BANCA D'ITALIA

EUROSISTEMA

Questioni di Economia e Finanza

(Occasional Papers)

Connected Italy

by Emanuela Ciapanna and Giacomo Roma

July 2020

Number 573

BANCA D'ITALIA
EUROSISTEMA

Questioni di Economia e Finanza

(Occasional Papers)

Connected Italy

by Emanuela Ciapanna and Giacomo Roma

Number 573 – July 2020

The series Occasional Papers *presents studies and documents on issues pertaining to the institutional tasks of the Bank of Italy and the Eurosystem. The* Occasional Papers *appear alongside the* Working Papers *series which are specifically aimed at providing original contributions to economic research.*

The Occasional Papers *include studies conducted within the Bank of Italy, sometimes in cooperation with the Eurosystem or other institutions. The views expressed in the studies are those of the authors and do not involve the responsibility of the institutions to which they belong.*

The series is available online at www.bancaditalia.it .

ISSN 1972-6627 (print)
ISSN 1972-6643 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

CONNECTED ITALY

by Emanuela Ciapanna* and Giacomo Roma*

Abstract

The purpose of this work is to describe the present conditions and possible development of telecommunication networks in Italy, with particular reference to new generation networks. We review the main technological solutions adopted from a cross-country perspective and investigate the determinants of the Italian lag on both the supply and demand side. We also assess the congestion risk associated with the COVID-19 emergency. The latter is interpreted as a large demand shock, whose effects on some sectors – namely smart working, e-commerce and e-government – are already visible. The main message from our analysis is that our country has shown varying degrees of resilience and adaptability to the shock: areas covered with high-speed broadband and clusters of firms and public administrations that had invested in digitalization in the past found themselves well equipped to face the shock. On the contrary, areas without an adequate bandwidth coverage, as well as firms and public administrations devoid of a settled digital culture, were caught unprepared. Our study reiterates the urgent need to maximize the coverage of the whole territory with high-speed internet broadband, and to invest in digital human capital development.

JEL Classification: K21, K23, L4, L96.
Keywords: telecommunication networks, telecommunication regulation, broadband, 5G, digital skills, smart working, e-commerce, e-government, COVID-19.
DOI: 10.32057/0.QEF.2020.573

Contents

* Bank of Italy, Directorate General for Economics, Statistics and Research, Structural Economic Analysis Directorate, Law and Economics Division.

Introduction[1]

The convergence of digital technologies, new materials and new processes has the potential to change the functioning of economies and societies drastically. The new 'knowledge society' offers great opportunities in terms of growth in productivity and efficiency, and an increase in social and individual well-being. As regards the real economy, digitalization allows for greater control and greater flexibility in the scale and scope of production, accompanied by reduced operating costs. For example, the massive use of big data obtained through sensors embedded in machines allows us to monitor the efficiency of the equipment, optimize operations and provide after-sales services. The Internet of Things, which incorporates physical objects into information flows along with cloud computing, is the catalyst for the sudden breakthrough in artificial intelligence applications, such as autonomous vehicles. In some scenarios,[2] within ten years, robots will be able to take care of the elderly, deliver food, perform agricultural work, maintain public infrastructure and provide many other services useful for everyday life.

Some benefits of using digital technologies are already tangible today. Digital technologies come to our aid, ensuring the dissemination of information, remote communication between individuals and the delivery of essential goods and services. Since the beginning of the crisis generated by the spread of COVID-19, the large-scale use of teleworking has ensured operational continuity in many companies, and e-learning platforms have made it possible to keep up with school and training courses. Furthermore, the sharing of information in real time and on a large scale has enabled scientists and researchers to work in a coordinated way and systematize the results of the progress in epidemiological, genetic and pharmacological experimentation. If Italy has managed not to come to a complete standstill, it is also thanks to 'next generation' networks, digital platforms and Industry 4.0 technologies, such as Cloud computing, 3D printing and the Internet of Things, now being widely employed to face the emergency.

[1] We would like to thank Fabrizio Balassone, Silvia Giacomelli and Paolo Sestito for their helpful comments.
[2] See, for instance, the Accenture Technology Vision 2019 Report.

For their enormous potential to be exploited in full, digital technologies need cutting-edge network infrastructures, capable of carrying large quantities of data at very high speeds. Just as the exponential increase in freight traffic has been matched by a rapid growth in the motorway, road and rail networks, so it is necessary to have efficient and performing ultrafast fixed and mobile broadband infrastructures in order to transport an increasing amount of data.

The purpose of this work is to describe the present state of telecommunication networks in Italy, with particular reference to new generation access networks (NGANs). We will review the main technological solutions adopted in a cross-country perspective and review supply-side factors, namely the structure of the legacy network, Italy's topographical characteristics and the role of regulation, as co-determinants of the connectivity lag. We also assess the current network congestion risk associated with the emergency. We interpret the latter as a demand shock, whose effects on some sectors (smart working, e-commerce and e-government) are already visible. In the last part of our work, we focus on these sectors, firstly analysed in a structural perspective and via a cross-country comparison, and then focused on through the lens of the current shock. We will finally provide some considerations about future perspectives for each point.

The main findings of the analysis are as follows.

• With respect to the average penetration rate of different broadband speeds, Italy ranks 17th out of 28 countries in the DESI connectivity index of the European Commission. Our country's placement improves when only mobile broadband is considered (3rd place).

• Regional heterogeneity persists in terms of both coverage and subscription. In order to guarantee ultra-broadband availability in the 'market failure' areas, the Government approved a public intervention plan financed with national and European funds. The implementation of the plan has experienced delays, especially for bureaucratic reasons, such as restrictions on permits by local authorities for excavations and fibre deployment. The pace of completion of new generation fixed networks is slow, even in

potentially profitable areas. The share of households covered by ultrafast broadband, based on the 'fiber to the premises' (FTTP) technology, is only 30 per cent in Italy, right after Germany (32.7 per cent), but quite far from France and a long way behind Spain (43.8 and 89 per cent respectively).

• The telecommunications industry in Italy is characterized by a high degree of competition: in the past 5 years, prices have shown negative dynamics and revenues, and margins have been shrinking as well. Despite low profitability, investment has grown at an average rate of over 7 per cent in the same period, due to the expansion of the fixed network and the huge outlay for the 5G frequencies, (whose auction reached €6.55 billion, the maximum value within the EU). However, doubts arise about the ability of the sector to maintain and indeed increase its investment capacity, which is fundamental to achieving the NGAN deployment objectives.

• Market structure is also evolving towards a greater degree of concentration in the mobile sector: in 2016, Wind and H3G merged to form Wind3; and in March 2020, the European Commission approved the joint venture between TIM's INWIT and Vodafone Towers. The possibility of creating a single operator for the fixed network to bring together the passive infrastructures of Open Fiber and TIM is still a highly debated topic.

• As far as the demand for digital services is concerned, smart working, e-commerce and e-government are less widespread in Italy than in other European countries. In addition to the non-uniform availability of ultra-broadband connections, the scarce diffusion of digital culture among managers, the fragmented structure of the retail sector, the low level of employees' digital skills and the governance shortcomings within public administrations all hinder their development.

•The COVID-19 emergency has put the network under stress because of the sudden increase in the demand for digital services. Our country has shown varying degrees of resilience and adaptability to the shock: the areas with high-speed broadband and the companies and public administrations that had invested in digitalization in the past have found themselves well equipped to face the situation. On the contrary, areas without

adequate coverage and businesses and administrations without a consolidated digital culture have been caught unprepared.

• We reaffirm the importance of accelerating investment in new generation networks, strengthening direct State intervention in market failure areas, promoting public-private partnerships in low profitability areas, but above all speeding up the transition from planning to implementation, streamlining administrative burdens and removing bureaucratic obstacles.

1. Connectivity and the state of networks

In line with the Digital Agenda for Europe (DAE) 2020, in 2016, the European Commission upgraded digitalization objectives[3] and proposed that all schools, transport hubs and main providers of public services, as well as digitally intensive enterprises, should have access to highest-speed internet connections (1 Gigabit/s) by 2025. In addition, all European households should have access to ultrafast networks (at least 100 Mbit/s), and all urban areas, as well as major roads and railways, should have uninterrupted 5G wireless broadband coverage.

In this increasingly ambitious scenario, Italy lags behind, and is far from reaching its own Digital Agenda objectives, namely, an ultra-broadband connection to the whole population, and ultrafast broadband (above 100 Mbit/s) to all business units and to at least half of the population by the end of 2020.

Since the first research works on the diffusion of broadband in Italy (Ciapanna and Sabatini, 2008), many efforts have been made, by both the Government and private operators. In 2007, the average fixed broadband[4] penetration rate, calculated as the number of available lines as a percentage of population, was 17.1 per cent in Italy, below the OECD average (19.6 per cent) and lower than in the other major European countries.

[3] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society*, COM(2016)587, September 14, 2016.
[4] At a minimum download speed of 2 Mbit/s.

Today, this indicator has reached 28.4 per cent. With an average annual increase of 4.3 per cent, the dynamics were similar to those of the other main European partners. In levels, the gap remains (the fixed broadband penetration rate is 32.3 per cent in Spain, 41.7 in Germany, and 43.7 in France). The mobile penetration rate is instead much higher, at 88.5 per cent, in line with the figures of the other main European countries.

A similar scenario is described by other indicators of digitalization development, such as the European Commission's DESI 2020 connectivity sub-index, which provide a weighted average of connection availability and subscription: Italy ranks 17th out of 28 countries, one position above France, but a long way below Germany (8th position) and Spain (5th).

As shown in Figure 1, on the supply side, the poor ranking is due to the lag in fixed new generation network coverage, mainly to the ultrafast broadband component (above 100 Mbit/s), whereas the sluggishness in demand is more uniform (see Figure 2a-b).[5] The overall index of fixed broadband connectivity for Italy shows almost full coverage against a take-up of 61 per cent of households. Demand is instead particularly high in terms of mobile broadband[6] subscriptions, involving more than half of all households and 88.6 per cent of individuals (see Figure 2c). Mobile broadband is mainly complementary to fixed broadband. However, there is a growing number of households, which rely on mobile internet only. In 2019, in Italy 23 per cent of households had mobile-only access, the second highest share in Europe after Finland (36 per cent). Connectivity is heterogeneous on a territorial basis, with southern regions lagging behind in all bandwidth coverage, with the sole exception of some big cities, in line with the country average (see panels a-b in Figure 3).

Many critical factors influence the Italian performance with respect to the connectivity index, both on the supply and on the demand side. In what follows, we will

[5] In fact, by analysing the coverage and subscription indices separately, the gap is mainly explained by the demand component in all but the upper speed range.
[6] Mobile on 4G technology, where the coverage is also above 99 per cent.

focus on supply-side critical factors, leaving the discussion of specific demand factors, interpreted through the lens of the COVID-19 shock, to the second part of our work.

2. Supply-side factors.

On the supply side, ultrafast-broadband diffusion and different speed availability in Italy are related to three main types of factors: first, the technological features of the telecommunications network inherited from the past; second, the topographic characteristics of our territory; and third, regulatory issues, shaping the competitive context where operators make their moves, and capable of generating distortions in their investment decisions.

2.1. Technological factors

Technical characteristics, such as the length of the local loop, the quality of the copper and the presence or lack of an alternative legacy infrastructure (i.e. coaxial cable)[7] have contributed to driving the investment decisions in different EU countries.

In Italy, we have witnessed a steady increase in the performances of the legacy copper network over the past 15 years, on which technologies such as VDSL2 proved able to provide great speed and bandwidth capacity.[8] However, the legacy copper network can support high capacities, but only over relatively short distances. The use of legacy networks as a 'last mile' delivery medium requires the use of coding/decoding devices close to the users' premises.

[7] The latter can provide the user (with the DOCSIS 3.0 protocol) with hundreds of megabits per second in countries like Netherlands, Belgium or Malta that have easily achieved a broadband coverage of 100 per cent.

[8] For instance, if the standard ADSL can reach a maximum theoretical speed of 8 Mbit/s (12 Mbit/s in the ADSL2+ version, today's latest improvement on copper), VSL2+ can reach 500 Mbit/s over distances of 50-100 metres and 100 Mbit/s at 200-250 metres. VDSL2 is employed as a solution in locations where FTTx cannot reach Multi-Dwelling Units (MDUs points). It utilizes twisted pairs on a bandwidth up to 30 MHz, but the signal degrades at 1.6 km and then its performance is the same as ADSL2+.

On the contrary, optical fibre can transfer billions of bits per second (10 Gbit/s) to the premises by means of long-distance glass wires. Fibre is a disruptive alternative for the legacy network as it changes the structure of the network itself: it does not need a huge capillary distribution of local telephone exchanges (LTEs), or a hierarchical structure among exchange points. The NGAN, based on pure fibre, is directly connected by long fibre tendrils to the customers' premises (the 'fiber to the home', FTTH). It is also a future-proof technology, quite disruptive for those operators that have based their business and investment in the copper network so far, not to mention the prohibitive costs of deployment, which appear difficult to recover, in the face of a generally low willingness to pay on the part of consumers.

As an optimal response, most Italian telecom operators have converged towards an intermediate solution that could still exploit the high quality of our legacy copper network (short lines, high quality material and so on) and considerably increase speed and bandwidth capacity, without embracing the drastic and expensive FTTH except for cases where it was in high demand. The choice fell on the 'fiber to the cabinet' (FTTC), a mix of fibre and copper lines, demanding lower investment thanks to the efficient use of the legacy network's last mile. The logic behind this alternative resides in bringing fibre from the LTE to a point of flexibility 'not too far' from users' premises (the cabinets), where active devices can be installed to encode/decode digital traffic and route it through the last mile of copper (secondary network) using VDSL2+ technology.

Italy has a very dense secondary network,[9] highly suitable for fibre and VDSL2 to reach up to 100 Mbit/s connection speed (France, for instance, has longer secondary networks and a higher average distance between cabinets).

This was actually the technological choice of the ex-monopolist, Telecom Italia, sole owner of the legacy copper network, and this is why Italy has done quite well in reaching the first objective of the DAE, with almost full coverage of the population with

[9] In Italy, there are 168,500 street cabinets (150,000 of them are managed by Telecom Italia, 13,500 by Fastweb and 5,000 by Vodafone Italia) and about 10,000 LTES, with an average of less than 400 users per cabinet and an average length of the secondary network of about 2-300 metres.

ultra-broadband (30-100 Mbit/s). As we have seen, the second objective, 50 per cent coverage of territory and the endowment of all businesses with ultrafast broadband is far from being accomplished: it would require higher capacity and lower latency, which could only be guaranteed by FTTH technology.

The strategy of Telecom Italia was partly dictated by its willingness to exploit its copper network as much as possible, still its most valuable asset, and partly due to the difficult financial conditions, ongoing for several years, with a debt burden of more than €27 billion against decreasing total revenues standing at €18 billion. If we add to this the constant disagreements involving Vivendi and Elliot, the two reference shareholders on the Board of Directors, it is clear that the company did not have the strength to undertake a long-term investment strategy in a new infrastructure, which would entail a substantial immobilization of assets and, implicitly, the simultaneous scrapping of the copper legacy one.

In this context, only three operators offer FTTH coverage: TIM, Fastweb and Open Fiber, a wholesale-only publicly owned company created in 2015 as a subsidiary of the incumbent in the electricity sector Enel and the Italian national promotional bank (Cassa Depositi e Prestiti – CDP) for the deployment of optical fibre. The progress of FTTH technology is constant, but it only covers a very small part of the country. Between 2015 and 2019, the share of access lines through FTTH increased from 1.5 to 5.7 per cent of the total. Most of the territory was endowed with a FTTC infrastructure, which has replaced the legacy network totally in copper (Figure 4). According to AGCOM, the Italian regulator for electronic communications, the increase in FTTH is driven by the growth of services provided by Open Fiber, while the ex-incumbent continues to show low figures with respect to this technology (Figure 5).

2.2. Topography and population density: the market failure areas.

Italy has a particularly heterogeneous topography: more than half of its territory is made up of rural or semi-rural areas,[10] which are usually mountainous or hilly, quite isolated and have a low population density and scattered houses. It is not profitable for private operators to invest in new generation fixed networks in these areas, because of the extremely high costs of fibre deployment and low rates of returns. Thus, in the Infratel[11] mapping of the Italian territory, they are classified as 'market failure' zones (or white areas), i.e. where only direct State intervention can bring the ultra-broadband infrastructure to the whole population. Aside from extremely peripheral or isolated small municipalities, market failure areas comprise entire hinterlands of large cities and even large provincial capitals, accounting for 26 per cent of all Italian real estate units.

The market failure areas were already suffering from the first generation digital divide, as the twisted copper pairs used for telephone connections there are very long and therefore did not have sufficient bandwidth to support a standard xDSL. In these areas, access to a broadband connection is only possible thanks to the fast development of mobile Long Term Evolution technologies (3G and 4G LTEs). Nevertheless, rural areas still lag behind in NGAN access, particularly when referring to fibre-based technologies (Figure 6).

Fixed network infrastructures based on different mixtures of cable, fibre and copper and in several topological scenarios, such as FTTH or FTTCab, face a significant weakness: the high cost borne by operators in serving sparsely populated areas that is too high to be recovered at reasonable monthly rates paid by users. In the market failure areas, only public intervention can lead to their coverage with high-speed broadband. The advent of both mobile (LTE and 5th generation - 5G) and fixed wireless access networks (linking fixed points with a wireless connection) has proved to be a satisfying alternative in terms

[10] According to the OECD classification, rural and semi-rural areas represent 77.4 per cent of the territory corresponding to 50 per cent of Italy's population.

[11] Infratel Italia (Infrastructures and Telecommunications for Italy SpA.) is an in-house company of the Ministry of Economic Development and is part of the Invitalia Group. Operational since 2005, it is the entity that implements the Government's Broadband and Ultra Wideband Plans.

of capacity performance, provided at a significantly lower cost. The problem to be solved in this perspective is to find enough spectrum and design innovative network topologies, with the fibre brought to the transmitting antennas in an FTTAS (Fiber To The Antenna Site) scheme.

As part of Italy's national ultra-broadband plan, the European Commission approved the strategy for a next generation access network as a national State aid scheme in June 2016, as a means to support ultra-broadband in market failure areas. Infratel, a company that reports directly to the Ministry of Economic Development, manages the entire project. Infratel has launched three tenders,[12] all won by Open Fiber, to whom it granted a 20-year concession. Open Fiber will build and manage the network and only sell connectivity to telecommunication carriers which in turn will provide their services to companies and private citizens by competing on equal terms. The plan provides for a total of €3 billion in financing, of which 46 per cent are from European funds, which are being used to create a capillary fibre optic network as far as the end user in about 7,000 municipalities.[13]

According to the plan, the works should be completed by 2020, but the roadmap has accumulated significant delays. According to the Ministry of Economic Development, as of January 2020, the work had only been completed in 424 municipalities out of 6,237, of which only 80 already tested. On the other hand, there are 1,831 municipalities where construction sites are ongoing, which in terms of real estate units make up 44 per cent of

[12] The first tender, worth €1.4 billion and covering the Abruzzo, Molise, Emilia Romagna, Lombardy, Tuscany and Veneto regions, was assigned in June 2017. The second tender was assigned in November 2017 and covers the rollout of fibre-based networks in the regions of Piedmont, Valle d'Aosta, Liguria, Friuli Venezia Giulia, Umbria, Marche, Lazio, Campania, Basilicata, Sicily and the autonomous province of Trento. The third and last tender for the provision of a broadband infrastructure in unserved and underserved rural areas worth €103 million was launched in April 2018 and covers the regions of Calabria, Puglia and Sardinia.

[13] Open Fiber is proceeding with the creation of networks in GPON (Gigabit Passive Optical Network) technology, an infrastructure that the immediate provision of connections of up to 1 Gbit/s per user, therefore with a much higher bandwidth in terms of capacity than initially envisaged in the rules of the tender. The technology will bring the connection speed up to 40 Gbit/s in download and 10 Gbit/s in upload, which will make the public network suitable for the market requirements for many years to come. The Open Fiber network architecture is GPON - P2P hybrid: downstream, the passive network is shared with an overall multiplexing factor of 1:16. From the street splitter (CNO), the connection becomes point-to-point up to the house. For institutions and companies, it is possible to have a dedicated PON branch. The 'scattered houses', i.e. the most isolated houses, will be covered by Fixed Wireless Access or FWA technology, essentially carrying the fibre to radio repeaters and covering the last mile via wireless access. It must be said that Open Fiber, thanks to the cadaster of all public infrastructures, is proceeding by recycling conduits and existing overhead lines where possible, in order to limit new excavations as much as possible and therefore to reduce costs and inconvenience for citizens.

the total expected for white areas. Several appeals before the administrative judge against the tender caused this delay. The Italian Competition Authority also condemned the incumbent TIM for abuse of dominant position because of its attempt to hinder the carrying out of the selection procedure.[14] In addition to this, bureaucratic constraints in receiving permits from local authorities (for excavation and laying of optical fibre) slowed down the process, notably in mountain-based municipalities.

To accelerate the process, the Government has allocated €5 million to complete a mapping of the cable ducts (the 'Sinfi') that would lead to significant savings on the excavation costs, which will go in favour of those municipalities that have difficulties in conferring data because of a lack of dedicated resources and specific professionalism. Completion is now expected by the end of 2022. The current COVID-19 emergency has renewed the pressure to accelerate the plan, given the need for bandwidth for smart working, video links, audiovisual content downloaded from the web and fears - albeit dispelled by telcos and the institutions - for the resilience of the network.

2.3. Access Network Regulation and investment incentives

Telecommunications is an infrastructure-based industry, where the network is an essential input and plays a decisive role in the market. One primary regulatory goal is to promote competition and to enhance social welfare. A common conflict of social and private interests may then arise when, for example, a pro-competitive regulatory measure that restricts the incumbent's monopoly behaviour also undermines the firm's incentive to invest. In the EU, regulatory choices were initially based on the exploitation of the existing copper network: this has stepped up the deployment of broadband networks, but it has not incentivized the shift to optical fibre networks (see the box 'The regulatory approaches to broadband markets').

[14] AGCM, February 25, 2020, Decision A514.

THE REGULATORY APPROACHES TO BROADBAND MARKETS

There are essentially three different regulatory approaches in worldwide broadband markets and they can be identified roughly as deregulatory in the US, interventionist in East Asia and a cross between full deregulation and intervention in the EU. In 2000, European legislation on local loop unbundling (LLU) was enacted. It only required the unbundling of the local loop to operators that had been designated by their national regulatory authorities (NRAs) as having significant market power. Later in 2002, with the approval of the New Regulatory Framework, the EU updated and broadened its regulatory framework, stating that 'markets should be regulated only in so far there is a risk that operators may have significant market power (SMP) which may result in dominant positions or SMP over customers and competitors'. Aimed at spurring competition and accelerating broadband deployment, Member States have successively required their incumbent telecommunications carriers to unbundle the local loop. This decision fostered a heated debate regarding the effect of such unbundling in the EU. Proponents support the viewpoint that unbundling can foster broadband deployment and bring about facilities-based competition, while opponents argue that unbundling distorts entrants' make-or-buy decisions, impedes investment incentives and thus proves to be a failure. Meanwhile, a global downward trend in firm-level telecommunications investment can be observed in most countries. The existing economic literature provides theoretical models and some empirical evidence on the effects of access regulation on the deployment of fibre-based infrastructures. In particular, global fibre coverage can vary non-monotonically with the access price of the copper network, due to the coexistence of three different effects: (i) the *replacement effect* that hinders infrastructure investment by alternative operators when the access price is low; (ii) the *wholesale revenue effect* that discourages the incumbent from investing in a higher quality network when the access price is low (since the entrant may invest as a reaction, and the incumbent will then lose some of its wholesale profits); and finally (iii) the *retail-level migration effect*. The latter acts as follows: when the access price to the copper network is low, the retail prices of the services, which rely on the copper network, are also low; therefore, in order to encourage customers to switch from copper to fibre, operators should also offer low prices for fibre services. This effect reduces the profitability of the fibre infrastructure, and hence, the incentives to invest in it.[15] Even if an inverse causal relation between LLU regulation and investment does not necessarily emerge from the literature, we learn from several contribution that there are specific market conditions or regulation settings that can be detrimental to providing incentives for a dynamically efficient solution (see also Briglauer, 2014). In Italy's fixed telecommunications panorama, the unbundling policy for the legacy network followed in the last decade could have played a role in further delaying investment in NGAN, through a combination of all three of the effects we mentioned before.

[15] For instance, Bourreau et al. (2012) and Inderst and Peitz (2012) show that, depending on the market demand characteristics, the mandated access to a copper network may have a positive or a negative impact on the incumbent operator's investment in fibre networks. These models also predict that higher access fees unambiguously incentivize the entrants to invest in NGA. Bourreau et al. (2014) extend these models on the presence of access regulation to fibre networks and find that NGA regulation dilutes the incentive to invest. Based on EU countries' data, Grajek and Röller (2012) find that access regulation negatively affects both total industry and individual operators' investment.

3. Future developments and the way forward for Italy's telecommunication networks.

3.1. The single passive network fibre infrastructure: the pros and cons of a merger

Since Open Fiber entered the wholesale market, offering its fibre network infrastructure, an intense debate has arisen on the opportunity of a merger between the Enel-CDP subsidiary and the Telecom Italia network operations, for an efficient coverage of the Italian territory with new generation fibre infrastructures. The assessment of the merger cannot be clear-cut, also because of the possible consequences for the financial stability of the two companies. The outcome will crucially depend on the way the operation is carried out.

On the positive side, the merger is desirable because infrastructure competition generates the risk of an inefficient duplication of investment and higher costs.[16] Secondly, infrastructural competition is – and will probably remain so for some years to come – asymmetric, since the incumbent, vertically integrated, today directly serves almost 50 per cent of the final residential demand and, indirectly 80 per cent of the residual demand through the other operators using its network (Fastweb, Vodafone, Wind , Tiscali and other minor service providers). The asymmetry is reinforced by Telecom Italia's dual role on the wholesale and retail market, which would contrast with the level playing field principle between the two network providers. Thirdly, according to its supporters, the merger would maximize digital growth, employment and social cohesion. It would guarantee fair competition between all service providers, in conditions of parity of inputs into the 'neutral' infrastructure; it would be easily invested with universal coverage obligations against a predefined fixed compensation, and it would turn out to be welfare maximizing for the whole economy.

On the negative side, the opponents to the merger solution put forward some caveats. Doubts have emerged about duplications: on the one hand, they should be

[16] In other sectors (rail transport, electricity, roads and highways), the risk of duplication has been avoided by reserving to the State the construction and management of the single infrastructure used by all competing service providers; or by assigning the concession via competitive procedures and for a defined period of time.

avoided, as they are costly and generate inefficient outcomes in a sector that configures as a natural monopoly, as any network industry does.

Nevertheless, we have seen in the previous sections that timing matters and that static and dynamic efficiency are not easy to reconcile. A single network is the first best option when it is in place or, paradoxically, when nothing is in place. This is not the case in the Italian telecommunications set-up. We have Telecom Italia's network where the mixed copper-fibre technology prevails, but FTTH is also increasing, and the Open Fiber's last generation pure fibre network, which is non-comparable in terms of extension and readiness, but could potentially perform much better.

In fact, we are not moving along a given technology diffusion curve; rather, the curve has been shifting with the technological upgrade from x-DSL to fibre (see Figure 7). In this scenario, infrastructural competition can be an advantage, as the incumbent is recovering investment costs, particularly in the 'grey areas' where private investment can be profitable for at most one operator. It is probably part of a pre-emptive strategy, but it could accelerate a better coverage of the country with NGAN.

The investment of Flash Fiber and the private-public partnership TIM-Infratel provide two examples of positive outcomes from infrastructure competition. Flash Fiber, a wholesale only operator, is a joint venture between TIM (80 per cent) and Fastweb (20 per cent) created in 2016 to promote the construction of an ultrafast broadband infrastructure using FTTH technology in 29 Italian major towns and cities. Flash Fiber's business plan, with an overall investment of €1.2 billion, envisages the connection of around 3 million households by 2020. Moreover, in July 2019, Infratel and TIM signed an agreement aimed at activating all the fibre-optic public network infrastructures. Infratel has built in 600 municipalities spread over eight regions[17] as part of its direct model. At the beginning of April, Infratel and TIM announced that the network had been completed in 241 municipalities and they set a target of 310 municipalities by the end of May.

[17] Abruzzo, Sardinia, Tuscany, Apulia, Calabria, Lazio, Lombardy and Marche.

3.2. The TIM-Vodafone joint venture and the INWIT new TowerCo: a big step towards 5G.

A different story is told regarding the recent birth of the largest Italian mobile passive infrastructure company, resulting from a joint venture between TIM and Vodafone Italia to share passive and signal processing equipment in their 2G, 4G and 5G networks in less densely populated areas, approved in March by the European Commission.

INWIT, currently a subsidiary of Telecom Italia, is an operator of a passive mobile telecommunications infrastructure. Following the transaction, it would also own and manage, in addition to its current telecommunication towers, those currently owned by Vodafone in Italy. The creation of the joint venture is part of a broader set of cooperation agreements between Telecom Italia and Vodafone, aimed at a fast rolling-out of 5G in Italy. The two operators will maintain separate spectrum holdings and core networks and continue to operate as two commercially independent mobile operators in Italy. As part of the Commission's preliminary investigation into the network sharing, Telecom Italia and Vodafone have decided to scale down their active sharing, leaving out the most densely and highly populated cities and centres of economic importance, corresponding to over 30 per cent of the Italian population and more than 33 per cent of data traffic. These corrections have allowed the risks of excessive concentration in the mobile compartment to be considered as a minor concern. In its final evaluation report, the European Commission 'welcomes this development, which increases the areas (and the percentage of Italian population) in which Telecom Italia and Vodafone will continue to compete on network quality while retaining the benefits of network sharing in other cities and towns as well as rural areas'.[18]

[18] Press release of the European Commission, March 6, 2020. The Commission added that 'Considering that with five mobile network operators, the Italian telecommunication markets are less concentrated than in other Member States and that concerns in relation to the network roll-out of recent entrants are being addressed by today's merger decision, those adjustments seem prima facie appropriate to alleviate possible concerns stemming from the network sharing agreements between Telecom Italia and Vodafone in Italy'.

It is estimated that for Vodafone, the agreement will result in synergies of over €800 million, in addition to the indirect benefits deriving from the synergies of INWIT. Vodafone received €2,140 million and expects an incremental income over time of more than €1 billion, which it intends to use to reduce debt. For TIM, the financial effect of the expected synergies will be in the order of over €800 million, in addition to the synergies estimated for the new INWIT in terms of improving the EBITDA for €200 million per year by 2026, thanks to economies of scope and new opportunities, while the effect of deleverage on debt is expected to decrease it by more than €1.4 billion over time.[19]

The INWIT operation, differently from the TIM-Open Fiber network potential merger, is symmetric. The merger involves two mature and large operators with similar characteristics in terms of market shares and vertical integration, and especially serves to increase both firms' firepower in the 5G investment race. Tim and Vodafone will share the active devices of their respective existing 4G networks to support the active sharing of the 5G network. They will also adapt their respective mobile transmission networks through the use of higher capacity fibre optic cables ('fiber-to-the-site' or 'backhauling'), to take full advantage of the characteristics of 5G, such as the greater speed and low latency, allowing for greater economies of scale. On this matter, the two companies will extend the current passive network infrastructure sharing agreement, from the current 10,000 sites to coverage on a national basis, with the aim of strengthening the development of 5G technology and using the network more efficiently, both in urban and rural areas.

3.3. The 5G challenge. Where do we stand?

The fifth generation of mobile telecommunication systems, or 5G, will be one of the most critical building blocks of our digital economy and society in the next decade.

According to the latest ITU standard, under optimal conditions 5G will provide a connection capacity of up to 1 million sensors per square kilometre, higher connection

19 TIM-Vodafone joint press release, July 2019.

speeds (20 Gigabit/s in download and 10 Gigabit/s in upload) and a lower latency (4 milliseconds).

Coverage of a given area will require a significantly increased number of base stations that will enhance the complexity of the infrastructure, including the need to deploy radio equipment on street facilities, such as traffic lights, lampposts, utility poles and power supplies. Another challenge relates to 5G connection links between base stations and the core network (backhaul), which rely on both fibre and wireless technologies. Considerable work is required for implementing fibre services and ensuring the availability of wireless backhaul solutions with sufficient capacity.

Furthermore, spectrum is a scarce and very valuable resource, and there is intense competition for spectrum at national, regional and international levels. As the radio spectrum is divided into frequency bands allocated to different radio communication services, each band may only be used by services that can coexist with each other without creating harmful interference. Addressing all these challenges generates the need for considerable investment by telecommunications operators, which will plausibly be more than compensated in the future (see the box '5G as the new general-purpose technology (GPT)'), but currently represent a considerable upfront commitment, to be carefully considered by policy-makers.

To support the deployment and take-up of 5G networks, the Commission presented a 5G Action Plan in September 2016. Today, Europe is one of the most advanced regions in the world when it comes to the commercial launch of 5G services, with an investment of €1 billion, including €300 million of EU funding. By the end of 2020, the first 5G services are expected to be available in 138 European cities.

Among EU countries, Italy is a frontrunner in 5G systems deployment: 5G readiness is the DESI sub-index where Italy outperforms, ranking fourth out of 28 countries, right after Germany, Finland and Hungary (Figure 8).

In 2017, the Ministry of Economic Development allocated radio spectrum (i.e. contiguous 100 MHz around the 3.7 GHz band) through licences for pre-commercial trials for a duration of four years. The operators that are currently running experiments are Vodafone (Milan), Wind Tre and Open Fiber (Prato and L'Aquila), and TIM, Fastweb and Huawei (Bari and Matera).

As reported by the European 5G Observatory, spectrum in the 700 MHz, 3.6GHz-3.8GHz and 26.5GHz-27.5GHz bands was auctioned in September and October 2018. The whole auction ended after 14 days of intense bidding, far above expectations, reaching €6.55 billion. All the five operators (Telecom Italia, Vodafone, WindTre, Fastweb, and Iliad) won some lots, with Telecom Italia and Vodafone being the protagonists. Licences will be valid from 2019 until 2037. Vodafone was the first operator to officially launch a 5G commercial service called 'Giga Network5G' in June 2019. As of October 2019, the service covers some parts of the cities of Milan, Bologna, Turin, Rome and Naples. Vodafone set a target to cover 100 main cities and key tourist locations by 2021.

The Italian Government's management of the auction resulted in one of the highest disbursement for participants in Europe, only comparable to the German one. In particular, according to the European 5G Observatory data, the allocation of the 3,400-3,800 MHz band reached a cumulative value of €4.4 billion, against the €4.2 in Germany, €1.3 billion recorded in the United Kingdom, €440 million in Spain and only €80 million in Ireland. After normalizing the data with respect to the population (and therefore to the different sizes of the markets concerned) it emerges that the unit price per MHz recorded in Italy was twice the German one, 3 times the British one and 4 times the Spanish one. This result was due to the peculiar regulatory distribution of the blocks put out to tender, which created an artificial scarcity situation: only four blocks were made available, which were of very unbalanced dimensions (two of 80 MHz and two of 20 MHz). The structure of the call for tenders triggered high competition between operators, and since bidders were not given the possibility of sharing the spoils more equally, Telecom Italia and Vodafone had to overbid to avoid being left with residuals. Out of a total of 14, the two big lots accounted for more than half of the total proceeds.

This peculiar auction design could have side effects in the future, both on market competition and on the future investment prospects, in the face of the companies' commitment to endow Italy with a fully-fledged and operational 5G infrastructure in the next 2 years.[20] The alternative would be either hiking prices, which is quite implausible within Italy's highly competitive mobile market, or cutting back on investment.

In 2018, (latest available official data), the telecommunications market showed a negative sign, registering a drop in total revenues of around 2 per cent, falling towards the value of €31.6 billion, reflecting the contraction in mobile services. In the latter compartment, the protracted price war made the prices of services drop by more than 7 per cent between the last quarter of 2018 and the corresponding period of 2019 (see Figure 9). Despite low profitability, investment has grown at an average rate of 3.3 per cent within the last 5 years, but this trend could soon flatten, thereby delaying 5G commercialization objectives.

5G AS THE NEW GENERAL-PURPOSE TECHNOLOGY (GPT)

So far, the Internet has developed its potential as an enabler of communication between individuals, and the 5G represents a quantum leap, as it enables communication among objects that will become producers and consumers of data and, more generally, producers of value. 5G makes it possible to create networks of connected objects in industrial sectors where connections did not previously exist: networks of cars, networks of machine tools and robots, networks of energy generators (smart grids), networks of goods transport vehicles, and finally networks of objects transported along logistics chain. For instance, in the automotive sector, 5G technology will connect cars to each other and exchange traffic information over short and long distances. Roads will be equipped with intelligent infrastructures and very low latency communication systems: computers capable of processing data so quickly that they can replace human drivers: in a future where self-driving cars will be ubiquitous, autonomous vehicles could be safer on roadways than human drivers are. Obviously, car manufacturers will try to enhance the data produced by these new networks of cars, sensors and computers. Nevertheless, within the paradigm of the 'discovery of value', the owners of vehicles, the managers of roads and highways, the owners of artificial intelligence algorithms and the telecommunications operators who have made communication possible will want to enhance the data collected, processed or transmitted by their devices as well. Production

[20] Based on the estimates of the European Commission, Asstel quantifies operators' investment between €22 and €27 billion for the development of ultra-broadband fibre and 5G networks (including the cost of licences for the use of frequencies). If we add up the investment planned for the expansion of the 4G networks, and the development of services and IT systems, the overall financial effort in the period 2018-2025 is estimated to reach €55 billion.

of new value and new competition on data and information will arise. Similar examples can be formulated for Industry 4.0 smart factories, the energy smart-grids and the networks linked to logistics chain (ships, trucks, trains, ports, stations and interchange nodes).

Moreover, 5G will be accompanied and boosted by the accelerated development of two other great technological innovations: artificial intelligence (AI) and blockchain. 5G will increase our data collection capabilities in real time and therefore the efficiency of AI algorithms. In turn, 5G networks will be managed and orchestrated by optimization algorithms. Finally, blockchain will enable secure micro-transactions between IoT objects and smart contracts to facilitate and enhance the generation of value in the real-time data market. 5G networks are networks of networks, where many logical slices, each consisting of one or more physical networks are interconnected. The slices are specialized subnets (automotive, content distribution, energy), logically distinct, but parts of a single physical network, capable of dynamically reconfiguring themselves using optimization algorithms.

In this scenario, the role of telecommunication operators is expected to change radically. Large networks of objects (vehicles, wearable devices, and infrastructures of all kinds) could connect with each other without the need for a specialized telecommunications operator, perhaps using free access frequencies (WiFi) or participating in future auctions for licensed frequencies. Connecting homes may no longer be the primary goal of the network. The FTTH technology may no longer be the only future-proof infrastructure: many competitors may join, such as 'fiber to the base stations', 'fiber to the infrastructures', or 'fiber to the 4.0 factory'. The very objective of total coverage with high capacity and low latency fast broadband (fixed, wireless, copper or fibre), the way we intend it today, could become outdated. Thus, telecommunications operators will not be the only ones to extract value from the connection of millions of objects and from the development of new applications based on the networks of vertical customers (car manufacturers, utilities, operators in the logistics chain). All the actors will contribute to creating the logical slices of the 5G network, which could facilitate investment in 5G (expected to be hundreds of billions of dollars worldwide) and accelerate the pace of this crucial industrial transformation. The new 5G networks allow the creation of heterogeneous networks, composed of a mix of macro and micro cells that use coordinated new frequency bands with very different coverage. This greater complexity results in increasing computational activity in the network nodes and the need for optimized and centralized management of the transmission points. We should not therefore be surprised at the proliferation of agreements between telecommunications operators for the common management of towers and spectrum and the emergence of wholesale-only operators or neutral hosts for the management of frequencies in virtualized networks. The new element in the current panorama of spectrum management is the strong demand by new market players for dedicated portions of the spectrum for uses defined as 'vertical'. In fact, the demand for 'dedicated spectrum' comes from the major dominant operators in the vertical automotive, energy or e-health markets. These are often large national champions (such as large car manufacturers or the manufacturing sector as a whole), applying for preferential access to dedicated portions of the spectrum as one of the qualifying points of a national

industrial policy. The request to reserve portions of spectrum for 'local' use does not come exclusively from the large vertical industries of the nascent 5G market, but also from micro-operators, namely operators who have a role of local incumbent in very restricted markets: a port, a railway station, an airport, a post office, or a large industrial plant. It could be an ISP, specialized operators or the infrastructure managers or owners themselves. Recent studies have shown that the role of micro-operators is very competitive with that of large connectivity providers.

4. The risks of overloading telecommunication networks due to the COVID-19 emergency

Following the lockdown measures taken by many Governments as a response to the COVID-19 outbreak, telecommunications networks are coming under unprecedented pressure to guarantee business continuity using remote modalities. The internet is really the enabling technology these days: it enables people to work and have meetings from home; it gives students the chance to complete their school programmes thanks to the e-learning platforms; and it helps to prevent excessive gatherings in supermarkets thanks to e-commerce. There is also the importance of e-health services and cooperation and the continuous exchange of clinical data between health professionals. All these services together risk clogging up our networks. If we also add an increase in video streaming and ludic digital activities, the situation could become worrisome.

In Italy, according to the Mix (Milan Internet exchange, data interconnection centre for 20 per cent of national traffic), since the Prime Minister's first lockdown Decree was issued on March 8, data traffic has registered a 70 per cent increase with respect to last year's average and is continually rising in the order of over 25 per cent (see Figure 10). A similar situation has been recorded in the other affected countries: for instance, in France a rise of 30 per cent is reported.

Telecommunication networks experts agree in considering the collapse of Internet as an extreme event, but they also argue we should expect outages, and speed and quality losses. In fact, while the backbone networks are built to resist these sudden peaks, local networks, connecting the last exchange point (e.g. the cabinet) to the premises (in this case our homes), are the weakest links, particularly those based on x-DLS on copper.

Therefore, the risk is that internet services will be slower and crash more often, as we are already experiencing in Italy and other EU countries.

Coordinated action involving governments, institutions, network operators and service providers is desirable, in order to prioritize the services most important for the community, even if this means temporarily violating the principle of net neutrality. European Commissioner Thierry Breton called for entertainment content to be downgraded, which is the most responsible for clogging the networks (as already done by some video streaming providers in Europe), whereas maximum priority should be ensured to all services and digital platforms closely related to the management of the health emergency; second in this ranking should be e-learning and teleworking. Moreover, Telecom companies are called upon to constantly monitor the networks and intervene promptly with their maintenance, and, where possible, physically expand the network capacity (e.g. activation of new optical links in the backbones).[21]

In Italy, Decree Law 18/2020 gave the Italian Communication Authority AGCOM an important role in the coordination and implementation of these general principles. AGCOM responded by issuing an operational document, which adapts the current regulation to make the decree operational. It also exhorts the ex-incumbent Telecom Italia and the other operators to accelerate in the provision of ultra-broadband to the largest possible number of households, following a logic of maximum coverage, even if this is in contrast with the economic incentives. The telecommunication operators promptly responded by activating many initiatives, from removing Giga caps, to free upgrading from ADSL to fibre until the end of June, to the provision of e-school and e-business platforms and assistance to consumers. Moreover, they accelerated their investment by activating new cabinets in white areas to provide fibre service to the population, increasing capacity and monitoring the peaks to minimize outages.

[21] In a joint statement, the European Commission and the Body of European Regulators for Electronic Communications (BEREC) outlined the conditions for applying exceptional traffic management measures to prevent network congestion. They pointed out that, when implementing exceptional traffic management measures, operators should consider proportionate solutions that would guarantee access to Internet to all users while being effective to manage congestion that might be caused by peak traffic, be limited in time to the strict necessary and ensure that equivalent categories of traffic are treated equally.

5. The demand for digital services

Many activities that, because of the strict lockdown measures, have to be performed remotely were in relatively low demand in Italy before the pandemic. They received an extraordinary boost, producing a digital demand shock. The current emergency also represents a stress test for our network and highlights the great potential of digitalization. It is desirable that a virtuous circle is generated so that the supply side will promptly respond to this unprecedented stimulus by speeding up broadband coverage and 5G networks commercialization. In the next section, we will focus on the state of the art of the main digital services in Italy, the first effects of the shock and some ways forward.

5.1. Smart working

According to the Eurostat Labour Force Survey (LFS), in 2019, 5.4 per cent of employed persons aged 15 to 64 in the European Union usually worked from home. This share has remained constant at around 5 per cent over the last decade. However, over the same period, the share of those who sometimes work from home increased from 6 per cent in 2009 to 9 per cent in 2019. As shown in Figure 11, Italy is at the bottom of the distribution, with a share of only 3.6 per cent of employed people usually working remotely, against 5.2 per cent in Germany and 7 per cent in France. In Italy, the share is much higher for the self-employed (12.9 per cent) than for employees (only 1.1 per cent),[22] and for men (3.8 per cent) than for women (3.3 per cent), counter to the trends in most EU countries. The share increases with age: it is 1.3 per cent on average for the age group 15-24 and raises to 3.6 and 4.1 per cent for those aged 25-49 and over 50 respectively, probably indicating that other factors, beside digital skills (generally more developed among the youngest) are in place, such as job seniority.

Following the outbreak of the COVID-19 emergency in Italy, within two weeks, thousands of workers were sent to work from home. It is the largest smart working

[22] This pattern was repeated in each Member State, with the highest values recorded in Finland where more than 40 per cent of self-employed persons usually working from home (46.4 per cent), the Netherlands (44.5 per cent) and Austria (43.6 per cent).

experiment ever carried out in our country. We are facing a mega test that is up against the technological backwardness of many companies (i.e. the existence of a server enabled for external connections) and the lack of an adequate connection in many areas of the country.

We have extensively discussed the problems relating to broadband connection coverage in the previous sections. Here we find it interesting to look at another possible driver of (or obstacle to) adopting smart working: the diffusion of digital culture within companies and among managers.

According to the Eurostat data on digital skills and ICT usage in enterprises, as of 2019, in Italy about half of workers in firms with at least 10 employees use a PC or other device with access to internet. It is quite a low share, in line with Spain, but 10 percentage points lower than in France and Germany. There is a considerable degree of heterogeneity among sectors: the figures range from 95 per cent in the ICT sector to 30 per cent in administrative and support service activities, whereas manufacturing and wholesale and retail trade register a share of 46 and 59 per cent respectively. The most worrisome element is that workers using a PC or device connected to the Web in firms with at least 10 employees represent 90 per cent of the total, so only 10 per cent of digitally skilled workers are employed in smaller firms. If we remember that in the Italian distribution of enterprises, the latter category accounts for 94 per cent, it is straightforward to conclude that our productive system lags behind in ICT adoption and digital literacy.

The distinction by firm size is the focus of a research conducted by the Observatory on smart working at the Polytechnic in Milan. According to the report, in 2019, 58 per cent of large companies launched smart working projects (56 per cent in 2018). Adding the 7 per cent of companies that have already activated informal initiatives and the 27 per cent who plan to do it in the future, only 8 per cent show no interest. Despite the modest growth, there is an increase in the maturity of the initiatives, upgraded from the state of experimentation to a new standard. They also comprise a greater number of workers: about half of the projects analysed are operational and the average company population involved goes from 32 to 48 per cent. Telecommunications companies, large banks,

insurance companies, utilities, and even the most advanced factories, have programmed the machinery remotely, and adopted structured forms of smart working. Numbers are much lower in SMEs, where structured smart working projects are only present in 12 per cent of firms, even though a sustained growth is registered compared with last year's figure of 8 per cent. Informal projects represent 18 per cent, but there is a high and increasing percentage of companies declaring no interest in the topic (from 38 to 51 per cent).

The figures we have cited are emblematic of the capacity of our productive system to react to the COVID-19 shock, with reference to smart working. Large firms already had all the instruments in place and could easily adjust and react;[23] small companies (i.e. most Italian production units) have been caught unprepared and will probably pay a higher price.

5.2. E-commerce.

According to the Eurostat data, the share of turnover sourced from e-commerce in total retail sector sales amounted to 10 per cent in 2019 in the EU28. This share has doubled over the last decade. With a 20 per cent share, the Netherlands tops the list of EU Member States, closely followed by the Czech Republic (19 per cent), and Denmark (18.0 per cent). Italy is at the bottom of this distribution too, with a share of only 4 per cent, against 8 per cent in France and 11 per cent in Germany. On the demand side, the share of Italian consumers that use e-commerce at least once within a reference period of 3 months is 28 per cent, one of the lowest in Europe and far behind the other major countries (Figure 12).

The recent health emergency has significantly affected competitive dynamics in the retail sector. Between January and April 2020, online sales in Italy grew significantly compared with the same period in 2019, notably during weekends. While until the end of

[23] For instance, Siemens already had 3,300 smart working employees; Eni had 4,500 and easily added other 11,000; in the Emilia Romagna and Liguria regions, the multi-utility Iren, Cnh Industrial and many others in a few days, and without too much difficulty, were able to continue their activity with flexible work options.

February they were growing by about 50 per cent if compared with the same period of 2019, the growth rate reached 100 per cent in mid-March and exceeded 200 per cent in mid-April (see Figure 13).

The current demand shift from physical stores to e-commerce in all affected countries, even those where this format was not very popular, could somehow become structural in the future, also depending on how long the restrictive measures are going to last. If so, we will witness a great transformation within the retail sector: market shares will probably be reallocated towards those firms able to compete in the online market and, along their value chain, towards their suppliers. Maybe, in contrast with the trend we have been observing for the last decade, small neighbourhood grocery stores will also survive, as they respond to proximity needs, while large chain stores that did not promptly invest in developing a digital branch may face more difficulties in preserving their market shares. If a consolidation process were triggered, it could also result in the surviving retailers having increased leverage over their manufacturer partners (monopsony power). The COVID-19 pandemic and the consequent lockdown measures, if prolonged, could have dramatic effects on the retail trade sector: the resulting cleansing and reallocation of market shares could bring about a rise in productivity, whereas the effects on both prices and employment are highly uncertain.

5.3. E-government.

According to the Commission's DESI indicator, Italy is below the European average for the development of digital public services (Figure 14). Even if there are good performances regarding open data, due to the creation of a national website following the legislation approved in the last few years, the level of online interactions between public authorities remains low: only 32.3 per cent of Italian internet users needing to send forms did so online, while the European average is 67.3 per cent. No progress has been made regarding the amount of data that is pre-compiled in public service online forms (which

lightens the administrative burden and improves the quality of the information given to the public administration) over the last seven years (Figure 15).

With respect to e-Health services, Italy ranks eighth in the European Union according to the DESI 2019 (Figure 16)[24]; 24 per cent of Italians have used health and care services provided online and 32 per cent of general practitioners use e-prescriptions. Moreover, there is some heterogeneity among regions: 14 out of 20 Italian regions have adopted the electronic health record, which can make patient health records available to both patients and doctors (including information on hospitalizations, medicines prescribed and clinical examinations) in electronic format (although only a minority of such records cover all health services). Most of the regions that have not yet implemented electronic health records are in the South of the country.

E-learning is not widespread in Italy. According to the latest available data from INVALSI, the national agency for school system evaluation (school year 2017-2018), the diffusion of computers in schools appears to be quite widespread (only about 10 per cent of elementary schools and about 20 per cent of middle or high schools do not have a computer). However, among students, the availability of technological devices is more limited, especially among elementary school pupils and those belonging to families with a lower than average income. Only 63 per cent of children in the second year of elementary school have a computer at home (56 per cent if with a lower than average income); almost 90 per cent of those in the second year of secondary school have a computer at home (80 per cent among the poorest students). Only in 2015 was a national plan launched with the aim of promoting students' digital skills and making digital technology a teaching tool, but this plan was poorly funded.

Several factors contribute to the low performance of the Italian public administration in the provision of digital services: the level of digital competencies of public employees, the lack of availability of IT tools, and the governance of the digitalization process.

[24] E-health is not covered by the DESI 2020.

In the Italian public administration, the share of public employees with low digital skill levels is higher than the European average (Figure 17).

Even if almost all Italian public administrations use the web for their activities, the degree of sophistication of the technologies they employ is highly heterogeneous. According to a Bank of Italy survey, in 2015, the Italian public administrations only had a good level of digitalization for tasks relating to the management of public finances (e.g. receipts and payments) and a limited interoperability between different functions and different administrations. The adoption of advanced technologies is not widespread: according to the National Institute of Statistics; in 2017, less than one third of the administrations had cloud-computing services and less than one in five had developed a mobile app. In both cases, only the administrations in the North-East and in the Centre of Italy were above the national average regarding their implementation. Regarding the delivery of services, the Bank of Italy survey shows that, in most cases, the website only allowed access to information but not interaction between the users and the administration.

The digitalization of the Italian public administration also suffers from the fragmentation of competencies through different administrative bodies, notably at local level, that have implemented digital processes at different times and to a different extent. It has only been in recent times that a national agency (the Digital Italy Agency – AgID) has been entrusted with the task of developing interoperable solutions for the digital public services delivered by different administrations. Moreover, last year a new department was created, reporting directly to the office of the Prime Minister, in charge of coordinating all the actions taken at national level for the digital transformation of the public administration. During the pandemic, the Government has appointed a team of experts to support this department in the exploitation of technologies to face the crisis.[25]

[25] The governance of the digital transformation is crucial, as is shown, for example, by the good performances of Spain, which ranks second in the DESI regarding e-government. As the European Commission pointed out in its latest report, the country's investment in the area of open government data was particularly noteworthy. Most of the digital-by-default strategy – the ICT Strategic plan for 2015-2020 - was already in place in 2019.

In recent years, some progress has been made through the development of national projects that have standardized the digital tools available for the interaction between users and public administrations. The Italian public administration performs well regarding online payment. PagoPA, the centralized node for public payments, which is also considered an example of good practice by the eGovernment Benchmark 2018 of the European Commission, allows about 400 payment service providers, included PayPal or Satispay, to provide their services.

However, in other fields the implementation has been slower than expected. The centralization of digital population registries (Anagrafe Nazionale Popolazione Residente) covers about tree quarters of the Italian population, but about 2,000 municipalities are still not interoperable. The e-identity system (Sistema pubblico di identità digitale – SPID) has reached 7.5 million users and only 4,300 public bodies deliver their services through this platform (at least half of Italy's municipalities are outside this system). In France, more than 15 million people use the equivalent FranceConnect, launched in 2017, which also enables people to access all the available services from the same website, while in Italy it is necessary to navigate the website of the competent administrative body. The French Government has also developed a platform (demarches-simplifiees.fr) that public administrations, citizens and businesses can use to communicate and manage a dematerialized administrative proceeding. In Finland, the Suomi.fi web service provides a single point of access to e-government services, so that citizens own information and electronic messages. The German EKONA digital identity can be implemented as an external identification service on the websites of various online services (like Paypal for online shopping): users are redirected to the 'My ELSTER' website on the German financial office portal and can log into their account.

The COVID-19 emergency has made evident the importance of the digitalization of public services and the limits in the spread of digital culture within the Italian public administration. Low digital skills and the limited use of smart working can partially explain the slowdown in administrative activity during the current pandemic.

Decree Law 18/2020 provides for smart working by default. However, it allows public employees to use their own devices when not provided by the administration and considers that, even if they are not in a position to work from home, they are considered to be on duty. At the same time, it suspends all administrative deadlines, which will restart at the end of the emergency period, and the functioning of the courts, except for urgent matters (e.g. involving the personal freedom of individuals). Regarding e-learning, COVID-19 has highlighted the lack of coordination and the differences in the use of technology between schools. With the current pandemic, the funds for e-learning were increased – €85 million were added to the initial provision of €30 million for 2020– and this should help to develop standardized tools for e-learning, while during the pandemic other private platforms are also being used.

Low-skilled public employees also have the worst performance regarding the use of smart working, which is not widespread in the Italian public administration. Bank of Italy estimates based on Italy's Labour Force Survey data show that, in 2019, less than 1 per cent of workers in the Italian public administration worked from home at least once in the reference month. Public employees who have used smart working are on average significantly better educated (more than half are graduates, compared with 27 per cent of graduates among those who have not used it) and are employed in professions that require more qualifications. [26]

However, public administrations are showing some progress in their willingness to move towards smart working. According to the Observatory on smart working at the Polytechnic in Milan, in 2019, the structured Smart Working projects doubled in the public sector (from 8 to 16 per cent), 7 per cent of PAs activated informal initiatives (1 per cent in 2018), and 6 per cent will start them in the next twelve months. The most advanced are large PAs, which in 42 per cent of cases have already introduced structured initiatives and in 7 per cent of cases have activated informal initiatives.

[26] See the 2019 Annual Report, chapter 12.

6. Concluding remarks

The Italian path of transition to the digital era is marked by light and shadow. While the development of the mobile infrastructure and the fixed broadband networks is in line with that experienced in other main European countries, Italy is still behind regarding ultrafast broadband networks. The networks are less developed in some areas of the country and this gap may deepen other pre-existing unfavourable divides. Rural areas are also lagging behind and the publicly funded programmes, that are progressing more slowly than expected, are only partially bridging the gap.

The current COVID-19 crisis shows that, where investment was effective and users were ready to benefit from the shift to digital instruments (e.g. large enterprises), resilience was greater. At the same time, lack of investment and other structural components, such as the low level of digital skills throughout the population, especially among specific categories (e.g. public employees), led to the slowing down or to the sudden stop of several economic activities.

Investment must be accelerated, in both viable and market failure areas. In the former, telecommunications operators will be further incentivized to invest by favouring (and not hindering) infrastructural competition and boosting demand. The latter could be sustained through different instruments, such as vouchers, which were envisaged in the national strategy but have never been implemented. At the same time, the administrative burden and other obstacles to investment will be removed. In the market failure areas, the projects will catch up and be swiftly completed. The current crisis show that fast Internet connection is necessary in all areas of the country, also in rural ones, which are one of the focuses of publicly funded interventions.

In some cases, sector-specific interventions are needed. For example, the development of e-government means modifying the governance of the digitalization process by speeding up the shift from the planning to the implementation phase, and by strengthening coordination and standardizing national projects fostering interoperability between administrations. The development of e-government requires the enhancement of

the digital skills of public employees, in the same way as the digital growth of Italy requires the enhancement of the digital skills of all individuals in every-day and working life. Training activities regarding digital skills are of the utmost importance within a lifelong learning scheme.

The present work provides evidence of how essential it is for our country to be endowed with a fully functional and ubiquitous ultra-broadband infrastructure and how urgent is to complete the coverage of the whole country with fixed and wireless new generation access networks, and also to accelerate the commercialization of 5G. In parallel, it reveals the need for an ambitious intervention to improve digital skills, targeting households, firms and public administrations. A country that proves itself able to pursue these two objectives will be undertaking a future-proof investment, making its economic fabric more flexible, more productive and more resilient.

References

Bourreau, M., C. Cambini and P. Dogan (2014), *Access Regulation and the Transition from Copper to Fiber Networks in Telecoms*, "Journal of Regulatory Economics", vol. 45, issue 3, 233-258

Bourreau, M., C. Cambini and S. Hoering (2012), *Ex ante regulation and co-investment in the transition to next generation access*, "Telecommunications Policy", vol. 36, issue 5, 399-406

Briglauer, W. (2014), *The impact of regulation and competition on the adoption of fiber-based broadband services: recent evidence from the European Union member states*, "Journal of Regulatory Economics", vol. 46, issue 1, 51-79

Ciapanna, E. and D. Sabbatini (2008), *Broadband in Italy: an overview*, Bank of Italy, Occasional Paper, 34

Ciapanna, E., (2019), *Regulation and Investment in the broadband networks: a model of strategic interaction in the EU27,* mimeo.

European Commission (2018), *eGovernment Benchmark 2018 – Securing eGovernment for all. Background report*

Giacomelli, S. and M. Tonello (2018), *Assessing bureaucratic start-up costs through Mystery Calls. Evidence from the One-stop shops for doing business*, "European Journal of Political Economy", v. 51, pp. 121-140

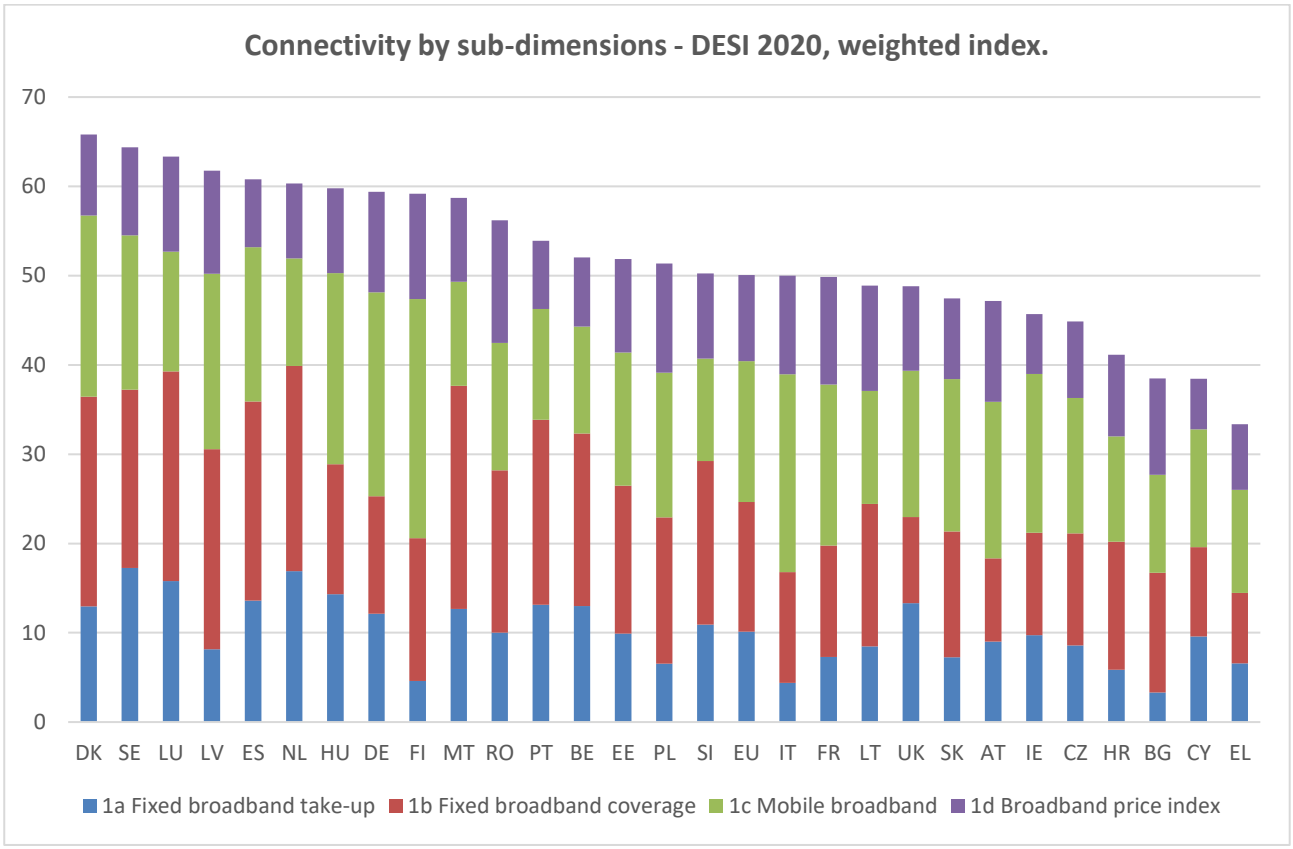
Grajek, M., and L.-H. Röller (2012), Regulation and Investment in Network Industries: Evidence from European Telecoms, "Journal of Law and Economics", vol. 55, issue 1, 189-216

Inderst, R., and M. Peitz (2012), *Network investment, access and competition*, "Telecommunications Policy", vol. 36, issue 5, 407-418

Laffont, J.-J., and J. Tirole, *Competition in Communications*, MIT Press, Cambridge, MA

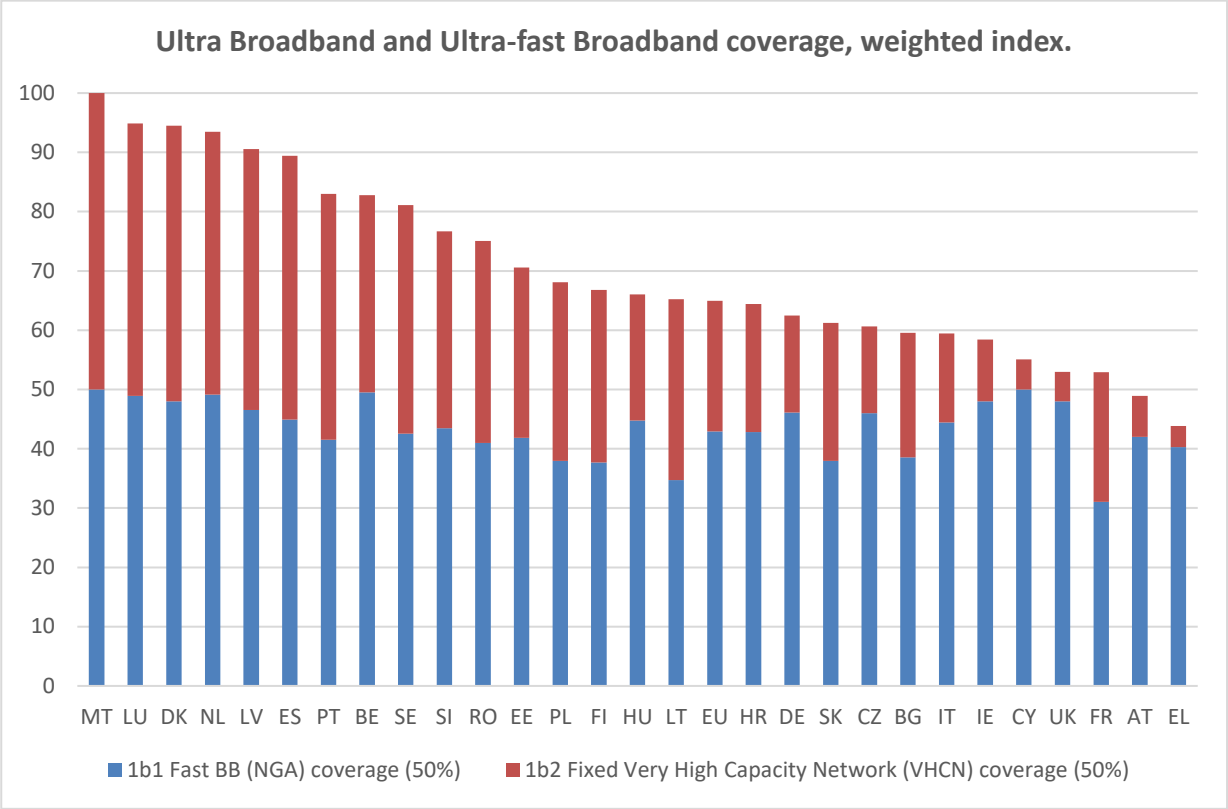
Tables and Figures

Figure 1



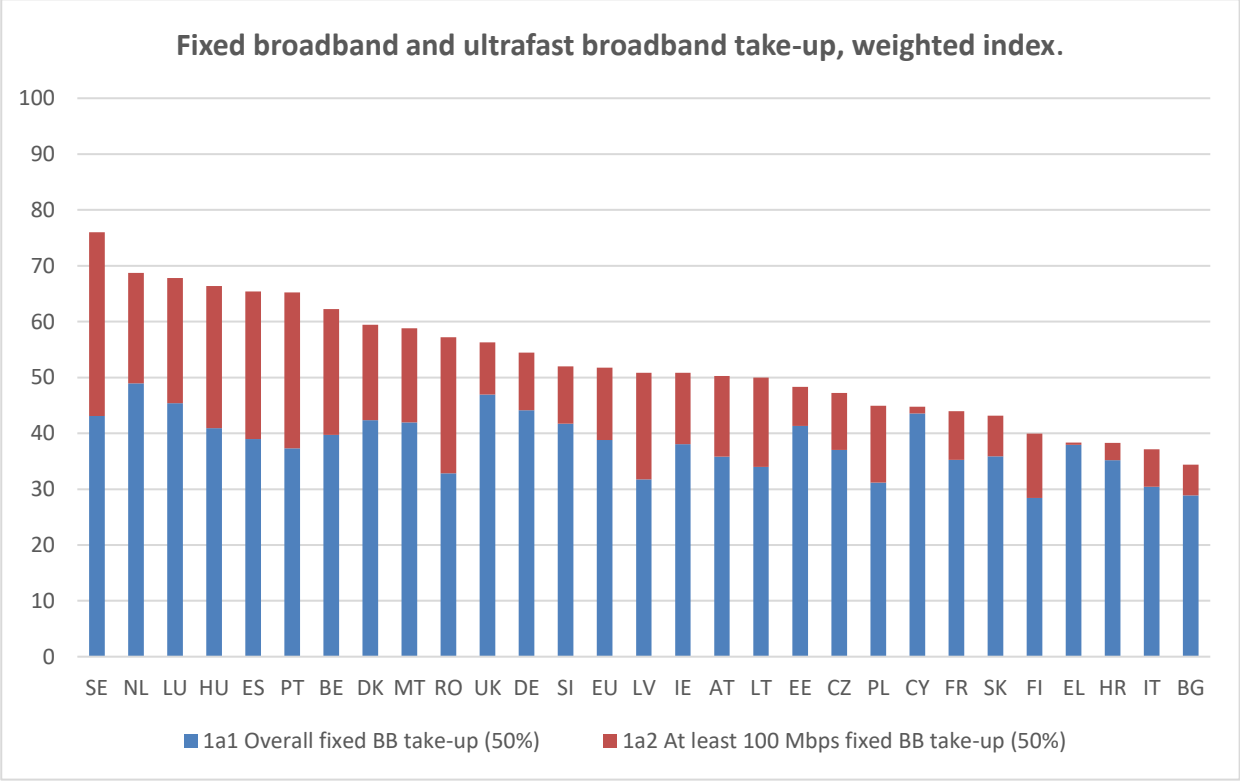
Source: European Commission.

Figure 2a



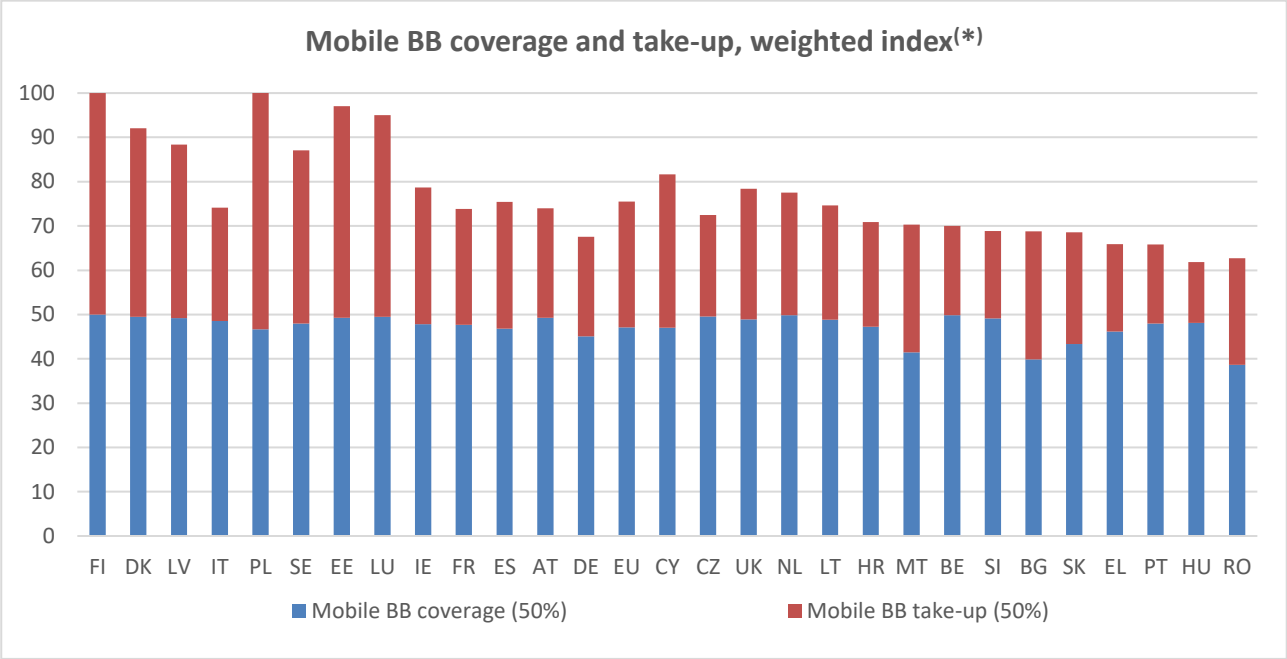
Source: European Commission.

Figure 2b



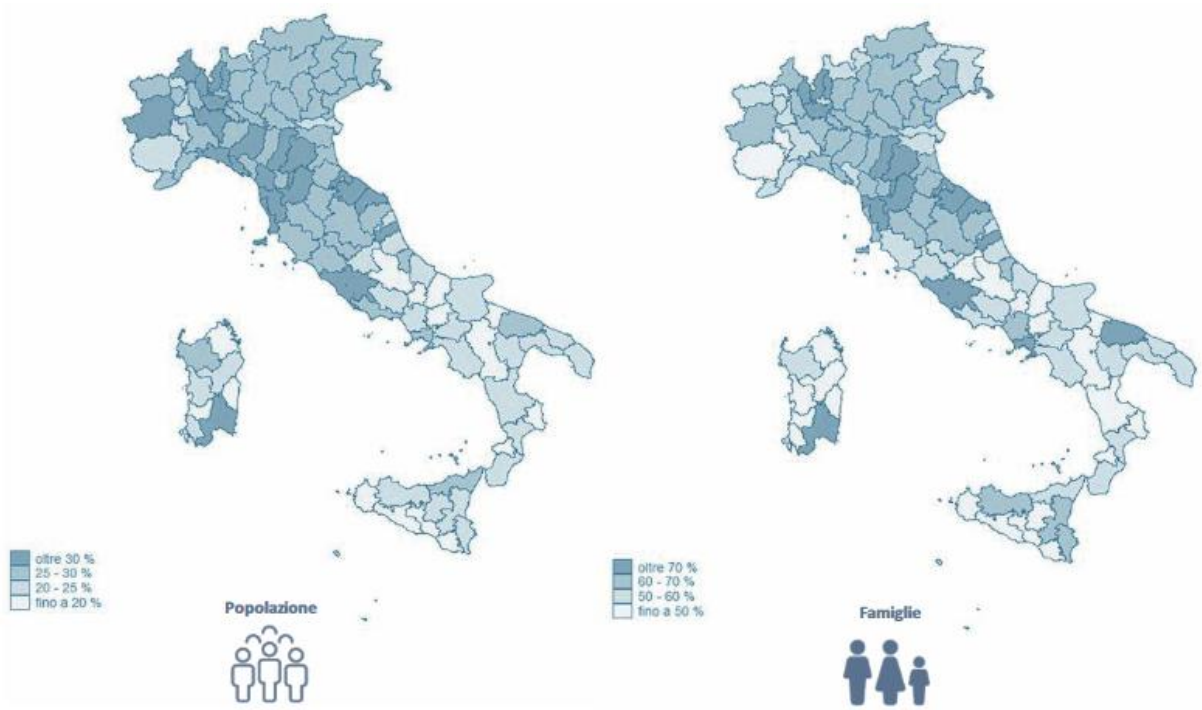
Source: European Commission.

Figure 2c



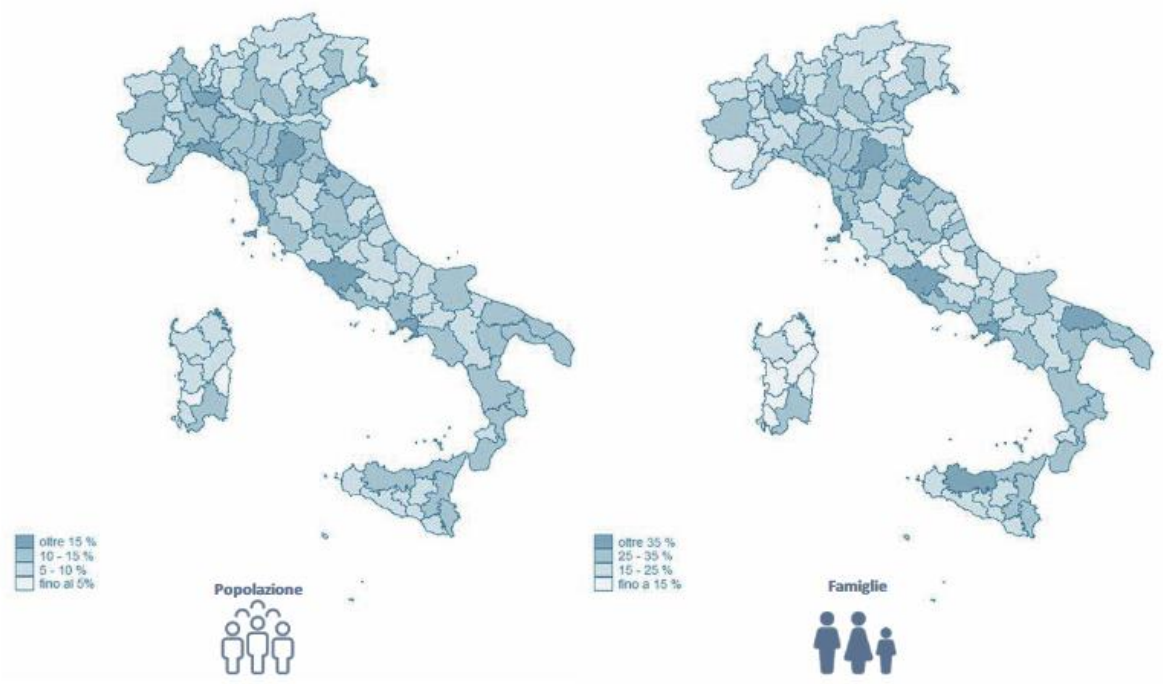
Source: European Commission. (*) 2019 data.

Figure 3a - Ultra broadband access by province (total population and households), December 2018



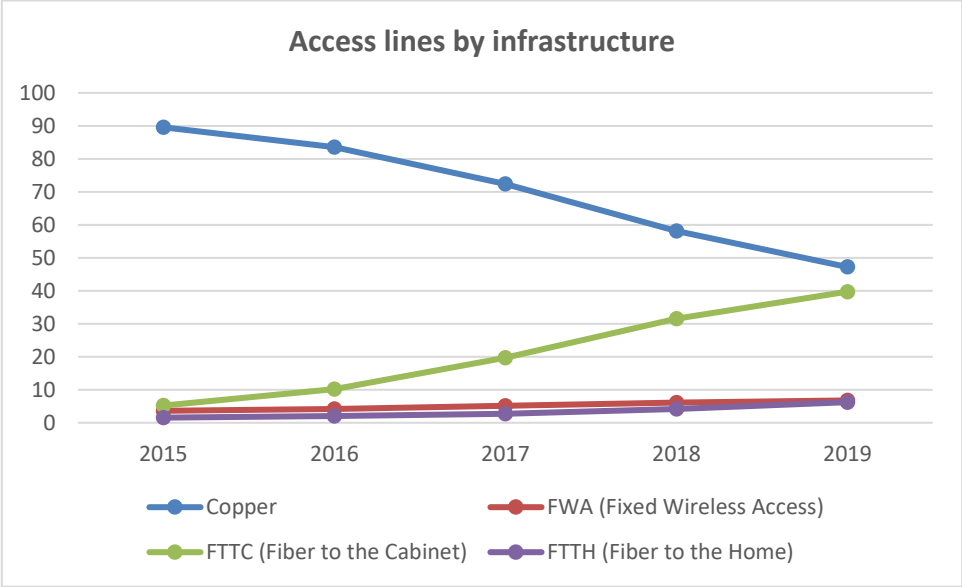
Source: AGCOM.

Figure 3b - Ultra-fast broadband access by province (total population and households), December 2018



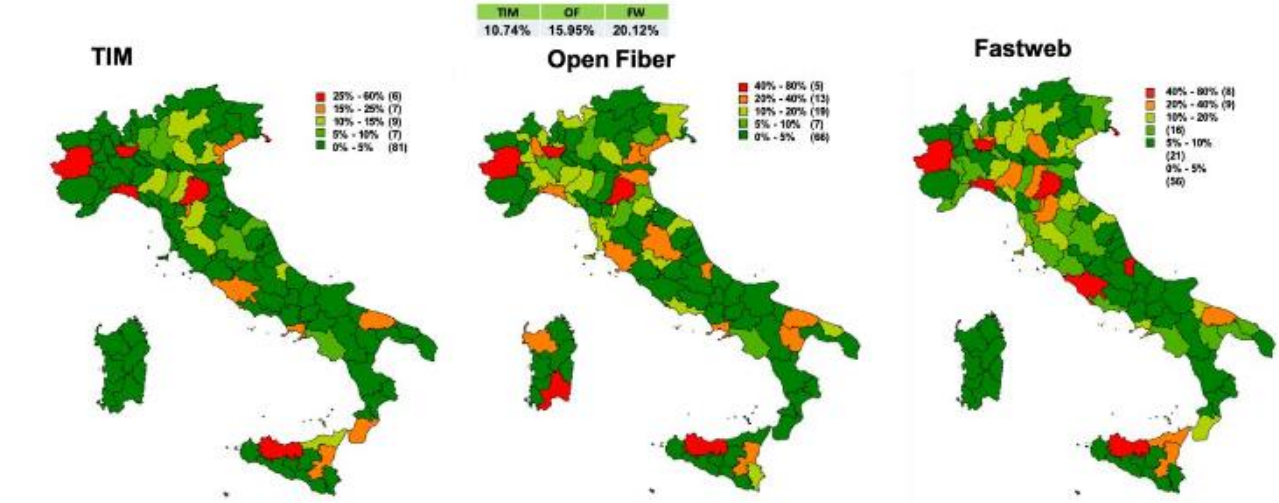
Source: AGCOM.

Figure 4



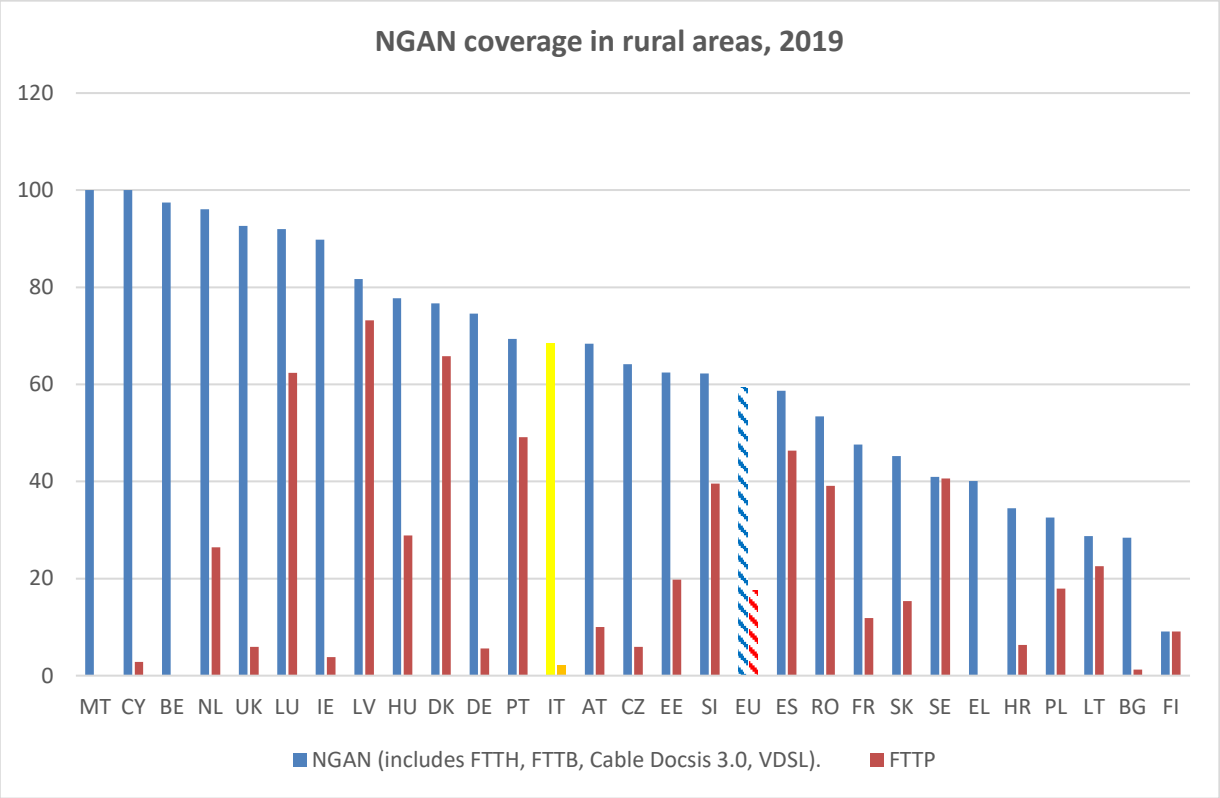
Source: AGCOM, Communication markets monitoring system 1/2020.

Figure 5 - FTTH coverage by operator and province, December 2018



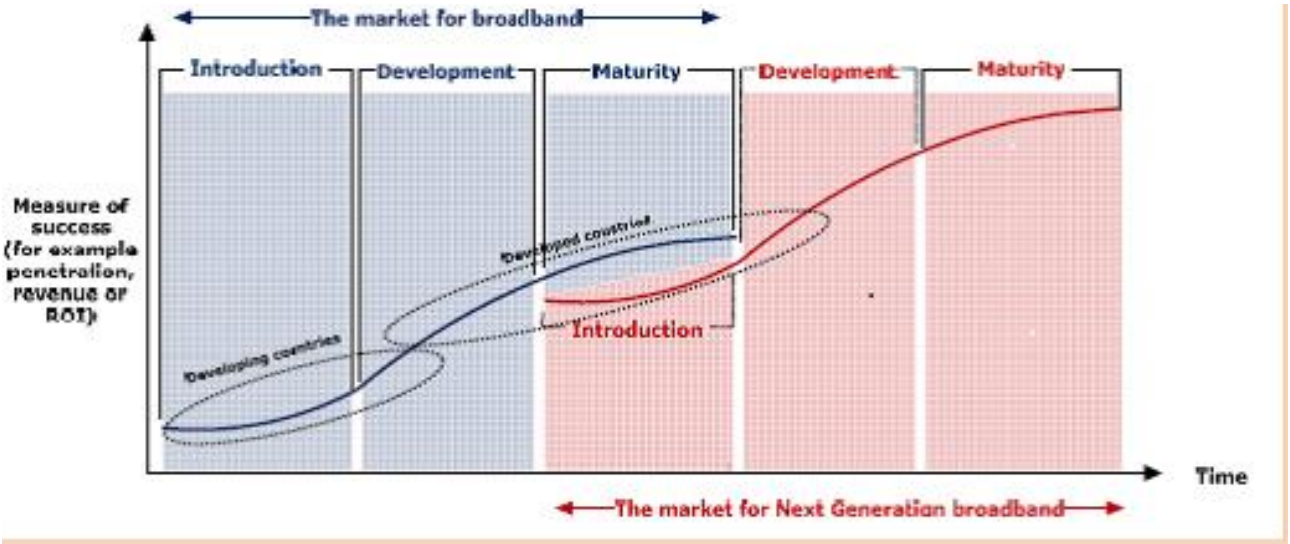
Source: AGCOM.

Figure 6



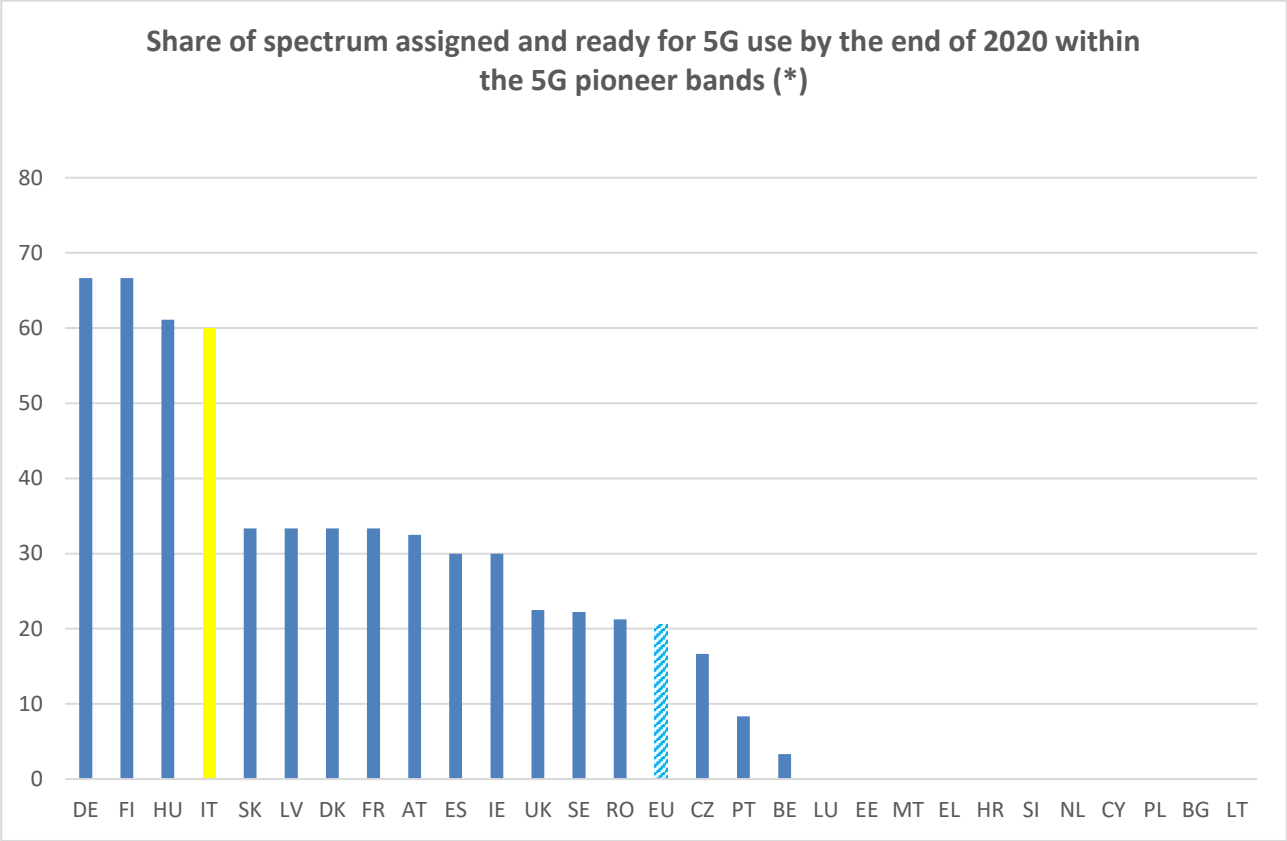
Source: European Commission.

Figure 7



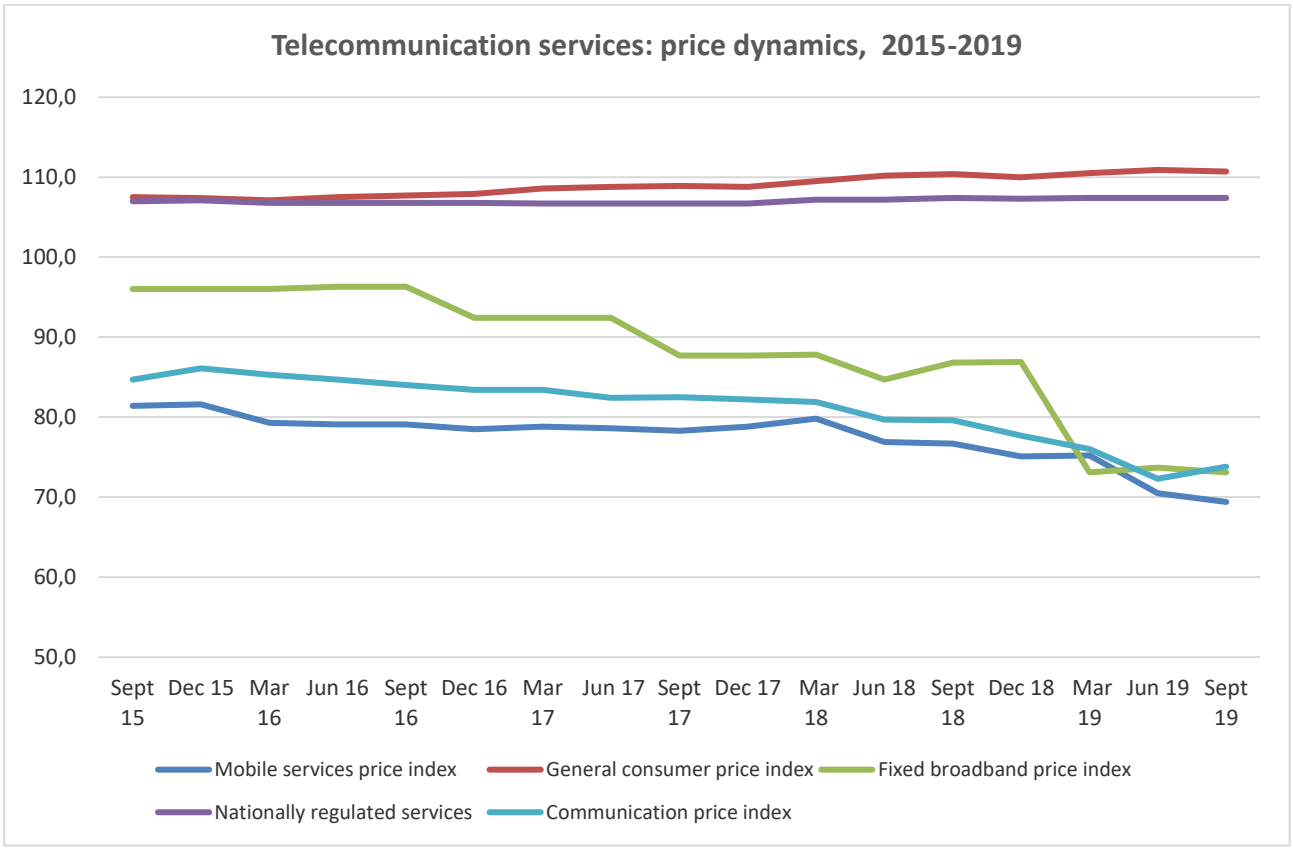
Source: Ciapanna, E., Regulation and Investment in the broadband networks: a model of strategic interaction in the EU27, mimeo, 2019.

Figure 8



Source: European Commission. (*): These bands are 700 MHz (703-733 MHz and 758-788 MHz), 3.6 GHz (3400-3800 MHz) and 26 GHz (1000 MHz within 24250-27500 MHz). All three spectrum bands have an equal weight.

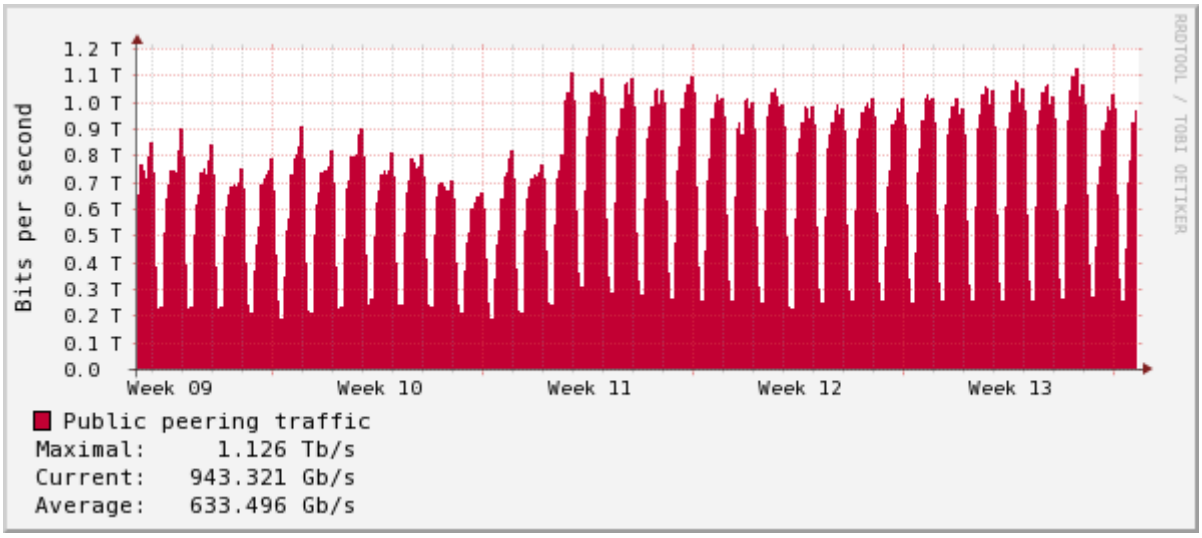
Figure 9



Source: ISTAT and AGCOM.

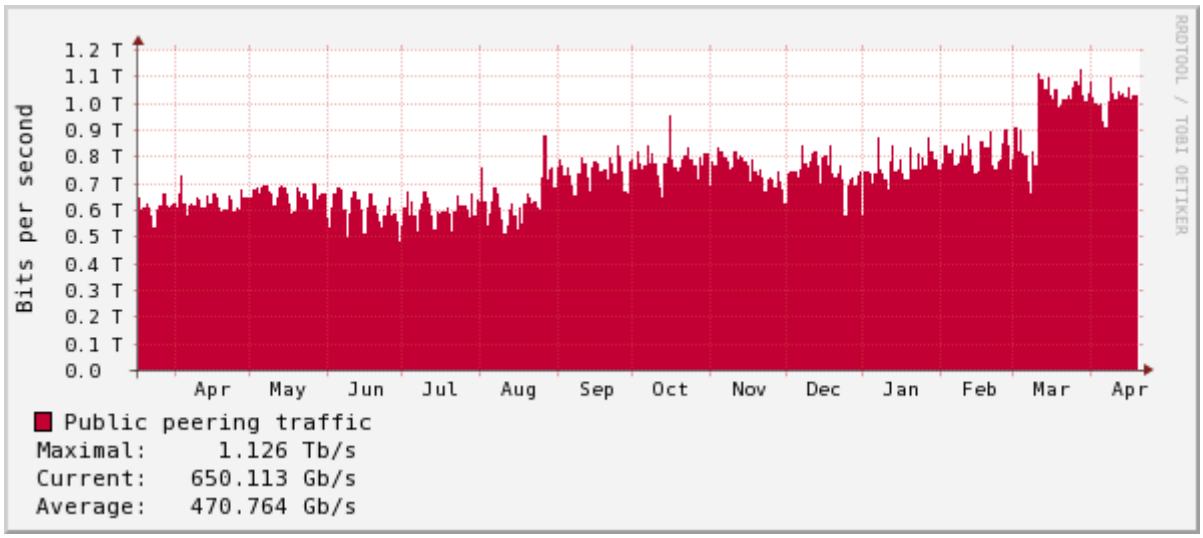
Figure 10 - Milan Internet Exchange traffic at different frequencies.

a) Monthly Graph - 2 Hour Average (February 24-March 29, 2020)



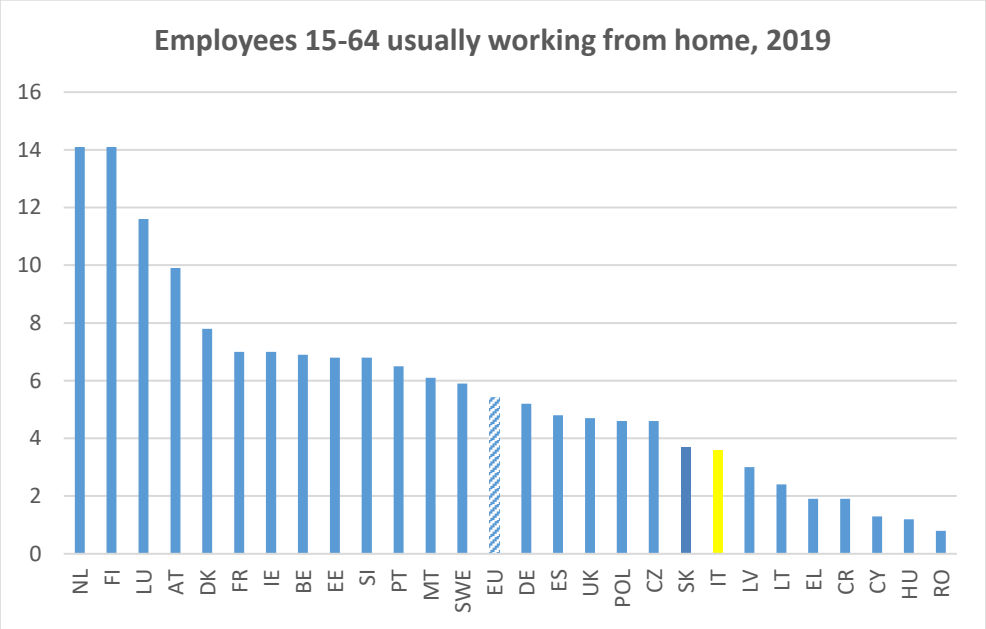
Source: Milan Internet Exchange.

b) Yearly Graph- 1 Day Average (April 2019-April 2020)



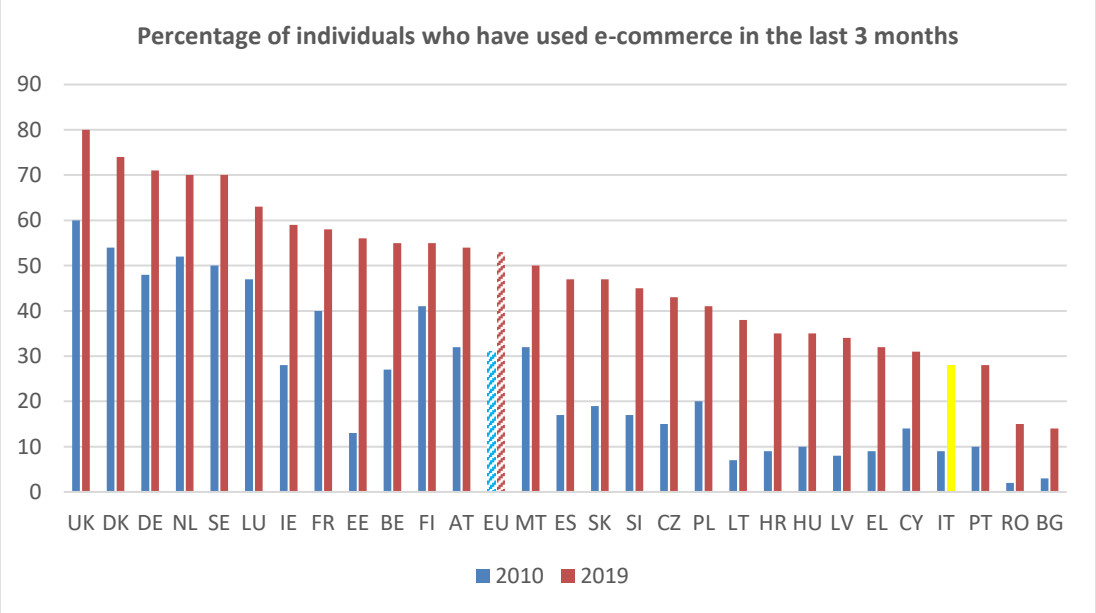
Source: Milan Internet Exchange.

Figure 11



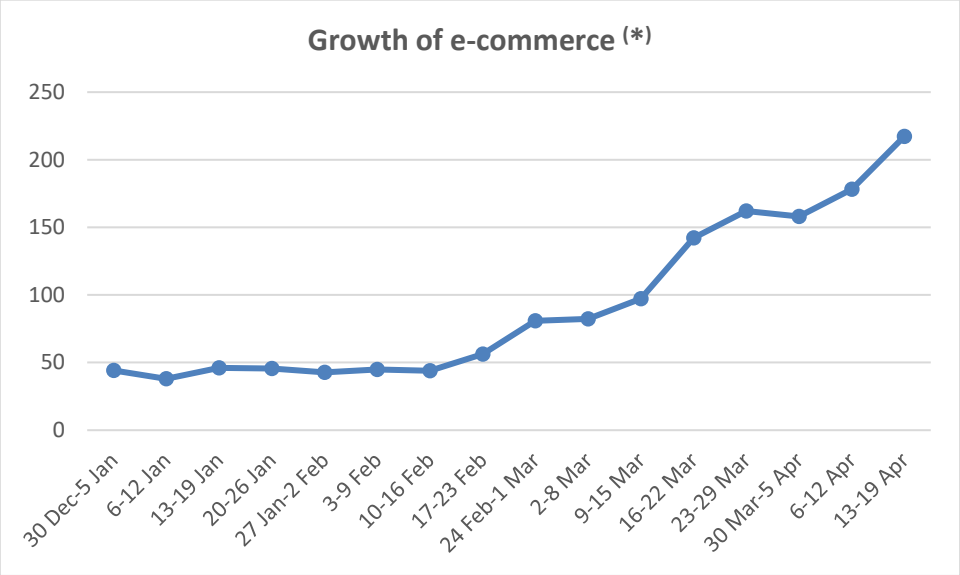
Source: Eurostat, EU Labour Force Survey 2019.

Figure 12



Source: Eurostat.

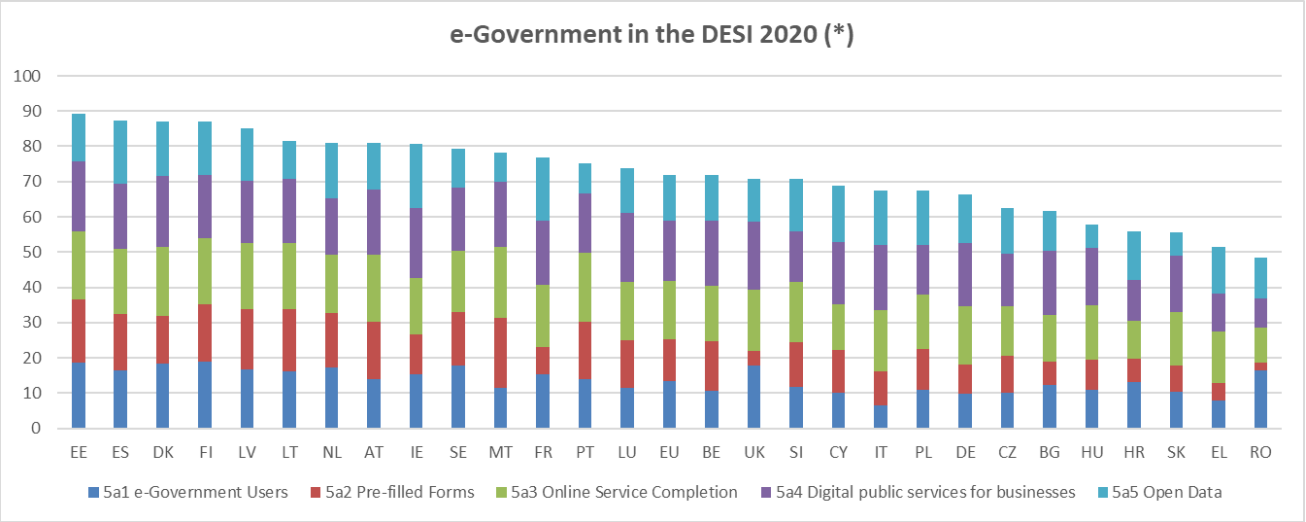
Figure 13



Source: Nielsen.

(*): year on year change of e-commerce sales (weekly data).

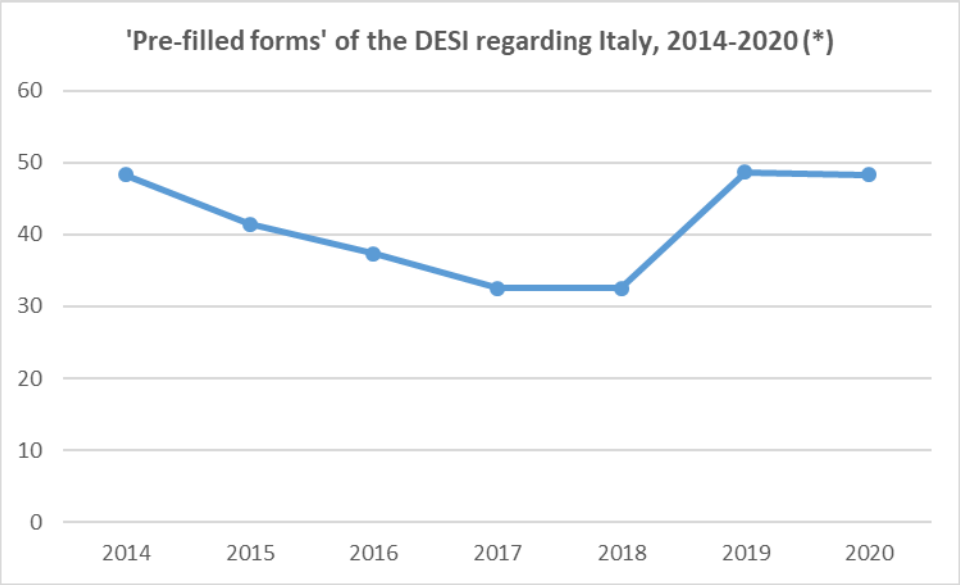
Figure 14



Source: European Commission.

(*): "e-Government users" is the percentage of individuals who sent filled forms to public authorities, over the internet, previous 12 months; 'pre-compiled forms' measures the amount of data that is pre-compiled in public services' online forms regarding different life events (business start-up, losing and finding a job, studying, regular business operations, moving (general administration), owning and driving a car, starting a small claims procedure); 'online service completion' is the share of administrative steps relating to the same life events that can be done online; 'digital public services for businesses' broadly reflects the share of public services needed for starting a business and for conducting regular business operations that are available online for domestics as well as for foreign users (services provided through a portal receive a higher score, services which only provide information (but have to be completed offline) receive a more limited score); 'open data' measures to what extent countries have an Open Data policy in place, the estimated political, social and economic impact of Open Data and the characteristics (functionalities, data availability and usage) of the national data portal.

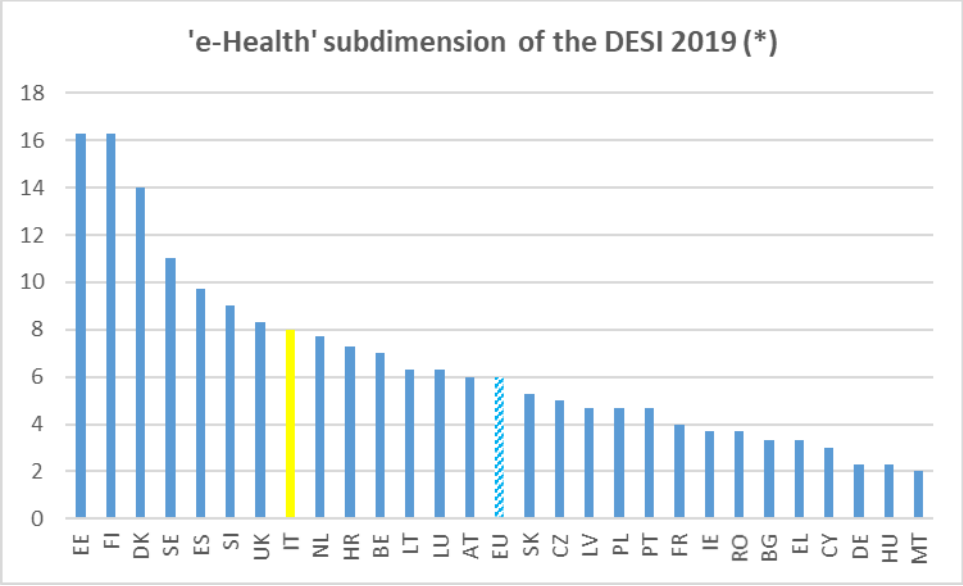
Figure 15



Source: European Commission.

(*): Amount of data that is pre-compiled in public services' online forms. The following life events are included: Business start-up, Losing and finding a job, Studying, Regular business operations, moving (General administration), Owning and driving a car, and Starting a small claims procedure.

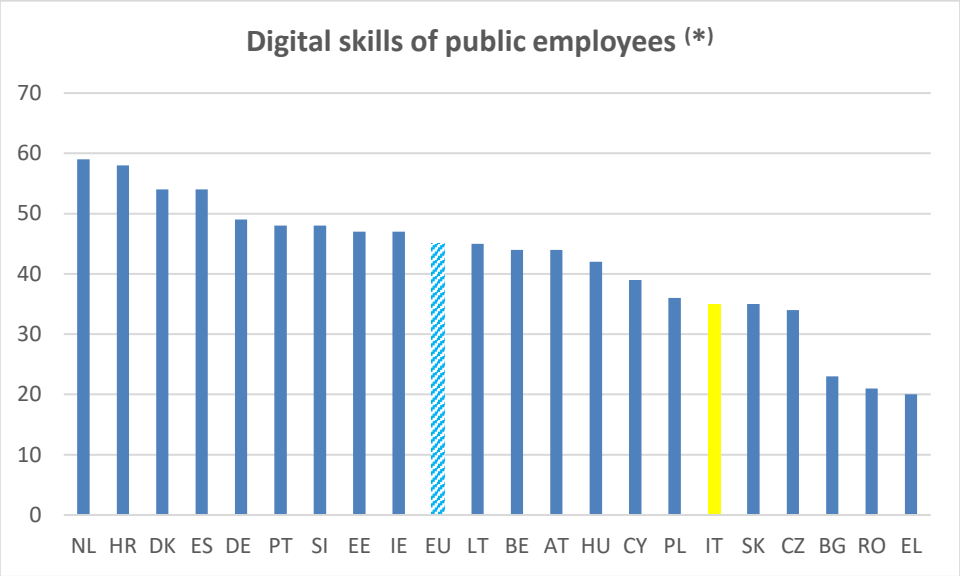
Figure 16



Source: European Commission Digital Scoreboard.

(*): DESI e-Health sub-dimension calculated as the weighted average of the normalized indicators: 5b1 e-Health (33%), 5b2 medical data exchange (33%) and 5b3 e-Prescription (33%). 'e-Health services' is the percentage of people who used health and care services provided online without having to go to the hospital or to a doctor's surgery; 'medical data exchange' is measured on the percentage of general practitioners who exchange medical data with hospitals and doctors; and 'e-Prescription' is the percentage of general practitioners using electronic prescriptions.

Figure 17



Source: Eurostat, 2019.

(*): Percentage of individuals working in public administration, defence, education, human health or social work activities who have above basic overall digital skills.