.85
Cov. Estimator:             Clustered
                                        F-statistic:                      25.590
Entities:                        6372   P-value                           0.0000
Avg Obs:                       1.8023   Distribution:                F(5,5107)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             25.252
                                        P-value                           0.0000
Time periods:                       2   Distribution:                F(5,5107)
Avg Obs:                       5742.0
Min Obs:                       5561.0
Max Obs:                       5923.0

                                    Parameter Estimates
===========================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                           0.0206     0.0237     0.8679     0.3855     -0.0259      0.0671
Renta_bruta_media_hogar  1.487e-05  6.008e-06     2.4746     0.0134   3.089e-06   2.665e-05
Pob65                      -0.0013     0.0088    -0.1462     0.8838     -0.0184      0.0159
Padron_Total            -5.419e-06  3.645e-06    -1.4869     0.1371  -1.256e-05   1.726e-06
year_2021                   0.0528     0.0135     3.8989     0.0001      0.0262      0.0793
const                       2.9039     0.3034     9.5709     0.0000      2.3091      3.4987
===========================================================================================

F-test for Poolability: 3.8888
P-value: 0.0000
Distribution: F(6371,5107)
```

18. Cob_100Mbps – Firm exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.1257
Estimator:                   PanelOLS   R-squared (Between):             -0.5014
No. Observations:               11461   R-squared (Within):               0.1257
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.4270
Time:                        09:42:28   Log-likelihood                   -1046.4
Cov. Estimator:             Clustered
                                        F-statistic:                      145.14
Entities:                        6407   P-value                           0.0000
Avg Obs:                       1.7888   Distribution:                F(5,5049)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             152.82
                                        P-value                           0.0000
Time periods:                       2   Distribution:                F(5,5049)
Avg Obs:                       5730.5
Min Obs:                       5692.0
Max Obs:                       5769.0

                                    Parameter Estimates
===========================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
-------------------------------------------------------------------------------------------
x                           0.0139     0.0250     0.5558     0.5783     -0.0351      0.0630
Renta_bruta_media_hogar -1.267e-06  5.601e-06    -0.2263     0.8210  -1.225e-05   9.712e-06
Pob65                      -0.0198     0.0097    -2.0333     0.0421     -0.0389     -0.0007
Padron_Total            -6.701e-06  6.944e-06    -0.9650     0.3346  -2.031e-05   6.912e-06
year_2021                  -0.2094     0.0134    -15.595     0.0000     -0.2357     -0.1831
const                       4.1017     0.3178     12.905     0.0000      3.4785      4.7248
===========================================================================================

F-test for Poolability: 3.3540
P-value: 0.0000
Distribution: F(6406,5049)
```

19. Cob_100Mbps – Self-employment entry

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0016
Estimator:                   PanelOLS   R-squared (Between):             -0.1778
No. Observations:               12201   R-squared (Within):               0.0016
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.1426
Time:                        09:43:50   Log-likelihood                   -1287.5
Cov. Estimator:             Clustered
                                        F-statistic:                      1.7166
Entities:                        6811   P-value                           0.1271
Avg Obs:                       1.7914   Distribution:                 F(5,5385)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             1.6593
                                        P-value                           0.1408
Time periods:                       2   Distribution:                 F(5,5385)
Avg Obs:                       6100.5
Min Obs:                       5984.0
Max Obs:                       6217.0

                                 Parameter Estimates
=============================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
---------------------------------------------------------------------------------------------
x                           0.0180     0.0247     0.7295     0.4657     -0.0304      0.0664
Renta_bruta_media_hogar -1.029e-05   4.32e-06    -2.3827     0.0172  -1.876e-05  -1.824e-06
Pob65                      -0.0095     0.0080    -1.1814     0.2375     -0.0252      0.0062
Padron_Total             3.638e-06  3.956e-06     0.9196     0.3578  -4.118e-06   1.139e-05
year_2021                   0.0169     0.0115     1.4726     0.1409     -0.0056      0.0394
const                       3.1607     0.2558     12.355     0.0000      2.6592      3.6623
=============================================================================================

F-test for Poolability: 3.1746
P-value: 0.0000
Distribution: F(6810,5385)
```

20. Cob_100Mbps – Self-employment exit

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:                      y   R-squared:                        0.0775
Estimator:                   PanelOLS   R-squared (Between):             -0.4141
No. Observations:               12475   R-squared (Within):               0.0775
Date:                Wed, Feb 18 2026   R-squared (Overall):             -0.3768
Time:                        09:44:22   Log-likelihood                   -1460.1
Cov. Estimator:             Clustered
                                        F-statistic:                      92.848
Entities:                        6947   P-value                           0.0000
Avg Obs:                       1.7957   Distribution:                 F(5,5523)
Min Obs:                       1.0000
Max Obs:                       2.0000   F-statistic (robust):             98.897
                                        P-value                           0.0000
Time periods:                       2   Distribution:                 F(5,5523)
Avg Obs:                       6237.5
Min Obs:                       6225.0
Max Obs:                       6250.0

                                 Parameter Estimates
=============================================================================================
                         Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
---------------------------------------------------------------------------------------------
x                           0.0105     0.0246     0.4264     0.6698     -0.0377      0.0587
Renta_bruta_media_hogar  8.029e-06  4.994e-06     1.6077     0.1080  -1.762e-06   1.782e-05
Pob65                      -0.0101     0.0083    -1.2110     0.2260     -0.0265      0.0063
Padron_Total            -6.003e-06  4.833e-06    -1.2420     0.2143  -1.548e-05   3.473e-06
year_2021                  -0.1807     0.0123    -14.744     0.0000     -0.2048     -0.1567
const                       2.7480     0.2773     9.9105     0.0000      2.2044      3.2916
=============================================================================================

F-test for Poolability: 2.7584
P-value: 0.0000
Distribution: F(6946,5523)
```