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Impact of Very High-Speed Broadband on Local Economic Growth: Empirical Evidence

Maude Hasbi*

Abstract

I estimate the impact of very high-speed broadband networks on some measures of local economic growth in France. I use panel data estimations with time- and municipal-fixed effects. I show that municipalities with a very high-speed broadband network tend to be more attractive for companies. I find a positive impact on the number of companies of all non-farm market sectors operating locally, along with a positive impact on company creation. In addition, municipalities with a very high-speed broadband network provide a more favorable environment for entrepreneurship, as it has a positive effect on the creation of sole proprietorships. The estimation results also show a positive impact on unemployment reduction.

Key Words: *Fiber; Very High-Speed Broadband; Local Economic Growth; Company Creation*

JEL Classification: L13, L50, L96

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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 the US,¹ Australia,² Japan,³ Mexico⁴ and a multitude of African countries⁵ have adopted a national broadband plan to ensure the whole coverage of their territory. In the European Union, the Commission has defined in 2013 a Digital Agenda for Europe, with the objective to provide by 2020 every household with access to at least 30 Mbps connection and half of the households with a subscription at 100 Mbps.⁶ 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). Very high-speed broadband includes both fast and ultra-fast broadband with speed above 30Mbps. In September 2016, the Commission reiterated its vision to turn Europe into a Gigabit Society by 2025.⁷

Higher connection speeds would allow all users, households, businesses and administrations, regardless of their size or geographic location, to benefit from enhanced and more efficient broadband services. It shapes the way companies do business, enhancing their capacities, broadening their markets. It improves households online experience, allowing them to use multiple connected devices at the same time, benefit from faster download speeds, carry on online transactions.

The contribution of this paper is to analyze whether very high-speed broadband availability has a causal impact on measures of local economic growth. Specifically, I investigate whether very high-speed broadband networks have an effect on the number of companies operating locally as well as on the creation of new businesses of all non-farm market sectors and on the unemployment rate. I highlight the impact of these networks on entrepreneurship, with a specific focus on sole

¹ "Connecting America: The National Broadband Plan, Federal Communications Commission," March 2010

² "The National Broadband Network" April 2009, modified in 2013

³ "E-Japan Strategy" 2001

⁴ "Mexican Digital Agenda" 2011

⁵ "National Information and Communication Technology Policy", final draft Nigeria, 2013; "National Projects for Broadband Connectivity" Burundi 2011

⁶ "A Digital Agenda for Europe," European Commission, COM(2010) 245.

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

proprietorships. I adopt a technology neutral approach by including all technologies delivering very high-speed services: fiber optical network (Fiber to the Home; FttH) and upgraded cable (Fiber to the Last Amplifier; FttLA). To the best of my knowledge, this is the first paper to estimate the impact of very high-speed broadband network on economic growth at a granular local level. The results provide policymakers with better insights on the role of very high-speed broadband for the local economy.

‘Digital technology currently represents 5.5% of the French GDP’, its share may increase by €100 billion by 2020.⁸ The digital economy contributed to \$79 billion to the Australian economy in 2013-2014, representing 5.1% of the Australian’s GDP.⁹ The deployment of next generation access networks (NGA) constitutes a major stake for economic and social development. Infrastructure investments have always been regarded as a tool of economic recovery in the short-term and as a factor of competitiveness and attractiveness in the long-term. The question is no longer whether broadband is important, it is already a must-have technology, but rather why not having it would be detrimental for a country economy.

This study relies on panel data covering more than 36,000 municipalities located in metropolitan France over 6 years, from 2010 to 2015. Panel data allows 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. 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.

To estimate the impact of very high-speed broadband networks on local economic growth, I use panel data analysis with time- and municipal-fixed effects. I also use matching estimator and difference-in-differences techniques as robustness checks. These evaluation methods are commonly used to estimate the average effect of a treatment or policy intervention.

I find evidence of the benefits of very high-speed broadband networks for local economic growth. They enhance municipalities attractiveness for companies, especially for companies from

⁸French Government’s website, March 2015 “9 things you didn’t know about France and digital technology”. Results taken from a 2012 study by McKinsey.

⁹“The Connected Continent II” 2015 Deloitte Access Economics Report, commissioned by Google

the tertiary sector, which rely more on ICTs. They also have a positive average effect on the number of companies operating in the construction sector, as their roll-out leads to an increase of the workload and may require the creation of direct jobs. In addition, municipalities with a very high-speed broadband networks provide a more favorable environment for entrepreneurship, as it has a positive effect on sole proprietorships. I also highlight the existence of positive spillovers for the local population. I observe a positive average effect on unemployment reduction.

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. Finally, Section 6 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 et al. (2014) and Kretschmer (2012) for broad literature reviews). It is widely accepted that, at the national level, ICT adoption has a positive effect in increasing productivity. However, ICT is a fairly large category regrouping basic equipments, such as computer, PCs, along with different types of Internet connections from narrowband to broadband of all speeds and more advanced fiber-optical broadband technologies.

With the steadily growing international enthusiasm for broadband deployment and today for the roll-out of high-speed broadband networks, researchers are becoming more interested in evaluating the role of broadband on economic growth. There is an extensive range of macro-level studies which bring empirical evidence on the positive impact of broadband adoption on economic growth (see Bertsek et al. (2013), Greenstein et al. (2011) and Holt et al. (2009) for comprehensive literature reviews). Gruber et al. (2014) evaluates 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 et al. (2001) and Dutz et al. (2009)). Thus, Gruber et al. (2014) highlight the rationale for public subsidies in the roll-out of broadband networks. Other studies for the US have found a positive association between broadband availability and employment (Crandall et al. (2007), Gillett et al. (2006)). However, there is limited empirical evidence of the effect of broadband availability on economic growth at the local level, especially 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 et al. (2013) for eight States in the US find no evidence that broadband availability reduces the unemployment rate. On the contrary, Whitacre et al. (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 to 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, literature focuses on broadband impacts on productivity and performances. Haller et al. (2015) show that on average more productive firms are more likely to have DSL broadband connection, but they find no evidence of broadband adoption on firm's 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 et al (2015) show that broadband availability and adoption increases 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 analysis the effect of broadband on the attractiveness of a territory for

firms. In her analysis, Mack (2014) evaluates the correlation between broadband speed and the establishment presence in Ohio. She finds a positive impact of broadband speed for agricultural and rural companies. However, she does not establish any causal relationship. Using local-level data, McCoy et al. (2016) analysis the impact of local infrastructure and of broadband networks on new business companies 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 focuses on the impact of old generation broadband technologies, such as DSL or co-axial cable 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). Besides, though realized at the local level, most of the studies are performed at a rather aggregated level, which is either the State or the county. I use data on more than 36,000 municipalities over 6 years, from 2010 to 2015. To the best of my knowledge, this is the first paper, which at such a granular local level, analyzes the impact of very high-speed broadband network on local economic growth. I specifically focus on the effect of very high-speed broadband networks on the number of firms operating locally, on the creation of new businesses and on unemployment.

3 Data

The data used in this analysis come from a wide range of sources covering a period which spans from 2006 to 2015. Descriptive statistics are available in Annex.

3.1 Dependent Variables

Data on the total number of companies and establishments, as well as on the number of company creations and 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 to 2015. For both companies and new companies, I have information for the three main non-farm market sectors: the industrial sector, the construction sector and the commerce, transport, service and administrative sector, i.e. the tertiary sector. For new establishments, I have data 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. Information were not available at the company level.

Unlike the establishment, which is a production unit geographically independent but juridically dependent of a company, the company is the smallest combination of legal and production unit. Therefore, the number of companies is smaller or equal to the number of establishments in a municipality.

Data on the unemployment rate also comes from INSEE. It is measured at the employment zone level for the years 2010 to 2015. In France, the employment zone is a higher administrative unit than the municipality.¹⁰ There are 297 employment zones in metropolitan France.

3.2 Very high-speed Broadband Networks

The main data on optical fiber deployment constitutes a panel of fiber deployment in metropolitan France (Corsica excluded) over 9 years, from 2006 to 2014. They have been extracted from Orange's Information System, SFR's website and Free users' community websites. Orange is the historical fixed-line incumbent. It owns the legacy copper network, which is used to provide DSL broadband services. SFR and Free are entrants 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).¹¹ All databases provide information at the municipal level with each municipality identified by a unique geographic code (the INSEE code). I have information on 36,036 French municipalities out of the 36,192 municipalities counted in metropolitan France in 2014. For each municipality, I know whether Orange and/or SFR has deployed an FttH

¹⁰According to INSEE definition an employment zone represents a geographical area within which most of the labor force lives and works and in which establishment can find the main part of the labor force.

¹¹Orange, SFR and Free are also the main competitors on the mobile market.

network.¹²

Regarding Free’s data, they have been extracted on an unofficial website updated by Free’s users community.¹³ The data are consistent with information gathered on other websites, as well as with Free’s Annual Reports. For each municipality, I know whether there are active fiber connections.

Second, data on cable upgrade to FttLA have been extracted from Numericable’s website for the years 2010 to 2014. Numericable, is the French cable-operator.¹⁴ For each municipality, I know whether Numericable has upgraded its cable network to provide very high-speed broadband services.

Finally, variables on the copper network have been taken from two databases coming from Orange’s Information System for the years 2010 to 2014. They provide information on the number of VDSL lines both at the Main Distribution Frame (MDF) and at the municipality level.

3.3 Explaining Variables and Controls

This database has been completed with two other sources. First, socio-demographic characteristics come from INSEE. I have economic data such as the unemployment rate at the municipal level for the years 2006 to 2013. Information on the different socio-professional groups and diplomas have also been collected for the years 2006 to 2013. Some other municipality characteristics have also been extracted from INSEE databases, such as population density, number of households, number of housing, the municipal urbanization degree. These information have all been collected by INSEE for the years 2006 to 2012.

Second, data on the average fiscal income per municipality has been collected from the General Direction of Public Finance’s website (Gouvernement Taxes Services, DGFIP) for the years 2007 to 2014. The average fiscal income is measured in the previous year, as people pay

¹²The database used in this study is similar to the one used in Bourreau, Grzybowski and Hasbi “Unbundling the Incumbent and Entry into Fiber: Evidence from France”. For further details upon the database construction and data collection, please refer to the aforementioned paper.

¹³See <http://francois04.free.fr/> and <http://serge.31.free.fr/>

¹⁴Numericable’s cable network covers 30% of the population living mostly in urban areas.

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.

4 Econometric Strategy

The choice of a location for a new company to operate is a fundamental decision, key to its success. Companies incur a high fixed cost when settling down. The choice of the company is driven by cost factors, such as the tax regime in the locality, the availability of infrastructures, such as transportation infrastructures, 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 Empirical Approach

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.¹⁵ 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.¹⁶ 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.¹⁷

Considering the type of data available, I implement a count model to address my main

¹⁵See Arauzo-Carod (2008) and Arauzo-Carod and Manjon-Antolin (2012) for a thorough discussion. For recent studies, see Alama-Sabater et al. (2011) and Siedschlag et al. (2013)

¹⁶See Jofre-Monseny et al. (2011) and Bhat et al. (2014).

¹⁷Following Becker and Henderson (2000) the equilibrium condition can be represented by a reduced form stochastic distribution for the count of new businesses.

question, which is whether very high-speed broadband networks have a causal effect on some socio-demographical variables of policy relevance: the number of companies operating locally, the number of new companies, both disaggregated into the three main non-farm market sectors of the economy: the construction sector, the industrial sector and the tertiary sector. I also estimate whether the presence of these networks has an impact: on entrepreneurship with the creation of sole proprietorships and on unemployment.

I follow the econometric literature by using a fixed effects model to eliminate potential endogeneity stemming from time-varying and time-unvarying regressors. The count of new companies operating in a municipality for each time period are modeled as a function of the local characteristics, with municipal- and time-fixed effects.

Then, I have,

$$Y_{it+1} = \alpha + \delta \textit{superfastbb}_{it} + \beta X_{it-2} + \gamma Z_{it-2} + \textit{year} + \eta_i + \epsilon_{it}. \quad (1)$$

Where :

$$Y_{it+1} = 0, 1, 2, \dots \quad (2)$$

Y_{it+1} is either the count of companies or the count of new companies or 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 has been deployed in municipality i at time t . I adopt a technology neutral approach by including all technologies through which very high-speed broadband services can be delivered: fiber optical network (FttH) and upgraded cable network (FttLA).

X_{it-2} is a matrix of location characteristics for municipality i at time $t - 2$ and Z_{it-2} a matrix of labor market characteristics for municipality i at time $t - 2$. η_i is a time unvarying fixed effect describing the influence of specific municipal characteristics, which may affect the attractiveness of the municipality and therefore bias the outcome of interest. For example, this can include a

specific tax regime to attract companies, a lower costs of capital, different regulations applying to real-estate, the presence of a specific regional policy. $year$ is a dummy variable for each year capturing year specific fixed effects. ϵ_{it} is an i.i.d. standard error clustered at the municipal level, capturing unobserved factors.

4.2 Potential Endogeneity

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 et al. (2011), McCoy et al. (2016)). This effect materializes mostly as reverse causality between the number of companies operating locally or the unemployment rate and very high-speed broadband availability.

In their analysis of the impact of local infrastructure on new business establishment, McCoy and al. (2016) argues that the endogenous relationship that may exist between broadband networks and companies is more likely to affect the stock of existing companies rather than the flow of company creations. I follow their argument and I estimate not only the impact of very high-speed broadband networks on the count of companies operating locally, but also on the count of new company creations.

The local labor market variable may also suffer from reverse causality. It includes the proportion of people with a third-level diploma, the number of people from the different socio-professional groups and the unemployment rate. To alleviate this concerns, I use 2 years lagged variables. I conduct robustness checks with lags of 3 years and 1 year, which give similar qualitative results. Besides, I estimate the impact of very high-speed broadband on local economic growth with other modeling approaches as robustness checks.

4.3 Empirical Models

In their decision to settle in a locality, I expect firms to be influenced by the potential market size and the quality of demand, in terms of expected purchasing power. In additions, I expect

that firms take into account the level of education and the composition of the population, in terms of qualification. I use lag variables of two years to control for potential issues of reverse causality.¹⁸

Then, I have considering the number of companies,

$$\begin{aligned} \ln_company_{it+1} = & \alpha + \delta \textit{superfastbb}_{it} + \beta_1 \textit{establishment}_{it-2} + \beta_2 \ln_households_{it-2} \\ & + \beta_3 \textit{density}_{it-2} + \beta_4 \textit{income}_{it-2} + \gamma_1 \textit{unempl}_{it-2} + \gamma_2 \textit{perc_uni_diploma}_{it-2} \quad (3) \\ & + \gamma_3 \textit{socio_professional_groups}_{it-2} + \textit{year} + \eta_i + \epsilon_{it}. \end{aligned}$$

Where $\ln_company_{it+1}$ represents the number of companies (in log) operating in municipality i at time $t + 1$ and $\textit{establishment}_{it-2}$ represents the number of establishments operating in municipality i at time $t - 2$. Unlike the establishment, which is a production unit geographically independent but juridically dependent of a company, the company is the smallest combination of legal and production unit. Therefore, the number of companies is smaller or equal to the number of establishments in a municipality. As a matter of fact, the number of companies in a locality is highly correlated with the number of companies in the previous years. I control for firm characteristics by disaggregating the companies into the three non-farm market sectors of the economy: the construction sector, the industrial sector and the tertiary sector.

I also add the number of households (in log) in municipality i at time $t - 2$, which is a proxy for the market size, as well as the population density in municipality i at time $t - 2$. Besides, I add the average fiscal income and the unemployment rate in municipality i at time $t - 2$. Both variables are approximations for the quality of demand, in terms of purchasing power.

As education plays a role on the decision of firms to operate locally, I add the percentage of inhabitants with a diploma from superior education in municipality i at time $t - 2$, as well as, the number of inhabitants of the different socio-professional groups in municipality i at time $t - 2$, which are a proxy for the qualification of the population. There are 6 socio-professional groups: group 1: Farmers; group 2: Craft workers, retailers, and business owners; group 3: Intermediate

¹⁸For all specifications different lags have been estimated, results are qualitatively similar.

occupations ; group 4: White collars; group 5: Employees; group 6: Blue collars.

η_i is a time unvarying fixed effect describing the influence of specific municipal characteristics, which may affect the attractiveness of the municipality and therefore bias the outcome of interest. $year$ is a dummy variable for each year capturing year specific fixed effects. ϵ_{it} is an i.i.d. standard error clustered at the municipal level, capturing unobserved factors.

Similarly, I have considering the number of company creations,

$$\begin{aligned} \ln_new_company_{it+1} = & \alpha + \delta \textit{superfastbb}_{it} + \beta_1 \textit{establishment}_{it-2} + \beta_2 \ln_households_{it-2} \\ & + \beta_3 \textit{density}_{it-2} + \beta_4 \textit{income}_{it-2} + \gamma_1 \textit{unempl}_{it-2} + \gamma_2 \textit{perc_uni_diploma}_{it-2} \\ & + \gamma_3 \textit{socio_professional_groups}_{it-2} + year + \eta_i + \epsilon_{it}. \end{aligned} \quad (4)$$

Where $\ln_new_company_{it+1}$ represents the number of new companies (in log) that have been created in municipality i at time $t+1$. I use the same set of explanatory variables. I also control for firm characteristics by disaggregating the new companies into the three non-farm market sectors of the economy.

The tertiary sector is the one which is predicted to benefit the most from the presence of very high-speed broadband. However, this sector is quite large and includes activities ranging from commerce, transportation, services and administration. It is however possible to disentangle the effects of very high-speed broadband networks on the creation of establishments from three sub-sectors: the commerce, transport and services; the provision of services to companies and the provision of services to households.

Then, I have considering the number of new establishments from the tertiary sector,

$$\begin{aligned} \ln_new_estab_{it+1} = & \alpha + \delta \textit{superfastbb}_{it} + \beta_1 \textit{establishment}_{it-2} + \beta_2 \ln_households_{it-2} \\ & + \beta_3 \textit{density}_{it-2} + \beta_4 \textit{income}_{it-2} + \gamma_1 \textit{unempl}_{it-2} + \gamma_2 \textit{perc_uni_diploma}_{it-2} \\ & + \gamma_3 \textit{socio_professional_groups}_{it-2} + year + \eta_i + \epsilon_{it}. \end{aligned} \quad (5)$$

Where $\ln_new_estab_{it+1}$ represents the number of new establishments from the tertiary sector

that have been created in municipality i at time $t+1$. Similarly, I use the same set of explanatory variables as previously.

In addition, I make 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.

Considering the number of new sole proprietorships,

$$\begin{aligned} \ln_new_proprietorship_{it+1} = & \alpha + \delta \textit{superfastbb}_{it} + \beta_1 \textit{establishment}_{it-2} + \beta_2 \ln_households_{it-2} \\ & + \beta_3 \textit{density}_{it-2} + \beta_4 \textit{income}_{it-2} + \gamma_1 \textit{unempl}_{it-2} + \gamma_2 \textit{perc_uni_diploma}_{it-2} \\ & + \gamma_3 \textit{perc_no_diploma}_{it-2} + \gamma_4 \textit{socio_professional_groups}_{it-2} + \textit{year} + \eta_i + \epsilon_{it}. \end{aligned} \quad (6)$$

Where $\ln_new_proprietorship_{it+1}$ represents the number of new sole proprietorships (in log) that have been created in municipality i at time $t+1$. I add in the set of explanatory variables, the percentage of inhabitants with no diploma in municipality i at time $t-2$. As during a time of unemployment, some people which 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 descriptive statistics).

Considering the unemployment rate, I estimate a panel data model with fixed effects. Then I have,

$$\begin{aligned} \textit{unempl}_{et+1} = & \alpha + \delta \textit{superfastbb}_{it} + \beta_1 \textit{establishment}_{it-2} + \beta_2 \ln_households_{it-2} \\ & + \beta_3 \textit{density}_{it-2} + \beta_4 \textit{income}_{it-2} + \gamma_1 \textit{unempl}_{it-2} + \gamma_2 \textit{perc_uni_diploma}_{it-2} \\ & + \gamma_3 \textit{socio_professional_groups}_{it-2} + \textit{year} + \eta_i + \epsilon_{it}. \end{aligned} \quad (7)$$

Where \textit{unempl}_{et+1} represents unemployment rate in employment zone e at time $t+1$. As said previously, there are less employment zones than municipalities. Similarly, I use the same set of explanatory variables as previously.

Nevertheless, I also estimate all specifications 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 amplitudes.¹⁹ The same exercise has been made without the different socio-professional groups, results are also qualitatively similar.

I expect to find a positive average effect of very high-speed broadband networks on local economic growth. Municipalities would appear more attractive for companies, especially for those operating in the tertiary sector, in which most of the businesses using ICTs belong. On the short-term, it is also expected that the roll-out of very high-speed broadband networks enhances activities in the construction sector. The benefits of very high-speed broadband networks are also expected to spill over to households. As far as unemployment is concerned, it is difficult to expect any significant impact in such a short time period. Investment in broadband network is seen by economists and policy makers as a way to increase productivity in the short-term, reducing employment. However, it should lead to the creation of new high-skill jobs in the long term, having a net positive effect. Therefore, if a positive effect could be expected in the long-term, it would take time to materialize in the statistics.

5 Estimation Results

Tables 5 and 6 show the estimation results of the impact of very high-speed broadband on companies, company and establishments creation and unemployment.

The model is estimated using a sub-dataset, which excludes the three main French agglomerations Paris, Lyon and Marseille. 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.²⁰ In addition, only municipalities with at least 2,000 inhabitants are included in the database. It is rather unlikely that private operators deploy a very high-speed broadband

¹⁹Results are available upon request.

²⁰Population 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 there is no arrondissement in Toulouse.

network in a municipality with less than 2,000 inhabitants. Therefore the database includes 4,933 municipalities over 6 years, from 2010 to 2015.

I find that the deployment of very high-speed broadband networks favors local economic development by increasing the number of companies operating locally. Table 5 shows that the number of companies increases by an average of 3.2% with the presence of a very high-speed broadband network.

To better capture the average effect of very high-speed broadband on the local economy, the companies 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. Very high-speed broadband networks tend to have on average a positive impact on all types of companies of the non-farm market sector. The amplitude of its positive impact tends to be higher for companies belonging to the construction sector, which is essentially an activity of deployment, installation or maintenance on the customer's work-site. Table 5 highlights a positive impact of very high-speed broadband on the number of companies from the construction sector, which increases by 4.7%.

I also find a positive impact of 2.7% on the number of companies from the tertiary sector, which rely more on ICT to conduct their business. 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.

The impact of very high-speed broadband networks seems to be the lowest on the number of companies from the industrial sector, which increases by 1.4%. The industrial sector is also implicated in network deployments but to a lower extent than companies from the construction sector. The industrial sector regroups all activities combining factors of production (facilities, supplies, work, knowledge) to produce material goods intended for the market. Therefore, unlike the companies from the construction sector which in the short-term encounter an increase in

their workload, companies from the industrial sector have a more stable production pace.

The increase in the number of companies from the construction sector could be the result of the construction of the infrastructure itself. The roll-out of a network may imply the creation of direct jobs, such as technicians, manual workers as civil engineering represents the major part of the work. Then, to a lower extent, direct jobs are also created in the industrial sector to manufacture the in-site telecommunication equipments and also all related devices or receptors such as the set-up boxes. Finally, indirect jobs are created in businesses that use ICT to operate, those ones are mostly present in the tertiary sector. This sector has been predicted to benefit the most from very high-speed broadband networks in the long-term.

The effects measured in the first part of Table 5 are based on the net number of companies resulting from the creation of new companies and the disappearance of those having ceased their activities. To get a better understanding of how the presence of very high-speed broadband networks can enhance municipality attractiveness to incentivize new companies to settle down, the second part of Table 5 shows the estimated effects of the presence of very high-speed broadband networks on the number of new local companies.

The results confirm a positive and significant impact of the presence of very high-speed broadband networks on company creation, which increases by an average of 2.7%. However, results are significant only for the number of new companies from the tertiary sector, which also increases by an average of 2.7%.

Nevertheless, the tertiary sector is fairly large and includes activities ranging from commerce, transportation, services and administration. Therefore, I estimate the impact of very high-speed broadband networks on some sub-sectors: the commerce, service and transportation; the provision of market services to households and the provision of market services to firms. The difference is that the estimations are run on the number of establishment creations for these sub-sectors. However only one specification displays a significant coefficient. I find a positive effect of very high-speed broadband on establishment creation for the commerce, service and transportation sub-sector. Table 6 shows that establishment creations in this sub-sector increases

by 6% in municipalities with a very high-speed broadband network.

Estimation results from Table 5 and the first part of 6 tend to confirm the findings of McCoy et al. (2016), which highlight that on average areas covered by broadband are more attractive for firms.

In addition, the second part of Table 6 highlights 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 2%. Similarly, the presence of very high-speed broadband networks also has an average positive impact on unemployment reduction, which decreases by an average of 7 percentage points.

These latter estimation results from Table 6 are in line with the empirical literature, especially the study from Gruber (2014), which finds that economic benefits from the achievement of the 2020 Digital Agenda for Europe mostly spill over to users and to the national economy. They are also confirmed by the study of Whitacre et al. (2014) which also finds a positive impact of broadband adoption on unemployment reduction.

5.1 Robustness Checks

In order to test the validity of the results obtained, I first conduct estimations on the same database as previously using the nearest neighbor (difference-in-differences) matching estimator method (Model 1). Besides, I estimate the same panel data model with fixed effects (Model 2) on a subsample, keeping only municipalities in which a very high-speed broadband network has been deployed in 2013 and municipalities in which no very high-speed broadband network has been deployed between 2010 and 2014. On the subsample, I also estimate a difference-in-differences model (Model 3). Lag variables are used to attenuate potential endogeneity problems. For all specifications different lags have been estimated, results are qualitatively similar. Besides all specifications for Model 2 and Model 3 have been estimated without the number of establishments in municipality i at time $t - 2$, results are qualitatively similar.

Tables 7 and 8 show estimation results for the average effect of very high-speed broadband

networks on local economic growth. Table 9 shows covariate balance statistics and assesses balance between treatment groups in the means and in the variances.

Tables 10 and 11 show results for the panel data model with fixed effects for deployments in 2013; Tables 12 and 13 show results for the difference-in-differences model for deployments in 2013. Figures 1 to 3 show the parallel trends assumption between the treated and the control group for some variables of local economic growth.

Table 14 provides an overview of the estimation results for all models.

5.2 Matching Estimator

Matching techniques are non-parametric estimators used to estimate average treatment effect (ATE). ATE are commonly used to measure the average impact of a treatment or a program intervention, by measuring the difference in outcome between a treated group and a control group (Rosenbaum and Rubin (1983)).

$Y_{it+1}(1)$, $(Y_{it+1}(0))$ denotes an outcome which is realized in time $t + 1$ if municipality i receives (doesn't receive) at time t a treatment $d_{it} = 1$ ($d_{it} = 0$).

The outcome of interest could either be the number of companies operating locally, the number of new companies or of new establishments or the unemployment rate. The treatment variable consists in a dummy variable indicating whether a treatment has been applied, i.e. whether a very high-speed broadband network is deployed in municipality i at time t . The control group consists in otherwise similar municipalities in terms of observable characteristics.

Then, the average treatment effect on the treated (ATT), which represents the average gain from the treatment for those who actually were treated, writes as follows:

$$ATT = E(\Delta Y_{it+1}(1) \mid d_{it} = 1) - E(\Delta Y_{it+1}(0) \mid d_{it} = 1) \quad (8)$$

The first term represents the expected value of the outcome of interest, in time $t + 1$, in municipalities in which a treatment has been received in time t , which is observable. However, the second term in Eq.(8) is non-observable. It represents the expected value of the outcome of

interest, in time $t + 1$, for the control group, had a treatment been received in time t . When evaluating the impact of a policy, or here of an investment decision, the researcher faces an identification issue. Besides, the treatment distribution may suffer from a selection bias. Considering the high costs of deployment, operators will select the municipalities in which to invest first depending on their return prospects. To alleviate these issues, matching estimators seek to reproduce the treatment group among the non-treated group using observable characteristics. Then the key parameter is to identify the relevant set of matches. Besides to avoid reverse causality, I use lag variables of two years.

Enter in the set of matches the number of households (in log), the population density, the average fiscal income and the unemployment rate all in municipality i at time $t - 2$. In addition, to match municipalities with the same type of economy, I introduce the percentage of companies from the commerce and service sector in municipality i at time t .

Then, the set of relevant matches is:

$$ln_households_{it-2}, density_{it-2}, income_{it-2}, unempl_{it-2}, perc_estab_commserv_{it}, year. \quad (9)$$

I expect to find slightly higher effects than with the previous model, as the average effects are estimated on the treated population.

Table 7 confirms the results obtained with the panel data model. I find that the number of companies increases by an average of 3.9% with the presence of a very high-speed broadband network. The number of companies from the industry sector is estimated to increase by an average of 4.1%. I also find a positive impact of very high-speed broadband networks on the number of companies from the tertiary sector, which increases by an average of 3.8%. Unlike in the previous estimation, the impact of very high-speed broadband network on the number of companies from the construction sector is not significant.

As regard the impact of very high-speed broadband networks on the creation of new companies, I find a positive average effect of 4.9%. Similarly, the number of new companies from

the tertiary sector increases by an average of 4.7%. Unlike in the previous estimation, I found a positive average impact on the creation of companies in the industry sector, which increases by 7%. However, the impact of very high-speed broadband networks on the number of new companies from the construction sector is still not significant.

Table 8 also confirm results from the panel data estimation as regard the creation of sole proprietorships. Municipalities in which a very high-speed broadband network has been deployed seem to favor entrepreneurship, with an average increase in the number of new sole proprietorships of 4.8%. However, estimation results are insignificant for unemployment, as well as for the number of new establishments in the commerce service and transport sector and for new establishments providing market services to households. Nonetheless, I find a positive impact on the creation of establishments providing market services to firms, which increases by an average of 5.6%.

5.3 Panel Data Model with Fixed Effects and Difference-in-Differences for Deployments in 2013

A second robustness check has been conducted using the same model as previously, but on a subsample (model 2). I still use the count modeling approach to estimate the impact of very high-speed broadband network on the number of companies and on company and establishment creation.

As previously, only municipalities with more than 2,000 inhabitants are included in the database. However, only municipalities in which a very high-speed broadband network has been deployed in 2013 and municipalities without a very high-speed broadband network between 2010 and 2014 are included in the sample in order to have the same structure as for model 3. In 2013, very high-speed broadband networks have been rolled-out in 430 municipalities, i.e. corresponding to 30% of the municipalities in the subsample. With the modification of the regulatory framework, private operators have intensified the deployment for this year compare to the years before, this is why the robustness checks has been conducted for this time period.

I use similar covariates as for the main econometric models, except for model 3 where the socio-professional variables are excluded for more coherence with the model structure.²¹

On this subsample, I run a third robustness check using a difference-in-differences model (model 3) for deployments occurring in 2013.²² This model is estimated to validate the results obtained with the panel data model with fixed effects. Model 3 aims at comparing the outcome of interest, i.e. the number of companies, of new companies, of new establishments and the unemployment rate, in the treated group (where a very high-speed broadband network has been deployed) and in the control group by estimating δ in a standard difference-in-differences model defined as:

$$Y_{it+1} = \alpha + \theta \textit{after}_t + \delta (\textit{after}_t * \textit{superfastbb}_i) + \beta X_{it-2} + \gamma Z_{it-2} + \textit{year} + \eta_i + \epsilon_{it}. \quad (10)$$

Where *superfastbb_i* indicates municipalities in which a very high-speed broadband network has been deployed and *after_t* the time period after the deployment (after 2013). As previously, *X_{it-2}* is a matrix of location characteristics for municipality *i* at time *t* − 2 and *Z_{it-2}* a matrix of labor market characteristics for municipality *i* at time *t* − 2. η_i is a time unvarying fixed effect, *year* a time fixed effect and ϵ_{it} an iid standard error, clustered at the municipal level.

I find that with the presence of a very high-speed broadband network, the number of companies increases by an average of 4% for model 2 and 4.6% for model 3. The number of companies increases by 1.8% (model 2) and 2.5% (model 3) for the industry sector, 6.3% (model 2) and 7.1% (model 3) for the construction sector and 3.2% (model 2) and 3.8% (model 3) for the tertiary sector.

As regard the impact of very high-speed broadband networks on new companies from all

²¹Estimations have been run including the socio-professional groups, the results are qualitatively similar, with slightly higher coefficients.

²²There were not enough municipalities in which a network has been deployed in 2010, 2011 to set up alternative specifications using the difference-in-differences methods. Besides, I lack data for the year 2015 to define an additional specification for the year 2014.

sectors of the non-farm markets, their number increases by an average of 4.7% (model 2) and 5.2% (model 3). The number of company creation increases by an average of 4.8% (model 3) for the industry sector; it is not significant for model 2. Business creation increases by 4.7% (model 2) and 5% (model 3) for the tertiary sector. There is no significant impact of very high-speed broadband networks on company creation in the construction sector for both models.

Having a look into the tertiary sector, I observe a large effect of very high-speed broadband networks on establishment creation in the commerce, service and transportation sector, which increases by an average of 9.4% (model 2) and 10% (model 3). However, there is no significant effects on the other sub-sectors. Very high-speed broadband networks also have a positive impact on the number of new sole proprietorships which increases by an average of 4.5% (model 2) and 4.8% (model 3) and on unemployment reduction, with a decrease of 6.9 percentage points (model 2) and 8.7 percentage points (model 3).

Estimations results from the difference-in-differences model confirms results obtained with the panel data model with fixed effects.

6 Discussion

Very high-speed broadband networks are considered by policy makers to be a significant factor of economic growth in many sectors of the economy. There is a large consensus among economists to support the benefits of infrastructure investment for the national economy. Many countries worldwide have adopted a national broadband plan, in which they set ambitious objectives for broadband availability.

As infrastructure investment produces spill overs, it affects all sectors of the national economy. However, the economic benefits vary significantly across sectors. Considering the evolution of the number of companies, we observe that the presence of a very high-speed broadband network has a direct effect on the construction sector, as it leads to job creation to deploy the network. It also stimulates further investment in ICT systems or devices, which positively benefits the industrial sector. As foreseen by policy makers and economic analysts, very high-speed

broadband networks have on average a positive impact for companies operating in the tertiary sector, where indirect jobs requiring ICT skills are mostly found.

However, if we take into account the average impact of very high-speed broadband networks on company creation, the estimation results reveal a mixed picture. Though they confirm that the presence of very high-speed broadband networks enhances municipality attractiveness for new businesses operating in the tertiary sector, they are not significant for establishment creation in the construction and industry sectors. Both results are not antinomic, as very high-speed broadband networks could have a positive effect on maintaining a healthy economy, by reducing the rate of establishment dissolution. Besides, I observe a positive effect on sole proprietorships. 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. I also find that very high-speed broadband networks' benefits spill over to the local population, as unemployment decreases.

Thus, this paper highlights the benefits of very high-speed broadband networks on local economic growth, providing further grounds for policy makers to stimulate investments from private operators. Besides, local government may also consider subsidizing or deploying their own very high-speed broadband networks to bring their benefits in areas where private investment is unlikely to occur. By financially supporting the deployment of broadband networks in areas which are not attractive for private operators, local government may help to open up small or medium municipalities, contributing to their economic development.

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Appendix

Table 1: Data sources

Data	time-period	Source
Fibre deployment by Orange	2010-2014	Orange's information system
Fibre deployment by SFR	2010-2014	SFR's website
Fibre 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 companies	2010-2015	INSEE
Number of new companies	2006-2015	INSEE
Number of new companies per sector	2011-2015	INSEE
Number of establishments	2009-2015	INSEE
Number of new individual companies	2009-2015	INSEE
Number of new establishments	2008-2015	INSEE
Number of new establishments per sector	2008-2015	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	Gouvernement's website: DGFIP

Table 2: Summary Statistics

	superfastbb	company	ind	construc	comm_adm
0	count	24084	24084	24084	24084
	mean	321.653	23.5182	44.547	253.5878
	sd	424.738	25.2864	51.4571	356.6237
	min	0	0	0	0
	max	7698	453	974	6462
1	count	4325	4325	4325	4325
	mean	1540.73	76.4365	171.296	1293.002
	sd	2868.65	124.909	309.373	2467.826
	min	0	0	0	0
	max	37469	1472	5695	30491
Total	count	28409	28409	28409	28409
	mean	507.247	31.5745	63.8434	411.8287
	sd	1263.85	57.2566	137.429	1083.627
	min	0	0	0	0
	max	37469	1472	5695	30491

Table 3: Summary Statistics

	superfastbb	new_company	new_ind	new_construc	new_comm_adm
0	count	42826	19551	19551	19551
	mean	46.3719	2.26587	6.71101	34.52274
	sd	81.3742	3.04861	10.131	47.55346
	min	0	0	0	0
	max	2420	84	243	880
1	count	4523	4123	4123	4123
	mean	264.211	8.66359	30.1938	189.1067
	sd	520.781	16.991	66.2329	375.6013
	min	2	0	0	2
	max	6389	212	1274	4711
Total	count	47349	23674	23674	23674
	mean	67.1809	3.38008	10.8007	61.44467
	sd	189.715	7.9894	30.4617	172.8268
	min	0	0	0	0
	max	6389	212	1274	4711

Table 4: Evolution of company creations in France

	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%

Sources: INSEE

Table 5: Panel data estimation with fixed effects: number of companies and creation of new companies

	company	industry	construction	tertiary	new company	new ind	new construction	new tertiary
superfastbb	0.0318*** (0.004)	0.0142** (0.006)	0.0468*** (0.005)	0.0265*** (0.003)	0.0255*** (0.007)	-0.0050 (0.018)	0.0118 (0.017)	0.0264*** (0.008)
establishment	0.0001*** (0.000)	0.0001*** (0.000)	0.0001*** (0.000)	0.0002*** (0.000)	-0.0005*** (0.000)	-0.0003* (0.000)	-0.0003** (0.000)	-0.0005*** (0.000)
households	0.2828*** (0.037)	0.3707*** (0.058)	0.1787*** (0.043)	0.3203*** (0.036)	0.2242*** (0.057)	0.2169** (0.106)	-0.0920 (0.113)	0.2726*** (0.060)
density	0.1819*** (0.028)	0.1714*** (0.056)	0.3671*** (0.101)	0.1489*** (0.019)	0.1819*** (0.047)	0.3377** (0.149)	0.3158*** (0.105)	0.1499*** (0.042)
income	0.0007 (0.001)	0.0005 (0.002)	-0.0032** (0.001)	0.0017 (0.001)	0.0042** (0.002)	0.0028 (0.004)	0.0136*** (0.004)	0.0032 (0.002)
unemployment	-0.0044** (0.002)	0.0002 (0.002)	0.0002 (0.002)	-0.0057*** (0.002)	-0.0036 (0.003)	-0.0008 (0.005)	0.0031 (0.005)	-0.0049* (0.003)
diploma superior	0.0022** (0.001)	0.0009 (0.001)	0.0007 (0.001)	0.0026*** (0.001)	0.0014 (0.002)	0.0001 (0.003)	0.0048 (0.003)	0.0006 (0.002)
group 2	0.0006 (0.003)	0.0040 (0.003)	-0.0002 (0.003)	0.0009 (0.003)	-0.0074** (0.003)	-0.0007 (0.006)	-0.0255*** (0.006)	-0.0026 (0.004)
group 3	0.0046** (0.002)	0.0016 (0.002)	0.0011 (0.002)	0.0047** (0.002)	-0.0034 (0.002)	-0.0047 (0.004)	-0.0035 (0.005)	-0.0033 (0.003)
group 4	-0.0021 (0.002)	0.0016 (0.002)	-0.0037** (0.002)	-0.0020 (0.002)	0.0021 (0.002)	0.0029 (0.003)	-0.0043 (0.004)	0.0040* (0.002)
group 5	-0.0024 (0.002)	-0.0003 (0.002)	-0.0026* (0.002)	-0.0024 (0.002)	-0.0010 (0.002)	0.0025 (0.003)	0.0012 (0.004)	-0.0015 (0.002)
group 6	-0.0016 (0.002)	-0.0011 (0.002)	-0.0025* (0.001)	-0.0016 (0.002)	-0.0006 (0.002)	0.0067** (0.003)	0.0008 (0.004)	-0.0005 (0.002)
y2010	-0.1401*** (0.007)	-0.0949*** (0.007)	-0.1643*** (0.006)	-0.1466*** (0.006)	0.1053*** (0.009)	0.0713*** (0.017)	0.2942*** (0.018)	0.0634*** (0.010)
y2011	-0.1222*** (0.006)	-0.0813*** (0.006)	-0.1476*** (0.006)	-0.1275*** (0.006)	0.1089*** (0.008)	0.0981*** (0.015)	0.3064*** (0.017)	0.0664*** (0.009)
y2012	-0.1019*** (0.005)	-0.0861*** (0.004)	-0.1230*** (0.004)	-0.1056*** (0.005)	0.0693*** (0.005)	0.0819*** (0.011)	0.2212*** (0.012)	0.0322*** (0.006)
y2013	-0.0538*** (0.005)	-0.0612*** (0.004)	-0.0764*** (0.004)	-0.0542*** (0.005)	0.0811*** (0.005)	0.1192*** (0.010)	0.1946*** (0.010)	0.0503*** (0.005)
Constant	5.2744*** (0.080)	2.4952*** (0.094)	3.4718*** (0.107)	4.9747*** (0.074)	3.1284*** (0.106)	0.0185 (0.210)	0.8838*** (0.214)	2.9089*** (0.115)
Observations	24,664	24,664	24,664	24,664	24,664	24,664	24,664	24,664
R-squared	0.157	0.098	0.201	0.187	0.026	0.009	0.049	0.008
Number of codgeo	4,933	4,933	4,933	4,933	4,933	4,933	4,933	4,933

Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Panel data estimation with fixed effects: establishments creation, new sole proprietorships and unemployment

	comm serv transp	service households	service firms	self-employment	unemployment
superfastbb	0.0609*** (0.013)	0.0142 (0.013)	0.0017 (0.012)	0.0186** (0.008)	-0.0685*** (0.009)
establishment	-0.0006*** (0.000)	-0.0004*** (0.000)	-0.0005*** (0.000)	-0.0004*** (0.000)	-0.0003** (0.000)
households	0.0564 (0.099)	0.2905*** (0.097)	0.5197*** (0.096)	0.2673*** (0.061)	0.4011*** (0.075)
density	0.1250** (0.049)	0.2864*** (0.070)	0.1323 (0.090)	0.1630*** (0.038)	-0.2313*** (0.083)
income	-0.0006 (0.004)	0.0105*** (0.004)	0.0089** (0.004)	0.0045** (0.002)	-0.0170*** (0.003)
unemployment	-0.0032 (0.005)	-0.0110** (0.005)	-0.0101** (0.005)	0.0026 (0.003)	0.0201*** (0.003)
no diploma				0.0063*** (0.002)	
diploma superior	-0.0007 (0.003)	0.0006 (0.003)	0.0055** (0.003)	0.0056** (0.002)	-0.0071*** (0.002)
group 2	-0.0070 (0.006)	-0.0055 (0.006)	0.0022 (0.006)	-0.0064* (0.004)	0.0003 (0.004)
group 3	-0.0031 (0.004)	-0.0017 (0.004)	-0.0070 (0.004)	-0.0025 (0.003)	-0.0062** (0.003)
group 4	0.0026 (0.003)	0.0046 (0.003)	-0.0019 (0.004)	0.0035 (0.002)	0.0002 (0.002)
group 5	-0.0060* (0.003)	-0.0033 (0.003)	0.0008 (0.003)	0.0008 (0.002)	0.0009 (0.002)
group 6	-0.0011 (0.003)	-0.0017 (0.003)	0.0016 (0.003)	0.0005 (0.002)	-0.0021 (0.002)
y2010	0.0874*** (0.016)	0.0363** (0.016)	0.1237*** (0.016)	0.1348*** (0.010)	-1.3183*** (0.011)
y2011	0.0977*** (0.014)	0.1123*** (0.014)	0.1009*** (0.014)	0.1568*** (0.009)	-0.6707*** (0.009)
y2012	0.0609*** (0.010)	0.0289*** (0.010)	0.0106 (0.010)	0.1125*** (0.006)	-0.1378*** (0.005)
y2013	0.0627*** (0.009)	0.0521*** (0.009)	0.0302*** (0.009)	0.1197*** (0.006)	-0.1087*** (0.003)
Constant	2.3907*** (0.183)	1.5421*** (0.188)	1.5264*** (0.187)	2.2788*** (0.172)	10.6428*** (0.136)
Observations	24,664	24,664	24,664	24,662	24,664
R-squared	0.008	0.008	0.009	0.040	0.867
Number of codgeo	4,933	4,933	4,933	4,933	4,933

Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Average treatment effect on the treated: number of companies and creation of new companies

	company	industry	construction	tertiary
superfastbb	0.0389** (0.018)	0.0417** (0.021)	0.0156 (0.022)	0.0376** (0.018)
Observations	24,663	24,663	24,663	24,663
	new_company	new_ind	new_construc	new_comm_adm
superfastbb	0.0489** (0.020)	0.0738** (0.035)	0.0270 (0.028)	0.0473** (0.019)
Observations	24,663	24,663	24,663	24,663

Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: Average treatment effect on the treated: establishments creation, new sole proprietorships and unemployment rate

	new_comm_serv	new_serv_firm	new_serv_hh	self_employment	unempl
superfastbb	0.0350 (0.024)	0.0560** (0.024)	0.0143 (0.020)	0.0479** (0.019)	0.1880 (0.007)
Observations	24,663	24,663	24,663	24,663	24,663

Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Covariate for Balance Test

	Treated			Control			Balance	
	Mean	Variance	Skewness	Mean	Variance	Skewness	Std-diff	Var-ratio
logcompany	6.851182	1.533895	.135496	5.389273	.6706536	.4902495	1.392437	2.287164
income	28.15982	114.9901	2.150705	24.30377	39.27378	1.859732	.4390619	2.927909
estab_commserv_perc	75.29228	88.98538	-.1754436	72.97792	131.1461	-.3442894	.2205997	.678521
unemployment	9.241138	9.971154	.5322561	8.068864	8.55693	.8047403	.385149	1.165272
year	2012.748	1.636565	-.7750018	2011.918	1.971847	.0775132	.6177503	.8299654
density	3.385195	17.49575	2.736165	.5085056	.7064065	6.434304	.9535567	24.76725
households	1.986323	1.44085	.137901	.6023305	.5017646	1.231698	1.404286	2.871565
sup diploma	31.11102	144.2238	.6448456	22.23553	70.46769	1.006821	.8566434	2.046665

Standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 10: Panel data estimation with fixed effects: number of companies and creation of new companies, deployments in 2013

	company	industry	construction	tertiary	new company	new ind	new construction	new tertiary
superfastbb	0.0396*** (0.010)	0.0178* (0.010)	0.0631*** (0.009)	0.0323*** (0.010)	0.0469*** (0.014)	0.0355 (0.027)	0.0017 (0.029)	0.0474*** (0.016)
establishment	0.0006*** (0.000)	0.0006*** (0.000)	0.0005*** (0.000)	0.0006*** (0.000)	-0.0016*** (0.000)	-0.0012** (0.000)	-0.0013** (0.001)	-0.0015*** (0.000)
households	0.3620*** (0.052)	0.4285*** (0.049)	0.2747*** (0.046)	0.4005*** (0.049)	0.3173*** (0.069)	0.1651 (0.138)	-0.0467 (0.150)	0.3802*** (0.080)
density	0.2733 (0.168)	0.2171 (0.159)	0.4586*** (0.149)	0.2391 (0.160)	0.4692** (0.226)	1.0974** (0.451)	1.3445*** (0.490)	0.3561 (0.262)
income	0.0011 (0.002)	0.0004 (0.002)	-0.0023 (0.002)	0.0019 (0.002)	0.0065** (0.003)	0.0055 (0.005)	0.0165*** (0.006)	0.0055* (0.003)
unemployment	-0.0043** (0.002)	0.0001 (0.002)	0.0008 (0.002)	-0.0058*** (0.002)	-0.0020 (0.003)	0.0031 (0.006)	0.0033 (0.006)	-0.0035 (0.003)
diploma superior	0.0019 (0.001)	0.0009 (0.001)	0.0001 (0.001)	0.0024* (0.001)	-0.0001 (0.002)	-0.0011 (0.004)	0.0016 (0.004)	-0.0005 (0.002)
group 2	0.0012 (0.002)	0.0044* (0.002)	-0.0015 (0.002)	0.0020 (0.002)	-0.0062* (0.003)	0.0012 (0.007)	-0.0236*** (0.007)	-0.0017 (0.004)
group 3	0.0058*** (0.002)	0.0018 (0.002)	0.0009 (0.002)	0.0058*** (0.002)	-0.0048* (0.003)	-0.0075 (0.005)	-0.0015 (0.006)	-0.0047 (0.003)
group 4	-0.0013 (0.001)	0.0032** (0.001)	-0.0022* (0.001)	-0.0014 (0.001)	0.0026 (0.002)	0.0039 (0.004)	-0.0048 (0.004)	0.0043* (0.002)
group 5	-0.0016 (0.001)	0.0002 (0.001)	-0.0011 (0.001)	-0.0017 (0.001)	-0.0004 (0.002)	0.0047 (0.004)	-0.0003 (0.004)	-0.0004 (0.002)
group 6	-0.0020 (0.001)	0.0001 (0.001)	-0.0030** (0.001)	-0.0021 (0.001)	-0.0026 (0.002)	0.0068* (0.004)	0.0003 (0.004)	-0.0027 (0.002)
y2011	0.0162*** (0.005)	0.0142*** (0.004)	0.0128*** (0.004)	0.0176*** (0.004)	-0.0028 (0.006)	0.0212* (0.012)	-0.0020 (0.013)	-0.0024 (0.007)
y2012	0.0326*** (0.006)	0.0104* (0.006)	0.0306*** (0.005)	0.0357*** (0.006)	-0.0507*** (0.008)	0.0065 (0.016)	-0.0822*** (0.018)	-0.0483*** (0.009)
y2013	0.0762*** (0.007)	0.0349*** (0.007)	0.0695*** (0.006)	0.0836*** (0.007)	-0.0495*** (0.009)	0.0185 (0.019)	-0.1176*** (0.021)	-0.0387*** (0.011)
y2014	0.1254*** (0.008)	0.0941*** (0.007)	0.1432*** (0.007)	0.1332*** (0.007)	-0.1337*** (0.011)	-0.0772*** (0.021)	-0.3055*** (0.023)	-0.0921*** (0.012)
Constant	4.9410*** (0.100)	2.2792*** (0.094)	3.1649*** (0.089)	4.6287*** (0.095)	2.9655*** (0.134)	-0.2810 (0.268)	0.6789** (0.291)	2.7040*** (0.156)
Observations	16,329	16,329	16,329	16,329	16,329	16,329	16,329	16,329
R-squared	0.119	0.090	0.156	0.147	0.030	0.008	0.045	0.011
Number of codgeo	3,266	3,266	3,266	3,266	3,266	3,266	3,266	3,266

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 11: Panel data estimation with fixed effects: establishments creation, new sole proprietorships and unemployment rate, deployments in 2013

	comm serv transp	service households	service firms	self-employment	unemployment
superfastbb	0.0939*** (0.025)	0.0202 (0.026)	0.0096 (0.026)	0.0446*** (0.016)	-0.0687*** (0.012)
establishment	-0.0018*** (0.000)	-0.0011** (0.000)	-0.0016*** (0.000)	-0.0013*** (0.000)	-0.0004* (0.000)
households	0.1904 (0.127)	0.3613*** (0.134)	0.6503*** (0.132)	0.3742*** (0.082)	0.3875*** (0.062)
density	0.6525 (0.414)	0.4701 (0.438)	0.4227 (0.431)	0.4696* (0.268)	-0.2810 (0.201)
income	0.0039 (0.005)	0.0125** (0.005)	0.0089* (0.005)	0.0064** (0.003)	-0.0182*** (0.002)
unemployment	-0.0039 (0.005)	-0.0100* (0.006)	-0.0087 (0.005)	-0.0011 (0.003)	0.0159*** (0.003)
diploma superior	-0.0032 (0.003)	0.0019 (0.004)	0.0036 (0.004)	-0.0006 (0.002)	-0.0046*** (0.002)
group 2	-0.0037 (0.006)	-0.0106 (0.006)	0.0045 (0.006)	-0.0060 (0.004)	0.0011 (0.003)
group 3	-0.0037 (0.005)	-0.0052 (0.005)	-0.0085* (0.005)	-0.0020 (0.003)	-0.0037 (0.002)
group 4	0.0045 (0.004)	0.0056 (0.004)	-0.0039 (0.004)	0.0018 (0.002)	0.0008 (0.002)
group 5	-0.0005 (0.003)	-0.0029 (0.004)	-0.0010 (0.004)	0.0010 (0.002)	0.0008 (0.002)
group 6	-0.0032 (0.003)	-0.0004 (0.004)	-0.0038 (0.004)	-0.0012 (0.002)	-0.0026 (0.002)
y2011	0.0045 (0.011)	0.0657*** (0.012)	-0.0278** (0.012)	0.0145** (0.007)	0.6480*** (0.005)
y2012	-0.0488*** (0.015)	-0.0203 (0.016)	-0.1327*** (0.016)	-0.0396*** (0.010)	1.1882*** (0.007)
y2013	-0.0613*** (0.017)	0.0053 (0.018)	-0.1137*** (0.018)	-0.0435*** (0.011)	1.2272*** (0.008)
y2014	-0.1274*** (0.019)	-0.0556*** (0.020)	-0.1414*** (0.020)	-0.1634*** (0.012)	1.3409*** (0.009)
Constant	1.8980*** (0.246)	1.3651*** (0.260)	1.5512*** (0.255)	2.5480*** (0.159)	9.1791*** (0.120)
Observations	16,329	16,329	16,329	16,327	16,329
R-squared	0.012	0.008	0.010	0.039	0.874
Number of codgeo	3,266	3,266	3,266	3,266	3,266

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 1: Parallel lines assumption: number of companies

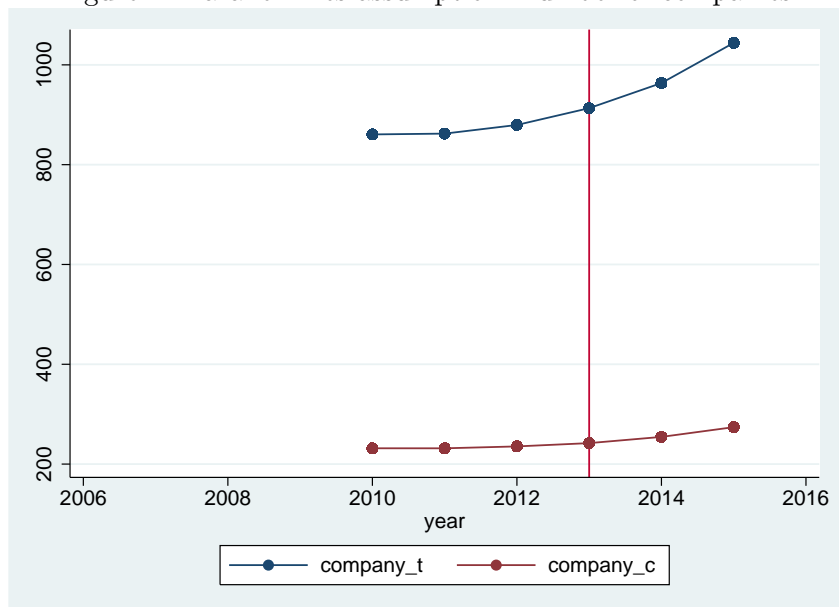


Figure 2: Parallel lines assumption: number of new companies

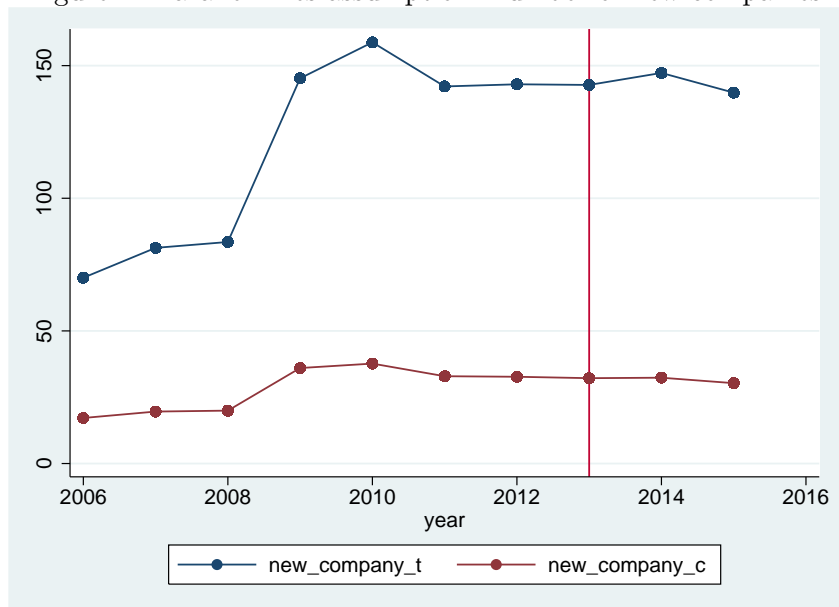


Figure 3: Parallel lines assumption: number of new sole proprietorships

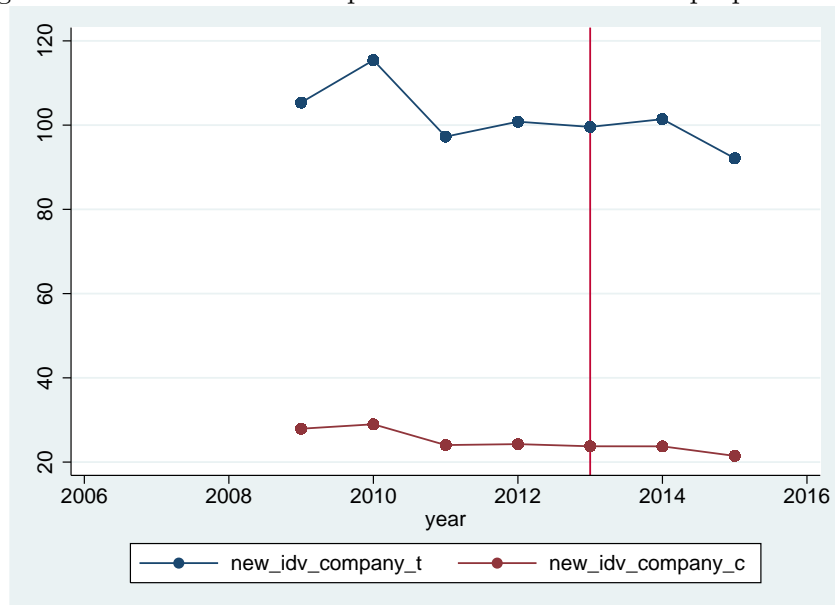


Figure 4: Parallel lines assumption: unemployment rate



Table 12: Difference-in-Difference: number of companies and creation of new companies, deployments in 2013

	company	ind	construc	comm_adm	new_company	new_ind	new_construc	new_comm_adm
_diff	0.0460*** (0.006)	0.0253*** (0.009)	0.0714*** (0.008)	0.0376*** (0.006)	0.0522*** (0.011)	0.0477* (0.026)	0.0193 (0.026)	0.0505*** (0.012)
establishment	0.0021*** (0.000)	0.0015*** (0.000)	0.0032*** (0.000)	0.0019*** (0.000)	0.0024*** (0.000)	0.0031*** (0.000)	0.0034*** (0.000)	0.0022*** (0.000)
households	0.9117*** (0.018)	0.8843*** (0.021)	0.6708*** (0.022)	0.9717*** (0.018)	0.8358*** (0.019)	0.4658*** (0.020)	0.6431*** (0.028)	0.8809*** (0.019)
density	-0.1041*** (0.014)	-0.1739*** (0.020)	-0.1099*** (0.020)	-0.1000*** (0.014)	-0.0515*** (0.014)	-0.0845*** (0.014)	-0.0355* (0.021)	-0.0499*** (0.013)
income	-0.0002 (0.002)	-0.0080*** (0.003)	-0.0130*** (0.003)	0.0022 (0.002)	-0.0010 (0.002)	-0.0101*** (0.001)	-0.0176*** (0.003)	0.0030 (0.002)
unemployment	0.0115*** (0.003)	-0.0160*** (0.004)	-0.0291*** (0.003)	0.0209*** (0.003)	0.0307*** (0.003)	-0.0031 (0.002)	0.0224*** (0.004)	0.0330*** (0.003)
diploma superior	0.0170*** (0.001)	-0.0008 (0.002)	0.0162*** (0.002)	0.0191*** (0.001)	0.0295*** (0.001)	0.0116*** (0.001)	0.0259*** (0.002)	0.0302*** (0.001)
y2011	0.0018 (0.002)	0.0236*** (0.003)	0.0132*** (0.003)	-0.0011 (0.002)	-0.0338*** (0.006)	0.0132 (0.012)	-0.0152 (0.013)	-0.0367*** (0.007)
y2012	-0.0089** (0.005)	0.0275*** (0.007)	0.0519*** (0.006)	-0.0209*** (0.005)	-0.1030*** (0.008)	0.0269** (0.012)	-0.0757*** (0.014)	-0.1131*** (0.009)
y2013	-0.0326*** (0.007)	-0.0651*** (0.005)	-0.0768*** (0.006)	-0.0275*** (0.007)	0.1106*** (0.006)	0.0960*** (0.012)	0.2035*** (0.013)	0.0826*** (0.007)
y2014	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)
time	0.0467*** (0.011)	0.1231*** (0.011)	0.1690*** (0.011)	0.0280** (0.011)	-0.2462*** (0.010)	-0.0621*** (0.013)	-0.3335*** (0.016)	-0.2231*** (0.011)
treated	-0.1289*** (0.028)	-0.0844* (0.043)	-0.1179*** (0.037)	-0.1309*** (0.028)	-0.0485* (0.026)	-0.0691** (0.030)	0.0176 (0.041)	-0.0517* (0.027)
Constant	4.3396*** (0.042)	2.6130*** (0.057)	3.1307*** (0.057)	3.8591*** (0.045)	2.0055*** (0.044)	0.2263*** (0.033)	0.6514*** (0.060)	1.6018*** (0.046)
Observations	16,329	16,329	16,329	16,329	16,329	16,329	16,329	16,329
R-squared	0.800	0.595	0.641	0.804	0.788	0.452	0.507	0.778
Mean control t(0)	4.340	2.613	3.131	3.859	2.005	0.226	0.651	1.602
Mean treated t(0)	4.211	2.529	3.013	3.728	1.957	0.157	0.669	1.550
Diff t(0)	-0.129	-0.0844	-0.118	-0.131	-0.0485	-0.0691	0.0176	-0.0517
Mean control t(1)	4.386	2.736	3.300	3.887	1.759	0.164	0.318	1.379
Mean treated t(1)	4.303	2.677	3.253	3.794	1.763	0.143	0.355	1.378
Diff t(1)	-0.0829	-0.0591	-0.0464	-0.0933	0.00368	-0.0213	0.0369	-0.00118

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13: Difference-in-Difference: establishments creation, new sole proprietorships and unemployment rate, deployments in 2013

	comm serv transp	service households	service firms	self-employment	unemployment
_diff	0.1061*** (0.020)	0.0110 (0.018)	0.0224 (0.020)	0.0488*** (0.012)	-0.0867*** (0.028)
establishment	0.0025*** (0.000)	0.0024*** (0.000)	0.0017*** (0.000)	0.0022*** (0.000)	0.0033*** (0.001)
households	0.9417*** (0.025)	0.9321*** (0.021)	0.9657*** (0.018)	0.8305*** (0.019)	-0.7813*** (0.086)
density	-0.0705*** (0.017)	-0.0504*** (0.014)	-0.0943*** (0.012)	-0.0619*** (0.013)	-0.2647*** (0.063)
income	0.0030 (0.003)	0.0105*** (0.003)	-0.0109*** (0.002)	-0.0059*** (0.002)	-0.0272*** (0.009)
unemployment	0.0609*** (0.004)	0.0114*** (0.003)	0.0134*** (0.003)	0.0358*** (0.003)	0.4579*** (0.015)
lag_d_perc	0.0136*** (0.002)	0.0403*** (0.002)	0.0342*** (0.002)	0.0302*** (0.001)	0.0351*** (0.007)
y2011	-0.0319*** (0.011)	-0.0644*** (0.011)	0.0465*** (0.012)	-0.0151** (0.007)	0.4918*** (0.009)
y2012	-0.1315*** (0.012)	-0.1900*** (0.013)	-0.0464*** (0.013)	-0.0868*** (0.008)	0.8609*** (0.023)
y2013	0.0981*** (0.011)	0.0545*** (0.011)	0.0853*** (0.012)	0.0000 (0.000)	0.0351*** (0.011)
y2014	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	-0.1473*** (0.007)	0.0000 (0.000)
time	-0.2862*** (0.015)	-0.2603*** (0.015)	-0.1310*** (0.014)	-0.1240*** (0.009)	0.6899*** (0.035)
treated	-0.0632* (0.038)	-0.0477 (0.032)	-0.1063*** (0.026)	-0.0539** (0.025)	0.5868*** (0.177)
Constant	0.7981*** (0.061)	0.3164*** (0.059)	0.8338*** (0.048)	1.7577*** (0.041)	5.6328*** (0.205)
Observations	16,329	16,329	16,329	16,327	16,329
R-squared	0.661	0.688	0.647	0.758	0.328
Mean control t(0)	0.798	0.316	0.834	1.758	5.633
Mean treated t(0)	0.735	0.269	0.728	1.704	6.220
Diff t(0)	-0.0632	-0.0477	-0.106	-0.0539	0.587
Mean control t(1)	0.512	0.0562	0.703	1.634	6.323
Mean treated t(1)	0.555	0.0195	0.619	1.629	6.823
Diff t(1)	0.0430	-0.0367	-0.0839	-0.00510	0.500

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 14: Sum up of effects

	Panel FE	ATT	diff. 2013	Panel FE 2013
company	3.2%	3.9%	4.6%	4.1%
industry	1.4%	4.2%	2.5%	1.7%
construction	4.7%	X	7.4%	6.3%
comm_adm	2.7%	3.8%	3.8%	3.4%
new_company	2.6%	4.9%	5.2%	4.5%
n_industry	X	7.4%	4.7%	3.1%
n_construction	X	X	X	4.2%
n_commadm	2.6%	4.7%	5%	4.5%
n_individual_comp	1.9%	4.8%	4.8%	4.3%
n_estab_comm_serv	6%	3.5%	10.1%	9.1%
n_estab_serv_hh	X	X	X	X
n_estab_serv_comp	X	5.6%	X	X
unemployment	6.9ppt	X	8.7ppt	7ppt

X: results are not significant