Telecommunications Policy 44 (2020) 101873

Contents lists available at ScienceDirect

Telecommunications Policy

journal homepage: www.elsevier.com/locate/telpol

Impact of very high-speed broadband on company creation and entrepreneurship: Empirical Evidence

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ARTICLE INFO

Keywords:
Fiber
Very high-speed broadband
Local economic growth
Company creation

JEL classification:
L13
L50
L96

ABSTRACT

This paper analyzes to what extend the local presence of very high-speed broadband networks has a causal impact on the creation of new businesses and sole proprietorships. Estimations are performed using micro-level panel data covering almost 5000 municipalities in metropolitan France, from 2010 to 2015. A count modeling approach with time- and municipal-fixed effects is first developed. It shows heterogeneous effects across sectors. Municipalities with a very high-speed broadband network tend to be more attractive for companies, with a positive effect on establishment creation within the tertiary sector and the construction sector. In addition, these municipalities seem to provide a more favorable environment for entrepreneurship. However, the benefits of very high-speed broadband are not equally distributed across municipalities and depend on the educational attainment of the population.

1. Introduction

Very high-speed broadband networks are seen as a key enabler for socio-economic development. Their roll-out has been made a priority worldwide and is considered as an investment for the future. Over the last few years, many countries, such as France,[1] the US,[2] Australia, Table 19[3] Japan[4] and Mexico[5] have adopted national broadband plans to ensure the whole coverage of their territory. In the European Union, the Commission has defined in 2013 a Digital Agenda for Europe.[6] In 2016, the Commission reiterated its vision to turn Europe into a Gigabit Society by 2025.[7]

Very high-speed broadband is considered as essential for firms to remain competitive both at the national and international levels. Very high-speed broadband includes both fast and ultra-fast broadband with speed above 30 Mbps.[8] In France, as in most part of the European Union, firms have already adopted broadband technology to conduct their activities.

The contribution of this paper is to analyze whether the presence of very high-speed broadband networks has a causal impact on

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[1] "Plan France Tres Haut Debit" February 2013.

[2] "Connecting America: The National Broadband Plan, Federal Communications Commission," March 2010.

[3] "The National Broadband Network" April 2009, modified in 2013.

[4] "E-Japan Strategy" 2001.

[5] "Mexican Digital Agenda" 2011.

[6] "A Digital Agenda for Europe," European Commission, COM(2010) 245, with the objective to provide by 2020 every household with access to at least a 30 Mbps connection and half of the households with a subscription at 100 Mbps.

[7] "State of the Union 2016: Towards a Better Europe - A Europe that Protects, Empowers and Defends".

[8] The Digital Agenda for Europe distinguishes different ranges of broadband speeds: basic broadband (between 256 Kbps and 30 Mbps), fast broadband (above 30 Mbps and up to 100 Mbps) and ultra fast broadband (above 100 Mbps).

https://doi.org/10.1016/j.telpol.2019.101873
Received 5 June 2019; Received in revised form 11 September 2019; Accepted 16 September 2019
Available online 26 September 2019
0308-5961/

the creation of new businesses of all non-farm market sectors operating locally. The impact of these networks is also highlighted on entrepreneurship, with a specific focus on the creation of sole proprietorships. It is rather unlikely that an operating firm decides to relocate to an area offering better broadband speeds. The expected benefits stemming from faster broadband use are unlikely to surpass the relocation cost. However, the presence of a next generation access network may make a city more attractive and therefore impact the location decision of new firms.[9]

A technology neutral approach is adopted. All technologies delivering very high-speed services are included: fiber optical network (fiber to the Home; FttH) and upgraded cable (fiber to the Last Amplifier; FttLA).[10] This paper contributes to a rather limited number of studies analyzing the role of broadband on entrepreneurship. It adds to the existing literature on broadband and economic growth which mostly investigates the effect of transitioning from dial-up Internet to basic broadband. The results provide policy-makers with better insights on the impact of very high-speed broadband on the local economy.

This study relies on panel data covering 4935 municipalities located in metropolitan France, representing approximately 75% of the population, over 6 years, from 2010 to 2015. Panel data allow me to control for municipal- and time-specific heterogeneity. The three French largest cities, Paris, Lyon and Marseille are excluded from the analysis. These cities are attractive by themselves for companies and households.[11] In addition, only municipalities with at least 2000 inhabitants are included in the database, as it is rather unlikely that a very high-speed broadband network has been rolled out during the time period of the study.[12]

To estimate the impact of very high-speed broadband networks on local economic growth, a count modeling framework, in the form of a negative binomial model is used. Robustness checks are performed using a panel data model with fixed effects and geographical time trends.

The estimations show evidence of heterogeneous effects from very high-speed broadband networks on company creation at the local level. They enhance municipalities' attractiveness for new establishments operating in the commerce, service and transport sector, which rely more on ICTs. In addition, municipalities with a very high-speed broadband networks provide a more favorable environment for entrepreneurship, as it has a positive effect on the creation of sole proprietorships. However, no significant effect is found for the creation of new businesses in the industry sector. After distinguishing between low- and high-skilled workforces, the results show that areas with high-skilled workers and a very high-speed broadband network attract away new companies in the construction sector and companies providing services to households. This pattern is also found as regards the creation of sole proprietorships. This highlights that the benefits of very high-speed broadband are not equally distributed across the different areas but also depend on the educational attainment of the population.

The remainder of the paper is organized as follows. Section 2 discusses the relevant literature on the effect of broadband on economic growth and deployment. Section 3 presents the data. Section 4 introduces the econometric framework. Section 5 presents the estimation results and Section 6 the robustness checks. Finally, Section 7 concludes.

2. Literature review

There is a substantial literature on the effect of ICT on GDP and more generally on economic growth at the national and regional level (see Czernich (2014) and Kretschmer (2009) for literature reviews). It is widely accepted that, at the national level, ICT adoption has a positive effect on productivity.

There is an extensive range of macro-level studies which bring empirical evidence on the positive impact of broadband adoption on economic growth (see Bertschek, Cerquera, and Klein (2013), Greenstein and McDevitt (2011) and Holt and Jamison (2009) for comprehensive literature reviews). Gruber, Hätönen, and Koutroumpis (2014) evaluate the net economic benefits that would derive from the achievement of the objectives of the 2020 Digital Agenda for Europe. They find that the economic benefits outweigh the costs of investment. Besides, they show that the economic benefits are only marginally appropriable by firms, as they mostly spill over to users and to the national economy. This result confirms other studies which found a positive impact of broadband availability on consumer surplus (see for example Crandall and Jackson (2001) and Dutz, Orszag, and Robert (2009)). Thus, Gruber et al. (2014) show that there is a rationale for public subsidies in the roll-out of broadband networks. Other studies for the US have found a positive relation between broadband availability and employment (Crandall et al. (2007), Gillet, Lehr, Osario, and Sirbu (2006)). However, there is limited empirical evidence of the effect of broadband availability on economic growth at the local level, especially

[9] Only the creation of new firms is included in the analysis. It does not include the expansion of existing firms per se. In the eventuality that a firm takes the strategic decision to expand and locate part of its activities in another municipality, the business expansion decision is equivalent to the creation of a new establishment in the selected municipality. To take into account this possibility, the analysis is realized at the establishment level and not at the firm level. A firm can have several establishments. An establishment is a production unit that is geographically individual but legally dependent on a firm (or "entreprise").

[10] Since 2013 Orange and other DSL operators have been upgrading their broadband networks to offer VDSL services, which can provide Internet speeds up to 50 Mbps to some consumers. However, the VDSL technology is not included in the study, because the connection speed depends on the copper line length and as such suffer from signal attenuation.

[11] They are the three largest municipalities in terms of population and are the only one decomposed into arrondissements (districts), with their own mayor and municipal council. See Section 4.2.

[12] In some less populated municipalities, local collectivities such as regions or departements have defined broadband plans to ensure the roll-out of faster broadband technologies. However, these projects are based on public initiatives and therefore require time to be approved. First, the collectivities shall prove that there is a lack of private investment, then they should defines a roll-out plan that should be cleared in accordance with the regulations on public subsidies. Therefore, public broadband initiatives networks are out of the scope of this study.

in rural areas.

Usually, studies realized at the local-level assess the impact of ICT on variables of local economic growth (see, for example, Kolko (2012)). There are only few papers focusing specifically on the effect of broadband adoption on local economic growth. Czernich (2011 and 2014) for German municipalities and Jayakar and Park (2013) for eight States in the US find no evidence that broadband availability reduces the unemployment rate. On the contrary, Whitacre, Gallardo, and Strover (2014) find that broadband adoption, availability and download speeds have an impact on economic growth in rural areas. They use a propensity score matching estimator on local-level data for non-metropolitan US counties for the years 2001–2010. They highlight a positive impact on unemployment reduction and on median household income. They also show that rural areas with high levels of download speeds tend to attract more creative class workers and to have a lower poverty level.

As far as firms are concerned, the literature focuses on the impact of broadband on productivity. Haller and Lyons (2015) show that on average more productive firms are more likely to have a DSL broadband connection, but they find no evidence of an impact of broadband adoption on firms' productivity or on productivity growth. Similarly, Bertschek et al. (2013) find no effect on labor productivity, but they find a positive effect on firms' innovation activities. Akerman, Gaarder, and Mogstad (2015) show that broadband availability and adoption increase the productivity of skilled workers, acting as a skill complement and lowers the productivity of unskilled workers, acting as a substitute for routine tasks.

Only few studies analyze the effect of broadband on the attractiveness of a territory for firms. In her analysis, Mack (2014) finds a positive correlation between broadband speed and the presence of agricultural and rural companies in Ohio. Using local-level data, McCoy, Lyons, Morgenroth, Palcic, and Allen (2018) analyze the impact of local infrastructures and broadband networks on new business creation in Ireland, excluding the Dublin city region. They find that on average areas covered by broadband are more attractive for firms.

This paper is related to the latter stream of literature. However, most of the studies on the impact of broadband on local economic growth focus on the impact of old generation broadband technologies, such as DSL or co-axial cable technologies and ignore the new high-speed broadband technologies. I attempt to fill this gap by assessing the impact of very high-speed broadband technologies, including fiber optical technology (Fiber to the Home) and upgraded cable technology (DOCSIS 3.0 or Fiber to the Last Amplifier or FttLA).[13] Besides, though realized at the local level, most of the studies are performed at a more aggregated level, which is either the State or the County.

3. Data

Data on the number of establishment creations come from INSEE, the French National Institute for Statistics and Economics Studies. They have been collected for each municipality for the years 2008–2015.[14] Information on the three main non-farm market sectors: the industrial sector, the construction sector and the tertiary sector, are available for each year.

The construction sector is essentially an activity of deployment, installation or maintenance on the customer's work-site. The industrial sector regroups all activities combining factors of production (facilities, supplies, work, knowledge) to produce material goods intended for the market. The tertiary sector encompasses a vast field of activities, ranging from commerce to administration, via transport, financial and real estate activities, services to business, personal services, education, health and social services. Therefore, data have been collected for three sub-sectors of the tertiary sector: the commerce, transport and services; the provision of services to companies and the provision of services to households.[15]

Data on fiber deployment in metropolitan France (Corsica excluded) have been extracted from Orange's Information System,[16] SFR's website,[17] and Free users' community websites for the years 2010–2014.[18] Orange is the historical fixed-line incumbent. It owns

[13] The FttH technology is also called fiber-to-the-premises (FTTP).

[14] A municipality, also called commune in French, is the lowest administrative division in France. It represents all parts of a town or a village under the same name, for example, Bordeaux, Nice or Rennes. Every municipality has an elected mayor and a municipal council. They have powers to manage the populations and land. Municipalities could be compared to civil townships and incorporated municipalities in the United States and Canada. The United Kingdom has no exact equivalent, it could be compared to districts in urban areas, but are closer to parishes in rural areas.

[15] According to INSEE services to companies broadly correspond to section M (scientific and technological activities) and section N (administration and product support services) of the classification of Economic Activities 2nd revision. They include among others for the M section: legal, accounting, management, architecture, engineering, control and technical analysis activities; scientific research and development; others scientific and technical activities (advertising and market research, veterinary activities, photograph, translation and interpretation). For the N sections: rental and leasing activities; travel agencies, tour operators; investigation and security activities; services to buildings and landscaping; call centers …. According to INSEE and in reference to the same classification, services to the households broadly correspond to the sections: R (arts, performances and recreational activities) and S (other services activities: computer and personal and domestics goods repair and other personal services).

[16] The data were obtained directly from Orange. There are three possible states of fiber deployment by Orange at a given concentration point in a municipality: 'deployed', 'in deployment' and 'planned'. Fiber is considered to be available in a municipality in a given year if there is at least one concentration point with status 'deployed'. The concentration point is a small street cabinet which aggregates cable lines and is connected to the individual premises. There can be more than one concentration point in a given municipality.

[17] SFR publishes regular press releases along with a map of France, in which all municipalities are listed where it has deployed fiber. For each year between 2010 and 2014 and each municipality, we observe whether SFR has deployed its network alone or in co-investment with another operator.

[18] The data were collected from two unofficial websites run by Free users: http://francois04.free.fr/and http://serge.31.free.fr/. The data collected from these websites are consistent with the information available on other websites and with Free's annual reports. For each municipality and each year it is known whether Free has active fiber connections.

the legacy copper network, which is used to provide DSL broadband services. SFR and Free are alternative operators which do not possess their own copper network. They provide broadband services by leasing access to the incumbent's local access network via local loop unbundling (LLU).[19] All data on fiber deployments provide information at the municipal level, with each municipality identified by a unique geographic code (the INSEE code). The information is available for 36,036 French municipalities out of the 36,192 municipalities counted in metropolitan France in 2014. For each municipality, it is known whether Orange and/or SFR has deployed an FttH network. Regarding Free, for each municipality, it is known whether there are active fiber connections from Free.

Data on cable upgrade have been extracted from Numericable's website for the years 2010–2014. Numericable is the French cable-operator.[20] For each municipality, it is known whether Numericable has upgraded its cable network to provide very high-speed broadband services.[21]

Table 1 shows the number of municipalities covered by each of these four main operators between 2010 and 2014. During the period of study, in 2013, the regulatory framework has been modified leading to an acceleration in fiber optical network deployment. In France public authorities are promoting co-investment between private operators in less densely populated areas.[22] Co-investment in the last mile of the network from the optical distribution frame is allowed to alleviate the costs of FttH roll-out.[23] In 2013, the list of very high-density areas has been modified leading to more possibilities for co-investment. Therefore, depending on the type of areas and the associated regulation, one or more very high-speed broadband networks can be deployed by one, two or three fiber operators either alone or in co-investment. In addition, one or several fiber networks can be deployed in areas where the cable network has been upgraded to very high-speed broadband or vice-versa. Table 2 shows the number of municipalities in which there are at least one fiber network, at least one upgraded cable network or at least one very high-speed broadband network.

Finally, socio-demographic data on the number of households per municipality, density of population, unemployment rate, education and types of employment come from INSEE and are collected at the municipality level. Data on the average fiscal income per municipality has been collected from the General Direction of Public Finance's website (Gouvernment Taxes Services, DGFIP).[24] Data have been collected for the years 2006–2012. Descriptive statistics are reported in the Annex in Tables 19–23

4. Econometric strategy

The choice of a location for a new company to operate is a strategic decision, key to its success. Companies incur a fixed cost when settling down. The choice is driven by cost factors, such as the tax regime in the locality, the availability of infrastructures, such as transportation and broadband infrastructures, but also by the cost and availability of human capital. In addition, companies consider the potential demand in the market for their products or services.

4.1. Theoretical assumptions and settings

The empirical literature on business location decisions is generally based on two approaches: discrete choice modeling and count modeling. The first discrete choice modeling approach is based on the analysis of business location decision as a function of firm characteristics, including the size and the industry sector, and alternative local characteristics, including population, human capital and infrastructures.[25] The unit of analysis is the company, whereas in the second count modeling approach, the unit of analysis is the territory. In this latter approach, the analysis consists in assessing how location characteristics can influence business location in the form of the count of businesses in each territorial unit.[26] The underlying assumption is that the number of new establishments that settle in a locality over a time period is determined by an equilibrium condition between a stochastic supply function representing the willingness of a company to start its business in the territory and a stochastic demand function for new firms in the territory. Following Becker and Henderson (2000), the equilibrium condition can be represented by a reduced form stochastic distribution for the count of new businesses.

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. The count of new establishments operating in a municipality for each time period is modeled as a function of the local characteristics, with municipal- and time-fixed effects.

Let i ($i = 1,2, ...,I$) index the territorial unit of analysis, i.e. the municipality. Let s ($s = 1,2, ...,N$) index the sector type. Let k

[19] Orange, SFR and Free are also the main competitors in the mobile market.

[20] Numericable's cable network covers 30% of the population, mostly in urban areas. Until 2014, Numericable published a list of the municipalities in which it has upgraded its cable network. Historical information have been collected using the wayback machine. See: archive.org/web/.

[21] The database used in this study is similar to the one used in Bourreau et al. “Unbundling the Incumbent and Entry into fiber: Evidence from France” (Mimeo). Further details upon the database construction and data collection provided on request.

[22] ARCEP Decision Nr 2009-1106 from the 22nd December 2009.

[23] Operators deploying a fiber optical network in less densely populated areas have to publish a call for co-investment and co-invest with interested operators. Operators can co-invest in 5% of lines or a multiple of 5% of lines (i.e., they can co-invest in 5%, 10%, 15%, etc. of the lines). Ex-post co-investment is also possible, but subject to a risk premium to compensate the commercial risk supported by the first investor.

[24] The average fiscal income is measured in the previous year, as people pay taxes on the year before. In other words, the amount of taxes paid for the year 2015 is calculated on the income received in 2014.

[25] See Arauzo-Carod (2008) and Arauzo-Carod and Manjon-Antolin (2012) for a thorough discussion. For recent studies, see Alama-Sabater, Artal-Tur, and Navarro-Azorin (2011) and Siedschlag, Zhang, and Smith (2013).

[26] See Jofre-Monseny et al. (2011) and Bhat, Paleti, and Singh (2014).

Table 1
Entry into fiber and upgraded cable in municipalities in France for years the 2010–2014.

	2010	2011	2012	2013	2014
Orange	117	196	299	456	589
SFR	83	150	214	347	425
Free	93	103	104	106	107
Numericable	202	202	329	699	1067

Out of the 36,080 municipalities.

Table 2
Number of municipalities in which at least one fiber network is deployed, at least one upgraded cable network is deployed or in which there are at least one very high-speed broadband network for the years 2010–2014.

	2010	2011	2012	2013	2014	2010–2014
At least one fiber network	95	164	260	409	527	1455
Upgraded cable	142	142	231	468	624	1067
At least one network	202	255	396	680	898	2431

Out of the 4935 municipalities included in the sample. There are at least 2431 municipalities in which a very high-speed broadband network is present. This is due to the fact that in some municipalities there are both one or several fiber networks and an upgraded cable network. Therefore lines 2 and 3 are not additive.

($k = 1,2, \ldots, K$) index the establishment. Let t ($t = 1,2, \ldots, T$) index the time, i.e. the year. Then, Y_{sit} represents the count of new businesses in sector s in municipality i at time t. By construction, Y_{sit} takes nonnegative integer values. It is assumed that new establishment will locate in an area where its can makes profits.

The establishment's level of profit depends on the local characteristics in municipality i, which impact its costs. It's level of profit is also determined by the characteristics related to the demand for its products or services.

$$\Pi_{skit} = \alpha + \beta X_{skit} + \delta superfast_{skit} + \gamma D_{skit} + \varepsilon_{skit}. \quad (1)$$

With X_{skit} the municipality specific local characteristics in year t that are relevant for establishment k operating in sector s. These local characteristics are related to cost and will therefore impact the level of profit the firms can expect in a certain geographic area. The determinants of business location decisions are likely to differ among the different sectors. Therefore the local characteristics relevant for one sector may not be the same as those relevant for another sector. Such characteristics can be related to the market size, the concentration of the market, the presence of local infrastructure and the labor market. Within these local characteristics one is considered to have a positive impact by policy makers and academics, the presence of a very high-speed broadband network, denoted $superfast_{skit}s$.

D_{skit} represents the municipality specific demand function in year t that are relevant for establishment k operating in sector s. It can be considered as a latent demand intensity for new businesses in sector s in local market i at time t. ε_{skit} is unobserved random factors that varies across establishments and locations.

Firm k will enter a territorial unit only if it expects to make positive profits.

$$Y_{sit} > 0 \text{ if } E(\Pi_{skit}) > 0. \quad (2)$$

Count data models are commonly estimated using a Poisson model. It allows to capture the discrete and nonnegative nature of the data. However, one of its main assumptions is that the variance is equal to the conditional mean, meaning that there is an equi-dispersion of the newly created establishments. However, this assumption is often violated. Following (Consul & Jain, 1973), a way to model overdispersion, which is present in our data, is to use a nonnegative model. Let's consider a fixed-effect overdispersion model. Then, considering the count of new businesses, all sectors combined, in municipality i at time t:

$$Y_{it}(\gamma_{it} \sim Poisson(\gamma_{it})). \quad (3)$$

where $\gamma_{it}|\delta i \sim \gamma(\lambda_{it,\delta i})$. With $\lambda_{it} = e^{xit\beta} + offset_{it}$, w_i the weight for the ith group and δi the overdispersion parameter.

The joint probability of the counts for each group is conditioned on the sum of the counts for the group, i.e. the observed $\sum_{t=1}^{n_i}(y_{it})$.

$$Pr(Y_{i1} = y_i 1, \ldots, Yini = y_i ni | X_i, \sum_{t=1}^{n_i}(Y_{it}) = \sum_{t=1}^{n_i}(y_{it})) = \frac{\Gamma(\sum_{t=1}^{ni}\lambda_{it})\Gamma(\sum_{t=1}^{ni}y_{it}+1)}{\Gamma(\sum_{t=1}^{ni}\lambda_{it}+\sum_{t=1}^{ni}y_{it}+1)} \prod_{t=1}^{} ni \frac{\Gamma(\lambda_{it}+y_{it})}{\Gamma(\lambda_{it})+\Gamma(y_{it}+1)}. \quad (4)$$

Then the conditional log likelihood is given by:

$$lnL = \sum_{t=1}^{n_i} w_i [ln\Gamma(\sum_{t=1}^{n_i}\lambda_{it}) + ln\Gamma(\sum_{t=1}^{n_i}\lambda_{it}+1) - ln\Gamma(\sum_{t=1}^{n_i}\lambda_{it} + \sum_{t=1}^{n_i} y_{it}) + \sum_{t=1}^{n_i}\{ln\Gamma(\lambda_{it}+y_{it}) - ln\Gamma(\lambda_{it}) - ln\Gamma(y_{it}+1)\}]. \quad (5)$$

As highlighted in the literature, there is a potential endogenous effect of broadband networks on company creation and more

generally on economic activity, see, for example, Kolko (2012), Mack, Anselin, and Grubesic (2011) and McCoy et al. (2018). Economic activities are more likely to thrive in areas with enhanced broadband infrastructures. In the meantime, areas with better broadband infrastructures are more likely to attract economic activities. Therefore, this effect materializes mostly as reverse causality between the number of companies operating locally and very high-speed broadband availability.

In their analysis of the impact of local broadband infrastructures on new business establishment, McCoy et al. (2018) argue that the endogenous relationship that exists between broadband networks and companies is more likely to affect the stock of existing companies rather than the flow of company creations. To mitigate this endogeneity problem, they restrict their analysis to new firms in each year and control for the pre-existing employment levels for each area and for each time period. I follow their argument and estimate the impact of very high-speed broadband networks on the number of new establishments created in each year. I also control for pre-existing level of companies for each area and each year using 2 years lagged variables. In addition, as the local labor market variables may also suffer from reverse causality, 2 years lagged variables are used. Households could choose to locate in areas with better job prospects and companies in areas in which they could hire their labor force. Robustness checks are performed with lags of 1 year and 3 years, which give similar qualitative results. Nevertheless, one can suspect that the estimation results might suffer from an upward bias.

Omitted variables may also be a potential source of endogeneity. For example, operators may have higher incentives to deploy a very high-speed broadband network in areas in which they can benefit from a more favorable tax regime or in which there is higher demand for faster broadband services. To mitigate this problem, I follow the econometric literature by using time-varying and time invariant fixed effects. Specific time trends are also added at the region/departement levels, in the robustness checks, to control for geographical trend in establishment creation.[27]

4.2. Empirical models

The model is estimated on a database including 4935 municipalities over 6 years, from 2010 to 2015. Only municipalities with at least 2000 inhabitants are included in the database. It is rather unlikely that private operators deploy a very high-speed broadband network in a municipality with less than 2000 inhabitants.[28] The three main French agglomerations, Paris, Lyon and Marseille are excluded as they are the three largest municipalities in terms of population and are the only ones decomposed into arrondissements (districts), with their own mayor and municipal council.[29]

$$Y_{it+1} = \alpha + \delta\, superfastbb_{it} + \beta\, X_{it-2} + \gamma\, Z_{it-2} + \mu\, year_t + \eta_i + \varphi_t + \varepsilon_{it}. \tag{6}$$

where:

$$Y_{it+1} = 0,1,2, \ldots \tag{7}$$

Y_{it+1} is the count (or number) of new establishments operating in municipality i at time $t + 1$. The variable of interest consists in a dummy variable, denoted $superfastbb_{it}$, which indicates whether a very high-speed broadband network, providing Internet connection of at least 30 Mbps, has been deployed in municipality i at time t. A technology neutral approach is adopted by including all technologies through which very high-speed broadband services can be delivered: fiber optical network (FttH) and upgraded cable network (FttLA).[30]

X_{it-2} is a matrix of location characteristics for municipality i at time $t - 2$. It includes the number of establishments operating in the municipality; the number of households; the population density; the average fiscal income and the unemployment rate. Z_{it-2} is a matrix of labor market characteristics for municipality i at time $t - 2$. It includes information on educational attainments and types of employment. η_i is a time invariant fixed effect which controls for differences across municipalities that are constant over time. $year_t$ is a dummy variable for each year capturing year specific effects. φ_t captures regional or departmental specific time trend.[31] Finally, ε_{it} is a standard error clustered at the municipal level, capturing unobserved factors.

Using (6), the number of business creation can be derived[32]

[27] There are 21 regions in metropolitan France (plus Corsica, which is not included in the analysis) and 94 departements (plus 2 in Corsica), which are not included in the analysis. Each region and departement has specific powers and may for example implement different tax regimes or policies which could make them more attractive for firms to locate.

[28] The analysis only takes into consideration private deployments and therefore does not include very high-speed broadband networks deployed or initiated by the public sector. Municipalities under 2000 inhabitants are not economically profitable for a private operator investing alone or in co-investment. Hence, they are excluded from the scope of this analysis.

[29] Population in 2013: Paris: 2.2 millions inhabitants, Marseille: 855,393 inhabitants, Lyon: 500,715 inhabitants, the fourth largest is Toulouse with 458,298 inhabitants, but even though the municipality size is comparable with Lyon, the density of population is much lower: 3942 inhabitants per km^2, compare to 10,583 inhabitants per km^2 for Lyon and there is no arrondissement in Toulouse.

[30] Due to data constraints, the effect of very high-speed broadband networks is estimated at time t on the number of new establishments at time $t + 1$. The latest data available for establishment creation is 2015. It is only possible to estimate a short-term effect. With longer dataset, it could be possible to estimate a medium or long-term effect.

[31] There are 21 regions and 93 departments.

[32] Few municipalities have 0 establishment creation, this number is set to 1. This can be done, because the number of 0 company creation is rather low: 1.4% for new establishments; 4.8% for new establishments from the construction sector; 0.7% for the commerce, service and transportation sub-sector; 1% for the provision of services to households sub-sector; 5.2% for the provision of services to companies sub-sector; 0% for the creation

$$new\_establishment_{it+1} = \alpha + \delta\ superfastbb_{it} + \beta_1\ establishment_{it-2} + \beta_2\ ln\_households_{it-2} + \beta_3\ density_{it-2} + \beta_4\ income_{it-2} + \gamma_1\ unempl_{it-2} + \gamma_2\ ln\_uni\_diploma_{it-2} + \gamma_3\ employment\_groups_{it-2} + \mu\ year_t + \eta_i + \varphi_t + \varepsilon_{it}, \quad (8)$$

where $new\_establishment_{it+1}$ represents the count of new companies that have been created in municipality i at time $t+1$. The presence of a very high-speed broadband network is likely to impact a firm's decision to enter a market differently depending on which sector this firm is going to operate. Therefore, new establishments are disaggregated into the three non-farm market sectors of the economy: the construction sector, the industrial sector and the tertiary sector. The tertiary sector is the one which is predicted to benefit the most from the presence of very high-speed broadband. It has been divided in three sub-sectors: the commerce, transport and services; the provision of services to companies and the provision of services to households.

$Establishment_{it-2}$ represents the number of establishments operating in municipality i at time $t-2$. As a matter of fact, the number of establishments in a locality is highly correlated with the number of establishments in the previous years.

The market size is approximated by the number of households (in log) and the population density (defined as the number of households divided by the surface of the municipality) in municipality i at time $t-2$. The average fiscal income and the unemployment rate in municipality i at time $t-2$ are proxy for the quality of demand, in terms of purchasing power.

Education is measured by the number of inhabitants (in log) with a diploma from superior education in municipality i at time $t-2$. Population qualifications is approximated by the number of inhabitants of the different socio-professional groups defined by INSEE, $employment\_groups_{it-2}$ in municipality i at time $t-2$. There are 6 socio-professional groups: Farmers (group 1), craft workers, retailers, and business owners (group 2), intermediate professions (group 3), white collars (group 4), employees (group 5) and blue collars (group 6).

The second specification makes a specific focus on entrepreneurship by assessing the impact of very high-speed broadband networks on the creation of sole proprietorships, i.e. the creation of companies owned and run by one individual:

$$new\_proprietorship_{it+1} = \alpha + \delta\ superfastbb_{it} + \beta_1\ establishment_{it-2} + \beta_2\ ln\_households_{it-2} + \beta_3\ density_{it-2} + \beta_4\ income_{it-2} + \gamma_1\ unempl_{it-2} + \gamma_2\ ln\_uni\_diploma_{it-2} + \gamma_3\ ln\_no\_diploma_{it-2} + \gamma_4\ employment\_groups_{it-2} + \mu\ year + \eta_i + \varphi_t + \varepsilon_{it}, \quad (9)$$

where $new\_proprietorship_{it+1}$ represents the count of new sole proprietorships that have been created in municipality i at time $t+1$. The number of inhabitants (in log) with no diploma in municipality i at time $t-2$ is added to the previous set of explanatory variables. As during a time of unemployment, some people who face difficulties to find a job may decide to create their own business. This has been observed with the 2008 economic crisis, with an increase in the number of sole proprietorships (see table 23 in Annex).

Besides, it has been shown in the literature that some benefits of basic broadband were found to be complementary with high-skilled labor forces. To asses whether this effect still materializes with the deployment of very high-speed broadband an alternative specification to 6 taking into account educational attainment is defined.

$$Y_{it+1} = \alpha + \delta\ superfastbb_{it} + (\delta\ superfastbb_{it}.\ \psi\ high\_skilled_{it}) + \beta\ X_{it-2} + \gamma\ Z_{it-2} + \mu\ year_t + \eta_i + \varphi_t + \varepsilon_{it}. \quad (10)$$

Following 10, we have for the count of business creation:

$$new\_establishment_{it+1} = \alpha + \delta\ superfastbb_{it} + (\delta\ superfastbb_{it}.\ \psi\ high\_skilled_{it}) + \beta_1\ establishment_{it-2} + \beta_2\ ln\_households_{it-2} + \beta_3\ density_{it-2} + \beta_4\ income_{it-2} + \gamma_1\ unempl_{it-2} + \gamma_2\ ln\_uni\_diploma_{it-2} + \gamma_3\ employment\_groups_{it-2} + \mu\ year_t + \eta_i + \varphi_t + \varepsilon_{it}, \quad (11)$$

and we have for the count of sole proprietorship,

$$new\_proprietorship_{it+1} = \alpha + \delta\ superfastbb_{it} + (\delta\ superfastbb_{it}.\ \psi\ high\_skilled_{it}) + \beta_1\ establishment_{it-2} + \beta_2\ ln\_households_{it-2} + \beta_3\ density_{it-2} + \beta_4\ income_{it-2} + \gamma_1\ unempl_{it-2} + \gamma_2\ ln\_uni\_diploma_{it-2} + \gamma_3\ ln\_no\_diploma_{it-2} + \gamma_4\ employment\_groups_{it-2} + \mu\ year + \eta_i + \varphi_t + \varepsilon_{it}, \quad (12)$$

Nevertheless, all specifications are also estimated without the number of establishments operating in municipality i at time $t-2$ to ensure that this variable does not impact or hide the significance of others. Results are qualitatively similar in terms of sign and significance, they also display coefficients of similar magnitudes.[33] The same exercise has been made without the different socio-professional groups; the results are also qualitatively similar.

(*footnote continued*)
of new companies run by one individual. Only establishment creation in the industry sector display a higher number of 0, with 17% of the municipalities having 0 establishment creation from the industry sector. However, results are qualitatively similar in terms of signs and significance.

[33] Results are available upon request.

Table 3
Establishment creation in all sectors and in the industry sector in France for the years 2010–2015.

	new establishment			new industry		
	whole sample	high skilled	low skilled	whole sample	high skilled	low skilled
very high-speed bb	1.0270***	1.0204***	1.0232	1.0105	1.0012	0.9394
	(0.005)	(0.005)	(0.023)	(0.019)	(0.090)	(0.058)
establishment	0.9160***	0.9586***	0.8803***	0.8911***	0.8362***	0.8299***
	(0.006)	(0.009)	(0.008)	(0.035)	(0.028)	(0.025)
households	1.1965***	1.1769***	1.5611***	2.0591***	1.6330***	1.6076***
	(0.037)	(0.038)	(0.115)	(0.144)	(0.292)	(0.197)
density	0.9622***	0.9734**	1.2418*	1.0735	0.7708	1.0491
	(0.011)	(0.011)	(0.153)	(0.052)	(0.189)	(0.179)
income	1.0037***	1.0025*	1.0081**	1.0147**	1.0175	1.0214***
	(0.001)	(0.001)	(0.003)	(0.006)	(0.011)	(0.008)
unemployment	0.9901***	0.9908***	0.9989	0.9904	0.9961	0.9950
	(0.002)	(0.002)	(0.003)	(0.009)	(0.010)	(0.008)
diploma superior	1.1733***			1.1459		
	(0.028)			(0.098)		
Constant	89.7514***	282.7232***	127.3393***	2.5397*	4.2610***	6.2001***
	(14.725)	(35.663)	(18.392)	(1.238)	(1.698)	(2.459)
Observations	24,674	12,246	12,246	24,594	12,233	12,160
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Prob > Chi2	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4935	2559	2557	4919	2559	2557

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4
Establishment creation in the construction sector and in the commerce, service and transport sub-sector in France for the years 2010–2015.

	new construction			comm serv transp		
	whole sample	high skilled	low skilled	whole sample	high skilled	low skilled
very high-speed bb	1.0432***	1.0403***	0.9943	1.0426***	1.0299***	1.0846**
	(0.010)	(0.011)	(0.054)	(0.008)	(0.008)	(0.043)
establishment	0.9253***	0.9998	0.8658***	0.9257***	0.9844	0.8756***
	(0.015)	(0.024)	(0.020)	(0.011)	(0.017)	(0.015)
households	0.9879	1.0547	1.3130	1.1846***	1.2482***	1.6643***
	(0.076)	(0.081)	(0.240)	(0.060)	(0.060)	(0.214)
density	1.0260	1.0327	1.1490	0.9172***	0.9290***	1.0948
	(0.030)	(0.031)	(0.330)	(0.012)	(0.012)	(0.206)
income	1.0065*	1.0041	1.0105	0.9963	0.9945*	1.0017
	(0.004)	(0.004)	(0.008)	(0.003)	(0.003)	(0.006)
unemployment	0.9942	0.9972	1.0007	0.9896***	0.9822***	1.0099**
	(0.004)	(0.005)	(0.007)	(0.003)	(0.004)	(0.005)
diploma superior	1.2218***			1.1885***		
	(0.071)			(0.049)		
Constant	50.0996***	130.2222***	111.4150***	54.3999***	171.6993***	88.3985***
	(21.039)	(43.620)	(49.033)	(14.569)	(35.891)	(22.132)
Observations	24,669	12,244	12,241	24,674	12,246	12,246
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Prob > Chi2	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4934	2559	2557	4935	2559	2557

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5
Establishment creation in the services to the companies and services to households sub-sectors in France for the years 2010–2015.

	service firms			service hh		
	whole sample	high skilled	low skilled	whole sample	high skilled	low skilled
very high-speed bb	0.9998	0.9954	1.0385	1.0177**	1.0174**	0.9570
	(0.007)	(0.007)	(0.044)	(0.008)	(0.008)	(0.043)
establishment	0.9240***	0.9698*	0.8736***	0.9430***	0.9720	0.9133***
	(0.011)	(0.016)	(0.016)	(0.012)	(0.018)	(0.017)
households	1.2476***	1.2437***	2.4128***	1.1061*	1.1645***	1.1761
	(0.065)	(0.062)	(0.354)	(0.065)	(0.067)	(0.176)
density	1.0047	1.0157	1.0062	1.0724**	1.0697**	1.9407*
	(0.018)	(0.019)	(0.237)	(0.032)	(0.033)	(0.685)
income	1.0031	1.0023	1.0022	1.0076***	1.0080***	1.0127**
	(0.002)	(0.002)	(0.006)	(0.002)	(0.003)	(0.006)
unemployment	0.9868***	0.9886***	0.9948	0.9911**	1.0005	0.9849***
	(0.003)	(0.004)	(0.006)	(0.003)	(0.004)	(0.006)
diploma superior	1.1619***			1.1517***		
	(0.050)			(0.053)		
Constant	72.2676***	197.0072***	119.8877***	50.2212***	90.5718***	85.8583***
	(22.151)	(43.570)	(43.067)	(16.461)	(23.164)	(27.369)
Observations	24,674	12,246	12,246	24,674	12,246	12,246
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Prob > Chi2	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4935	2559	2557	4935	2559	2557

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6
Creation of individually owned companies in France for the years 2010–2015.

	Individually owned company		
	whole sample	high skilled	low skilled
very high-speed bb	1.0186***	1.0128**	1.0079
	(0.005)	(0.006)	(0.027)
establishment	0.9263***	0.9823	0.8822***
	(0.008)	(0.012)	(0.010)
households	0.9529	1.0186	1.4749***
	(0.042)	(0.043)	(0.136)
density	0.9506***	0.9662***	1.1795
	(0.012)	(0.013)	(0.181)
income	1.0044***	1.0029*	1.0067*
	(0.002)	(0.002)	(0.004)
unemployment	0.9969	0.9957	1.0061
	(0.002)	(0.003)	(0.004)
diploma superior	1.1678***		
	(0.035)		
no diploma	1.2229***	1.1656***	1.1641**
	(0.040)	(0.045)	(0.073)
Constant	21.8739***	68.5122***	84.1254***
	(8.041)	(24.073)	(44.169)
Observations	24,674	12,246	12,246
Employment groups	Yes	Yes	Yes
Year	Yes	Yes	Yes
Prob > Chi2	0.00	0.00	0.00
Municipality	4935	2559	2557

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5. Estimation results

Tables 3–6 show the estimation results of the impact of very high-speed broadband on the creation of establishments and sole proprietorships. For a better interpretation, all tables display the incidence rate ratios representing the exponentiated values of the regression coefficients.[34]

The first and forth columns of each table display results estimated on the whole sample. In the other columns, the estimations have been run on two sub-samples to take into account the level of education of the local population. The second and forth columns (high skilled) show the estimation results for municipalities having a high-skilled workforce, i.e. the log of the number of inhabitants having obtained a diploma from superior education is higher than or equal to the median. While the third and last columns, (low skilled), show the estimation results for municipalities having a low-skilled workforce, i.e. the log of the number of inhabitants having obtained a diploma from superior education is lower than the median.

The first column of Table 3 highlights a positive impact of very high-speed broadband on new business creation. The percentage change in the incidence rate of the creation of establishments is a 2.7% increase in municipalities having a very high-speed broadband network compared to the other municipalities. To better capture the effect of very high-speed broadband on the local economy, the establishments are disaggregated into the three main categories of the non-farm market sector: the industrial sector, the construction or building sector and the tertiary sector. As expected, municipalities benefit from the spill over of the local presence of very high-speed broadband networks, helping them to maintain and develop a healthy economic sector. However, the presence of very high-speed broadband networks does not have an impact on the creation of all types of establishments of the non-farm market sector.

Considering the whole sample, Tables 4 and 5 show that firms operating in the construction sector and in the commerce, service and transport sub-sector as well as firms providing services to households are more likely to enter municipalities in which there is a very high-speed broadband network. The percentage change in the incidence rate of company creation in the construction and in the commerce, service and transport sectors is a 4% increase in municipalities having a very high-speed broadband network compared to the other municipalities. The percentage change for company creation in the provision of services to households is a 1.8% increase. However, no effect has been found as regards company creation in the industry sector or in the provision of services to firms.

Table 6 highlights that municipalities with a very high-speed broadband network tend to be more attractive for sole proprietorships. The percentage change in the incidence rate of new individually owned company is a 1.9% increase in municipalities having a very high-speed broadband network compared to the other municipalities.

The estimation results tend to confirm the findings of McCoy et al. (2018), which suggest that on average areas covered by broadband are more attractive for firms. Besides, the estimation results are also in line with the empirical literature, especially the study from Audretsch, Belitski, and Desai (2015) which highlights a positive effect of broadband infrastructure on entrepreneurship in technology oriented sectors and the study from Gruber et al. (2014), which shows that economic benefits from the achievement of the 2020 Digital Agenda for Europe mostly spill over to users and to the national economy.

Overall, the results show that firms are more likely to settle in municipalities with larger market size and higher population density as well as in richer areas and areas with a lower unemployment rate. However, the concentration of the market has a negative impact on business creation. Municipalities in which there is a high number of firms already operating are less attractive for new firms. The results also highlight that firms tend to favor municipalities in which the proportion of highly educated inhabitants is higher.

This finding is conformed to the literature and relates also to another finding showing that the effects of broadband varies in magnitude depending on the population's level of skills. Broadband has been shown to be complementary with high-skilled workforce (see for example Akerman et al. (2015)). Therefore it is policy relevant to assess whether the benefits from very high-speed broadband are equally distributed across municipalities with higher educated population and lower educated population.

The results from Tables 3–6 highlight that educational attainment has a positive effect on the appropriation of the benefits of faster broadband technologies. The results show that municipalities with both a very high-speed broadband network and a number of inhabitants having a diploma from superior education superior or equal to the median are more attractive for firms. 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. This pattern holds for all sectors in which a positive effect of very high-speed broadband has been found, except for the commerce, service and transportation sub-sector.

As regards the magnitude of the incidence rate ratios, the are found to be similar for the sub-sample with high-skilled workforces and for the whole sample. This combined with the absence of significant effect of the presence of a very high-speed broadband on establishment creation in the low-skilled municipalities implies that educational attainment plays an important role in the appropriation of the benefits of faster broadband technologies.

As regards the creation of individually owned companies, the results also show that the presence of a very high-speed broadband is complementary to educational attainment. However, the percentage change in the incidence rate of new sole proprietorships is lower in the sub-sample of high-skilled areas compare to the whole sample (1.3% increase compared to 1.9% increase respectively). This could be explained by the fact that during a time of unemployment, some people who face difficulties to find a job may decide to create their own business. As mentioned previously this has been observed with the 2008 economic crisis in France. In both sub-

[34] The incidence rate ratio represents the change in the dependent variable in terms of a percentage increase or decrease, with the precise percentage determined by the amount the incidence rate ratio is either above or below 1.

samples and in the whole sample, the results highlights a positive impact on the number of inhabitants without a diploma on entrepreneurship.

6. Robustness checks

6.1. Model settings

In order to test the robustness of the results, estimations are conducted using panel data model with time-varying and time invariant fixed effects. Specific time trends are also added at the region/departement levels to control for geographical trends in establishment creation. There are 21 regions in metropolitan France and 94 departements.[35] Each region and departement has specific powers and may implement different tax regimes or policies which could make them more attractive for firms. Specifically, in accordance with the 2009 law on the digital gap, both regions and departements are competent to implement, initiate or ease the deployment of high-speed and very high-speed broadband networks.[36] As such, they can offer more interesting tax regime or ease the administrative burden for the operators. These specific policies may also benefit to other companies as spill-over effects.

Let's consider Equ.6 and use log-transformation for better interpretation,

$$\begin{aligned} ln\_new\_establishment_{it+1} = {} & \alpha + \delta\, superfastbb_{it} + \beta_1\, establishment_{it-2} \\ & + \beta_2\, ln\_households_{it-2} + \beta_3\, density_{it-2} + \beta_4\, income_{it-2} + \gamma_1\, unempl_{it-2} \\ & + \gamma_2\, perc\_uni\_diploma_{it-2} + \gamma_3\, employment\_groups_{it-2} + \mu\, year_t + \eta_i + \varphi_t + \varepsilon_{it}, \end{aligned} \tag{13}$$

where $ln\_new\_establishment_{it+1}$ represents the number of new companies (in log) that have been created in municipality i at time $t + 1$. The same independent variables as in Eq. (8) are included in the model. New establishments are also divided into the three non-farm market sectors of the economy and the tertiary sector is divided into three sub-sectors.

And we have for the sole proprietorship creation,

$$\begin{aligned} ln\_new\_proprietorship_{it+1} = {} & \alpha + \delta\, superfastbb_{it} + \beta_1\, establishment_{it-2} \\ & + \beta_2\, ln\_households_{it-2} + \beta_3\, density_{it-2} + \beta_4\, income_{it-2} \\ & + \gamma_1\, unempl_{it-2} + \gamma_2\, perc\_uni\_diploma_{it-2} + \gamma_3\, perc\_no\_diploma_{it-2} \\ & + \gamma_4\, employment\_groups_{it-2} + \mu\, year + \eta_i + \varphi_t + \varepsilon_{it}, \end{aligned} \tag{14}$$

where $ln\_new\_proprietorship_{it+1}$ represents the number of new sole proprietorships (in log) that have been created in municipality i at time $t + 1$. The same dependent variables as in Eq. (9) are included in the model.

6.2. Estimations results

Tables 7–9 show the estimation results of the impact of very high-speed broadband on the creation of establishments and of sole proprietorships. Tables 11–14 show the estimation results for two-samples: areas with high-skilled workforces, i.e. the log of the number of inhabitants having obtained a diploma from superior education is higher than or equal to the median (high skilled) and areas with low-skilled workforces (low skilled), i.e. the log of the number of inhabitants having obtained a diploma from superior education is lower than the median. In the first specification (1) there is no geographic specific time trend, in (2) specific time trends at the regional level are added, in (3) specific time trends at the department level are added.

The results highlight that the availability of very high-speed broadband networks favors local economic development by increasing the number of new establishments created locally. Table 7 confirms that the number of new establishments increases by an average of 2.8% with the presence of a very high-speed broadband network. This effect is reduce to 1.6% when adding region specific time trends and becomes insignificant with department specific time trends.

Distinguishing between the different sectors highlights the existence of heterogeneous effects from the presence of a very high-speed broadband network on company creation across the different sectors. In Table 8 a positive and significant impact is only found for the creation of establishments from the commerce service and transportation sector, in which firms rely more on ICT to conduct their business. In this sub-sector, the number of new establishments increases by 6%. This effect is reduced to a bit less than 4% with the introduction of region or department specific time trends.

The estimation results also highlight the existence of a positive impact of very high-speed broadband networks on the creation of sole proprietorships, with an increase in new companies created by one individual by roughly 1.8%. This effect is of somewhat similar amplitude with the introduction of region or department specific time trends (1.7% and 1.4% respectively).

Unlike the main model, Table 10 does not show any significant effect on the creation of establishments of either of the other two tertiary sub-sectors, i.e. the provision of services to companies and to households. In addition, very high-speed broadband networks is not found to have any significant impact on establishment creation in the industry and construction sectors (Tables 7 and 8).

However, taking into account the population's education level in the different municipalities leads to find similar results to the main negative binomial model. Table 11 confirms that companies are 2.5% more likely to be created in municipalities having both a

[35] Corsica represents also a region composed of two departements in metropolitan France, but is not included in the analysis.

[36] Law n^{r} 2009-1572 of the 17th december 2009 against the digital divide (relative a la lutte contre la fracture numerique).

Table 7
Establishment creation in all sectors and in the industry sector in France for the years 2010–2015.

	new establishment			new industry		
	(1)	(2)	(3)	(1)	(2)	(3)
very high-speed bb	0.0277***	0.0161**	0.0097	0.0011	−0.0115	−0.0065
	(0.007)	(0.007)	(0.007)	(0.018)	(0.018)	(0.019)
establishment	−0.0005***	−0.0006***	−0.0006***	−0.0002	−0.0005***	−0.0005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
households	0.2285***	0.2120***	0.2054***	0.1945*	0.3035***	0.2761**
	(0.058)	(0.059)	(0.061)	(0.116)	(0.118)	(0.121)
density	0.1914***	0.1505***	0.1184***	0.3075**	0.2608**	0.2072
	(0.038)	(0.030)	(0.030)	(0.125)	(0.128)	(0.131)
income	0.0049***	0.0037**	0.0032*	0.0048	0.0046	0.0020
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.005)
unemployment	−0.0048*	−0.0035	−0.0025	−0.0010	−0.0014	−0.0002
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)
diploma superior	0.0014	0.0004	0.0001	−0.0009	−0.0009	−0.0015
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Constant	3.3730***	3.4773***	3.3352***	0.2270	0.2999	0.4268*
	(0.093)	(0.094)	(0.100)	(0.211)	(0.216)	(0.233)
Observations	24,674	24,674	24,674	24,674	24,674	24,674
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	Yes	Yes	No	Yes	Yes
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4935	4935	4935	4935	4935	4935

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departmental specific time trend.

Table 8
Establishment creation in the construction sector and in the commerce, service and transport sub-sector in France for the years 2010–2015.

	new construction			comm serv transp		
	(1)	(2)	(3)	(1)	(2)	(3)
very high-speed bb	0.0180	0.0112	0.0010	0.0611***	0.0386***	0.0351**
	(0.017)	(0.017)	(0.018)	(0.013)	(0.013)	(0.014)
establishment	−0.0003***	−0.0004***	−0.0004***	−0.0006***	−0.0007***	−0.0007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
households	−0.0851	−0.0124	−0.0512	0.0566	0.0805	0.0685
	(0.114)	(0.119)	(0.124)	(0.099)	(0.103)	(0.106)
density	0.2831**	0.1734*	0.1753*	0.1254**	0.1092**	0.0537
	(0.113)	(0.092)	(0.099)	(0.049)	(0.046)	(0.044)
income	0.0126***	0.0122***	0.0107**	−0.0006	−0.0005	−0.0007
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
unemployment	0.0025	0.0016	0.0022	−0.0032	−0.0011	0.0008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
diploma superior	0.0048	0.0045	0.0048	−0.0007	−0.0023	−0.0032
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	1.3267***	1.3516***	1.3976***	2.4758***	2.4742***	2.2261***
	(0.202)	(0.204)	(0.225)	(0.175)	(0.180)	(0.191)
Observations	24,674	24,674	24,674	24,674	24,674	24,674
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	Yes	Yes	No	Yes	Yes
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4935	4935	4935	4935	4935	4935

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 9
Creation of individually owned companies in France for the years 2010–2015.

	Individually owned company		
	(1)	(2)	(3)
very high-speed bb	0.0183**	0.0167**	0.0143*
	(0.008)	(0.008)	(0.008)
establishment	−0.0004***	−0.0005***	−0.0006***
	(0.000)	(0.000)	(0.000)
households	0.2665***	0.1890***	0.1842***
	(0.061)	(0.064)	(0.066)
density	0.1633***	0.1342***	0.1047***
	(0.038)	(0.035)	(0.033)
income	0.0045**	0.0034	0.0029
	(0.002)	(0.002)	(0.002)
unemployment	0.0026	0.0034	0.0034
	(0.003)	(0.003)	(0.003)
diploma superior	0.0056**	0.0040*	0.0038
	(0.002)	(0.002)	(0.002)
no diploma	0.0064***	0.0055***	0.0053***
	(0.002)	(0.002)	(0.002)
Constant	2.4108***	2.6541***	2.5313***
	(0.169)	(0.170)	(0.175)
Observations	24,672	24,672	24,672
Employment groups	Yes	Yes	Yes
Year	Yes	Yes	Yes
Geographic time trend	No	Yes	Yes
Prob > F	0.00	0.00	0.00
Municipality	4935	4935	4935

Standard errors clustered at the municipal level in parentheses: *** $12p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 10
Establishment creation in the services to the companies and services to households sub-sectors in France for the years 2010–2015.

	service firms			service hh		
	(1)	(2)	(3)	(1)	(2)	(3)
very high-speed bb	0.0012	−0.0055	−0.0105	0.0142	0.0170	0.0103
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.014)
establishment	−0.0005***	−0.0005***	−0.0006***	−0.0004***	−0.0006***	−0.0006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
households	0.5211***	0.4266***	0.4823***	0.2864***	0.2397**	0.2041*
	(0.096)	(0.099)	(0.100)	(0.097)	(0.101)	(0.104)
density	0.1324	0.0573	0.0051	0.2872***	0.2826***	0.2737***
	(0.090)	(0.070)	(0.067)	(0.070)	(0.073)	(0.080)
income	0.0089**	0.0058	0.0052	0.0105***	0.0095**	0.0089**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
unemployment	−0.0100**	−0.0083*	−0.0071	−0.0111**	−0.0101**	−0.0102**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
diploma superior	0.0054*	0.0043	0.0034	0.0007	0.0002	0.0009
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	1.6433***	1.8418***	1.7631***	1.5830***	1.7658***	1.5886***
	(0.180)	(0.176)	(0.180)	(0.181)	(0.185)	(0.200)
Observations	24,674	24,674	24,674	24,674	24,674	24,674
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	Yes	Yes	No	Yes	Yes
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	4935	4935	4935	4935	4935	4935

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 11
Establishment creation in all sectors by workforce's skills level in France for the years 2010–2015.

	new establishment					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.025***	−0.001	0.018***	0.004	0.013**	−0.004
	(0.006)	(0.029)	(0.006)	(0.030)	(0.006)	(0.037)
establishment	−0.000***	−0.005***	−0.000***	−0.005***	−0.000***	−0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	0.030	0.452***	0.024	0.439***	0.033	0.416***
	(0.058)	(0.091)	(0.056)	(0.092)	(0.059)	(0.095)
density	0.145***	0.203***	0.094**	0.190***	0.057*	0.185***
	(0.047)	(0.077)	(0.038)	(0.070)	(0.034)	(0.065)
income	0.004**	0.008**	0.003	0.006	0.003	0.004
	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
unemployment	−0.008***	−0.002	−0.007***	−0.002	−0.006**	−0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	4.101***	2.937***	4.201***	3.071***	4.131***	2.729***
	(0.133)	(0.131)	(0.134)	(0.134)	(0.140)	(0.160)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, *y$p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departmental specific time trend.

Table 12
Establishment creation in the construction sector by workforce's skills level in France for the years 2010–2015.

	new construction					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.047***	−0.043	0.043**	−0.020	0.033*	−0.037
	(0.018)	(0.056)	(0.018)	(0.058)	(0.018)	(0.065)
establishment	−0.000	−0.005***	−0.000	−0.005***	−0.000	−0.005***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	−0.156	0.096	−0.121	0.178	−0.169	0.112
	(0.135)	(0.210)	(0.138)	(0.217)	(0.142)	(0.227)
density	0.316***	0.162	0.200*	0.105	0.164	0.101
	(0.118)	(0.179)	(0.104)	(0.157)	(0.106)	(0.168)
income	0.009	0.015*	0.006	0.016**	0.005	0.014
	(0.005)	(0.008)	(0.005)	(0.008)	(0.006)	(0.009)
unemployment	−0.000	0.007	−0.002	0.005	0.001	0.006
	(0.008)	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)
Constant	2.002***	0.872***	2.168***	0.928***	2.356***	0.708*
	(0.364)	(0.268)	(0.372)	(0.279)	(0.393)	(0.394)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob 12> F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 13
Establishment creation in the services to households sub-sectors by workforce's skills level in France for the years 2010–2015.

	new services to households					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.032**	−0.063	0.029**	−0.054	0.025*	−0.103
	(0.013)	(0.053)	(0.013)	(0.055)	(0.013)	(0.067)
establishment	−0.000*	−0.004***	−0.000***	−0.005***	−0.000***	−0.005***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	0.165*	0.392**	0.096	0.422**	0.113	0.364*
	(0.096)	(0.184)	(0.098)	(0.192)	(0.104)	(0.204)
density	0.144**	0.527***	0.109*	0.517***	0.108	0.558***
	(0.063)	(0.098)	(0.066)	(0.098)	(0.070)	(0.092)
income	0.014***	0.010	0.014***	0.006	0.014***	0.003
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.008)
unemployment	−0.002	−0.015**	−0.001	−0.015**	−0.001	−0.015**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
Constant	1.645***	1.434***	1.878***	1.748***	1.672***	1.515***
	(0.264)	(0.255)	(0.278)	(0.265)	(0.298)	(0.342)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** yy12$p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 14
Creation of individually owned companies by workforce's skills level in France for the years 2010–2015.

	new individual companies					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.019***	−0.021	0.018**	0.001	0.017**	−0.016
	(0.007)	(0.033)	(0.007)	(0.034)	(0.007)	(0.039)
establishment	−0.000	−0.005***	−0.000***	−0.005***	−0.000***	−0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	0.063	0.526***	0.001	0.447***	0.022	0.413***
	(0.065)	(0.110)	(0.067)	(0.113)	(0.068)	(0.117)
density	0.116***	0.168*	0.068*	0.171**	0.031	0.169**
	(0.044)	(0.089)	(0.040)	(0.087)	(0.038)	(0.082)
income	0.005**	0.008*	0.004*	0.006	0.004*	0.004
	(0.002)	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)
unemployment	−0.003	0.004	−0.003	0.005	−0.002	0.004
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)
no diploma	0.004**	0.002	0.003*	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	3.156***	2.306***	3.398***	2.442***	3.260***	2.241***
	(0.192)	(0.217)	(0.197)	(0.220)	(0.205)	(0.272)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Prob > F	No	No	No	No	No	No
Adj R-squared	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** 12$p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 15
Establishment creation in the commerce, service and transport sub-sector sector by workforce's skills level in France for the years 2010–2015.

	new comm serv transp					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.044***	0.063	0.026**	0.038***	0.025**	0.116*
	(0.013)	(0.053)	(0.012)	(0.013)	(0.012)	(0.067)
establishment	−0.000**	−0.006***	−0.000***	−0.001***	−0.000***	−0.006***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
households	−0.089	0.195	−0.015	0.072	0.008	0.167
	(0.108)	(0.168)	(0.107)	(0.102)	(0.114)	(0.182)
density	0.141***	0.063	0.099*	0.108**	0.024	0.146
	(0.055)	(0.082)	(0.052)	(0.046)	(0.053)	(0.091)
income	−0.008*	0.011	−0.008*	−0.001	−0.009**	0.014*
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)	(0.008)
unemployment	−0.012**	−0.001	−0.010*	−0.003	−0.009*	0.000
	(0.006)	(0.006)	(0.006)	(0.004)	(0.006)	(0.007)
Constant	3.476***	1.706***	3.361***	2.471***	3.218***	1.176***
	(0.270)	(0.248)	(0.273)	(0.180)	(0.292)	(0.283)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** yy$p < 0.05$, * 12$p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departmental specific time trend.

Table 16
Establishment creation in the industry sector by workforce's skills level in France for the years 2010–2015.

	new industry					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	0.008	0.009	−0.007	0.001	0.003	−0.012
	(0.020)	(0.044)	(0.021)	(0.047)	(0.022)	(0.061)
establishment	−0.000	−0.003**	−0.000**	−0.003**	−0.000**	−0.004***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	0.233	0.073	0.287*	0.199	0.247	0.211
	(0.168)	(0.170)	(0.172)	(0.173)	(0.180)	(0.178)
density	0.209	0.543***	0.146	0.526***	0.084	0.458***
	(0.151)	(0.092)	(0.152)	(0.092)	(0.150)	(0.108)
income	0.005	0.003	0.004	0.003	0.003	−0.000
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.007)
unemployment	−0.012	0.006	−0.012	0.006	−0.011	0.006
	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)
Constant	0.679	−0.023	0.788*	0.080	0.982**	−0.075
	(0.428)	(0.241)	(0.442)	(0.251)	(0.464)	(0.260)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 17
Establishment creation in services to the companies sub-sector by workforce's skills level in France for the years 2010–2015.

	new services to firms					
	(1)		(2)		(3)	
	high skilled	low skilled	high skilled	low skilled	high skilled	low skilled
very high-speed bb	−0.002	−0.004	−0.000	−0.013	−0.004	0.002
	(0.011)	(0.051)	(0.011)	(0.054)	(0.011)	(0.067)
establishment	−0.000	−0.006***	−0.000*	−0.006***	−0.000*	−0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
households	0.180*	0.946***	0.119	0.840***	0.136	0.856***
	(0.099)	(0.169)	(0.100)	(0.174)	(0.104)	(0.179)
density	0.154*	−0.126	0.087	−0.149*	0.044	−0.205**
	(0.079)	(0.100)	(0.070)	(0.090)	(0.069)	(0.103)
income	0.010***	0.006	0.008**	0.001	0.009**	−0.003
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)
unemployment	−0.016***	−0.003	−0.015***	−0.001	−0.014***	−0.001
	(0.005)	(0.007)	(0.005)	(0.007)	(0.005)	(0.007)
Constant	2.683***	1.295***	2.875***	1.463***	2.899***	1.200***
	(0.243)	(0.250)	(0.248)	(0.255)	(0.254)	(0.283)
Observations	12,348	12,326	12,348	12,326	12,348	12,326
Employment groups	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Geographic time trend	No	No	No	No	No	No
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Municipality	2661	2637	2661	2637	2661	2637

Standard errors clustered at the municipal level in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ with (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

Table 18
Summary of effects.

	Negative binomial model			Panel FE (1)		
	Whole Sample	High skill	Low skill	Whole Sample	High skill	Low skill
Geographic time trend	No	No	No	No	No	No
new establishment	2.7%	2.04%	–	2.8%	2.5%	–
new industry	–	–	–	–	–	–
new construction	4.32%	4.03%	–	–	4.5%	–
new comm serv transp	4.26%	2.99%	8.46%	6.1%	3.8%	7.4%
new service to firms	–	–	–	–	–	–
new services to households	1.77%	1.74%	–	–	3.7%	–
new individual companies	1.86%	1.13%	–	1.8%	2%	–
	Panel FE (2) Whole Sample	High skill	Low skill	Panel FE (3) Whole Sample	High skill	Low skill
Geographic time trend	Yes	Yes	Yes	Yes	Yes	Yes
new establishment	1.6%	1.6%	–	–	1.4%	–
new industry	–	–	–	–	–	–
new construction	–	3.7%	–	–	3.1%	–
new comm serv transp	3.9%	2%	3.5%	3.5%	–	11.4%
new service to firms	–	–	–	–	–	–
new services to households	–	3.8%	–	–	3.5%	–
new individual companies	1.7%	1.8%	–	1.4%	1.7%	–

Results are not significant. Incidence rate ratios are displayed for the negative binomial model, while percentage are displayed in the panel data models. With (1) no specific geographic time trend (2) regional specific time trend (3) departemental specific time trend.

very high-speed broadband network and a highly skilled workforce. This pattern holds also after adding region and departement time-trends but with coefficients of lower magnitudes (the effect is reduced to 1.8% with the introduction of region specific time trends and to 1.3% with department specific time trends).

Similar results are found for the creation of companies in the construction sector, in the provision of services to households sub-sector and in the creation of new sole proprietorship (Tables 12–14). Besides, the addition of region and department time-trend do not change the results and the coefficients maintain a somewhat similar magnitude. This highlights an unequal distribution of the benefits stemming from very high-speed broadband with the continuance of the divide between territories and people and show the importance of education in the digitalization of the society. Areas with a higher level of educational attainment are more likely to receive the economic benefits of the presence of a very high-speed broadband network.

The only sector which is not following this pattern is the commerce, service and transport sub-sector. Similarly to the results obtained with the negative binomial model, Table 15 shows that both areas with high-skilled and low-skilled workforces benefit from the presence of a very high-speed broadband network in terms of company creation in this specific sector. In addition, the impact of the presence of a very high-speed broadband network is higher in areas with low-skilled workforces. In these areas with low-skilled workforces, company creation in the commerce, service and transportation sub-sectors are 3.8% more likely than in similar areas without a very high-speed broadband network. In comparison, in areas with high-skilled workforces, company creation in that sector are 2.6% more likely than in similar areas without such network. This effect is strengthened after adding regional and especially department time-trend, for the areas with low-skilled workforces. Whereas the magnitude of the effect remains the same in areas with high-skilled workforces.

Similarly to the results obtained with the negative binomial model, Tables 16 and 17 show that there is no significant effect of the presence of a very high-speed broadband on company creation in the industry sector and in the provision of services to firms.

Overall, when taking into account the impact of education coupled with the presence of a very high-speed broadband networks, the estimation results for both the negative binomial and the panel data models converge. Table 18 provides a summary of the effects of the presence of a very high-speed broadband network on company creation for each model and specification.

7. Conclusion

This paper analyzes whether the presence of very high-speed broadband networks has a causal impact on the creation of new businesses and sole proprietorships operating locally. Based on micro-level panel data covering almost 5000 municipalities from 2010 to 2015, the estimation results confirm that the presence of next generations access networks enhances municipality attractiveness for the creation of new businesses. However, they also highlight heterogeneous effects across sectors and an unequal spatial distribution of their benefits depending on the education level of the local population.

As foreseen by policy makers and economic analysts, very high-speed broadband networks have on average a positive impact on the creation of establishments operating in the commerce, service and transport sector, where indirect jobs requiring ICT skills are mostly found. This result holds independently of the education level of the population. Moreover, municipalities in which a very high-speed broadband network has been deployed seem to provide a favorable environment for the creation of companies owned by one individual. However, in the construction sector and in the provision of services to households sub-sector, the benefits of the presence of a very high-speed broadband network are only visible in areas with high-skilled workforces.

Thus, the paper shows evidence of the benefits of very high-speed broadband networks on local economic growth, providing further grounds for policy makers to stimulate investments from private operators. However, the unequal distribution of their benefits underlines the importance of education in the digitalization of the society. Thus, it implies that broadband policies defined to promote broadband deployment could be accompanied by educations policies. More educated people are more likely to use new ICT-related technologies. To ensure that everyone having or not obtained a diploma from superior education has sufficient digital skills, specific ICTs courses could be implemented in primary and secondary schools to familiarize the young ones with the use of digital technologies.

Local government may also consider subsidizing or deploying their own very high-speed broadband networks to bring their benefits in areas were private investment is unlikely to occur. By financially supporting the deployment of broadband in areas which are not attractive for private operators, and defining appropriate education policies, local government may help to open up small or medium municipalities, contributing to their economic development and to the reduction of the digital divide.

A limitation of this paper is that the causal relation, intended to be estimated, between the local presence of very high-speed broadband networks and establishment creation may be subject to endogeneity. Though mitigated by the introduction of fixed effects, location specific time trends and lagged variables, the estimation results may suffer from an upward bias. In addition, the deployment of very high-speed network is relatively new. As a result, it is only possible, at this stage, to estimate short-term effects. Nevertheless, it fills a gap in the literature by providing empirical evidence on the impact of next generation broadband technologies on company creation and entrepreneurship at the local level.

In future research, when the broadband industry in France develops further and more detailed information becomes available, it may become possible to estimate longer-term effects. Besides, it may also become possible to include municipalities located in rural areas.

Appendix

Table 19
Data sources

Data	time-period	Source
fiber deployment by Orange	2010–2014	Orange's information system
fiber deployment by SFR	2010–2014	SFR's website
fiber deployment by Free	2010–2014	Free users' community + Free annual Reports
Cable upgrade to FttLA	2010–2014	Numericable's website
Copper upgrade to VDSL	2010–2014	Orange's information system
Population and population density	2006–2012	INSEE
Number of establishments	2009–2015	INSEE
Number of new establishments	2008–2015	INSEE
Number of new establishments per sector	2008–2015	INSEE
Number of new individual companies	2009–2015	INSEE
Unemployment rate (employment zone)	2010–2015	INSEE
Unemployment rate (municipality)	2006–2013	INSEE
Socio-professional groups	2006–2013	INSEE
Diploma	2006–2013	INSEE
Average fiscal income	2008–2015	DGFIP

Table 20
Summary Statistics of new establishment creation in municipalities in which there are no very high-speed broadband network and in municipalities in which such networks are present for 2010–2015

superfastbb		new estab	new industry	new construction
0	number	40136	30503	30503
	mean	53.74798	3.164476	7.954234
	sd	93.84598	5.056969	13.81333
	min	0	0	0
	max	2854	154	422
1	number	4556	4456	4456
	mean	291.8479	11.22195	35.08954
	sd	582.0718	22.13058	78.23895
	min	2	0	0
	max	6895	272	1382
Total	number	44692	34959	34959
	mean	78.02041	4.19151	11.413
	sd	218.2463	9.588983	32.06984
	min	0	0	0
	max	6895	272	1382

Table 21
Summary Statistics of new establishment creation in municipalities in which there are no very high-speed broadband network and in municipalities in which such networks are present for 2010–2015

superfastbb		comm serv transp	serv firm	serv hh	self-employment
0	number	30503	30503	30503	30507
	mean	17.03232	15.43491	12.37249	35.521
	sd	30.31258	28.87787	19.6356	58.23732
	min	0	0	0	0
	max	684	1140	650	1675
1	number	4456	4456	4456	4456
	mean	80.13106	97.59358	58.62118	170.6194
	sd	150.4043	214.3319	122.598	355.2885
	min	0	0	0	2
	max	1781	2629	1519	4609
Total	number	34959	34959	34959	34963
	mean	25.07512	25.90715	18.26751	52.73915
	sd	64.24479	85.63102	49.89729	145.1681
	min	0	0	0	0
	max	1781	2629	1519	4609

Table 22
Summary Statistics of municipalities characteristics depending on the presence of a very high-speed broadband network for 2010–2015.

superfastbb = 0	Obs	Mean	Std. Dev.	Min	Max
very high-speed bb	22,244	0	0	0	0—
Log households	22,244	.6018638	.7084372	-.5798185	4.287551
Density	22,244	.5082713	.8402949	.0061227	22.228
Income	22,244	24.83115	6.410401	11.70111	93.92572
Unemployment	22,243	8.068325	2.924978	.7879174	23.36437
Diploma superior	22,244	6.534982	.7916415	4.521789	10.2113
Employment Group 1	22,243	.9262509	1.262252	0	14.26941
Employment Group 2	22,243	4.370464	1.862798	.3215278	19.00736
Employment Group 3	22,243	8.507279	4.981792	.3703476	38.93547
Employment Group 4	22,243	16.48502	4.119012	4.417697	33.89401
Employment Group 5	22,243	18.58884	3.147126	6.259647	59.98574
Employment Group 6	22,243	15.70258	5.335259	1.518563	43.17521
superfastbb = 1	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
very high-speed bb	2431	1	0	1	1—
superfastbb = 1	2431	1.986916	1.200245	-.3424903	5.48361
Density	2431	3.386413	4.183277	.0690158	32.3145
Income	2431	28.60889	10.75691	13.63772	96.68176
Unemployment	2431	9.239826	3.157701	3.218383	20.0696
Diploma superior	2431	8.18004	1.222907	5.402678	11.8673
Employment Group 1	2431	.1766701	.4497058	0	5.977555
Employment Group 2	2431	3.391422	1.407479	.4860267	11.55946
Employment Group 3	2431	13.88258	8.134198	1.757328	39.82872
Employment Group 4	2431	17.36628	3.430124	6.318347	29.07394
Employment Group 5	2431	17.73534	3.258804	5.068726	31.66955
Employment Group 6	2431	11.27054	4.501131	1.487381	29.58163

Table 23
Evolution of company creations in France between 2002 and 2015
Sources: INSEE

	2002–2008	2008–2010	2010–2011	2011–2015
Industry	23%	124.5%	−15.7%	−12.3%
Construction	61.5%	65.6%	−11.5%	−21.8%
Commerce (retail)	50.1%	81.1%	−13.2%	−21.3%
Commerce (wholesale)	9.3%	10.4%	−13%	−2.3%
Accommodation restaurant	45.5%	33.5%	−5.8%	10.2%
Transportation	33.5%	27.2%	−1.9%	127.8%
Information and communication	59.1%	138.3%	−13%	−2.1%
Services to households	109.7%	212.5%	−22.8%	−28.9%
		2009–2010	2010–2011	2011–2015
Sole proprietorships		7.9%	−16.8%	−5.7%

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.telpol.2019.101873.

References

Akerman, A., Gaarder, I., & Mogstad, M. (2015). The skill complementarity of broadband Internet. *Quarterly Journal of Economics, 130*, 1781–1824.
Alama-Sabater, L., Artal-Tur, A., & Navarro-Azorin, J. M. (2011). Industrial location, spatial discrete choice models and the need to account for neighbourhood effects. *The Annals of Regional Science, 47*, 393–418.
Arauzo-Carod, J. M. (2008). Industrial location at a local level: Comments on the territorial level of the analysis. *Tijdschrift voor Economische en Sociale Geografie, 99*, 193–208.
Arauzo-Carod, J. M., & Manjon-Antolin, M. C. (2012). (Optimal) spatial aggregation in the determinants of industrial location. *Small Business Economics, 39*, 645–658.
Audretsch, D., Belitski, B., & Desai, S. (2015). Entrepreneurship and economic development in cities. *The Annals of Regional Science, 55*, 33–50 In press.
Becker, R., & Henderson, V. (2000). Effects of air quality regulations on polluting industries. *Journal of Political Economy, 108*, 379–421.
Bertschek, I., Cerquera, D., & Klein, G. J. (2013). More bits- more bucks? Measuring the impact of broadband Internet on firm performance. *Information Economics and Policy, 25*, 190–203.

Bhat, C. R., Paleti, R., & Singh, P. (2014). A spatial multivariate count model for firm location decisions. *Journal of Regional Science, 54*, 462–502.
Consul, & Jain (1973). A generalization of the Poisson distribution. *Technometrics, 15*, 791–799 In press.
Crandall, R. W., & Jackson, C. (2001). The $500 billion opportunity: The potential economic benefit of widespread diffusion of broadband Internet,. In L. Shampine (Ed.). *Down the wire: Studies on the diffusion and regulation of telecommunications technologies*. Nova Science Publisher.
Crandall, R. W., Litan, R. E., & Lehr, W. (2007). *"The effects of broadband deployment on output and employment: A cross-sectional analysis of U.S. Data" Issues in economic policy*. The Brooklin Institution Number 6.
Czernich, N. (2014). Does broadband Internet reduce the unemployment rate? Evidence for Germany. *Information Economics and Policy, 29*, 32–45.
Czernich, N., Falck, O., Kretschmer, T., & Wößmann, L. (2011). Broadband infrastructure and economic growth. *Economic Journal, 121*, 505–532.
Dutz, M., Orszag, J., & Robert, W. (2009). *The substantial consumer benefit of broadband connectivity for us households*. Compass Lexecon Internet Innovation Alliance.
Gillet, S. E., Lehr, W. H., Osario, C. A., & Sirbu, M.a (2006). *Measuring the Economic Impact of Broadband Deployment*Final Report National Technical Assistance, Training, Research and Evaluation Project No. 99-07–13829.
Greenstein, S., & McDevitt, R. C. (2011). "The broadband bonus: Estimating broadband internet's economic value. *Telecommunications Policy, 35*, 617–632.
Gruber, H., Hätönen, J., & Koutroumpis, P. (2014). Broadband Access in the EU: An assessment of future economic benefits. *Telecommunications Policy, 38*, 1046–1058.
Haller, A. H., & Lyons, S. (2015). Broadband Adoption and firm productivity: Evidence from Irish manufacturing firms. *Telecommunications Policy, 39*, 1–13.
Holt, L., & Jamison, M. (2009). Broadband and contributions to economic growth: Lessons from the US experience. *Telecommunications Policy, 33*, 575–581.
Jayakar, K., & Park, E. A. (2013). Broadband Availability and employment: An analysis of county-level data from the national broadband map. *Journal of Information Policy, 3*, 183–200.
Jofre-Monseny, J. R. M.-L., & Viladecans-Marsal, E. (2011). The mechanisms of agglomeration: Evidence from the effect of inter-industry relations on the location of new firms. *Journal of Urban Economics, 70*, 61–74.
Kolko, J. (2012). Broadband and local growth. *Journal of Urban Economics, 71*, 100–113.
Kretschmer, T. (2009). Information and communication technologies and productivity growth: A survey of the literature. *OECD Digital Economy Papers, 195*, 471–485.
Mack, A. E. (2014). Businesses and the need for speed: The impact of broadband speed on business presence. *Telematics and Informatics, 31*, 617–627.
Mack, A. E., Anselin, L., & Grubesic, T. H. (2011). The importance of broadband provision to knowledge intensive firm location. *Regional Science Policy & Practice, 3*, 17–35.
McCoy, D., Lyons, S., Morgenroth, E., Palcic, D., & Allen, L. (2018). The impact of local infrastructure on new business establishments. *Journal of Regional Science, 58*, 509–534.
Siedschlag, I., Zhang, X., & Smith, D. (2013). What determines the location choice of multinational firms in the information and communication technologies sector? *Economics of Innovation and New Technology, 22*, 581–600.
Whitacre, B., Gallardo, R., & Strover, S. (2014). "Broadband's contribution to economic growth in rural areas: Moving towards a causal relationship. *Telecommunications Policy, 38*, 1001–1023.