Broadband and Firm Entries in Lithuania

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Abstract. The ongoing digitalization had a global impact on economic patterns. With better broadband infrastructure, new businesses rely more on digital tools and technologies, are able to grow faster, and reach customers in remote markets. However, despite the growing importance of high-speed internet, there is a lack of research linking broadband provision to firm entries. This paper fills this gap by examining the relationship between the improvements in mobile internet speed and the firm entries in Lithuania over the 5-year time period from 2014 to 2019, the active phase of implementation of the Digital Agenda for Europe. As a result, we observed a negative and significant at 10% level relationship between changes in internet speed and business creation, which contradicts the recent findings in the existing literature.

Keywords. broadband, firm entries, Lithuania, entrepreneurship

1. Introduction

High-speed internet availability is widely assumed to foster the public and private sectors of the economy, leading to overall economic prosperity. Understanding the urgency of transformations in the digital era, many governments have initiated different large-scale programs to support the development of ICTs in the last decade, such as *the National Broadband Plan* in the United States or *Digital Agenda* for the EU.

The ambitiousness of the European digital transformation plan was, however, that EU members were extremely different at the time of its adoption in 2010. For instance, the telecommunications' infrastructure in Western Europe was in better condition, despite the existing disparities in network quality. At the same time, the condition of telephone lines in Eastern Europe left much to be desired. Furthermore, given that Eastern European countries also partially inherited a socialist legacy in terms of entrepreneurial culture, innovation, and digital literacy, their overall economic development path was very different from that of the developed West. Hence, it was most likely that all stated goals could not be achieved simultaneously by all EU members on time.

Albeit scholars tried to link ICTs and their effects on economies, they focused more on general problems, such as economic prosperity, productivity, or regional development, while at the same time much less is known whether changes in broadband infrastructure relate to the emergence of new firms. Besides, existing studies focus primarily on the US and, to a lesser extent, on other *'best practices'* like China, Germany, France, or Spain, while peripheral cases extremely rare reflect in the scientific literature.

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For this study, we would like to focus exactly on a rather peripheral case of Lithuania, a developing Eastern European economy with problems rooted in its socialistic legacy. We tried to explore the link between the developments in broadband availability in Lithuania between 2014 and 2019 and the possible changes in firm entries. Our contribution is twofold: on the one hand, we observed negative statistical significance for the broadband variable, which contradicts the majority of existing studies; on the other hand, we statistically confirmed the previous findings that some other parameters, e.g., the higher presence of an economically active population or higher wages, positively relate to the appearance of new businesses, both in advanced and developing economies.

This paper unfolds as follows: In Section 2, we provide a short literature background on the topic. Section 3 briefly describes the case of Lithuania from the perspective of broadband development and firm creation. Data and Methodology are presented in Section 4, followed by Results and Discussion. Finally, Section 6 summarizes the outcome of our study.

2. Literature Background

The up-to-date scientific literature has documented multiple ways in which ICTs improve economics and society, e.g., overall economic [1] or regional [2] development, firm performance, and employees' productivity [3]. Still, the question of whether broadband speed upgrades necessarily contribute to employment rates among residents is under debate [4]. With the emergence of ultra-broadband connections and 5G mobile communications, the firms' productivity problem is increasingly being associated with the externalities caused by artificial intelligence [5], as AI-investing firms are performing better in terms of gross sales and market valuations.

Fewer is known about the positive effects of internet availability on innovation [6], although recent studies document positive effects of AI-based applications on product and business model innovation [7] and the increasing role of neural networks or machine learning in enterprise innovation management [8]. The role of ICT on business location [9] also remains unclear. Some scholars explored that broadband availability may increase the probability of starting a business, but rather a certain speed level is required for organic business development [10]. Generally, not too many papers link entrepreneurship and ICTs [11], due to the complexity of analysis and data imperfections.
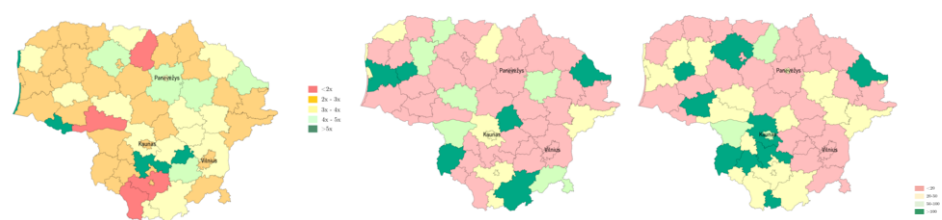
The research on the latter problem is mostly US-related [12], [13]; few papers for Europe document the effects for China [14], Germany [15], [16], France [17], and Spain [18]. Some countries lack up-to-date scientific studies on recent digital improvements and their effects on economics and society. Lithuania is one such example, for which there are very few papers exploring the effects of ICT. While some outdated papers are rather descriptive and study the link between broadband speed upgrades and the public and private sectors [19], newer papers investigate digital collaboration [20], the tourism industry [21], and the impact on the shadow economy of Lithuania [22].

3. The Case of Lithuania

Broadband Provision. Even though the first digital lines appeared in Lithuania in 1992, the biggest technological advances started there only in the new millennium. The country bypassed the (A)DSL era due to the poor quality of the phone network inherited from the Soviet Union and featured its first broadband initiative, *RAIN project*, in 2004, focusing on spreading the fiber optic lines across the whole country, mainly in rural regions.

The broadband development plan in accordance with the Digital Agenda of Europe for Lithuania was approved in 2014. Similar to other countries, this document suggested improvements in the digital literacy of the population, e-government solutions, better connectivity between economic units, etc. Later, the initial plan was extended by the *Digitization Roadmap for 2019-2030*, including digitalization strategic goals up to 2030. By 2019, Lithuania was in close to the EU average measured by the DESI index [23], with severe fixed broadband connectivity problems and a lot of progress with respect to mobile networks (see Figure 1). One of the most important issues that was filed in the report was the below-EU average population's digital literacy.

Entrepreneurship. With a complex history rooted in its past under the Soviet regime, Lithuania is still lagging behind many European countries in terms of doing business. On one hand, Lithuania has recently implemented policies and programs to encourage the growth of small businesses [24]. On the other hand, the country is facing multiple challenges on its transition path towards a better entrepreneurial milieu. Greblikaitė [25] mentions several reasons for that: the overall demographic situation forcing highly qualified individuals to migrate in seeking a better-paying job, low levels of financial support of talented young specialists, and insufficient entrepreneurial skills in the earlier stages of innovative start-up creation. Besides, the overall perception of entrepreneurship within the country remains to be rather negative (employers tend to pay the lowest possible salary and thus appear as greedy and unjust people in the eyes of society). Even though some improvements took place recently (see Figure 1), mostly in the municipalities located in the southern part at the borders of Belarus, Poland, and Russia, the start-up rate seems to be lower than in other EU countries, mainly because of the fear of failure, market shortages, and an insufficient amount of highly qualified personnel.

Figure 1. Changes in average mobile broadband speed from 2014 to 2019 (left), firm entries per 10 000 inhabitants in 2014 (center) and 2019 (right), municipalities

4. Data and Methodology

In this paper, we tried to explore whether the changes in broadband availability in Lithuania in terms of the Digital Agenda had some plausible effect on firm entries. While in our previous studies for Germany we made a simple one-time projection due to data scarcity reasons (which, however, just explored the relationship between broadband and entries), in this paper we try to analyze the differences between two time periods with fixed effects. Initially, the regression model in our case was formulated as:

$$Entries_t = \beta_{0_t} + \beta_{1_t} \times Broadband_t + \beta_{2_t} \times Controls_t + F_t + \varepsilon_t, \qquad [1]$$

where F stands for regional-specific characteristics (e.g., surface area) that are different between observed entities but constant over time. Here, we compared the effect between two important milestones of policy intervention, or 2014 and 2019[2]:

$$Entries_{2014} = \beta_{0_{2014}} + \beta_{1_{2014}} \times Broadband_{2014} + \beta_{2_{2014}} \times Controls_{2014} + F_{2014} + \varepsilon_{2014} \quad [2]$$

$$Entries_{2019} = \beta_{0_{2019}} + \beta_{1_{2019}} \times Broadband_{2019} + \beta_{2_{2019}} \times Controls_{2019} + F_{2019} + \varepsilon_{2019} \quad [3]$$

When we eliminated a possible bias from the model thanks to the omission of F, our regression model was finally formulated as:

$$\Delta Entries = \beta_{0_{\Delta t}} + \beta_{1_{\Delta t}} \times \Delta Broadband + \beta_{2_{\Delta t}} \times \Delta Controls + \varepsilon. \qquad [4]$$

Next to the dependent variable, *Entries*, and the *Mobile broadband speed* explaining variable, we added several control variables. Prior to all, we included population related variables such as the *share of economically active individuals*, which is usually directly attributed to firm creation [26], or the *average wage*, as households with spare finances more often decide to set up their own business [27], and *higher poverty risks* may diminish the number of new entrants. Among other variables, we were able to retrieve the financial data (for instance, in the form of *municipal expenditures* or *foreign direct investments* which usually contribute to higher levels of entrepreneurial activity), and a number of *criminal records* considered as a counter-factor for new entries [28]. The data for this analysis was retrieved from the official statistics portal of the Lithuanian State Data Agency[3], with except for mobile broadband obtained from the Communications Regulatory Authority of the Republic of Lithuania[4].

5. Results and Discussion

5.1. Robust Check

For our analysis, we divided the whole sample of sixty Lithuanian municipalities into two parts: high-density (cities and surrounding regions) and low-density (rural) areas.

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[2]The second milestone in the Digital Agenda was actually set for 2020, but we opted for a previous year due to the COVID-19 outbreak, which could distort the outcome.
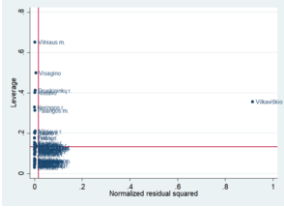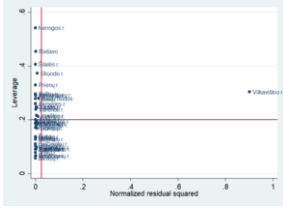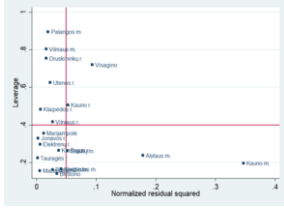
[3]https://osp.stat.gov.lt/web/guest/pradinis (Retrieved: 30.03.2022)

[4]Lietuvos Respublikos ryšiu reguliavimo tarnyba: https://matavimai.rrt.lt/

Initially, we got an extremely high *Prob > F* value for the whole sample that demonstrated the absence of statistically significant evidence to reject the null hypothesis, as well as a very low R-squared value (Model 1).

Keeping though in mind that some municipalities could benefit from other neighboring countries just thanks to their location, we decided to prove whether our data sample is possibly contaminated with influential observations (outliers). To do that, we computed Cook's distance[5] (a measure that combines the data on residuals and leverages of observations) for all of our samples. Some of our observations were considered outliers (see Table 1), e.g., Vilkaviškio region in the first two samples and the city of Palanga and Visagino region in the latter sample.

Table 1. Outliers and Cook's Distances

Whole sample	Low dense	High dense
Vilkaviškio r. 1.0109760	**Vilkaviškio r. 1.2737301**	**Palangos m. 2.380375**
Vilniaus m. -.1825513		**Visagino 1.289704**
Visagino -.0777906		Vilniaus m. -.5015274

After that, we re-run the robust regression (a re-weighted form of OLS based on the goodness of observations and omitting the outliers). The results are presented in Table 2, Models 2a to 2c. In all models, we now observe severe changes in *Prob > F* values as well as *R-squared*. The *broadband speed* variable is statistically significant (at 10% level), but with a negative sign. The share of economically active population is positively significant in the whole model and for high-dense areas (at 1% level). While *average wage* is positively related to firm entries in all of the models, municipal expenditures are negatively significant at 1% level (excepting high density areas). Finally, we observed a negative significance for *crimes and misdemeanors* in the whole sample at 1% level, while *poverty risks* and *foreign direct investments* remained insignificant in our analysis.

5.2. Discussion

For the case of Lithuania, the outcome for the broadband variable is strikingly different from the existing in academic literature. Stunning at first glance, that phenomenon is possibly rooted in the stationery phone line infrastructure: while its quality was so poor and made the spread of ADSL technology barely possible, the authorities introduced the first initiatives to bring optic cables (even to remote areas) already in the mid-2000s. Hence, a good-quality internet probably became a part of everyday life in Lithuania

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[5]If an observation has a *Cook's D value* greater than 1, it is considered an influential (outlier) that may potentially distort the regression estimates and will be omitted for the robust regression.

Table 2. Effect on Firm Entries in Lithuania between 2014 and 2019

	Model 1	Model 2a	Model 2b	Model 2c
Broadband speed [Mbit/s]	1.488 [3.147]	-0.425 * [0.229]	-0.439 * [0.227]	-3.227 [2.077]
Population 15-65 [share]	8.986 [28.64]	6.117 *** [2.086]	2.805 [3.893]	36.22 *** [6.722]
Average wage [thousands of EUR]	0.779 [0.870]	0.145 ** [0.063]	0.223 *** [0.074]	0.368 ** [0.152]
Crimes	-0.0231 [0.0331]	-0.00735 *** [0.00241]	-0.0142 [0.0164]	-0.00707 [0.00490]
Poverty risk [rate]	-4.684 [4.607]	0.0464 [0.335]	-0.247 [0.335]	-0.732 [1.284]
Municipal expend. [thsd. EUR per capita]	-7.480 [30.88]	-8.420 *** [2.249]	-9.896 *** [2.840]	-0.00586 [4.685]
FDI [thsd. EUR, LN]	-6.580 [28.08]	-1.072 [2.045]	-2.403 [1.766]	0.236 [13.24]
Constant	-402.6 [428.4]	-24.34 [31.23]	-53.69 [34.33]	46.90 [112.6]
Observations	**60**	**59**	**39**	**18**
Area	**Whole**	**Whole, robust**	**Low-dense**	**High-dense**
Fixed effects	**Yes**	**Yes**	**Yes**	**Yes**
Prob > F	0.847	0.000	0.001	0.002
R-squared	0.060	0.482	0.507	0.844
Adjusted R-squared	-0.066	0.412	0.399	0.735

Standard errors in parentheses. * p: 0.1 ** p: 0.05 *** p: 0.01

much earlier and was no longer the main decisive factor for firms where to set up their businesses.

Obviously, the wealth of households seems to be the main factor affecting the appearance of new firms in Lithuania, especially considering the below-average salaries in the country compared to the EU level. Along with that, the share of the active population also seems to be important, precisely in high-dense areas where the share of technologically driven firms is generally higher and the demand for highly skilled labor is present. Crimes and misdemeanors are considered factors that scare off potential founders, although in the Lithuanian case, their effect on firm entries is quite modest.

Very unusual is the fact that municipal expenditures per capita are negatively significant (at 1% level) in our sample. Generally, it is assumed that higher expenses should exactly help individuals and, thus, increase the chance of new firm entries. Still, it depends on the art of expenditures and which social groups benefit from them most. Exact data on that is, unfortunately, unavailable; however, in Lithuania the majority of new entrants rely mostly on internal resources, and that governmental or municipal financial aid is distributed unequally. Foreign investments, on the contrary, do not play an important role in forming the entrepreneurial milieu in Lithuania, mainly due to their overall small amount in the national economy.

6. Concluding Remarks

Unlike other up-to-date papers investigating the effects of changes in broadband availability in so-called *'best practices'*, we explored the case of Lithuania, which was not covered in the literature to this point of time. Our study focuses on the link between recent improvements in digital infrastructure under the Digital Agenda for Europe policy intervention and the changes in firm population. Several major results may be derived from our analysis. First of all, we observed a negative effect of recent broadband improvements for Lithuania, which contradicts the findings in the existing literature. Still, this outcome may be explained in a way that a good quality of Internet became a part of everyday life in this country much earlier and possibly was considered by individuals and businesses as granted. Secondly, we confirmed the positive and statistically significant effect for the share of the active population and the wealth of households, which stand in line with existing findings. Finally, we found a negative significance for the amounts of municipal expenditures affecting the number of new entries; this result contradicts the findings for the US, but mainly due to the fact that state aid to businesses in Lithuania is limited and unevenly distributed across the country.

  For this study, we used data on average mobile broadband speed instead of coverage ratio due to the severe data limitations. This indicator measures precisely the quality of the internet but does not provide an indication of what proportion of the population has access to or uses broadband connections. Still, we believe that this shortcoming does not have a great impact on the outcome, while both mobile and fixed broadband are undergoing roughly the same improvements in the EU. Whether the data on the direct use of the internet by households or the degree of coverage would be available, it could be interesting to re-run the research. Additionally, we retrieved no data on firm entries broken down by economic sectors, so further paper improvement could be done upon the availability of this information.

References

[1] S. Gomes, J. M. Lopes, and L. Ferreira, "The impact of the digital economy on economic growth: The case of OECD countries," *RAM: Revista de Administração Mackenzie*, vol. 23, 2022.

[2] H. Atasoy, "The effects of broadband internet expansion on labor market outcomes," *ILR Review*, vol. 66, no. 2, pp. 315–345, 2013.

[3] E. Tranos and E. A. Mack, "Broadband provision and knowledge-intensive firms: A causal relationship?" *Regional Studies*, vol. 50, no. 7, pp. 1113–1126, 2016.

[4] W. Briglauer, N. S. Dürr, O. Falck, and K. Hüschelrath, "Does state aid for broadband deployment in rural areas close the digital and economic divide?" *Information Economics and Policy*, vol. 46, pp. 68–85, 2019.

[5] D. Czarnitzki, G. P. Fernández, and C. Rammer, "Artificial intelligence and firm-level productivity," *Journal of Economic Behavior & Organization*, vol. 211, pp. 188–205, 2023.

[6] C. Chen and A. Ye, "Threshold Effect of the Internet on Regional Innovation in China," *Sustainability*, vol. 13, no. 19, pp. 1–13, 2021.

[7] T. Babina, A. Fedyk, A. He, and J. Hodson, "Artificial intelligence, firm growth, and product innovation," *Journal of Financial Economics*, vol. 151, p. 103 745, 2024.

[8] Z. Bao and C. Wang, "A multi-agent knowledge integration process for enterprise management innovation from the perspective of neural network," *Information Processing & Management*, vol. 59, no. 2, p. 102 873, 2022.

[9] C. Duvivier, "Broadband and firm location: Some answers to relevant policy and research issues using meta-analysis," *Canadian Journal of Regional Science/Revue canadienne des sciences régionales*, vol. 42, no. 1, pp. 24–45, 2019.

[10] B. Drilo, N. Stojčić, and M. Vizek, "Broadband speed and firm entry in digitally intensive sectors: The case of Croatia," *Društvena istraživanja*, vol. 31, no. 1, pp. 19–38, 2022.

[11] K. Sarachuk and M. Mißler-Behr, "ICT, economic effects and business patterns: A text-mining of existing literature," in *Proceedings of the 2020 the 3rd International Conference on Computers in Management and Business*, 2020, pp. 40–45.

[12] Y. Chen, L. Ma, and P. F. Orazem, "The heterogeneous role of broadband access on establishment entry and exit by sector and urban and rural markets," *Telecommunications Policy*, pp. 1–15, 2023.

[13] H. M. Stephens, E. A. Mack, and J. Mann, "Broadband and entrepreneurship: An empirical assessment of the connection between broadband availability and new business activity across the united states," *Telematics and Informatics*, vol. 74, p. 101 873, 2022.

[14] M. Yang, S. Zheng, and L. Zhou, "Broadband internet and enterprise innovation," *China Economic Review*, vol. 74, p. 101 802, 2022.

[15] K. Sarachuk, M. Mißler-Behr, and A. Hellebrand, "Ultra-High-Speed Broadband Internet and Firm Creation in Germany," in *International Scientific Conference on Innovations in Digital Economy*, Springer, 2020, pp. 40–56.

[16] K. Sarachuk and M. Mißler-Behr, "Is ultra-broadband enough? The relationship between high-speed internet and entrepreneurship in Brandenburg," *International Journal of Technology*, vol. 11, pp. 1103–1114, 2020.

[17] C. Duvivier and C. Bussière, "The contingent nature of broadband as an engine for business startups in rural areas," *Journal of Regional Science*, vol. 62, no. 5, pp. 1329–1357, 2022.

[18] N. Romero-Castro, M. López-Cabarcos, and J. Piñeiro-Chousa, "Finance, technology, and values: A configurational approach to the analysis of rural entrepreneurship," *Technological Forecasting and Social Change*, vol. 190, pp. 1–13, 2023.

[19] R. Gatautis and A. Tarute, "ICT impact on competitiveness: The case of private sector in Lithuania," *The Macrotheme Review*, vol. 3, no. 9, pp. 214–229, 2014.

[20] M. Mačiulienė and A. Skaržauskienė, "Evaluation of co-creation perspective in networked collaboration platforms," *J. of Business Research*, vol. 69, no. 11, pp. 4826–4830, 2016.

[21] D. Labanauskaitė, M. Fiore, and R. Stašys, "Use of e-marketing tools as communication management in the tourism industry," *Tourism Man Perspectives*, vol. 34, p. 100 652, 2020.

[22] R. Remeikienė, L. Gasparėnienė, Y. Bayar, R. Ginevičius, and I. M. Ragaišytė, "ICT development and shadow economy: Empirical evidence from the EU transition economies," *Economic Research-Ekonomska istraživanja*, vol. 35, no. 1, pp. 762–777, 2022.

[23] European Commission, "Digital Economy and Society Index (DESI) - 2019 Country Report Lithuania," Report, 2019.

[24] OECD, *The missing entrepreneurs 2019: Policies for inclusive entrepreneurship*. OECD Publications Centre, 2019.

[25] J. Greblikaitė, "Development of Entrepreneurship in Lithuania: Becoming Social Entrepreneurs," *Entrepreneurship and Firm Performance: Nova Science Publisher's*, 2016.

[26] C. Armington and Z. Ács, "The determinants of regional variation in new firm formation," *Regional studies*, vol. 36, no. 1, pp. 33–45, 2002.

[27] J. Parajuli and K. Haynes, "Spatial heterogeneity, broadband, and new firm formation," *Quality Innovation Prosperity*, vol. 21, no. 1, pp. 165–185, 2017.

[28] E. Mack and A. Faggian, "Productivity and broadband: The human factor," *International Regional Science Review*, vol. 36, no. 3, pp. 392–423, 2013.