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The impact of infrastructural capital on economic growth and entrepreneurial activity

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Abstract

The aim of this work is to provide an integrated discussion on the essential role that infrastructure plays in the global economy, both from a macroeconomic point of view (economic growth and development at country level) and from an entrepreneurial perspective. Comprehensive and detailed research is available with respect to the positive influence of infrastructure investment and endowment on economic growth, as well as on welfare and wellbeing. Much less explored is the relationship between infrastructure and entrepreneurship, although some empirical evidence suggests that a positive link might be present. The paper provides a detailed review of literature on both phenomena, paired with available evidence and data from international organizations on infrastructure investment across advanced, emerging and low-income developing countries. An original analysis on the impact of infrastructure on entrepreneurial activity is also provided, with data collected at province level for Italy: our findings suggest that infrastructure matters for entrepreneurial ferment, especially that related to the provision of institutional services and regulations. Finally, we bring all our findings and considerations into the current conjuncture, which is one of the most challenging the world has experienced in the last century: by considering the dreadful effects brought about by the COVID-19 pandemic and the current geopolitical tensions around the world, we wish to highlight how infrastructure investment, with careful planning and focus on sustainability and resilience, can represent a critical factor in both economic and political discussion for a new growth path.

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Introduction

In a world once again on the verge of global recession due the COVID-19 outbreak and the geopolitical tensions that do not seem to ease soon, the role of infrastructures today and tomorrow is a challenging one. The claim of this work is that infrastructure are a formidable countercyclical tool in a time when consumption, investment and trade are at risk: they are an indispensable part of the fiscal stimulus plans that many countries are adopting in the current weeks and months in an attempt to alleviate the negative effects of economic paralysis, while improving employment opportunities and fostering competitiveness. Today and tomorrow, the role of infrastructure is more critical than ever before.

The goal of this work is to provide some insights on the aspects and channels through which infrastructure shape the world we live in: in particular, on the ways in which infrastructure can stimulate economic growth, development, and even entrepreneurial activity through the stimulus of employment, innovation, optimism and confidence in the future. Infrastructure is not merely a silent and immobile factor of the economy: rather, it is what shapes the landscape in which economy takes place and individuals operate. Oftentimes, it is a precondition and a deal breaker for growth and prosperity.

The following thesis is developed as follows: the first Chapter focuses on defining with clarity the concept of infrastructure and the different and heterogenous types of which it is made of, by reporting the several definitions and considerations brought about by economic literature on the subject over the years. In the second Chapter we will investigate how infrastructure shapes the world in which we live by affecting numerous channels of the economy and sometimes leading towards either growth or underdevelopment. In this context, we will discover how quality provision and management of infrastructure services may actually be way more valuable than the mere endowment of physical infrastructure capital.

In the third section of the paper we will provide an original analysis as to how infrastructure can affect the level of entrepreneurial ferment with respect to data collected for Italy at Province level, with the aim of providing some intuitions on which types of infrastructure (digital, transportation, education, institutional) could affect entrepreneurship at local level.

In the final Chapter, we will translate our findings and considerations in the current global conjuncture, which as we know presents exceptional and historic challenges.

This paper does not aim at extinguishing the phenomenon of infrastructure investment, nor does it claim to provide all insights on the subject: there is undoubtedly much scope for further considerations and reflections. The sake of the work will however be reached if we will be able to highlight how essential infrastructure is for our economic development and wellbeing, and therefore to emphasize how fundamental it is at this difficult time to consider the big picture, and project perspective interventions for future generations by ensuring policies that treasure elements such as quality, sustainability, inclusivity, and flexibility.

I. Infrastructure concept and framework

« You and I come by road or rail, but economists, they travel on infrastructure ».

Margaret Thatcher

1.1 A definition of infrastructure

In many government budget policy discussions, the term "infrastructure" has been used to describe spending that mostly pertains to transportation, particularly roads and highways. It has also been used to refer to spending on water projects, environmental energy, broadband, public lands, and public housing. The infrastructures category appears to be composed of various goods and services, holding different functions and features, and ultimately belonging to different areas of competence and government.

Infrastructure and infrastructure-related services have always been present, but the word itself is relatively recent. The term first appeared in usage in the late 1880s: the word comes from French, with *infra-* meaning below and *structure* meaning building.

Infrastructure is the foundation upon which the structure of the economy is built - often, quite literally. The concept of infrastructure, and not only the word, has however largely, and surprisingly, been absent from the history of economic analysis. In Adam Smith's vision of economic development, infrastructure plays a key role in determining trade, specialization, economies of scale, productivity progress, and, eventually, development: yet during the 19th century, and much of the 20th century, infrastructure virtually disappeared from economics. In Marx, in Walras, in Marshall, in Keynes, the output is produced only by labor and capital, and the latter is conceived as an undifferentiated type of productive capital of private enterprises. Still, governments invested heavily in infrastructure over the 19th century, transforming then-developing countries into today's developed ones.

Even in the post-World War II period, when development became a proper branch of economics, references to infrastructure and their role are scarce. Until the 1970s, infrastructure, even under a different name, hardly existed as an analytic concept or category in economic theory and policy.

To this day, when talking about infrastructure, it is quite common to refer to expressions such as "transport", "telecommunication", "access to energy" and so on: however, these are only the services that use existing infrastructure and not the infrastructure itself. Moreover, in the public discussion, infrastructure is often thought

of in terms of economically relevant sectors such as electricity, transport, and energy, while there is a general consensus that facilities such as hospitals, schools and governmental institutions ought to be considered infrastructures too.

Indeed, in absence of a standard definition, any comparison between studies on the subject is challenging. A comprehensive definition of infrastructure is therefore needed, in order to discuss government policy proposals and when thinking about how an economy can grow and prosper.

Before reviewing several relevant definitions provided over time by eminent scholars, it is important to remind the definition of public good and to keep in mind that public good does not coincide with publicly owned infrastructure.

In the proper economic sense, public goods are defined as goods that are both *non-excludable* and *non-rival*: individuals cannot be effectively excluded from using them, and use by one individual does not reduce the good's availability to others. One classic example of public good is national defense: national armies protect the citizens of a sovereign nation against the threat of invasion; it is virtually impossible to exclude someone from benefiting from the services of national defense; likewise, there is no relevant incremental cost in protecting an additional user or citizen.

Public finance theory stresses that a basic rationale for government provision of goods and services is that, for one reason or another, private economic agents are unable or unwilling to accomplish the task - what is known as *market failure*. In the case of public goods, having no practical manner to exclude particular subjects from consuming the goods or services, private agents would be unable to charge and receive a price such as to yield a competitive return (this is also known as the so-called "free-rider problem", where a free-rider is a person who receives the benefit of a good or a service without paying for it). Thus, the private market would fail to properly allocate resources to their most efficient uses.

Another justification for public provision arises from *economies of scale* in production, which allow for substantial decreases in cost along with increases in the scale of production: and while pricing mechanisms can be developed so as to ensure an efficient allocation of resources, it is also necessary in such cases to allow a monopolist to engage in the entirety of production. Perhaps the most efficient, or at least the most easily monitored producing entity would then be the government itself.

Infrastructure is therefore often understood as goods provided by the governments, due to its characteristics of public goods and economies of scale. One of the most discussed topics in the infrastructure debate is the inevitability of the public provision of certain goods or services, as many infrastructures are considered essential for citizens and consumers.

Curiously, for two centuries, infrastructure as an analytic concept has been practically absent from the economist's toolbox: across economic studies, there is no standard definition of infrastructure, instead, academic literature counts several slightly different perspectives on the subject.

The OECD's Glossary of Statistical Terms defines infrastructure as '*the system of public works in a country, state or region, including roads, utility lines and public buildings*'.

Hirschman (1958) defined infrastructure as "*essential structures through which goods and services of general interests are being provided*".

Prud'homme (2004) describes infrastructure as consisting of "*capital goods that are not consumed directly: rather, in combination with labor and possibly other inputs, they provide services*". He also produced a table identifying those he conceived as infrastructure and their corresponding service, which is reported below.

Table 1 – *Infrastructure and associated services*

Service	**Associated infrastructure**
Transportation	*Roads, bridges, tunnels, rail tracks, harbors…*
Water supply	*Dams, reservoirs, pipes, treatment plants…*
Water disposal	*Sewers, used water treatment plants…*
Irrigation	*Dams, canals*
Garbage disposal	*Dumps, incinerators, compost units*
District heating	*Plant, network*
Telecommunication	*Telephone exchanges, telephone lines…*
Power	*Power plants, transmission & distribution lines*

Source: Prud'homme, 2004

Our definition of infrastructure will include more elements with respect to those presented by Prud'homme: still, what is important to us is the insight that when analyzing, discussing and designing policy measurements concerning infrastructure, what should matter is the service provided much more than the infrastructure itself. Policies should therefore focus on granting a proper service provision, rather than on the mere infrastructure endowment.

According to Prud'homme, services associated with infrastructures have six specific features.

1. They are capital intensive;
2. They involve a long gestation period;

3. They are very long-lasting, with life being measured in decades if not in centuries, and require corresponding financing and maintenance;
4. They are space-specific, being generally immobile. As a consequence of immobility and long life duration, infrastructure investments will shape the economic geography or regional policy of a country for decades.
5. They are associated with market failures in the traditional forms of public goods, externalities, decreasing costs, or merit goods. This is usually considered to imply some form of public intervention.
6. They have a double kind of consumption, being consumed by both households and enterprises. This turns them into being a final consumption item and an intermediate consumption item at the same time. By this means, infrastructure increases welfare directly and increases output too. The relative importance of these two consumptions "*varies with each infrastructure, and over space and time, but in general, the consumption of enterprises seems to be somewhat greater than that of households*" (Prud'homme, 2004, p. 6).

It is important to note that the existence of market failures is not an automatic justification for government intervention: it only provides a presumption of the need for government intervention. But in practice, one has to take into account possible government failures and compare the costs and benefits of both options.

Henckel and McKibbin (2010) agree with Prud'homme and point out infrastructure assets such as internet, telephone (fixed-line and mobile), rail, air, sea and road transportation, energy and water. Without differentiating between sectors and services, they also recognize the features of lack of perfect competition, presence of network externalities and the fact that infrastructure is a public good.

A similar definition was provided by Chambers (2007), according to whom infrastructure assets are the physical structures, facilities, and networks that provide essential services to the public. Chambers includes in his analysis not only transportation structures, energy and utility companies and communication entities, but also social services such as educational facilities and hospitals.

More broad and generic definitions are not missing. For instance Weisdorf (2007) identifies infrastructure as "the essential facilities and services that the economic productivity of a community or organization depends on. As a real return asset class, infrastructure includes those assets that are involved in the movement of goods, people, water, and energy". Also Fulmer (2009) considers infrastructure as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions".

Perhaps one of the most punctual definitions of infrastructure is provided by Torrisi (2009), who states that infrastructure in an economic sense (stemming from the

original military definition referring to permanent military installations such as barracks and airports) refers to two main features:

- infrastructure is a capital good, provided in large units, meaning that it is originated by investment expenditure and is characterized by long duration, technical indivisibility, and a high capital-output ratio.
- infrastructure is also a public good in the proper economic sense since it fulfills the criteria of being not excludable and not rival in consumption. Sometimes the characteristic of being a public good is "weakened" so that infrastructure does create external effects but does not achieve the maximal level of externalities represented by public goods.

Despite the difficulties related to its exact meaning, in the public discussion the term infrastructure, fortunately, made a successful terminological career, rising to a formula of political technocracy.

For the purpose of this paper, we will aim at a generic yet encompassing definition of infrastructure, which we build by combining the findings of the scholars noted before. Thus, we will define infrastructure as the basic structures of a business, region, or nation, which present relevant common features:

1. They tend to be capital intensive and require high-cost investments.
2. They require long gestation periods and are long-lasting once completed.
3. They often involve the production of public goods.
4. They involve economies of scale.
5. They are consumed both by households and enterprises.
6. They provide spillovers from users to nonusers.

Then again, as this study will focus on specific categories of infrastructures, we will need a correspondent classification.

1.2 Infrastructure classification

As observed in the case of infrastructure definition, and perhaps as a natural consequence of its lack of clarity, infrastructure classification has also been conceived in many different ways in academic literature, where several types of categorizations have been proposed.

For our purposes, the classification which best suits our analysis is the one provided by Jochimsen (1966), who distinguished between *material* (or economic), *personal* and *institutional* infrastructures. This approach makes it possible to differentiate between the effects and the determinants of infrastructure, specifying each approach by the category of infrastructure under investigation.

The definitions we previously presented are focused on describing what is conceived as material or economic infrastructure. This is the type of infrastructure on which this analysis will focus the most: however, institutional infrastructure will also play a relevant role in the discussion.

Personal infrastructure

Personal infrastructure refers to "*the number and the qualities of people in the market economy characterized by the division of labour with reference to their capabilities to contribute to the increase of the level and the degree of integration of economic activities*" (Jochimsen, 1966, p 133).

The concept of personal infrastructure can be overlapped with the one of human capital, defined by OECD as "*the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being*" (OECD, 2001, p. 18).

The concept of human capital has a long history, being presented also by Adam Smith in his *Wealth of Nations* work in 1776. The term itself was first coined by economist G.S. Becker, who in his 1964 book *Human Capital* viewed education, on-the-job training and health as components of human capital with consequences for earnings and economic productivity.

The key aspect of human capital has to do with the knowledge and skills embodied in people and accumulated through schooling, training and experience that are useful in the production of goods, services and further knowledge.

Human capital can be further distinguished between two components:

- *Traditional human capital*, that is the cognitive skill or the ability to learn. It embodies many complex processes, including deduction, induction, abstraction, and memory. Cognitive skills have been studied and analyzed since the early 20th century and numerous studies identify linkages between cognitive skills and educational and occupational outcomes (college grade point average, income, job prestige, and so on). For further insights on this interesting topic, see Kuncel & Hezlett, 2007; Ng, Eby, Sorensen, & Feldman, 2005; Robbins et al., 2004).
- *Non-traditional human capital* can be thought of as all those psychological characteristics which go beyond cognitive skills, that is personality traits, vocational or career interests, and psychosocial/academic-related factors. All these features shape how a person behaves socially, performs at work or school, persists in case of failure, and so on. The studies on the subject are quite numerous (see for instance Duckworth & Seligman 2005, Heckman 2011, Heckman & Kautz, 2012).

A close concept to human capital is the one of *social capital*: while human capital is embodied in individuals, social capital is embodied in relationships. For the most part, social capital has been defined in terms of networks, norms and values, an inherited culture, traditions of a given society, and the way these allow agents and institutions to be more effective in achieving common objectives (see Gendron, 2004, for a focus on the topic).

We will not dive too deep into these concepts, as they are not so touched by the analysis provided in this study. However, towards the end of the paper human capital will return as driver for infrastructure investment – so some definitions are proper. In particular, we highlight the capacities that human capital involves, as described by David (2001):

- the capacity of *interpreting flows of data and structured information* required for purposive individual actions and inter-personal transactions among economic agents;
- the capacity for *providing a variety of physical labour service-inputs* in production processes;
- the cognitive basis of *entrepreneurial market activities*;
- the *creative agency in the generation of new knowledge* underlying technological and organizational innovations.

Institutional infrastructure

Institutional infrastructure "*comprises the grown and set norms, institutions and procedures in their reality of constitution, insofar as it refers to the degree of actual equal treatment of equal economic data, excluding meta-economic influences. It determines the framework within which economic agents may formulate their own economic plans and carry them out in co-operation with others*" (Jochimsen, 1966, p 117).

In this sense institutional infrastructure, being assigned the function of social integration of values, is the goal and the raison d'être of economic and legal policy.

This category of infrastructure includes formal institutions such as laws, property rights, rules, as well as informal institutions such as individual habits, groups' routines, traditions, social values, and also the facilities and the procedures granted to implement these norms by the State. Several economists have analyzed the impact of institutions on economic growth and the investment environment, and explored the depth to which institutions affect the incentives that modify human interactions (see for instance North 1991; Globerman and Shapiro 2002; Buhr 2003 and Decuir –Viruez 2004).

Institutions could be considered a precondition for economic development, rather than a simple affecting factor: not only do they attract investments, but they create the very basic conditions under which the private market operates and where enterprises can emerge and grow. When working properly, they can attract FDI (Foreign Direct Investments) and favorite the implementation of new approaches, techniques, and practices (there is an extensive literature on the subject – see for instance Smarzynska and Wei 2001; Globerman and Shapiro 2002; Maiorano and Stern 2007).

Overall, they are one of the main channels through which innovations can occur, especially in those cases where such innovations introduce radical changes in fundamental ways of thinking and operating at various levels – and socio-political acceptance in particular (North 1990; Tompkins and Adger 2005).

In the vast body of literature concerning the differences in economic growth and development across poor and rich countries, institutions possibly play the most crucial role. Many scholars do believe that the reason behind the lack of economic growth in some under-developed countries is to be found in the lack of proper institutions rather than on geographical matters: according to this vision, institutional arrangement is the key determinant of the joint evolution of economic and political development.

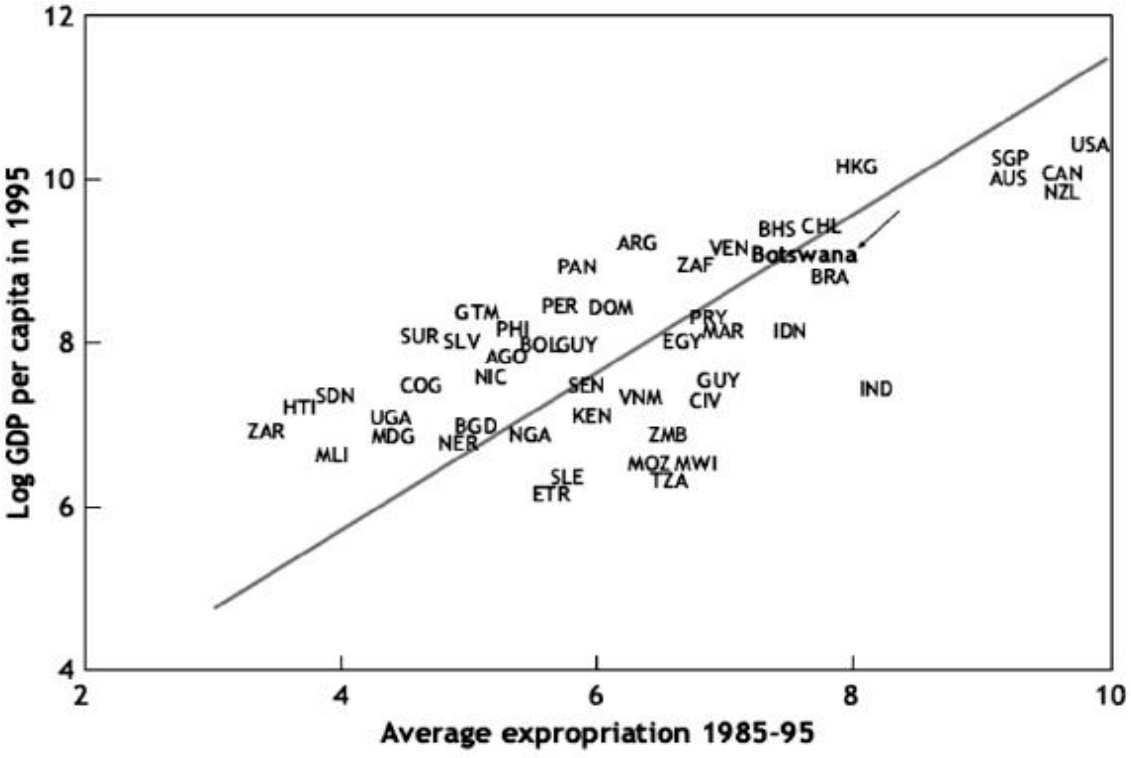
How does institutional infrastructure practically affect the economy? The channels are multiple and analyzing them in depth would require a very long time. For the purposes of this paper, however, we can identify three main channels through

which "good" or "inclusive" institutions impact on growth and development – the attribution of good institutions is taken from Acemoglu, Johnson and Robinson (2012):

1. Good institutions will provide clear, transparent and predictable frameworks ensuring economic agents are certain about the legal structure in which they are operating.
2. Good institutions will be able to place constraints on political actors, limiting the potential for arbitrary policy change (also Henisz, 2002).
3. Good institutional infrastructure will provide secure property rights so that subjects with productive opportunities will be encouraged to start investments on a broad cross-section of the society.

The crucial effect of good institutions is that they ensure that economic growth becomes inclusive among social classes, whereas "bad" or "extractive" institutions will have the opposite effect, excluding some categories from the benefits that come from economic prosperity by concentrating power in the hands of an elite - therefore discouraging development.

Figure 1 – *Correlation between property rights reinforcement as a measure of institutional quality and GDP per capita*



Source: Acemoglu, Johnson and Robinson, 2002
Note: on the horizontal axis, protection against expropriation risk measure.

For a glance at the strong correlation between good institutions and economic performance, see the table taken from Acemoglu, Johnson and Robinson (2002): their study comprehended data collected from 50 different countries and explained the so-called 'Botswana exception'. [1]

The insight that we take from considerations on human and institutional infrastructure should be the following: without a proper and solid network of human competence and social norms and rules, even the most advanced and sustainable material infrastructure will not be sufficient to drive economic growth.

Material infrastructure

Material infrastructure is understood as " *...1. The totality of all earning assets, equipment and circulating capital in an economy that serves energy provision, transport service, and telecommunications; 2. Structures etc. for the conservation of natural resources and transport routes in the broadest sense and 3. Buildings and installations of public administration, education, research, health care and social welfare*" (Jochimsen, 1966, p. 103).

Material infrastructure essentially consists of goods and services able to satisfy the needs of economic agents arising from physical and social requirements that are felt because of human nature itself.

As we have previously seen, these capital goods have certain properties in common, such as their long duration, technical indivisibility and a high capital-output ratio. Given a certain economic setup, material infrastructure plays the fundamental role of fulfilling social needs and mass production.

To take a closer look at the interaction of supply and demand of material infrastructure, we can rely on the very comprehensive findings by Buhr (2003), from which the following table is taken.

As we can see, Buhr's setup is very related to the one presented by Prud'homme, yet more comprehensive and detailed. From here, we can draw some common features that characterize material infrastructure as a category:

[1] The Botswana Exception as explained by the authors can be described as follows: despite being small and in a precarious geographic and political situation, Botswana was able to experience rapid and stable economic growth in its post-colonial history, therefore constituting an exception in the African continent. Although the presence of diamonds has been significant for its development, the most plausible reason for its economic performance appears to be the adoption of good policies and institutions (having a quite efficient public service structure and bureaucracy, and a valid system of law and contract) - Acemoglu, Johnson and Robinson, *An African success story: Botswana*, SSRN Economic Journal, 2002

Table 2 – *Material infrastructure to satisfy requirements of human life*

Want	Infrastructure output	Material infrastructure
Physical requirements		
Water	*Drinking water, water for industrial uses, irrigation water, water for generating hydro-electric power*	*Reservoirs, canals, water ways, pipes, irrigation facilities*
Warmth	*Gas, oil, electricity, coal, nuclear energy*	*Drilling platforms, pipelines, generation plants, coal mines*
Light	*Electricity, gas*	*Generation plants, drilling plants, circuits, pipelines*
Health	*Medical care, refuse collection, wastewater disposal*	*Hospitals, dumps, sewerage systems*
Protection against nature, shelter	*Accommodation, working places, flood protection*	*Houses, buildings, plants, levees*
Social requirements		
Security	*Legislation (laws), judiciary, stability of the value of money, protection against crimes, outward defense, military goods*	*Public buildings, police stations, military installations*
Information	*Usage of telephones, mobile phones, radios, television, Internet, newspapers*	*Telecommunication facilities, post offices, newspaper production works*
Education	*Childcare, lectures, research, lending out books*	*Kindergartens, schools, universities, research institutions, libraries*
Mobility	*Usage of roads by cars, buses, trucks*	*Roads, highways*
	Usage of tracks by trains	*Tracks, train stations*
	Usage of airports by airplanes	*Airports*
	Usage of ports by ships	*Ports*
Environmental protection	*Clean air and water*	*Air purification filters, waterworks*

Source: Buhr, 2003

1. Material infrastructures are complementary to each other: housing, for instance, is closely related to public utility networks.
2. Because of the economic necessities of mass production, material infrastructure is not available for individual consumption only. Fixed costs are usually so high that they require a joint production of large volumes of output.
3. Since fixed costs are different across capital stocks, material infrastructure provision occurs under the conditions of different market structures – from natural monopoly to competition. The supply-side of material infrastructure will depend on production functions, finance situation, and organizational structures of infrastructure producers such as industrial enterprises and administrative units.

Not only does material infrastructure represent today's challenge in terms of policy and government decisions: it is also the subject of everyday business decisions. Business, commerce, and international trade all depend on the state of material infrastructure to transport goods and raw materials, gain access to and provide essential services, communicate, and function.

There is no doubt that strong infrastructure performance can ultimately support economic efficiency: this paper aims to provide an analysis on the impact that infrastructure can have on both economic growth and on entrepreneurial activity. The following chapter is going to dive into this topic.

II. How infrastructure shapes the global economy

«Well-maintained infrastructure is perhaps the most striking and observable difference between impoverished nations and prosperous ones. In many ways, it is synonymous with economic development».

Efosa Ojomo, "*Building Infrastructure That Lasts*",
Clayton Christensen Institute, 2018

2.1 The impact of infrastructure investment on economic growth

2.1.1. Measuring the magnitude

Infrastructure is often mentioned as a prerequisite for the success of development policies and is currently a crucial topic on the agenda of politicians and international institutions. But while most economists agree on the fact that infrastructure investment matters for growth and is necessary for a country to industrialize and prosper, the measure of such investment return is still being debated. This should not surprise us. When analyzing the impact of infrastructure on output and growth, in fact, the issues are many.

First of all, there might be *reverse causality*: infrastructure and output may seem correlated, but this does not necessarily mean that more infrastructure translates into more output. In fact, we could also argue that more output makes it possible to finance more infrastructure, resulting in a true "chicken and egg" problem.

Secondly, infrastructure investment is a *component of output*: an increase in infrastructure investment will mechanically raise aggregate demand and output, even if it won't contribute to increasing productivity and output.

Moreover, many of the needs that infrastructure meet tend to fall into the welfare category, and welfare, as Prud'homme points out, "*is only a relatively distant cousin of GDP*" (Prud'homme, 2004). A large share of the benefits of infrastructural capital (i.e. improved security, time savings, improved health, a cleaner environment, improved outdoor recreation) presents magnitudes that are difficult if not impossible to measure and cannot be included in the official measures of national output like GDP.

Even placing a value to infrastructure stock represents a problem. In fact, how could we possibly compute the value of the Suez canal, or the Channel tunnel, or the Panama canal? We might refer to their historic cost – if known; or, we could compute how much it would cost to build them anew. Still, we would encounter depreciation and repairs issues, and any answer we would give would be very dependent upon our choice of evaluation - and therefore, very questionable.

It is important to note that researchers have of course been aware of all these pitfalls in infrastructure measurement, and have done their very best to avoid them through sophisticated econometric techniques or independent data. Physical indicators have been used instead of monetary ones, to bypass the valuation difficulty, and infrastructure usage variables were introduced.

These approaches, however, developed over a long period of time. In fact, up until the late 1980s the relationship between infrastructure and economic growth had been largely neglected: it became suddenly very fashionable only after a seminal paper written by David A. Aschauer (1989) called "*Is public expenditure productive*?"

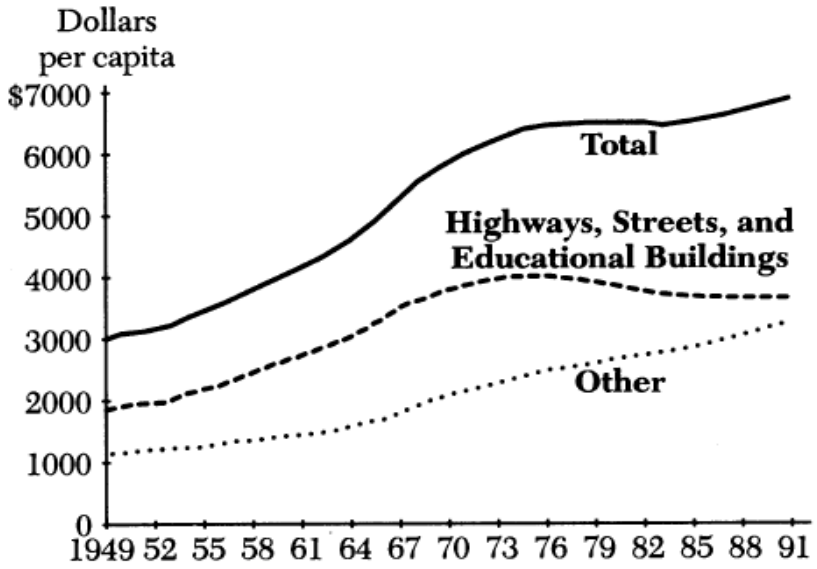
The goal of Aschauer's analysis was to determine the reasons behind the decline in productivity growth that the United States experienced during the 1970s, which had puzzled economists for years. Most analyses had sought explanations in energy prices, social regulation, the composition of the workforce, research and development, different rates of obsolescence of the private capital, and a number of other matters.

Aschauer provided a unique explanation, suggesting that the decline in productivity growth was largely due to a decrease in public investment in infrastructure. According to his findings, "*a core infrastructure consisting of streets and highways, airports, electrical and gas facilities, mass transit, water systems, and sewers should possess the greatest explanatory power for productivity*" (Aschauer, 1989, p. 17). He estimated a degree of elasticity of 0.24 – meaning that a 1% increase in investment in public infrastructure would result in a 0.24% increase in the private sector's output.

Aschauer's paper was followed by an unusual amount of attention from both politicians and economists, and was used by liberal politicians to rescue government spending and projects that had been cut by Reagan's presidency. Authors like Gramlich (1994) even suggested that politicians have exploited Aschauer's works to avoid necessary budget cuts and led to an actual "research bubble" on the subject.

Gramlich made a strong critique of Aschauer's conclusion and provided a different explanation by pointing out that since 1973 was the watershed year beginning the overall US national productivity decline, it is not surprising that simple time-series analyses find a correlation between the stock of infrastructure capital and overall productivity. The rise of net real stock of state and local structure per capita before the 1970s occurred in part because of the building of a complex interstate highway system, and in part because of the building of several educational structures to meet rapid increases in the school and college-age population. According to his analyses (which took into account both engineering assessments and econometric estimates), the US did not really experience an infrastructure shortage.

Figure 2 – *State and local net capital stock per person in the US (1987 prices)*



Source: Tatom, 1993 (cited by Gramlich, 1994)

Aside from the discussion related to the US case, Aschauer's estimations were heavily criticized by the following research. In particular, the main critiques against his findings were the following:

- The excessive levels of elasticity: such levels would lead to a rate of return on public capital that lay above that of private capital. And many economists pointed out that if public investment were as profitable as Aschauer claimed, private investors would be clamoring to float bonds to build roads, highways, and sewers.
- The past-value approach: because some investment has been productive in the past, that does not necessarily mean it will be productive in the future. That is, it could be highly beneficial to build up a network of highways, but at the same time, it could be not beneficial at all to expand that network in the future. Therefore, simply looking at past patterns as Aschauer did might tell little about future beneficial aspects of public investment.
- The reverse-causality issue, which was not taken into consideration.
- Relying on expenditure as a measure of infrastructure investment.

Despite the critiques of Aschauer's estimations, most studies do suggest that infrastructure contributes to economic development.

Elhance and Lakshamanan (1988) find that larger output levels can be produced with a less than proportional rise in infrastructure stocks – especially economic infrastructure stocks. In an empirical analysis conducted for 98 countries in the period

1960-1985, American macroeconomist Barro (1991) suggests that public investment can raise the rate of economic growth in the long run by raising the returns to private investment, but only if this effect is greater than the negative impact of the increased tax rates needed to pay for it. A very similar conclusion was reached by Crafts (2009), according to whom investment in productive government expenditure is positively correlated with economic growth (with an estimated average elasticity of around 0.2), but the effect is partly offset by the effects of the taxation needed to finance it. Calderón, Moral-Benito and Servén (2015) present new estimates of returns to infrastructure that are very robust and address many of the methodological shortcomings of previous studies. Their estimates of the output elasticity of infrastructure, which rely on a multi-dimensional measure of the physical stock of infrastructure as opposed to infrastructure spending, lie between 0.07 and 0.10 (a 10 percent rise in infrastructure assets would directly increase GDP per capita by 0.7 to 1 percent). And the list goes on: for further estimates, see Sanchez-Robles, 1998; World Bank, 2004; Sahoo and Dash, 2008; Daido and Tabata, 2013.

Nevertheless, we might be more interested in understanding how infrastructure contributes to economic development, rather than how much. If we bear in mind the insight provided by Prud'homme and Buhr, we know that what matters for economic development is infrastructure usage rather than the mere infrastructure endowment. For instance, a bridge connecting two relevant urban hubs could be free or priced: according to the case, the bridge will have a very different contribution to economic development. In the infrastructure investment universe, over-investment and under-utilization are quite common, much more than in the private investments universe, where they automatically translate into benefits forgone and therefore do not last very long.

Therefore, we will now shift our focus from infrastructure capital to infrastructure service, with the aim of understanding the mechanisms through which economic infrastructure impacts the economy.

2.1.2. Understanding the channels

From a development perspective, infrastructure operates through several channels: we present a graphic summarization in Figure 3 below.

First, infrastructure-related services intuitively improve *welfare for households*: overall, a rule of thumb is that between one-third and one half of infrastructure services are used as final consumption by households (Prud'homme, 2005; Fay and Morrison, 2007). This effect however can hardly be accounted for in the GDP, although we may be able to appreciate it by looking at labour productivity.

In the case of poor countries, the magnitude of the effect on households is massive: newly connected poor consumers enjoy large welfare gains from new infrastructure, especially if they involve improvements to water and sanitary services as well as electricity. Infrastructure investments in general have a disproportionate influence on the incomes and welfare of the poor by reducing costs to access markets, raising returns on existing assets, facilitating human capital accumulation, and facilitating agglomeration economies and the dissemination of knowledge.

Furthermore, infrastructure investments produce *employment effects* related to both its production and its maintenance – this in turns leads to a cyclic process of development. In the long run, this mechanism will produce a new general equilibrium in the relative prices of both factors of production and final products – at a higher level of income and employment (Elhance and Lakshamanan, 1988).

On the intermediate consumption side, adequate economic infrastructure is proven to reduce the *cost of production* for enterprises (Prud'homme, 2004; Henckel & McKibbin, 2010). For small producers and firms of developing countries, access to markets and contacts with potential clients rely on the presence of suitable and relatively cheap transport and telecommunication network. Lack of transport infrastructure impacts productivity costs through an array of channels, from the complete inability to access some markets in some rural areas, to impact on logistic and inventory costs. The development of telecommunication infrastructure (in particular mobile telephony) has been shown to have an important effect on the ability to run businesses in remote parts of Asia and Africa (Vodafone, 2005; Jensen, 2007). Similarly, electricity is a critical input for many industrial and service activities: frequent power outages and unstable voltage induce high costs and are even shown to deter some type of investments (Alby et al., 2009). Higher quality telecommunication supply also makes it possible for firms to use more sophisticated tools. Finally, economies of scale will arise, resulting in improved inventory management.

Possibly the most interesting effect of infrastructure on development, however, is *market enlargement*. In this case, we are referring to labour market, goods market and also capital market via telecommunication infrastructure.

Transport infrastructure in particular radically reduces distances and trade costs, thus helping to create new markets and realize the returns to agglomeration. Powerful evidence in favor of this benefit is offered by Li (2010) for the case of China, where the current level of transport costs is still the most significant trade friction, and by Brooks (2010) for Asia more generally.

By lowering barriers and facilitating the encounter between supply and demand, infrastructure can produce intensified competition, greater specialization, innovations and economies of scale – the functioning of the mechanism being quite similar to lower trade tariffs. According to Prud'homme, "*all the analyses that assess the economic benefits due to increased trade can be used to show the contribution of improved infrastructure to economic growth*" (Prud'homme, 2004). Many studies agree: Hummels (2001) argues that for the period 1950–1998 faster transport – air shipping and faster ocean vessels - was equivalent to reducing tariffs from 32% to 9%. The use of containers in ocean transport produced massive efficiency gains in long-distance transport of commodities: according to Limão and Venables (2001), lowering trade costs by 10% through transport infrastructure investment can increase exports by more than 20%.

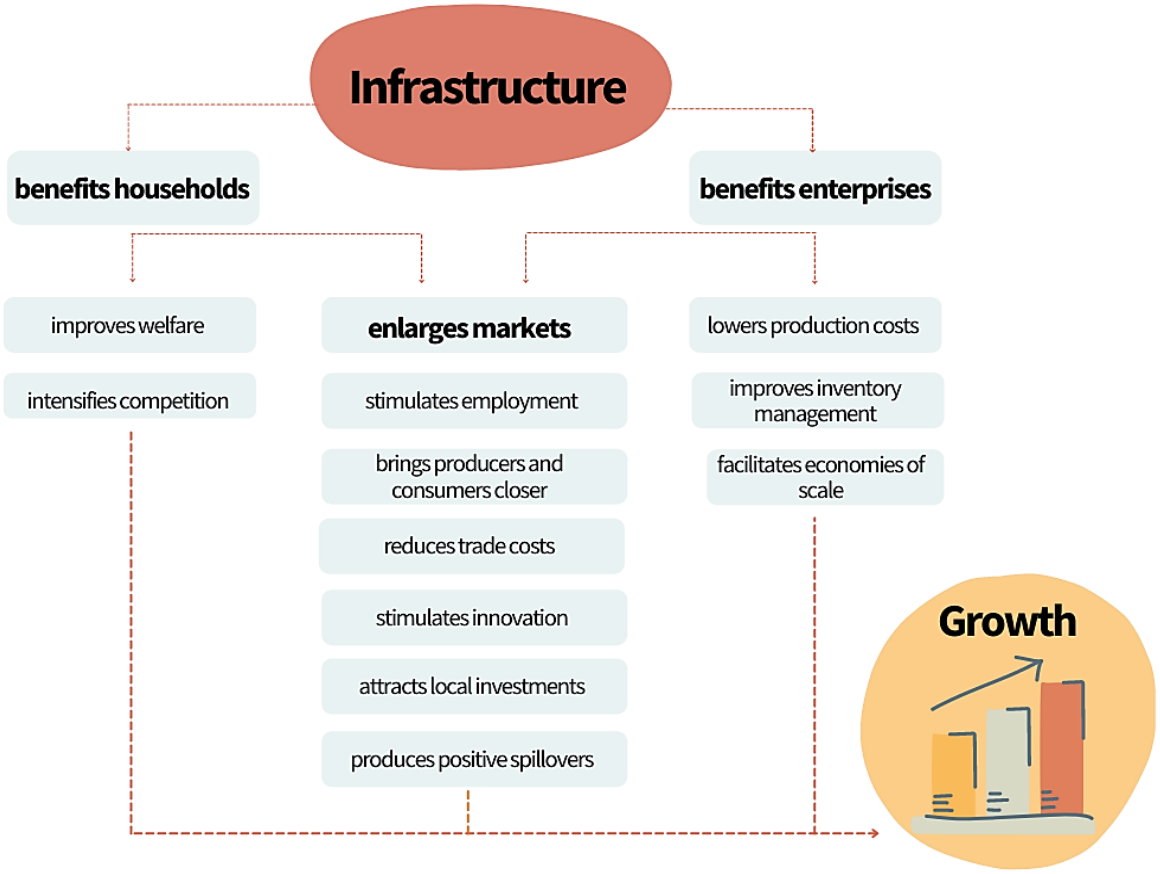
There is no doubt infrastructure is a key ingredient in a country's ability to capture gains from trade. Not only it influences a country's absolute and comparative advantage by mitigating the constraints of factor endowments and promoting intra- and inter-regional integration: it also stimulates a complex interdependent process in which infrastructure determines the patterns of trade, and the patterns of trade determine the level and type of infrastructure. We can note, however, that these types of benefits are likely nonlinear: once an efficient and uncongested transport network is in place, further investments would likely lead to limited direct benefits (Straub, 2011).

Adequate infrastructure is most definitely a prerequisite for attracting more productive economic activities into the target region – therefore leading to higher per capita incomes and rising demand for both industrial and consumer goods. This mechanism seems to be working also when referring to foreign direct investments or FDIs. When countries, especially those in the process of developing, compete for FDIs, the country that is best prepared to address infrastructure jams will secure a greater amount.

Sahoo (2006) claims that more effective public investment in economic and social infrastructure, along with stable economic policies, would create an enabling environment for attracting FDIs to South Asian countries. Since FDIs had a positive and significant impact on growth in four South Asian countries (India, Bangladesh, Sri

Lanka and Nepal), Sahoo suggests an improvement in domestic investment and in infrastructure facilities in the other Asian countries in order to achieve higher growth. Furthermore, FDI have a positive impact on export growth through positive spillovers. For more detailed evidence on how infrastructure facilities positively impact FDI inflows, see Kumar (1994), Loree and Guisinger (1995), Asidu (2002).

Figure 3 – *How infrastructure contributes to development* [2]



Infrastructure does not simply lower barriers among countries: it actually overcomes them by promoting positive growth spillovers across regions. In some cases, it can bring landlocked countries to absorb beneficial growth spillovers from neighboring countries. As a consequence of the mechanisms of globalization, policies adopted in one country are likely to affect economic outcomes in other countries, especially if they border with each other. When considering infrastructure investments, it seems that this is also true: several studies have measured and analyzed this 'contagion' effect. Collier and O'Connell (2007) find that a 1% increase in neighbors' growth increases a country's own growth rate by 0.4 to 0.7%. Investment in transport

[2] The flowchart is an extension of the basic structure proposed by Prud'homme (2004).

and communication infrastructure (along with more formalized trading agreements) has helped countries such as Austria and Switzerland to prosper (Roberts and Deichmann, 2011). Easterly and Levine (1998) prove that there is systematic contagion across borders, causing economic growth performance of a country to influence the neighbors' long run growth rate: moreover, they show that while improving policies alone boosts growth substantially, the growth effects are much larger if neighbor countries act together, suggesting a 'neighbour multiplier' effect. In their study, Easterly and Levine noted that the mechanism has worked in a negative sense in the African case: Africa contains many groups of neighbours who individually are ethnically fragmented, something that contributes to the choice of bad policies and bad growth outcomes. The neighbour multiplier magnified these bad growth outcomes, causing much larger effects of the political economy of ethnic divisions.

This contagion mechanism, whether resulting in positive or negative outcomes, is directly caused by:

- Common use of certain infrastructure.
- Policy imitations: policies are often copied by neighbours. Governments that attain high growth with a given set of policies provide a model of the efficacy of such policies to the government (and citizenry) of neighbouring countries. But there may be negative policy imitation too: governments do not necessarily maximise growth; they may maximise rent-seeking opportunities. Thus, policies that are bad for growth might be imitated if they demonstrate to be good for creating rent-seeking opportunities or some goal that is desired by the policy-making elite.
- Flows of FDIs: since the general legal, institutional and technological conditions may be similar across two neighboring countries, foreign investors may find it easier and less costly to move next door once success is achieved in a neighbouring country: for the same reason, should the investments be less profitable in a certain country, foreign investors may switch to further regions.
- International trade: as international trade may be likely to occur between neighbours, positive performance in one country will spill over to neighbouring countries through trade.

Infrastructure investments directly or indirectly affect all these channels. Thus, when considering infrastructure policies (and also when assisting at policy decisions taken by our neighbours) the spillover effect should always be taken into account. Auerbach and Gorodnichenko (2013) even documented that the strength of the spillover effect is larger during recessions, suggesting that public investment may stimulate demand in economic downturns.

2.1.3. Global trends in infrastructure investment

Now that we assessed the channels through which infrastructure investments impact on development, we are interested in discovering the historical and geographical patterns that such investments have followed in the recent span of time. We purposely focus our observations between year 2000 and 2019, stopping right before the global outbreak of the Covid-19 pandemic – whose effects and dramatic impact will be discussed in Chapter 4.

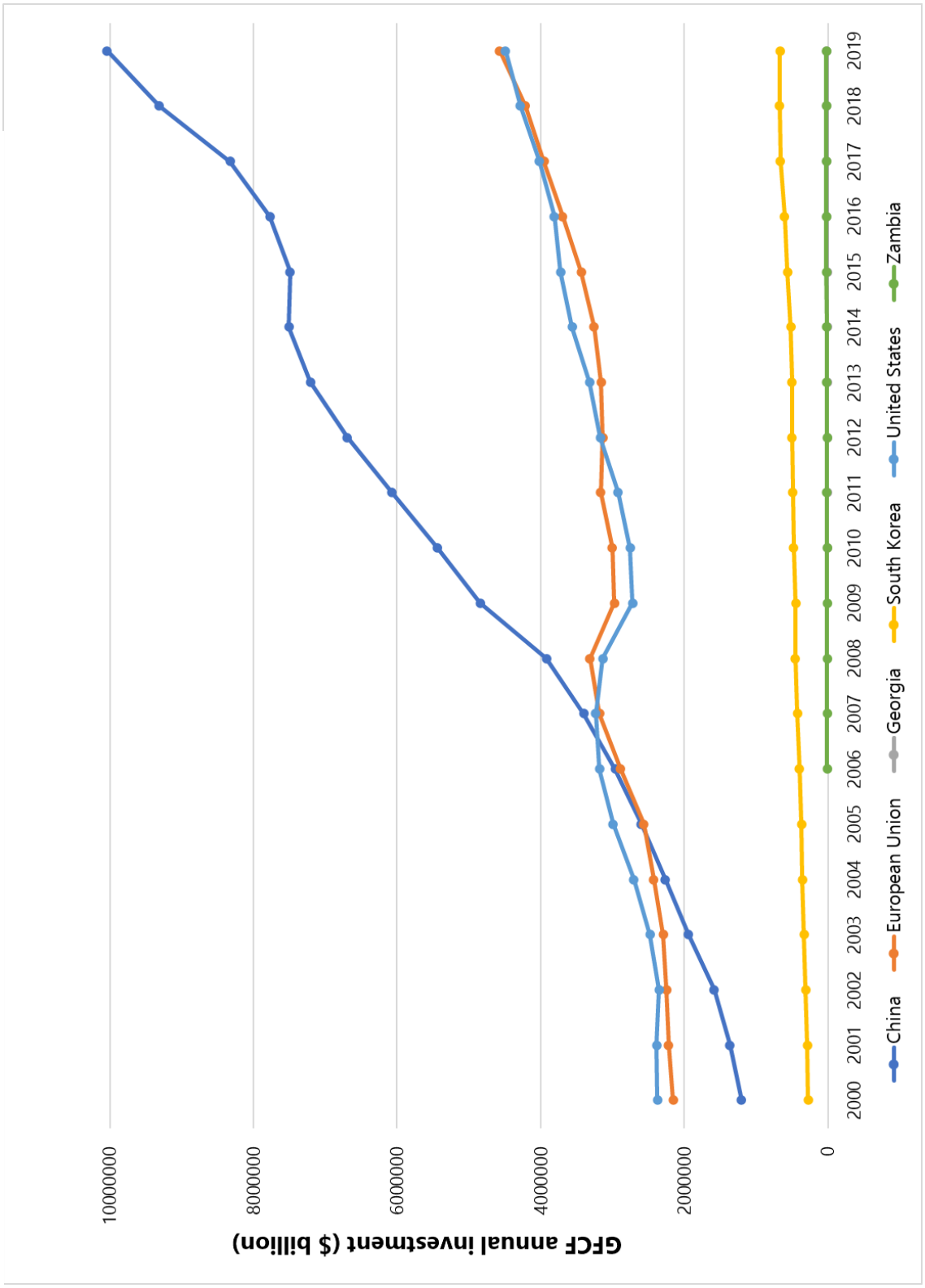
To start our considerations, we choose a group of countries that are representative of different categories of income and growth rate: the United States and the European Union as symbols of advanced economies; China and South Korea as emerging, rapidly growing economies; Zambia and Georgia as representatives of low income, developing countries. With respect to emerging economies, which are experiencing rapid and sometimes not so sustainable growth, low-income developing countries or LIDCs are still, to this day and for different reasons, struggling in their journey towards development.

We start by building a time series (Figure 4) which considers the total annual investment in Gross Fixed Capital Formation ($ billion) by the selected countries, with the data available in the OECD database. Gross Fixed Capital Formation or GFCF is a measurement frequently used by international organization to assess the degree of public investment in infrastructure: it can be thought as the total spending dedicated to physically improve existing assets, purchase new ones or to build tangible items such as roads, highways, houses or buildings (Council of Europe Development Bank, 2017).

From the mere graphic representation (numerical data are made available in the Appendix) we can make important considerations.

The dynamics followed by the European Union and the United States seem to be very comparable, with the immediately recognizable drop in public investment following the financial crisis in 2007. Most of the advanced countries were crucially affected: but after an initial fall in GFCF investment, many of them adopted infrastructure investments as a countercyclical measure to stimulate new demand and re-generate growth. This approach is reflected by the modest increase after 2010 in both the US and the EU. From 2010 onwards, the gross growth in GFCF in advanced economies followed a steady growing trend.

Figure 4 – *Gross Fixed Capital Formation ($ billion) between 2000-2019 for selected countries*



ND: Data are taken from OECD dataset

China and South Korea, on the other hand, although not comparable with respect to the magnitude of their investments in GFCF, do have one aspect in common: none of them seem to have been affected much by the economic crisis of 2008. Quite the contrary, the gross amount of GFCF made at country level experienced a boost, in the case of China, and a steady growth, in the one of Korea, which lasted until the end of our period of consideration. The growth in GFCF in China is impressive to say the least and reflects the ambitious government policies of accumulating a massive infrastructure capital stock – more on that later on in this same section.

Finally, and intuitively, the magnitude of the investments sustained by poor countries like Zambia and Georgia gets completely lost with respect to the investments brought about by more developed countries.

We now consider the GFCF share of GDP for the same selected countries over the same period. The data are again available in the OECD database and result in the time-series presented in Figure 5: this representation provides more interesting insights.

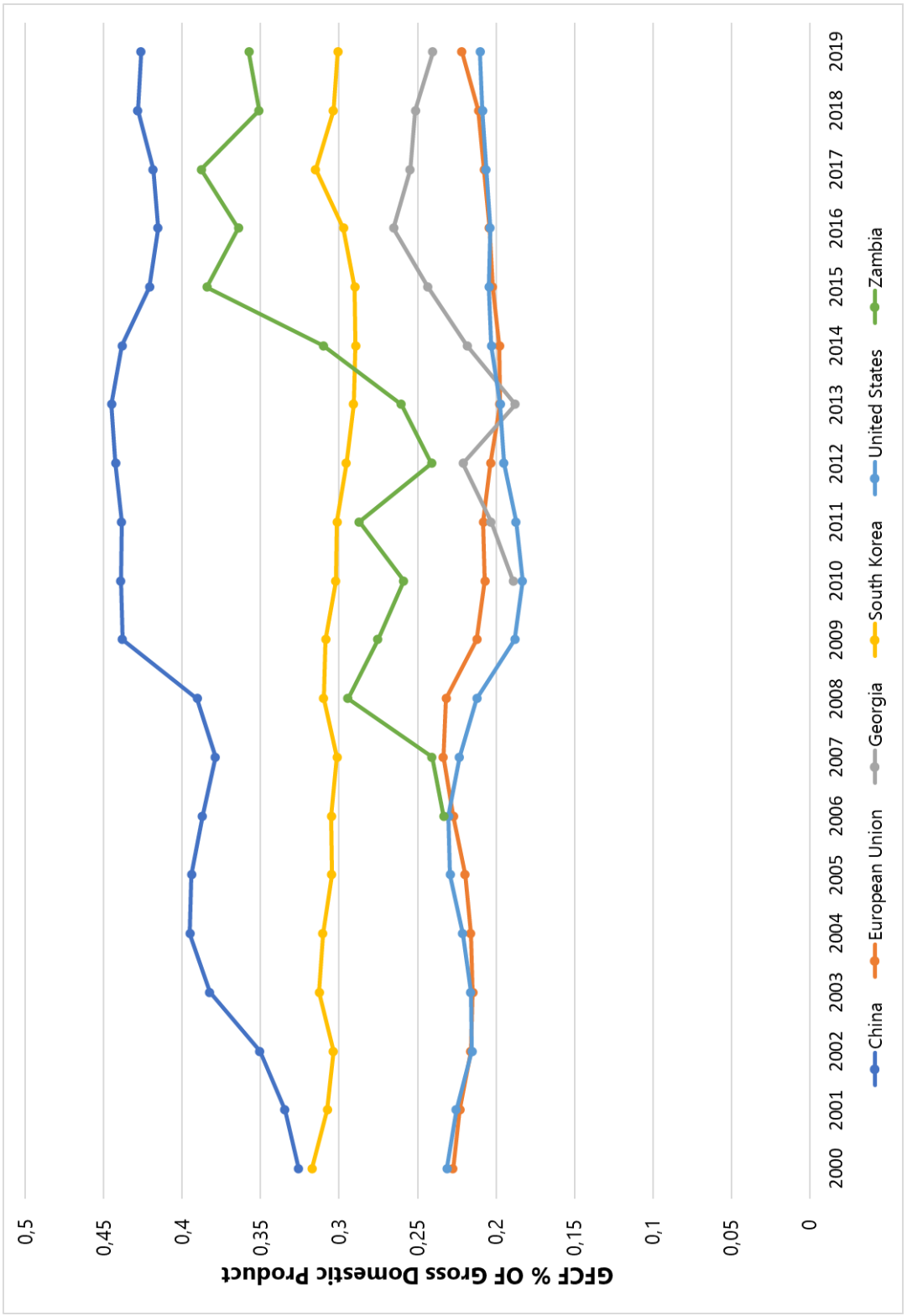
The European Union and the US still seem to be following a similar trend: however, the effects of the global crisis are much more evident here, and seem to be more long lasting. In the US case the fall in GFCF investment is dramatic up until 2010, after which a modest upward trend begins resulting in a quite steady-state growth, while the European Union's decline only comes to a stop in 2013. Besides, for both economies, the 2019 figures show that the shares of the beginning state are not matched. The average GFCF share of GDP in the EU was equal to 22.7% and resulted in 22.2% in 2019; for the US, the same percentage fell from 23.1% in 2000 to 21% in 2019.

South Korea was rather consistent with its GFCF policy, maintaining its share of GDP around 30/31% over the considered period. China, already starting from a high 32.6% share of GFCF in 2000, maintained a rapid growth up until 2013, when it reached a peak of 44.5%, followed by a slight decline which led to a final 42.6% in 2019.

A very interesting dynamic is offered by low income developing countries Zambia and Georgia, whose data are available only starting from 2006 and 2010 respectively. While their trends are both quite volatile, it is quite evident how an increasing share of their GDP is being devoted to GFCF.

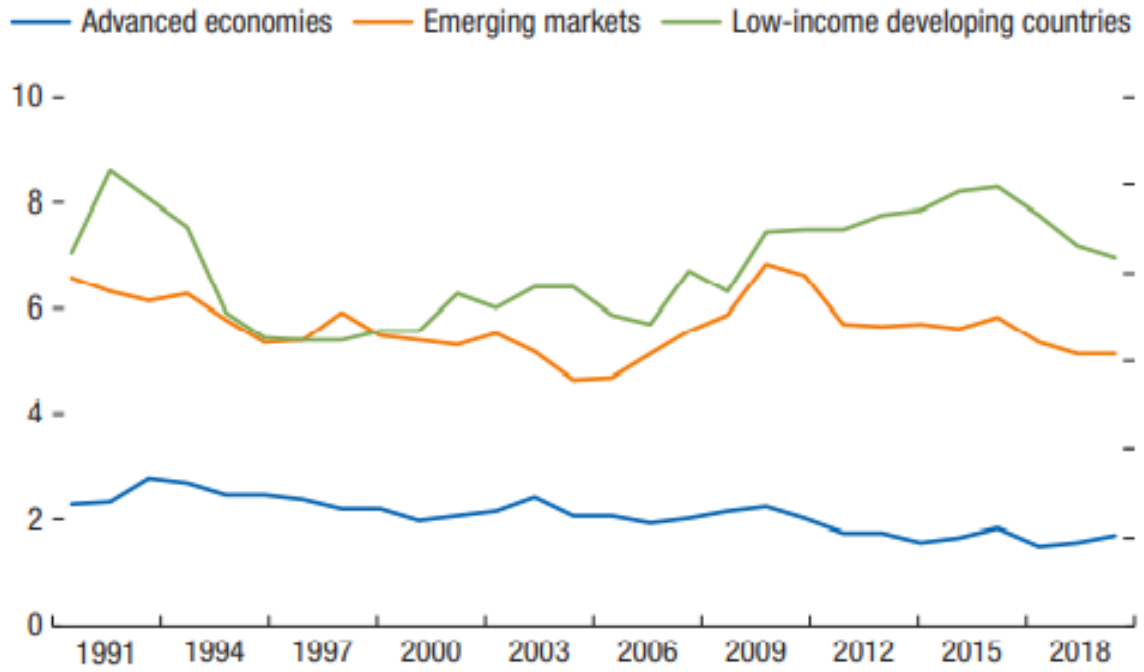
These empirical observations are consistent with the economic literature on the subject: the ratio of public-investment-to-GDP across countries seems to differ by income groups. The IMF has estimated that in advanced economies, public investment in new infrastructure projects has declined from an average of 2.4 % of GDP in the 1990s to a historic low of less than 2% after 2010. In low-income developing countries on the other hand, public investment in new infrastructure as a share of GDP has been

Figure 5 – *Gross Fixed Capital Formation as share of GDP between 2000-2019 for selected countries*



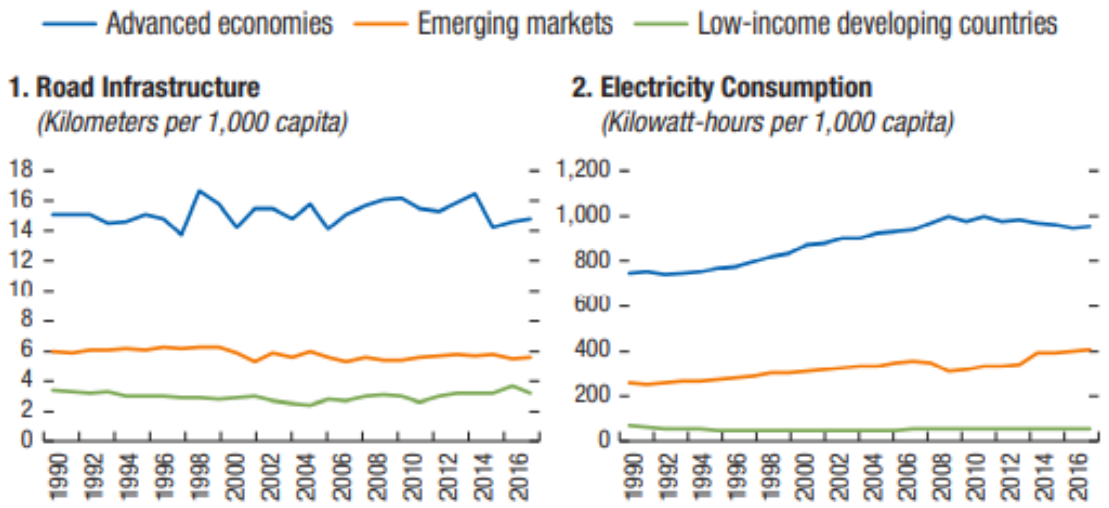
ND: Original graph (data taken from OECD dataset)

Figure 6 – *Trends in public investment in new infrastructure projects, 1991-2018 (% of GDP, simple average of each country group)*



Source: World Economic Outlook database – IMF Staff estimations.

Figure 7 – *Physical infrastructure by income group, 1990-2016*



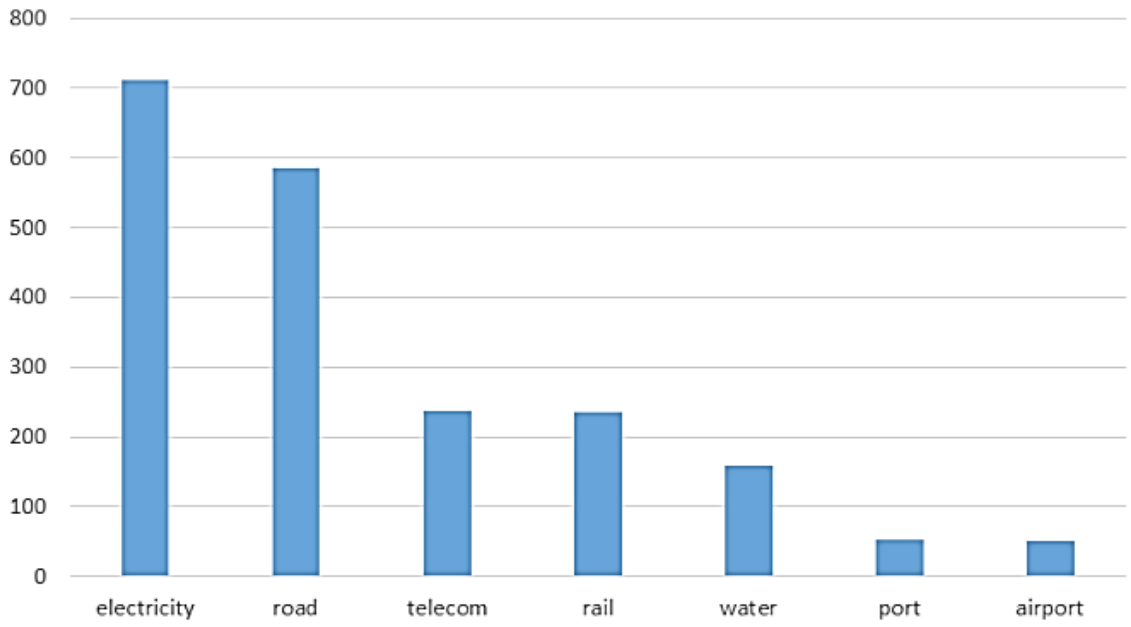
Source: World Development Indicators.

generally rising since the mid-1990s, at 7% in 2018. Emerging market investment levels have historically alternated between an average of 5 and 7% of GDP (Figure 6).

Despite a consistently larger percentage of public-investment-to-GDP, both emerging markets and low-income developing countries significantly lag behind advanced economies in infrastructure provision. Kilometers of roads per capita have been almost stagnant in all three groups since 1990, with a per capita road stocks of emerging markets and low-income developing countries at a level less than one-third that of advanced economies (Figure 7). Electricity consumption has equally stagnated at a very low level in low-income developing countries, while consumption in advanced economies reached its peak around 2008, and emerging economies continue to increase their consumption. Large and persistent disparities between higher- and lower-income countries persist to this day (Miyamoto, Gueorguiev, Honda, Baum and Walker, 2020).

Indeed, overall investment in infrastructure increased globally during 2009-2010, mostly as a countercyclical measure: however, it then progressively decreased in 2013-2014, when major stimulus measured around the world were being phased out, and then, recovering, it remained steady. Since 2007, global infrastructure spending has been mainly focused on two sectors: electricity and roads, which account for almost two thirds of the total spending – mostly driven by developing countries. The electricity sector accounted for the highest growth (+33%).

Figure 8 – *Global average annual infrastructure investment by sector, 2007-2015 ($ billion)*

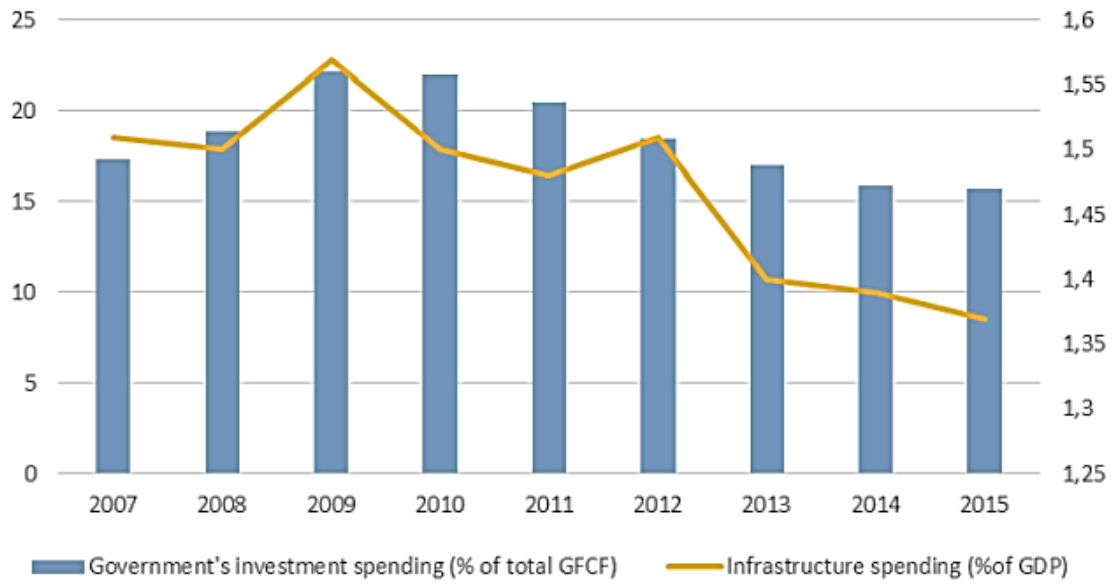


Source: Oxford Economics

The United States case

In the United States, where the 2008 global crisis originated, Gross Fixed Capital Formation accounted for 22% of GDP in 2007; two years after, it had fallen at 19% - mostly due to household spending crumble. In response to the Great Recession, the Obama administration issued the American Recovery and Reinvestment Act in 2009, an economic stimulus package worth $831 billion. While 55% of the resources were allocated to state and fiscal relief and tax incentives, the remaining 45% was allocated to federal spending programs – especially infrastructure such as transportation, communication, sewer services improvements, energy efficiency upgrades and scientific research programs. According to the US Congressional Budget Office, the Recovery Act positively impacted on both GDP and employment: real GDP rose by a low 1.7% and a high of 9.2%, while the unemployment rate reduced by a low of 1.1% and a high of 4.8% (US Congressional Budget Office, 2017).

Figure 9 – *US Government's investment and infrastructure spending, 2007-2015*



Source: Oxford Economics and OECD.

After the peak in 2009, the US infrastructure spending as percentage of GDP followed a downward trend: however, analyses by the Brookings Institution (2019) shows that the share of operation and maintenance spending in total public infrastructure spending in the United States has grown steadily, while the share of capital spending has fallen. This trend, which intensified over the last decade points to a growing focus on *maintaining* existing infrastructure. The road sector is the area with the biggest gap, where investment needs are almost twice the current investment

trend; in telecommunications, energy and water facilities, US investment has been lower than for other developed economies in recent years; however, the overall quality of these infrastructures is very high, suggesting that only a small increase of future investments is needed. As is well known, the rail network in the US is not as extensive as in many other developed economies, since it is not widely used for internal travel in the country.

The European Union case

The European Union countries experienced a similar, general downward trend from 2010 onwards: especially after the outbreak of the 2011-2012 sovereign debt crisis and the period of cyclical fiscal consolidation adopted in many countries, most of the government spending was devoted to current expenditure. Germany was one of the few countries having a broader fiscal room: German Chancellor Angela Merkel launched a $50 billion stimulus package in 2009, which included €17.3 billion of infrastructure investment. It is not a coincidence, perhaps, that Germany took less than half the time needed by the Eurozone to make up the ground its lost during the recession. Even after the return to stability, however, investment rates in infrastructure have been below pre-crisis levels, with the biggest drop registered in transportation and education sectors.

Importantly, the decline in public GFCF was not universal across Europe, given the heterogeneity of the area – with economies having fundamentally different macroeconomic factors guiding public investment: larger decreases occurred in those states where infrastructure quality was already quite poor.

According to the Council of Europe Development, five clusters of countries can be identified inside the EU in this respect, all of which exhibit distinct characteristics regarding their respective GFCF growth rates, GDP recoveries and government deficit levels.

Countries belonging to Group 1 registered the most severe decline in GFCF average growth: here, the austerity programs enacted to reduce large government deficits often targeted public investment spending. The weak economic recoveries that followed exasperated the situation, bringing about further budget constraints[3]. Group 1 countries have major declines in GFCF since the beginning of the 2008 recession. Most striking is that, while on average central government public investment in recent years had begun to show signs of healing (again, we leave the Covid-19 outbreak to the following Chapters), local investment still remained in negative growth territory –

[3] A side note: Italy represents the 'top amongst the worst', with a decline in GFCF growth of -6.03%, while Spain had the largest contraction (-11.05%).

and a recovery to pre-crisis levels was still far off. The decline in housing investment, health and education is quite visible; the rise in economic infrastructure (growing by 9.2%) accounts for the countercyclical measures cited before.

Table 3 – *Clustering based on GFCF growth rates vs GDP growth and government deficit levels in the European Union (2009-2015)*

	Countries[40]	Key characteristics: Avg. GDP growth (09-15)	Avg. GFCF growth (09-15)	Avg. Government Deficit (09-15)
Group 1 ▪ Severe GDP downturn ▪ Significantly negative GFCF growth rate	Spain, Cyprus, Ireland, Portugal, Greece, Croatia, Italy	0.44%	-8.35%	-7.28%
Group 2 ▪ Weak GDP recovery ▪ Drop in GFCF growth rate	France, Netherlands, Czech Republic, Lithuania, Slovenia, Estonia, Austria, Germany, Romania, Poland	1.55%	-0.99%	-3.54%
Group 3 ▪ Weak GDP recovery ▪ Positive GFCF growth rate	Latvia, Belgium, Finland, Bulgaria, Norway	1.91%	2.13%	-3.07%[41]
Group 4 ▪ Weak GDP recovery ▪ Large increase in GFCF growth	Denmark, Slovak Republic, Hungary	1.06%	8.82%	-3.22%
Group 5 ▪ Healthy GDP recovery ▪ Weak GFCF growth	United Kingdom, Iceland, Sweden, Switzerland	5.29%	2.83%	-3.05%

Source: Council of Europe Development Bank, 2017

Group 2, which accounts for the majority of the EU state members, lists countries where GFCF growth declined since 2009. Some countries, like Germany, Romania and Poland, saw a rather modest public GFCF contraction (-0.27%, -0.21%, -0.09% respectively). Similarly, they have seen central and local public investment growth either stay negative or float around zero since the beginning of the crisis, with central public investment only seeing growth since 2014.

Group 3 is characterized by countries which also saw weak GDP recovery, but with positive public GFCF growth rates and low government deficit levels. Group 3 countries have in fact seen a healthy recovery in public GFCF to the pre-crisis level at both central and local investment levels: both local and central government investment levels (as a share of GDP, starting 2013) surpassed their pre-crisis peaks. However, recently the year-on-year growth, although still positive, is declining. In these countries, the increase in local GFCF has been, on average, focused in increased

spending in housing (up 2.7% to 16% of total local investment) and economic infrastructure (up 3.8% to 25% of total local public investment).

Group 4 is a set of outliers, where the growth rates of GFCF are the strongest of the sample, yet coupled with relatively weak GDP recoveries. The strong public investment recovery was primarily led by strong central government investment. Local investment in these countries experienced a see-saw pattern, with investment declining before the crisis, recovering in the immediate years after 2008, only to drop again in 2011, and recovering starting in 2013. In contrast, central government investment exhibited a more traditional pro-cyclical trend, with short lived growth after the crisis and a healthy recovery afterwards – with public investment far surpassing precrisis levels. General public services, which before dominated local investment at 35.3%, dropped by 16%, while investment priorities have been relocated to economic infrastructure (up 4% to 20% of total local investment), environmental protection (up 3.8% to 24%), and education (up 5% to 12%).

Lastly, group 5 includes countries that saw relatively strong economic recoveries, but relatively low GFCF growth rates. Notably, all of these economies are not part of the Eurozone: here, public investment levels stayed at low levels for several years after the first drop – yet recently, these countries had been experiencing an upward growth trend. The proportion of local investment priorities has been shifting towards economic infrastructure (up 1.7% to 16% of total investment in the post-crisis period), and health (up 1.6% to 24.4%). The proportion of local GFCF for the other classes has remained, for the most part, relatively unaffected.

Figure 10 – *Group 1: % of GFCF spending categories prior and after the 2008 crisis*

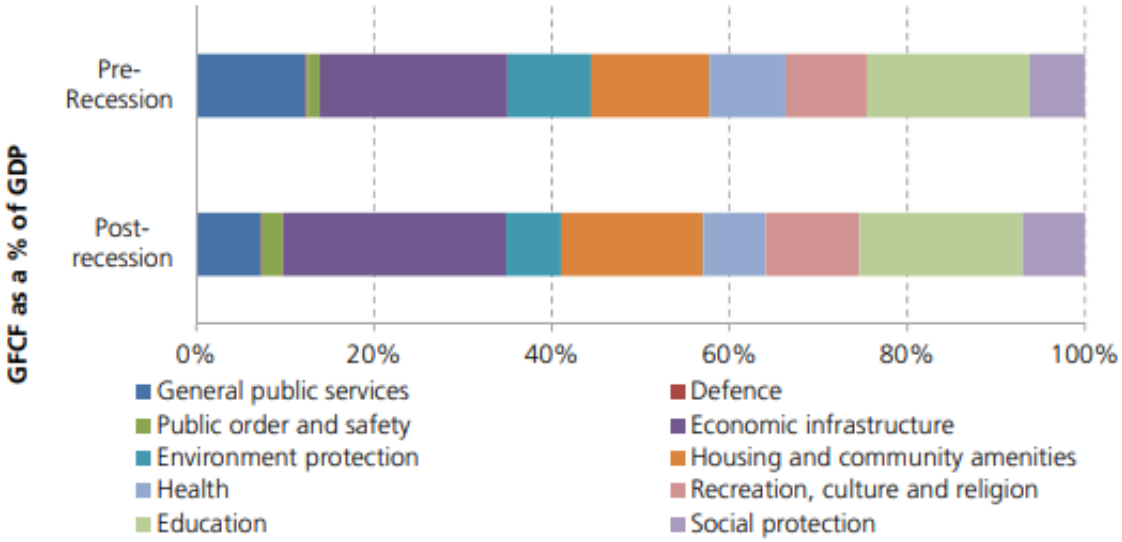


Figure 11 – *Group 2: % of GFCF spending categories prior and after the 2008 crisis*

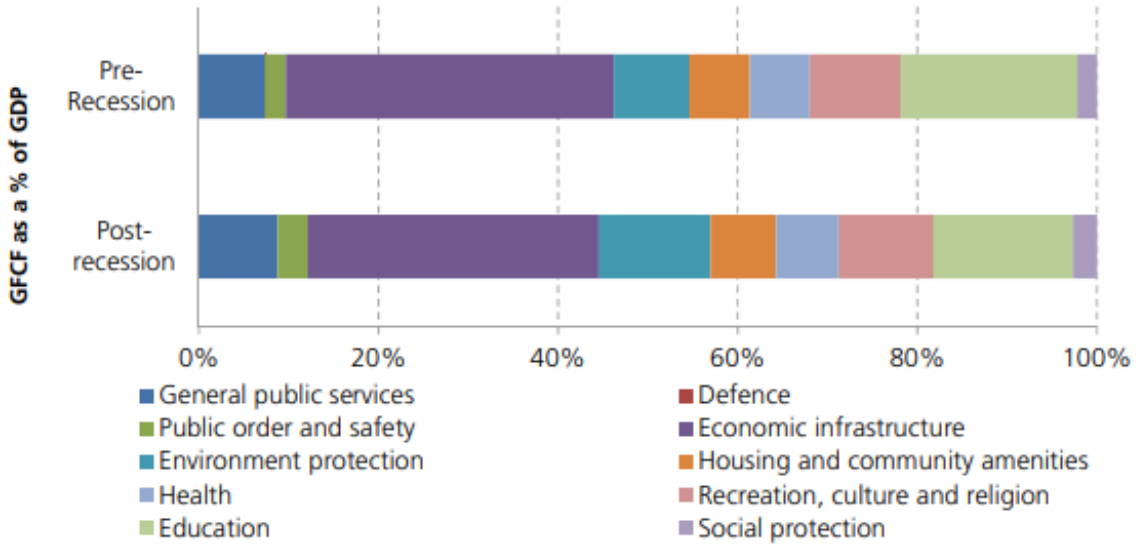


Figure 12 – *Group 3: % of GFCF spending categories prior and after the 2008 crisis*

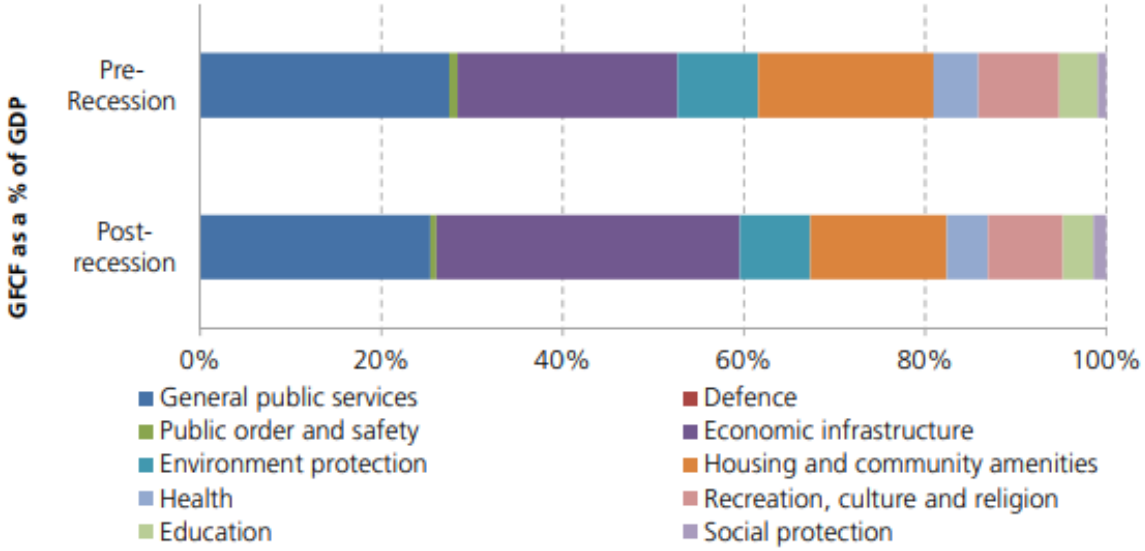


Figure 13 – *Group 4: % of GFCF spending categories prior and after the 2008 crisis*

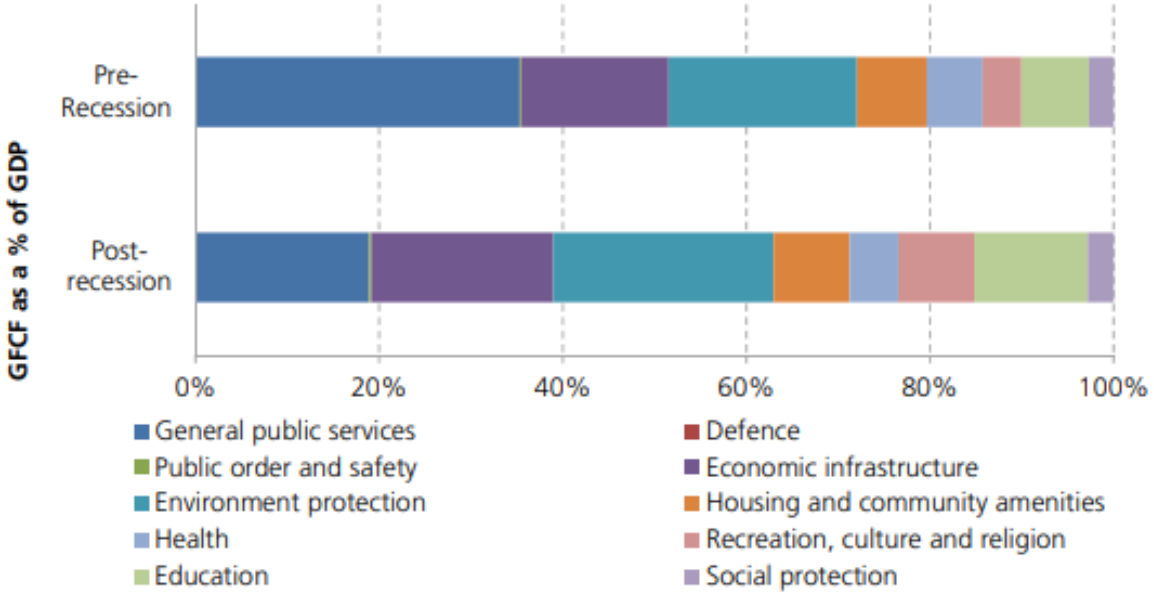
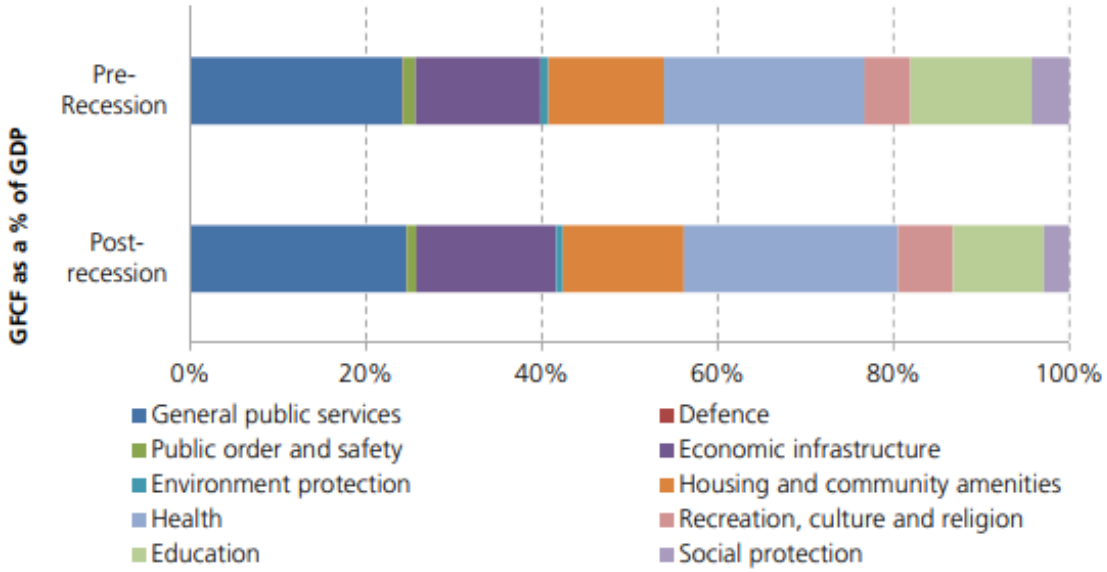


Figure 14 –*Group 5: % of GFCF spending categories prior and after the 2008 crisis*



Source: EUROSTAT and CEB staff calculations

The China case

Asia is the region that invested more in infrastructure, with spending increased by more than 50% between 2007 and 2015, and now accounting for an average expenditure per country of more than 4% of GDP (double that of Europe and the US, respectively 2% and 1.47% of GDP). As a result, Asia is way ahead of Europe as for what concerns the global spending in infrastructure, for which it accounts for 59%: and China is at the very heart of this mechanism. The country seems to have bet on infrastructure as a major driver of its long-term growth.

The development of an extended infrastructure network represented the fundamental engine for post-revolutionary China, with large investments coming both from the central government and from publicly owned financial institutions and enterprises, mainly funded with resources accumulated via large international trade inflows. The low level of industrialization and the fast demographic growth that featured the post-revolutionary economy asked for a decisive and generalized infrastructure investment effort: the development of networking and transportation links became the fundamental goal of the Chinese leadership. Between the first 1990s and 2011, it is estimated that China was able to accumulate an infrastructural capital stock equal to about 75% of the national product, a level in line with advanced economies (Bank of Italy, 2014).

Right after the 2008 financial crisis the Chinese government - which was progressively moving towards a more consumption-driven economy - acted to prevent the impact of the reduced external demand and intervened with a massive stimulus package announced by the State Council of the People's Republic of China in November 2008. The package, worth $586 billion, is impressive if we acknowledge that China's economy was only one-third the size of the US at the time. Public infrastructure represented its biggest share (51%), with a focus on transportation, energy saving, gas emissions cuts, environmental engineering projects and technology innovation. The stimulus had an estimated contribution of 1.2% in the GDP increase, which was around 8.4% in 2009.

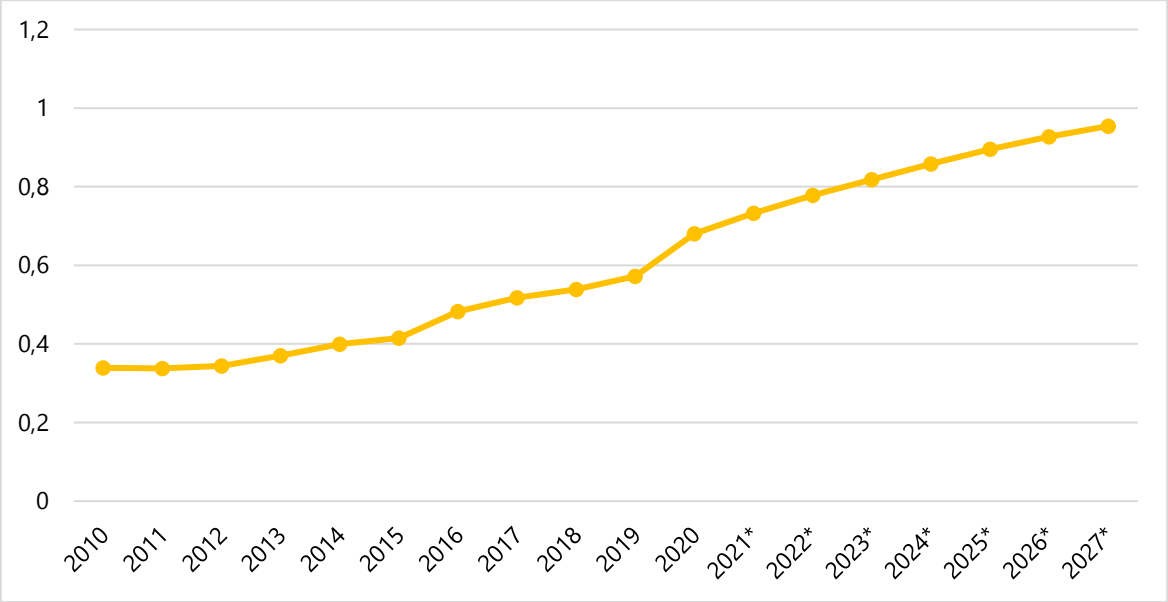
However, in recent years several economic studies and international institutions have questioned the Chinese policy with respect to accumulating huge stocks of infrastructural capital, arguing that many of the selected investments and projects do not actually create economic value. Evidence suggests that for over half of the infrastructure investments in China made in the last three decades, the costs are larger than the benefits they generate, which means the projects destroy economic value instead of producing it.

A study by Ansar, Flyvbjerg, Budzier and Lunn (2016) tapped into evidence from 95 large Chinese road and rail transport projects and 901 transport projects– the

largest dataset of its kind on China's infrastructure that exists. According to the analysis, it seems that the majority of the investments suffer of cost overruns – which on average amount to 31%. And there's more: nearly two thirds of the projects turn out to have traffic shortfalls averaging more than 40%, while some received less than 20% of their forecast traffic. At the other extreme, more than a third experienced congestion with an average traffic surplus of more than 60%.

Last but not least, it is known that China, like other Asian economies such as Japan, has chosen to debt finance a lot of its projects. China's debt pile is a matter of increasing international concern. The International Monetary Fund repeatedly urged China to reduce its reliance on debt-fuelled growth: by investing in projects that are not profitable, China is in fact also weakening its ability to pay back such debt, therefore putting the whole world at possible risk.

Figure 15 – *National debt in relation to GDP in China (with forecasts until 2027)*



Source: International Monetary Fund

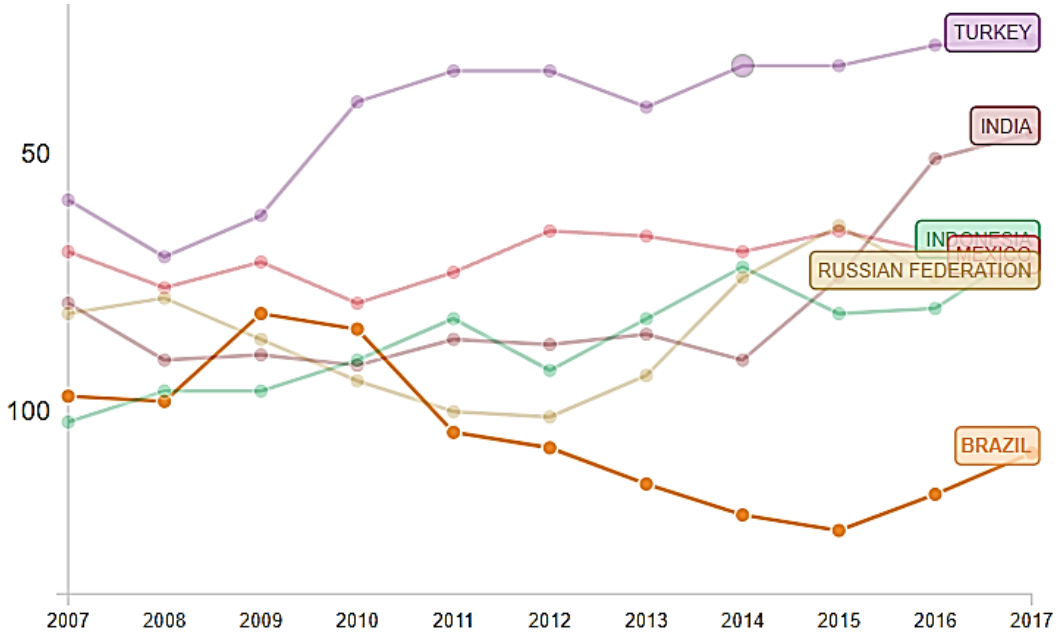
The Chinese infrastructure projects planification therefore presents relevant pitfalls. Local governments often act accordingly to quantitative growth rate goals, without considering the economic return and feasibility of the single project and without incorporating medium-term financial sustainability measures in their expenditure programs.

Emerging countries

Emerging economies (notable examples are Brazil, India, Indonesia, Russia, Mexico and Turkey) are facing relevant challenges in the provision of economic infrastructures, especially in the transportation sector, logistics, energy, electricity and telecommunications. Infrastructure investments represent, in their case, a true matter of urgency to keep up with the rapid demographic and economic growth.

Many emerging countries are far from relying on a sufficient endowment of infrastructural networks, both in the sense of physical presence and of accessibility to households and enterprises. Besides, the demand for infrastructure is going to continuously increase together with the needs coming from rapid industrialization and urbanization. Estimating the future requirements in terms of infrastructure investments is a particularly complex task in the case of emerging countries, also in consideration of the scarcity of complete statistics referring to the quantity and quality of the government expenditures. Here, the public role continues to be of crucial importance: many emerging countries governments need to reinforce infrastructure projects investments in order to keep up with the global competitors and the long run economic growth. In some cases, the current deficit is a consequence of a lack of expenditure in the past, sometimes due to strict budget constraints or to policy choices which privileged current expenditures over capital stock accumulation.

Figure 16 – *Quality of overall infrastructure Index for selected emerging countries, 2007-2017*



Original graph (data taken from World Bank dataset)

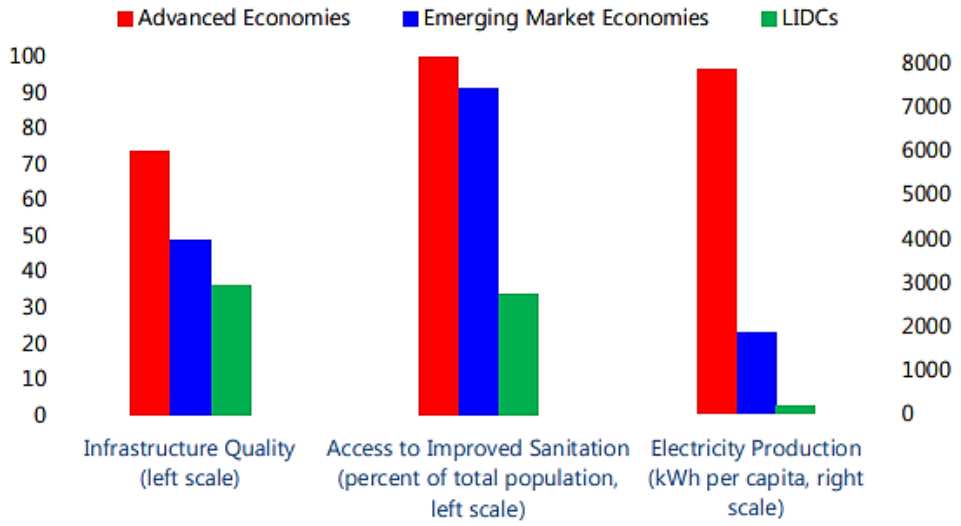
Almost all of the cited emerging economies have registered a decisive improvement in the past few years in the quality of overall infrastructure as indexed by the World Bank – notable progresses have been made by both Turkey and India, with Turkey actually surpassing China in terms of quality of the investments.

Much space for improvement on the other hand remains for Indonesia, Mexico, Russia and especially Brazil, which after a promising surge between 2008 and 2010, experienced a sharp decline in overall quality. In the case of Brazil, the economic slowdown experienced after 2010 had such heavy consequences that the country has not still been able to recover to pre-crisis levels: just like for other emerging countries, difficulties related to the implementation of infrastructure projects (delays, excessive bureaucracy, complex regulation, difficulties in accessing financial resources) seem to still discourage private investments as well as hindering public interventions.

Low-income developing countries (LIDCs)

Scaling up infrastructure investment is intuitively widely seen as a key pillar in national development strategies in low-income developing countries. And in fact, in recent years, many developing countries have been boosting infrastructure investment, mostly through public spending, but also with a growing participation of the private sector.

Figure 17 – *Selected infrastructure indicators, 2013-2015*



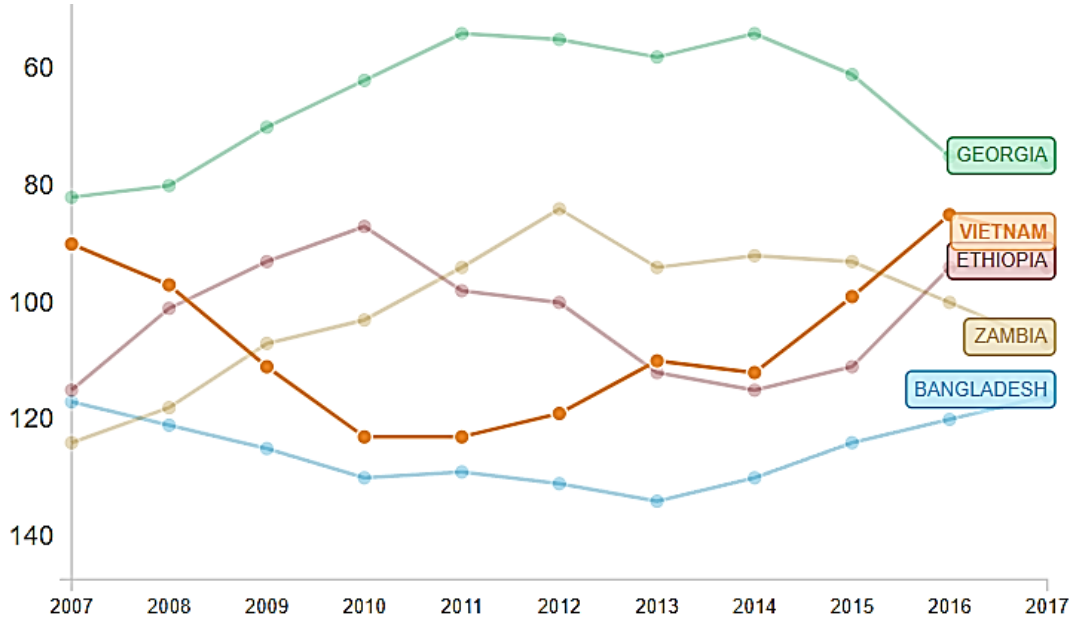
Source: The World Bank, World Economic Forum, United Nations (IMF calculations)

As we have seen the quality, quantity and accessibility of economic infrastructure in LIDCs lag considerably behind those of advanced and emerging economies, with the gap being particularly large in the power sector. 43% of firms in LIDCs identify access to electricity as a major constraint to their business activity, while 24% feel the same with respect to transportation; 74% of enterprises in LIDCs experience power outages, with the average firm experiencing 11 power outages per month, which results in a cost of about 7.1% of annual sales (IMF, 2017).

Data on physical infrastructure show that there has been a sharp improvement in most LIDCs over the past 15 years; a few countries, such as Vietnam, stand out with impressive performance across a range of indicators.

Progress however has not been homogenous across sectors. Information and communication technology (ICT) has developed dramatically, with the number of internet servers growing from near zero in 2005 to the average of 6 servers per million people in 2015. Electricity generation per capita has increased by 57% on average, with very large increases in a few countries, such as Bhutan and Vietnam. Access to improved water and sanitation facilities rose on average by 20% from 2000 to 2014.

Figure 18 - *Quality of overall infrastructure Index for selected LIDCSs, 2007-2017*



Original graph (data taken from World Bank dataset)

On the other hand, improvements in transport infrastructure have been relatively minor, even though transportation is usually the largest item in LIDC capital budgets. Firm-level data from the World Bank Enterprise Survey confirm these trends, as the share of firms identifying electricity and water insufficiencies as major

constraints to their business activity sharply decreased over the last decade, while almost no progress is observable in transportation infrastructure.

Overall, the quantity and quality of infrastructure in LIDCs continue to lag. Despite faster growth, electricity generation capacity remains considerably lower than in emerging markets. Furthermore, electricity supply is also less reliable. Road density also lags behind, although the gap has got smaller. Mobile phone penetration made huge improvements from near zero in 2000 to 72 per 100 people in 2014, but was still significantly lower than 118 per 100 people in emerging economies.

Survey-based measures about the quality of national infrastructure compiled by the World Economic Forum show a noticeable improvement in perceived infrastructure quality in LIDCs in the second half of the 2000, but no progress for the median LIDCs since 2010, leaving a large gap with advanced and emerging market economies.

One last, meaningful observation can be made if we consider how, despite the impressive increase in GFCF investments as a share of GDP made by both Zambia and Georgia in the past few years, the World Bank indicator shows a downward trend with respect to the quality of infrastructure.

Survey-based measures of infrastructure quality suggest that the recent increase of public investment in emerging economies and low-income developing countries has helped reduce the perceived disparity in infrastructure across countries: but the quality of infrastructure has been notably decreasing. This consideration brings us to the following section, where we discuss the importance of raising the efficiency and productivity of public investment, particularly for those with insufficient and low-quality infrastructure.

2.2 The challenge of efficient governance in infrastructure investments

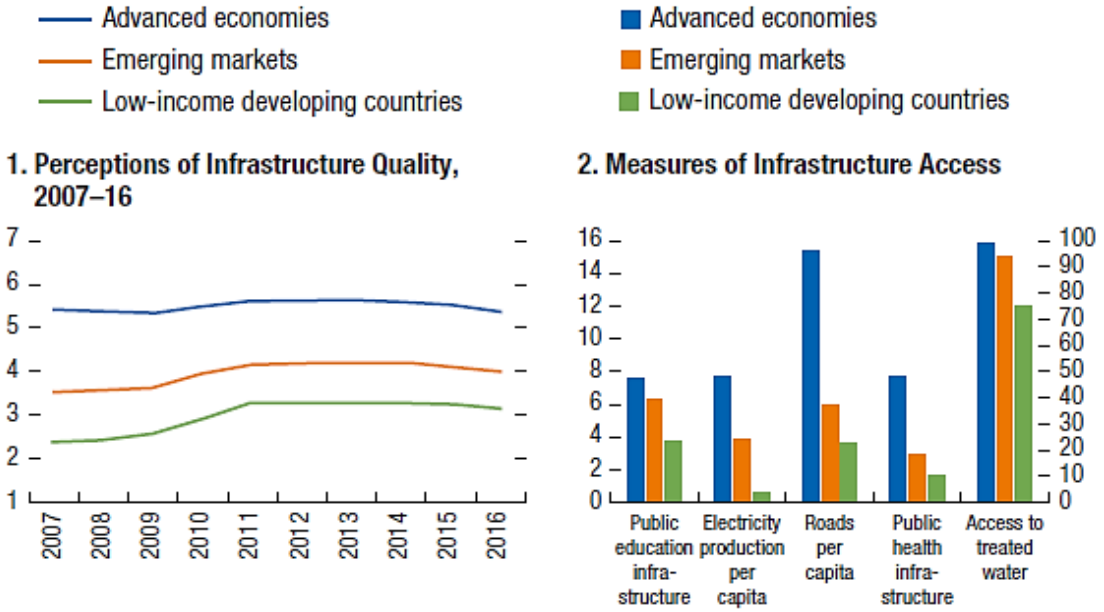
When we described institutional infrastructures in Chapter 1, we highlighted how the presence of good institutions in a country may be considered a precondition for growth rather than an affecting factor. Indeed, the issue of governance is closely related to the one of financing structure: and while the investment in new infrastructural capital has been studied thoroughly by literature, little attention has been given to the effective use of capital stocks once they are in place. Yet if capital stocks are not used effectively, additional capital formation may be of little help in stimulating growth.

Empirical research shows how the problem of inefficiency is particularly severe for infrastructure: the 1994 World Development Report suggested that 12 billion dollars in timely road maintenance in Africa over the preceding decade would have avoided the need for 45 billion dollars in rehabilitation and reconstruction; moreover, power and water supply systems in Africa on average both deliver only 60 and 70 percent, respectively, of their generating capacity. Easterly and Levine (1996) reported that, while Chad may have 15000 telephones, 91 percent of all telephone calls are unsuccessful. Such deficiencies often arise from inadequate management of existing infrastructure assets, rather than from inadequate levels of new construction. While long-run multipliers of infrastructure projects can be sizable when government capital is productive, inefficiencies such as implementation delays will reduce short-run multipliers in most cases (Ramey, 2020).

Why are infrastructure projects so vulnerable to mismanagement? The reasons are several and reflect the challenges related to policymaking. Political dynamics may undermine sound infrastructure decision-making when processes for identifying priority projects and choosing delivery modes are not sufficiently formalized. Coordination across different levels of the government is often difficult, and this increases the risk of wasted resources and poor integration. Uncertainty with respect to revenue flows and sources can erode confidence in a project's affordability – and in the commissioner's credibility. Unstable regulatory frameworks can prevent long-term decisions.

It follows that efficiency in infrastructure investments is mostly determined by the quality of bureaucratic and legal procedures. Poor governance wastes public and private resources, opening doors for inefficiencies and corruption. Repeatedly, economists have advocated the establishment of 'infrastructure banks' to depoliticize the choice of infrastructure projects, improve their implementation, monitoring and evaluation, reduce financing costs through the issuance of safe long-term infrastructure bonds and better leverage private capital (Agénor 2013).

Figure 19 – *Indicators of infrastructure quality and access*



Source: World Economic Forum 2017.

Note: shows the perceived quality of overall infrastructure with the question "*How do you assess the general state of infrastructure (for example, transport, communications, and energy) in your country*?" rated from 1 ("*extremely underdeveloped—among the worst in the world*") to 7 ("*extensive and efficient—among the best in the world*")

Source: World Development Indicators 2017.

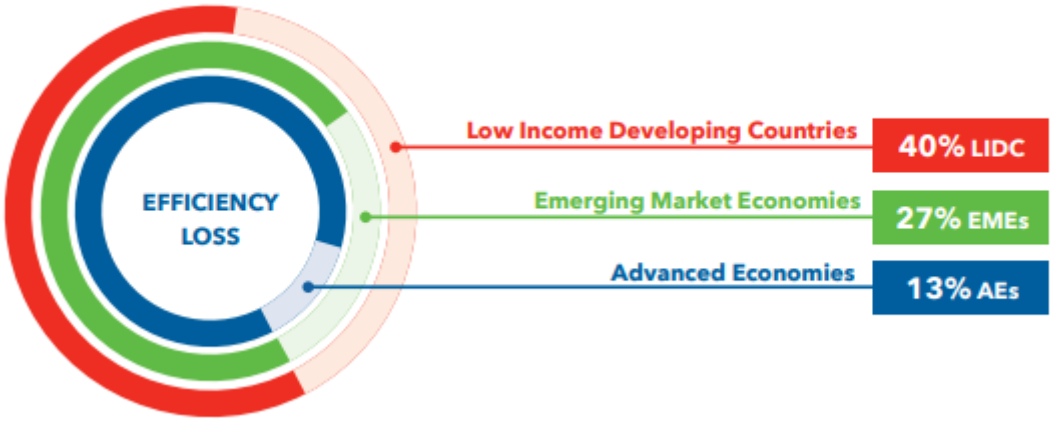
Note: units vary to fit scale. *Left scale*: public education infrastructure is measured as secondary teachers per 1,000 persons; electricity production per capita as thousands of kilowatt-hours per person; roads per capita as kilometers per 1,000 persons; and public health infrastructure as hospital beds per 1,000 persons. *Right scale*: access to treated water is measured as a percentage of the population.

If efficiency is high, production organization changes monotonically from small-scale to large-scale production. Along with this change, people are more willing to support increases in public infrastructure expenditures. Due to the evolution of production organizations and public infrastructure, the economy eventually converges

to a steady-state equilibrium characterized by "high-quality infrastructure, large-scale production, and high per-capita income". However, if efficiency is low, the economy may be trapped in a steady-state equilibrium characterized by "low-quality infrastructure, small-scale production, and low per-capita income" (Daido and Tabata, 2013).

Low and middle-income countries that use infrastructure inefficiently therefore pay in terms of economic growth, benefiting from a much smaller gain from infrastructure investments. It is argued that over one-quarter of the differential growth rate between Africa and East Asia can be attributed to the difference in the effective use of infrastructure resources. An even stronger effect is observed when comparing high and low growth rate economies, where more than 40% of the growth differential is due to the efficiency effect, making it the single most important explanator of differential growth performance (Hulten, 1996; La Porta et al., 2008; Chakraborty and Dabla-Norris, 2011).

Figure 20 – *Losses from poor infrastructure governance*



Source: International Monetary Fund

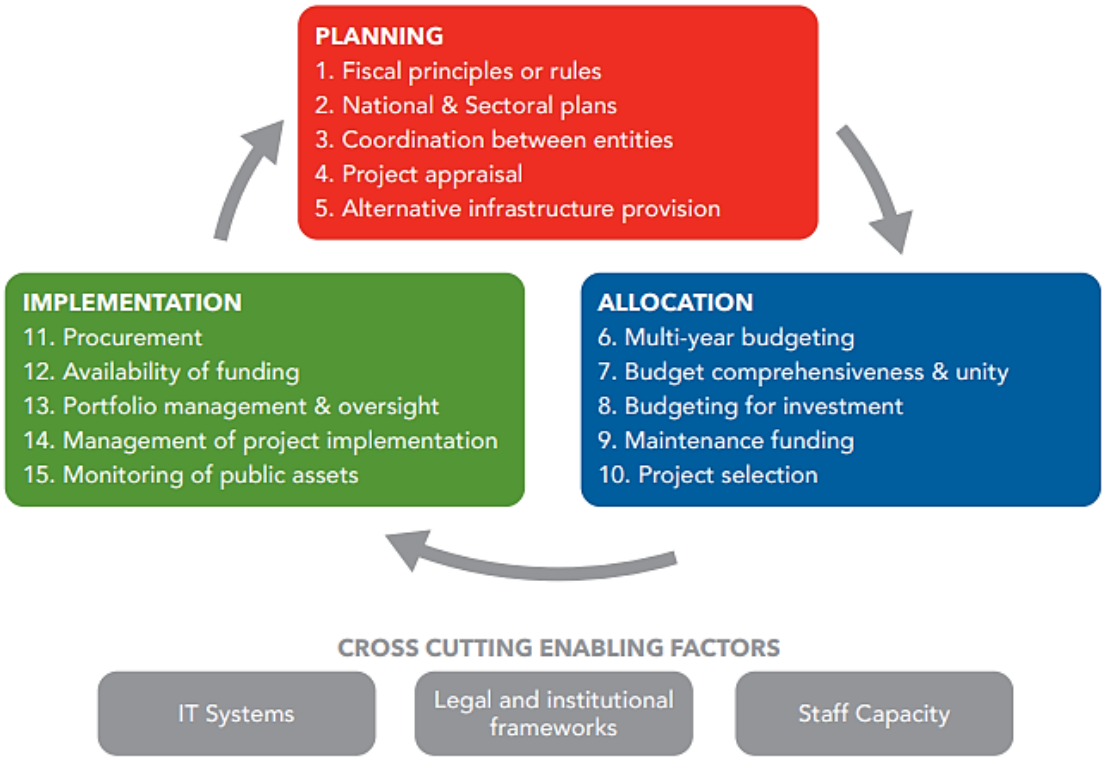
In countries with stronger governance, public investments generate better macroeconomic outcomes than in countries with weaker governance: where governance is strong, an investment of 1% of GDP increases output by about 0.8% in the same year, and by 3.2% percent in the medium term (Miyamoto, Guerguiev, Honda, Baum and Walker, 2020). In contrast, in countries with weaker governance, the output response is if anything negative, and marginally statistically insignificant. Government credibility tends to raise the level of productivity as well as the steady-state per capita income (Esfahani and Ramirez, 2003).

Effective governance intuitively also impacts public debt: while countries with stronger infrastructure governance eventually reduce the debt-to-GDP ratio through

public investment shocks, public debt will increase in countries with weaker governance (Abiad, Furceri and Topalova, 2015). This may reflect the fact that in countries with stronger governance, higher public investment may be accommodated within available resources, without significantly affecting the fiscal balance. Last, after a public investment shock, private investment tends to increase in countries with stronger governance, and it declines in countries where governance is weaker.

In Figures 20 and 21 below we can see graphically how stronger governance can make a difference in terms of output, public debt and private investment. From a measurement point of view, stronger or weaker infrastructure governance can be proxied by using the IMF's Public Investment Management Assessment or PIMA in the case of emerging and low-income developing countries, whereas for advanced countries the World Bank's government effectiveness indicator, which is strongly correlated with the PIMA, allows for more available observations.

Figure 21 – *The PIMA framework*

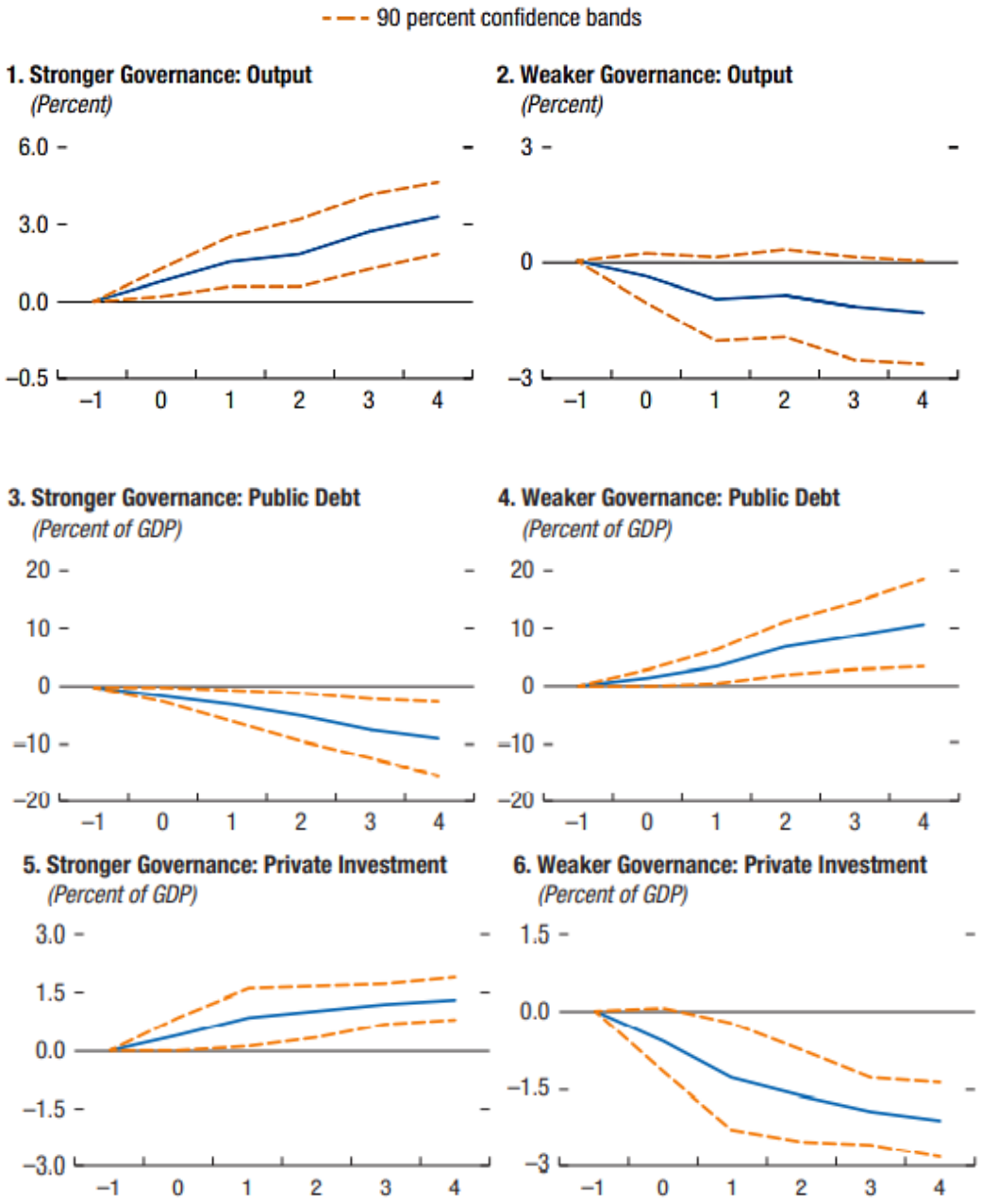


Source: International Monetary Fund

The PIMA was developed by the IMF to help countries assess the strength of their public investment management practices, with particular attention dedicated to countries with high debt levels, low revenue collection, and little fiscal space. The

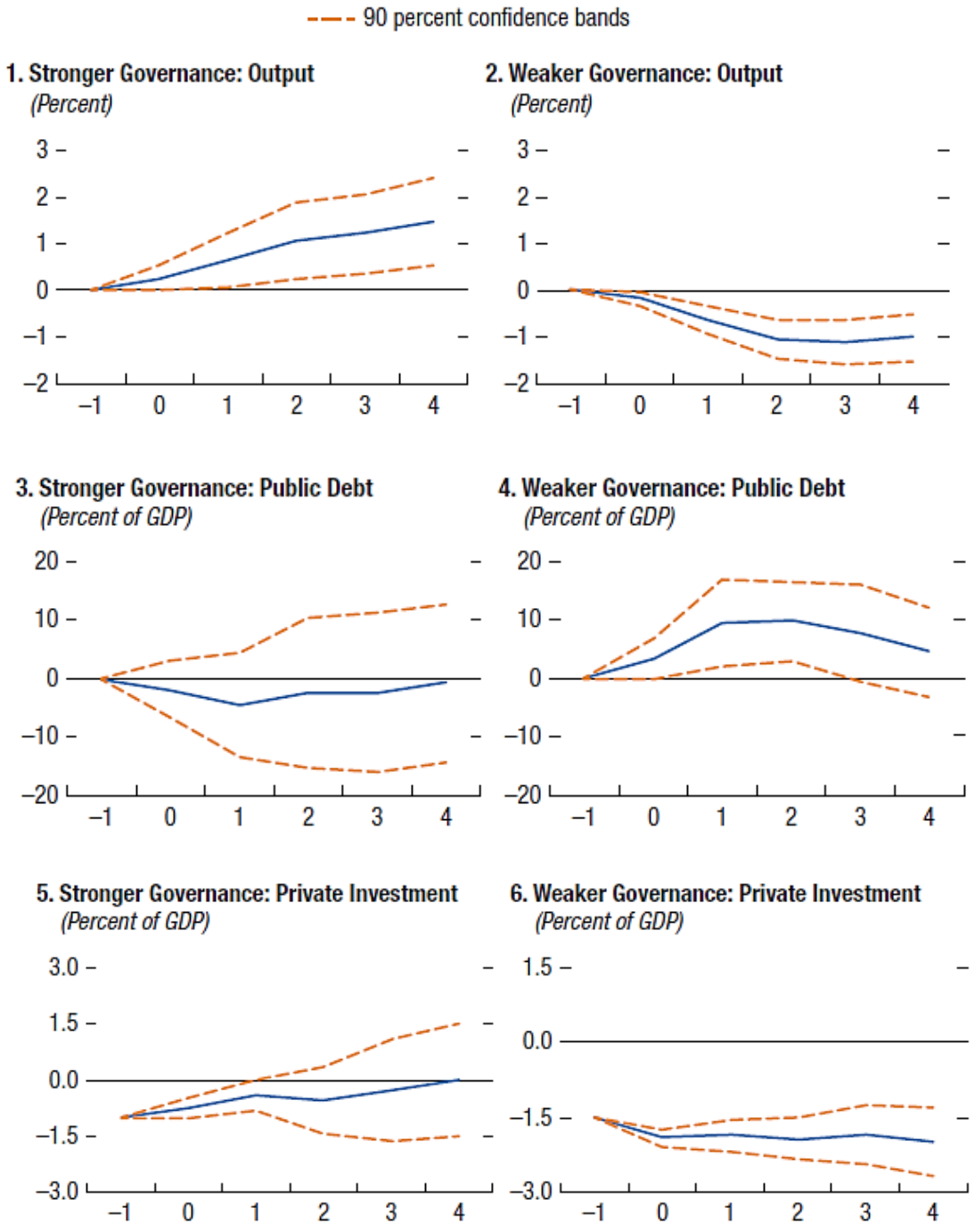
PIMA framework examines the institutional design and effectiveness of 15 key practices, called "institutions" and 3 enabling factors supporting infrastructure governance, which shape decision-making at the key stages of the public investment cycle.

Figure 22 – *Effects of public investment shocks in* ***advanced economies:*** *the role of infrastructure governance*[4]



[4] Note: the X-axis indicates n years after the public investment shock; t=0 represents the year of the investment; the investment represents an increase of 1% of GDP in public investment spending [Sample size: 507; n. of countries: 17].

Figure 23 – *Effects of public investment shocks in* ***emerging markets and low-income developing countries****: the role of infrastructure governance*[5]



Source of Figures 22 and 23: International Monetary Fund calculations.

[5] Note: the X-axis indicates n years after the public investment shock; t=0 represents the year of the investment; the investment represents an increase of 1% of GDP in public investment spending [Sample size: 792; n. of countries: 44].

As for what concerns the planning stage, efficient investment planning requires institutions that ensure public investment is fiscally sustainable and effectively coordinated across sectors and levels of government. During the allocation stage, the process of assigning public investment to the most productive projects requires comprehensive, unified, medium-term planning and objective principles for assessing and selecting projects. Finally, during the implementation phase, institutions must ensure projects are fully funded, transparently monitored, and effectively managed throughout their implementation.

The three cross-cutting enabling factors address issues such as the legal framework supporting infrastructure, staff capacity to implement and manage processes, as well as the adequacy of IT systems to enable good practices in all three phases of the public investment cycle.

From Figures 22 and 23, the implication for infrastructure policy is clear: projects aimed only at infrastructure construction may have a limited impact on economic growth, and may actually a negative effect if they divert domestic resources away from the maintenance and operation of existing stocks. Therefore, a key priority in many economies - particularly in those with relatively low efficiency of public investment - should be to raise the quality of infrastructure investment by improving the public investment process. Achieving better outcomes requires institutional and organizational reforms that are more fundamental than simply designing infrastructure projects and spending money on them.

In the 2017 OECD Infrastructure Report, it is argued that poor governance is a major reason why infrastructure projects often fail to meet their timeframe, budget, and service delivery goals. In an attempt to gather information about the main challenges faced by countries in infrastructure governance, in 2016 the OECD run a dedicated survey on 25 OECD countries – Italy included – and suggested ten corresponding actions to take. The challenges, their description and the proposed measures are summarized in the table below.

Table 3 – *Infrastructure-related policymaking challenges and recommendations*

Challenge	*Description*	*Policy recommendation*
Nature of infrastructure itself	Multi-institutional planning, multiple goals, long-term impact, sensibility to the political cycle, complementarity across sectors	Appropriate strategic planning: presence of a strategic infrastructure plan, dedicated process/units, presence of an inter-ministerial institution to design infrastructure strategies.
Threats to integrity	Corruption, excessive officials' discretion on the investment	Conflict of interest policies, confidential information

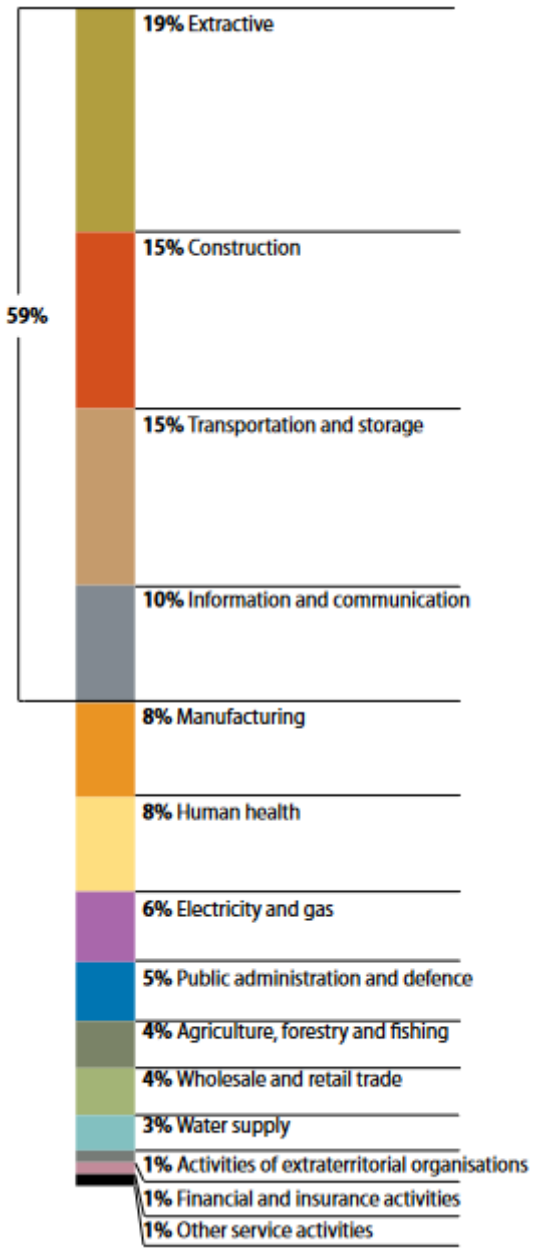
	decision, scale and complexity of the projects, multiple stakeholders involved, electoral-based decision-making.	regulation, political contribution and spending limits, lobbying activities regulation, transparency
Delivery modality	Public works/ private-public partnership/ hybrid approaches	Considering the country's conjuncture, assess the objectives and features of the sector, choose a delivery mode coherent with the project features (cost vs benefits, risk analysis)
Regulation	Uncertain/unclear regulation; uncertain funding; information asymmetries	Coordinating regulatory bodies and layers of requirements; making data and information available; stimulating trust and confidence in the investment regime
Consultation process	Avoiding captures by specific groups of interests; ensure that the project takes account of the overall public interest	Dialoging across stakeholders, openness of projects, well-publicized procedures
Coordination across levels of government	Difficulties in managing the collaboration across levels of government (regions, municipalities…), different priorities or benefits	Larger engagement of the national government in ensuring a common framework, dialogue platforms, financial incentives
Affordability and value for money	Sustainability of the investment, assessment of the overall value for money	Prioritization of projects that are in line with development goals; assessment of both future revenue flows and risks
Useful data	Collection, procession and disclosure of relevant data required to compare the overall projects costs (also relevant for monitoring)	Use of KPIs, Supreme Audit Institutions (SAI), timely and manageable disclosure of key data
Asset performance	Overseeing the performance of infrastructure service delivery through its lifespan.	Monitoring systems, institutions, re-negotiations, ex-post evaluations
Resilience	Infrastructure systems should be adaptable to new circumstances (natural disasters, disruptions, pandemics...)	Governance framework ensuring resilience of multiple critical infrastructure sectors.

Source: OECD, 2017 (elaborated)

Insufficient planning in all kinds of projects often impedes a successful implementation and operation later in the project cycle: this is particularly true for infrastructure, where the nature of the investment is extremely complex – we already considered the challenges brought about by the long-term impact and gestation period, the need to serve multiple objectives and the involvement of different levels of government. Without a strategic, coordinated framework and budget allocation, possibly with the presence of a dedicated institution, a national long-term strategic vision is difficult to implement – therefore opening doors to inefficiencies.

Corruption allegations also often surround government-led infrastructure projects: the OECD Foreign Bribery Report (2014) suggests that 60% of foreign bribery cases occurred in four sectors that are very much related with infrastructure: that is, extractive, construction, transportation and storage, and telecommunications sectors. 10 to 30%of investments in a publicly funded construction project can be lost via corruption and mismanagement, according to the Construction Sector Transparency Initiative (2012). Politicians may favour projects that benefit their electoral base even when not cost-effective; all phases, from selection to implementation, can be subjected to favoritisms or bribing.

Figure 24 – *Cases of bribery across sectors (%) between years 2000-2014*



Source: OECD Analysis - Sectors identified with reference to the UN International Standard Industrial Classification of All Economic Activities (UN ISIC)

It is crucial, therefore, to put in place adequate mechanisms to avoid conflict of interests, monitoring irregularities, regulation of lobbying and political contribution activities, so as to ensure credibility and integrity to the whole operation. Consultation

processes are very effective in enhancing the legitimacy of the project amongst the stakeholders and the whole affected community.

The aspect of delivery modality has long been debated: while some believe that the public sector should have full discretionary control on infrastructure projects and implementation, others suggest that a more private-oriented delivery modality would allow for greater efficiency and higher returns; hybrid approaches with private-public partnerships are often advocated. However, the most efficient delivery model is generally not given: rather it should depend on the level of control exercised and on the risk allocation, plus on cost-benefit analyses. Unfortunately, oftentimes the choice of modality is based on habit and lacks specific criteria.

Whatever the choice of delivery is, the willingness to invest in infrastructure projects will crumble if a good regulatory design is not put in place. Credibility and certainty about the avilable fundings and the project life-cycle timing generate the confidence that in turn allows for investments to be started, maintained and upgraded. Therefore, transparency and availability of information are needed to set up a regulatory framework that is clear, certain, and not perceived as overly burdensome.

At the same time, it is important that the funded projects prove to be affordable and to generate value. Oftentimes, politicians will prefer to build new projects with high visibility rather than spending on maintaining and upgrading existing assets, therefore threatening the value for money of the investment. Accounting standards, the presence of an audit institution and running affordability analyses are the basic policy recommendations to guarantee sustainability: the usage of efficient tools such as KPIs to collect, process and disclosure key data plays a fundamental role in ensuring effective monitoring of assets' performance throughout their lifespan.

Quite intuitively, phenomena such as natural disasters, pandemics, wars, revolutions and political instability can have a tremendous negative effect on growth and investment returns. We will deepen this concept in Chapter 4 when considering the current conjuncture: for now, we simply highlight the importance of ensuring that infrastructure investments are made to be adaptable to new future circumstances, resistant to disruptions and as flexible as possible: in one word, resilient.

Strong infrastructure governance — i.e., strong public sector institutions in planning, allocating, and implementing public investment in infrastructure — not only improves efficiency, but is also critical for macroeconomic stability, economic growth and fiscal sustainability. This is particularly important for countries with high debt levels, low revenue collection, and little fiscal space.

III. Infrastructure for entrepreneurship

«Innovation must lead infrastructure for a simple yet compelling reason: innovation produces new types of products and markets, and it is virtually impossible to know how to run those markets efficiently before they are created ».

Professor Myron Scholes,

Nobel for Economics Prize winner, 1997

3.1 Infrastructure and entrepreneurship: a mysterious relationship

While there is a multitude of studies analyzing the key role of infrastructure in economic growth and development, research on the impact of infrastructure on entrepreneurship is relatively scarce. Up until the first 2010s, virtually no study had considered the relationship between infrastructure and entrepreneurial activity: as Woolley (2013) observed in one of the few existing studies linking infrastructure to entrepreneurship, ''*The development of infrastructure for entrepreneurship remains elusive*'' (Woolley, 2013, p. 2).

Such an omission in the literature is quite surprising, especially if we consider that, as we have seen, there is a general consensus that infrastructure and economic development *are* linked and influence one another. Moreover, since infrastructure investment typically enhances the connectivity of people, intuitively this leads to benefits for entrepreneurial activity.

Entrepreneurship, defined as the discovery and exploitation of profitable opportunities (Shane and Venkataramn, 2000), is indeed a game-changer. According to Schumpeter (1934) it is the fundamental engine driving the change process in a capitalist society. Over four million new companies are started each year around the world creating jobs, driving innovation and, in turn, generating other firms. At the industry level, new firms disrupt markets through the process of "creative destruction," when existing firms are displaced and new industries emerge (Schumpeter, 1942). Entrepreneurial ventures also disrupt markets with new products, services, or even process innovations. In turn, governments benefit from the tax revenue generated from product and service sales, corporate revenue, and job income, all of which support spending across the economy. Entrepreneurship is also crucial for social change: increasingly, entrepreneurs are tackling substantial social problems such as poverty, education, the protection of the environment and of human rights. Thus, the success of nascent firms is important for economic health, innovation, and social wealth, all of which influence the competitiveness of countries, regions, and cities (for empirical findings on the subject, see Acs and Armington, 2003; Acs et al., 2009; Wennekers & Thurik, 1999).

Audretsch and Thurik (2001 and 2004) write about a significant change occurred globally as a shift from large companies towards small, mainly new companies and define this new economic period as an 'entrepreneurial economy', based less on the traditional contribution of natural resources, labor and capital, and more on the input of ideas and knowledge. Paradoxically, in this context, the increase in uncertainty creates opportunities for small and young companies, resulting in higher entrepreneurship rates. We note, however, that entrepreneurship is not a prerogative of small and young ventures: it can also occur in large, incumbent companies – where it is known as corporate entrepreneurship. Finally, the OECD emphasizes that self-employment is also an important source of entrepreneurship and growth especially for small businesses – with the potential to increase employment in the long run (OECD, 2000).

Given the importance of entrepreneurship and since economic growth often moves together with it, knowing the factors that encourage it is crucial for policymakers. With the aim of determining how to best support such an important component of society, researchers and practitioners continue to ask why some regions exhibit a greater degree of entrepreneurial activity than others: and a univocal answer has not yet been reached.

Entrepreneurship determinants can be studied according to a certain level of analysis: we can logically distinguish between *micro*-, *meso*- and *macro*-levels of entrepreneurship drivers, with the subject of research being respectively individual entrepreneurs, industry sectors and the national economy.

From the beginning of entrepreneurship research, numerous studies have focused on the critical role of the individual on entrepreneurial intention and success, since the role of the entrepreneur is fundamental in the success and growth of a firm's value. Factors such as individualism, uncertainty avoidance, family environment and support, self-confidence, personal motivation, risk-taking propensity, education levels, previous professional experience, and resilience all seem to affect and shape the individual intention to start a new venture (there is numerous evidence on this subject: see for instance Shapiro, 1982; Baughn & Neupert, 2003; Tyszka et al., 2011; Lindquist et al., 2015; Simanjutak et al., 2016).

However, in recent years, management and strategy literature is increasingly looking towards the *meso*- and *macro*- determinants of entrepreneurship, e.g. the context in which new ventures are formed and grow - therefore shifting the unit of analysis from individuals to the framework in which they operate. In one of the first researches on the subject, Van de Ven (1993) stated: "*A common bias in Western culture is to attribute innovations to an individual entrepreneur, who at an occult date and place came up with the innovation through a stroke of genius or fortune. Although examples exist to support this bias, historical studies show that most innovations are collective achievements of*

the efforts of many actors working over an extended period, often in parallel and independent locations" (Van de Ven 1993, p. 212).

During the late 1980s, the so-called 'ecological approach' to entrepreneurship scholarship emerged: as Aldrich (1990) points out, this perspective emphasizes that new company start-ups are highly dependent upon macro-processes both within and between organizational populations. Intra-population processes (such as prior foundings, dissolutions, and organizational density) structure the environment into which new ventures are born. Cooperative and competitive relationships between populations of organizations affect the distribution of resources available to entrepreneurs. Finally, institutional factors (government policies, political events, cultural norms...) shape the macro-context within which these population processes occur (Aldrich 1990, p. 7). The concept of '*entrepreneurial infrastructure'* was emerging and beginning to be discussed and considered.

The social system framework proposed by Van de Ven and Garud (1989) defines the three components of such an "infrastructure for entrepreneurship".

The first element considered is resource endowments, e.g. "*the basic resources necessary to support proprietary instrumental activities*" such as the creation/ identification of entrepreneurial opportunities (Van de Ven and Garud, 1989). Knowledge, novel ideas and technology are considered to be the cornerstones of opportunities (Venkataraman, 2004): therefore, resource endowments that are crucial to entrepreneurship are

- Basic scientific and technological knowledge;
- A pool of competent labor;
- Financing mechanisms.

According to the knowledge spillover perspective, locations embedding more knowledge have more entrepreneurial opportunities and foster the formation of new firms (Audretsch and Keilbach, 2007). In the same way, a training labor pool is crucial for entrepreneurial ventures to thrive. Saxenien (1994) points to the ability of people to interact and connect with others as facilitating new firm startups: in particular, she observes that the high degree of entrepreneurial activity in California's Silicon Valley is attributable to a high degree of interactions among people in the region who *''meet at trade shows, industry conferences and the scores of seminars, talks, and social activities. Relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived…. This decentralized and fluid environment promotes the diffusion of intangible technological capabilities and understandings''* (Saxenien 1994, pp. 96–97).

Knowledge resource endowments are often linked to R&D activities of incumbent large firms, universities, and governments. Universities are generally

considered one of the main sources of scientific and technical knowledge, and developers of human capital that is essential for entrepreneurship (Qian, Acs & Stough, 2013). Universities foster opportunity creation, recognition and development, and educate workers that help entrepreneurial ventures enact these opportunities. They provide training of students, scientists, laboratories and internal structures dedicated to fostering the creation of cutting-edge technology and new knowledge. Incumbent firms are also instrumental for advancing knowledge through R&D, developing the labor pool through training and learning, and bringing people together to share information and develop opportunities: the mechanisms through which employees can develop ideas and transfer technology to a new firm to be explored outside the borders of the existing organizational structure are the so-called corporate spinoffs.

Government laboratories and research centers are also sources of scientific and technical knowledge: however, they have been largely neglected in the literature. The limited research that does exist shows that government labs and research centers generate technology and intellectual property that is needed to establish new firms (Mowery and Ziedonis, 2001). Firms that obtain government fundings, moreover, are more likely to receive funding from investors (Lerner, 1999). Government's support to new businesses not only improves firm creation, but also firms' long-term performance – almost every country has government-granted loan system for small businesses. Policies that reduce the time and administrative paperwork needed to start a business also increases countries' start-up activity (Djankov et al, 2002), while countries where the capital requirement for starting a business are higher and labor market regulations are more rigid show lower rates of entrepreneurship (Van Stel, Storey and Thurik, 2007). In the same way, laws protecting property rights and intellectual property in particular, together with bankruptcy laws that provide safety nets by ensuring that entrepreneurs reduce the downside risk of starting new ventures, are encouraging fort start-up activity (Venkataraman, 2004).

Private mechanisms such as angel investment and venture capital also act as funding infrastructure for entrepreneurship:

- Venture capital or VC refers to funding that a company invests into a firm in exchange for partial equity ownership of the company and is obtained from firms that pool resources of multiple investors - VC often includes individuals, firms, and large institutions such as pension funds. Not only does it provide funding but also mentorship, relevant network opportunities, and credibility to external stakeholders.
- Angel investment is funding for a start-up firm in exchange for a share of equity ownership of the firm or convertible debt from single individuals or teams of investors with similar investment strategies who pool individual capital together. It tends to fund earlier-stage firms with respect to VC and can

realize gains from the investment only when they are able to sell their share. The average angel investment tends to contribute about $300,000 to new ventures (Sohl, 2013).

The second element of infrastructure affecting entrepreneurship is institutional arrangements: in a similar way to what we have seen for economic growth and development, institutional arrangements act to establish and codify norms and values related to new ventures, which help reduce uncertainty for entrepreneurs and their stakeholders. Institutional arrangements seem to be particularly important for emerging domains of activity that are still lacking structure to support new ventures, industries and economies (North, 1990).

The third element of entrepreneurial infrastructure is proprietary function support: that is, the structure through which firms are able to transform knowledge and resources into products and services for commercialization (applied R&D, manufacturing, marketing, access to market, and so on). Proprietary functions are the foundation for entrepreneurial activity, both individual and corporate, and infrastructure as we have defined it in this study is the enabler of proprietary function support. Entities such as private business incubators, accelerators, firms supplying legal services, firms supplying marketing and communication services, business advisors, telecommunications companies and generally all firms providing support services that enable entrepreneurs to access the market are part of the proprietary function support network.

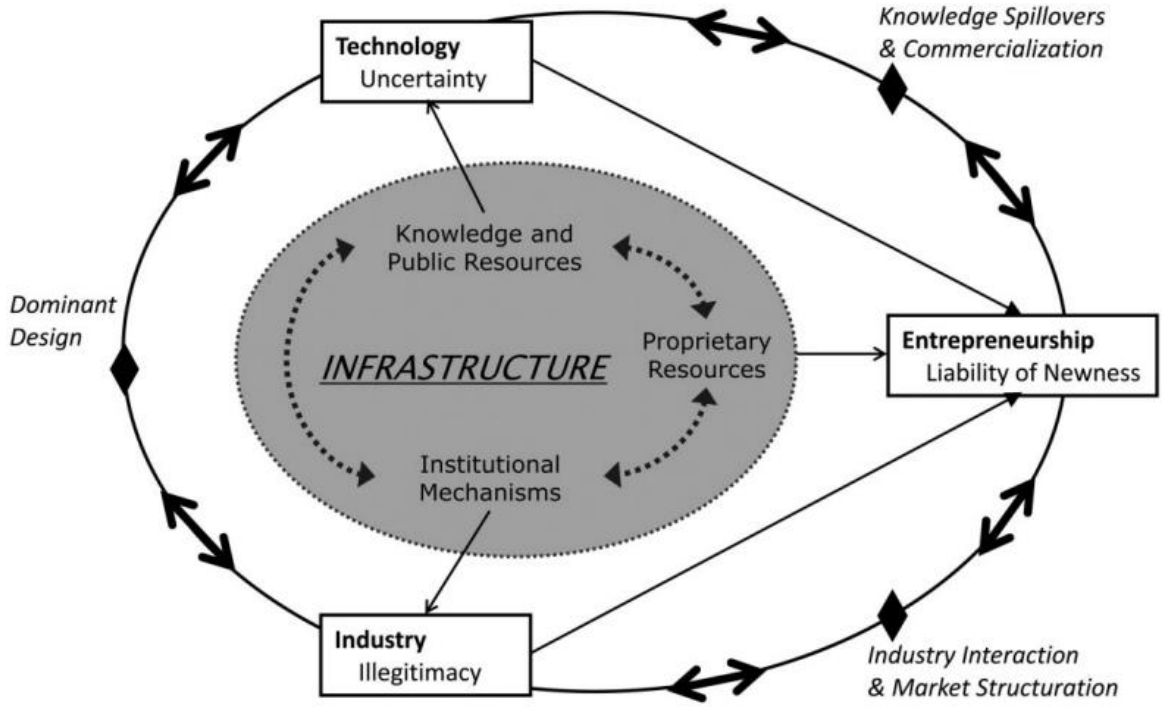
After the initial setup of the social system framework by Van de Van and Guard (1989), empirical research has progressed in defining and identifying the environmental elements that influence entrepreneurial activity.

A study on 15 EU member States by Grilo and Thurik (2004) drew some interesting conclusions on the factors influencing both the demand for and the supply of entrepreneurship. Among explanatory variables, in addition to demographic variables, the survey examined such characteristics as how the respondents perceived administrative complexities, availability of financial support, approximate risk tolerance, respondents' preferences for self-employment and country-specific effects. One of the surprising results was that the perception of the lack of financial support does not have a discriminatory effect on various ways of entrepreneurial involvement. On the other hand, the tax system seems to be a relevant entrepreneurship determinant: ambiguously written regulations, frequent changes in tax law, expiration clauses and various levels of regional and national taxation significantly affect the degree of entrepreneurship in a given region. According to the OECD (1998), immigration policy and regional development policy dealing with urbanization processes also affect the age composition and dispersion of employees in a given area, respectively.

Sternberg (2009) identifies a multitude of spatial influences on entrepreneurial activity, spanning from the extent of physical capital and human capital, to social capital and knowledge capital. When interpreted from the lens of Audretsch and Keilbach (2007), the latter three can be interpreted as enhancing entrepreneurial opportunities and capabilities, while the first limits such entrepreneurial opportunities and capabilities.

According to Woolley (2013), nascent technology firms operating in new industries endure a "trifecta of burdens": the firms' own 'liability of newness'; the industry's lack of legitimacy and cohesive structure; and the technology's inherent uncertainty. Knowledge, resources, institutional arrangements and proprietary function support are used by entrepreneurs to overcome these burdens: as we can see from Figure X, each burden can be connected to the type of infrastructure element essential for overcoming it.

Figure 25 – *Infrastructure for nascent technology entrepreneurship in new industries and the trifecta of burdens*



Source: Woolley, 2013

For instance, knowledge and public resources enable clarification of uncertainty related to the nascent technology; the lack of legitimacy of a new industry can be overcame with institutionalization mechanisms; and new ventures procure proprietary resources to overcome their own liability of newness. data here show how the elements

are not independent. The elements interact and configure during systemic coevolution to become a cohesive infrastructure which not only supports technological and industry emergence, but enables further entrepreneurship (Woolley, 2013).

In the following section of this Chapter, we will provide an original analysis on how an 'infrastructure for entrepreneurship' impacts on entrepreneurial ferment – considering specific types of infrastructure. The analysis is inspired by the work by Audretsch, Heger and Veith (2015), which was the first study to link infrastructure to entrepreneurial activity levels: by analyzing the impact of different types of infrastructure on the startup rate at the level of German counties, the analysis was able to identify the types of infrastructure which matter the most for entrepreneurial activity in Germany.

Our scope is to provide a new, original insight on the mysterious relationship between infrastructure and entrepreneurship – and provide materials for further discussion and analysis.

3.2 Infrastructure for entrepreneurship: an impact analysis

3.2.1. Hypotheses and data collection

In this section, we will assess the impact of entrepreneurial infrastructure on entrepreneurship activity in Italy: after identifying four measurements of entrepreneurial infrastructure (reflecting respectively transportation, digital, institutional and education/knowledge infrastructure) we will test their impact on entrepreneurial activity level or ferment across Italian Provinces. According to our findings, we build a simple multiple linear regression model that helps to better understand which types of infrastructure are the most conducive for entrepreneurial activity.

As output variable, we rely on the "*Indice di Fermento Imprenditoriale*", a recent and original Index developed by the Institute for Entrepreneurship and Competitiveness of LIUC University (2019). The IFI aims at identifying which Italian Regions and Provinces have been able to create a thriving entrepreneurial ecosystem that stimulates competitiveness and the growth perspective of the belonging firms. By evaluating several dimensions of entrepreneurial activity, it provides a comprehensive framework evaluating how easy (or how difficult) it is to be an entrepreneur across all Italian Provinces.

The IFI is based on twenty different indicators, each assessing a particular aspect of the dimensions that contribute to the formation and the prosperity of entrepreneurial ecosystems. The list of the indicators embodied in the IFI is visually represented in Figure 26 below and is built as follows:

<u>Industrial framework:</u>

- Industrial specialization: level of industrial specialization with respect to national average (workforce);
- High-growth level firm density: (n° of active firms registering a 20% or higher growth in turnover in the last three years - normalized).

<u>Financial development:</u>

- Early Stage Deals: n° of early-stage startup investments (normalized);
- Financial specialization: level of financial specialization with respect to national average (workforce).

Skills development:

- Hubs: n° collaborative hubs, coworking spaces, technological hubs (normalized);
- Online communities: n° of entrepreneurial-related communities (normalized);
- Incubator and accelerator programs: n° of incubator and accelerator programs – (normalized);
- Events and competitions: n° of entrepreneurial-related events, competitions and workshops (normalized);
- Academic stars: n° of innovation and entrepreneurship-themed academic publications (normalized);

Entrepreneurial performance:

- Value-added growth: percentage of variation of total added firm value;
- Population growth: percentage of variation of resident population;
- Firms birth rate: percentage of variation of registered active firms;
- Workforce growth: percentage of variation of total workforce;
- Export growth: percentage of variation of total added export value;
- Value of production growth (traded clusters): percentage of variation of production growth value in traded clusters;
- Income growth: percentage of variation of hourly salary;

Innovation:

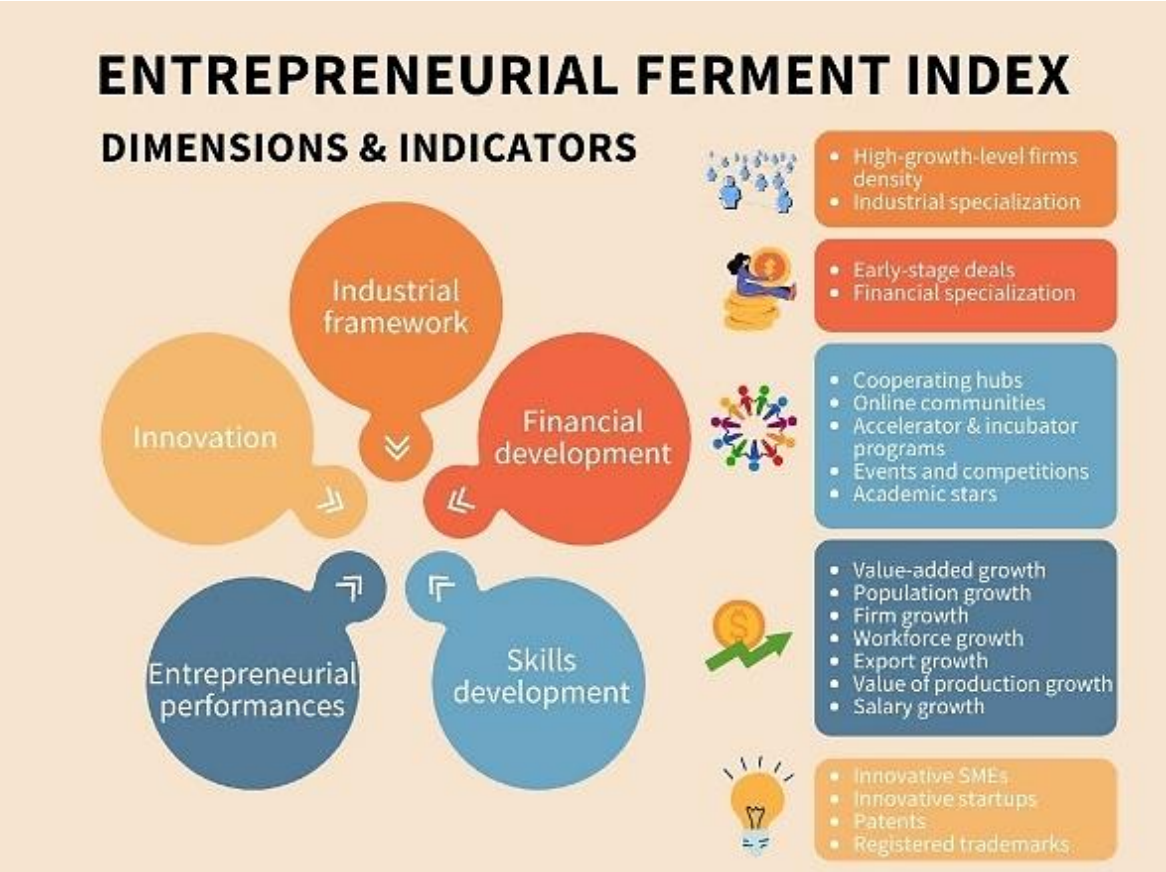
- Innovative SMEs: n° of active innovative SMEs (normalized);
- Innovative Startups: n° of active innovative startups (normalized);
- Patents: n° of deposited patents (normalized);
- Registered trademarks: n° of registered trademarks (normalized);

We believe the IFI to be a detailed and comprehensive measurement of entrepreneurship vitality and prosperity: our aim is to understand how selected infrastructure elements impact Italian Provinces' IFI and therefore, the easiness to do business.

Empirical evidence on the positive impact of infrastructure investment on economic growth and development usually refers to infrastructure as a homogenous concept, assuming that there is such thing as generic 'infrastructure spending'. This is obviously a simplification needed in order to draw macroeconomic conclusions. However, when considering entrepreneurship, we cannot afford to consider infrastructure as a homogenous entity. Therefore, we identify a set of representative infrastructures. We are interested in finding in out which types of infrastructure

endowments – if any – play a role in making a sound and prosper entrepreneurial ecosystem.

Figure 26 – *IFI's Five Dimensions and 20 Indicators:*



Elaborated from Institute for Entrepreneurship and Competitiveness – LIUC University (2021)

1) *Transportation infrastructure* is here measured by the infrastructure endowment index yearly provided at Province level by ISTAT: this indicator considers both the physical infrastructure endowment (number of highways nodes, number of railway stations, number of harbours) and the logistic chain network (by weighting the physical endowment data with the density of workforce operating in the transport and transport-support related services).

2) *Digital infrastructure* is here measured as the percentage of households benefiting from FTTH coverage with respect to total households. FTTH (Fiber-To-The-Home) is currently the most advanced type of broadband connection and allows the highest performance in terms of speed and efficiency of Internet connection. Data per single Province are collected yearly by AGCOM (Autorità per le Garanzie nelle Comunicazioni) and provided in form of Open Data.

3) *Institutional infrastructure* is here measured through the IQI (Institutional Quality Index) developed by Professors Annamaria Nifo (University of Sannio – Benevento) and Gaetano Vecchione (University of Naples Federico II – Napoli). The IQI is inspired by the World Governance Indicator proposed by Kauffman et. Al (2010) and is very close to the European Quality Index (EQI) measurement. However, the IQI is based on objective data rather than on the EU citizens' perceived quality of institutional infrastructure; moreover, the IQI is available at the Province level[6].

4) *Educational (e.g. human capital) infrastructure* is here measured as the number of Province residents in possession of a first-level bachelor's degree with respect to the total number of residents. A consideration: we deliberately chose to consider graduated residents instead of students enrolled in college per Province, as several studies point out that the number of enrolled college students is not to be considered an appropriate measure of education levels. Many Italian Provinces and regions, in fact, present high numbers of enrolled students but quite low levels of graduated students, possibly reflecting a high number of students who have not completed university exams within set time periods.

All of our collected data, both for dependent and independent variables, refer to year 2019 and to 105 Italian Provinces: some data were not available for the Provinces of Carbonia-Iglesias, Medio-Campidano, Barletta-Andri-Trani, Ogliastro and Olbia, so they were not considered in this analysis.

[6] IQI items concern 5 pillars of institutional quality: (1) *Voice and accountability* capturing the citizens degree of participation in public elections, civic and social associations, the number of social cooperatives, the INVALSI test and the cultural liveliness; (2) *Government effectiveness* measuring the endowment of social and economic structures and the administrative capability of provincial and regional governments in terms of health policies, waste management and environment; (3) *Regulatory quality* concerning the degree of openness of the economy; (4) *Rule of law* summarizing data on crime against persons or property, magistrate productivity, trial times, tax evasion and shadow economy; (5) *Corruption* collecting data on crimes against the Public Administration, the number of local administrations overruled by the federal authorities and the Golden-Picci Index (A. Nifo and G. Vecchione, "Do Institutions Play a Role in Skilled Migration? The Case of Italy", 2014).

3.2.2. Modelling and results

We start by the easiest form of testing: that is, by visually representing our variables and their possible interaction through a scatterplot of observations where each dot represents an Italian Province. Complete numerical data are provided in the Annex.

All four scatterplots potentially suggest a positive relationship between the considered variable and the entrepreneurial ferment. We verify by running a linear regression for each variable and considering the significance of the relationship – all four variables seem to present a positive and significant relationship with the output.

We proceed with building a model of multiple linear regression, which can be described as follows:

$$\mathbf{Y = \beta 0 + \beta 1(dig) + \beta 2(tr) + \beta 3(iqi) + \beta 4(edu) + \epsilon}$$

Where dig, tr, iqi and edu represent our four infrastructure variable measurements: % of FTTH-covered households, transportation infrastructure endowment Index, Institutional Quality Index and % of bachelor-graduated residents.

By running a multiple linear regression in R, we find that:

- there is a significant and positive relationship between transportation infrastructure and entrepreneurial ferment, all else being equal (adjusted slope: 0.155).
- there is a significant and positive relationship between educational infrastructure and entrepreneurial ferment, all else being equal (adjusted slope: 2.556).
- there is a significant and positive relationship between institutional infrastructure and entrepreneurial ferment, all else being equal (adjusted slope: 16.058).
- we do not reject the hypothesis of no relationship between FFTH coverage and entrepreneurial ferment, because P-value = 0.0567.

With an adjusted R2 of 0.61, we have a sufficient goodness of fit of our model.

We use plot diagnostics to check for the suitability of our linear model: below are the plots used to check for linearity, homoscedasticity, normal distribution of residuals and influential observations.

Figure 27 – *Transportation infrastructure vs Entrepreneurial Ferment Index*

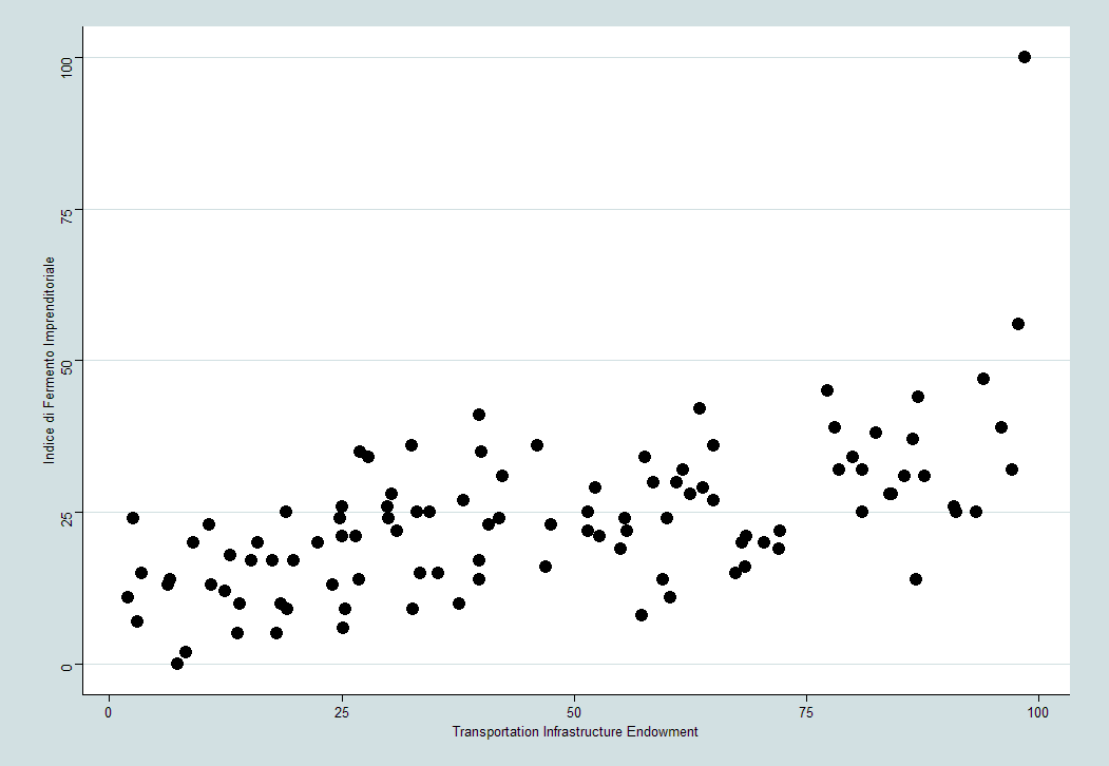


Figure 28 – *Digital infrastructure vs Entrepreneurial Ferment*

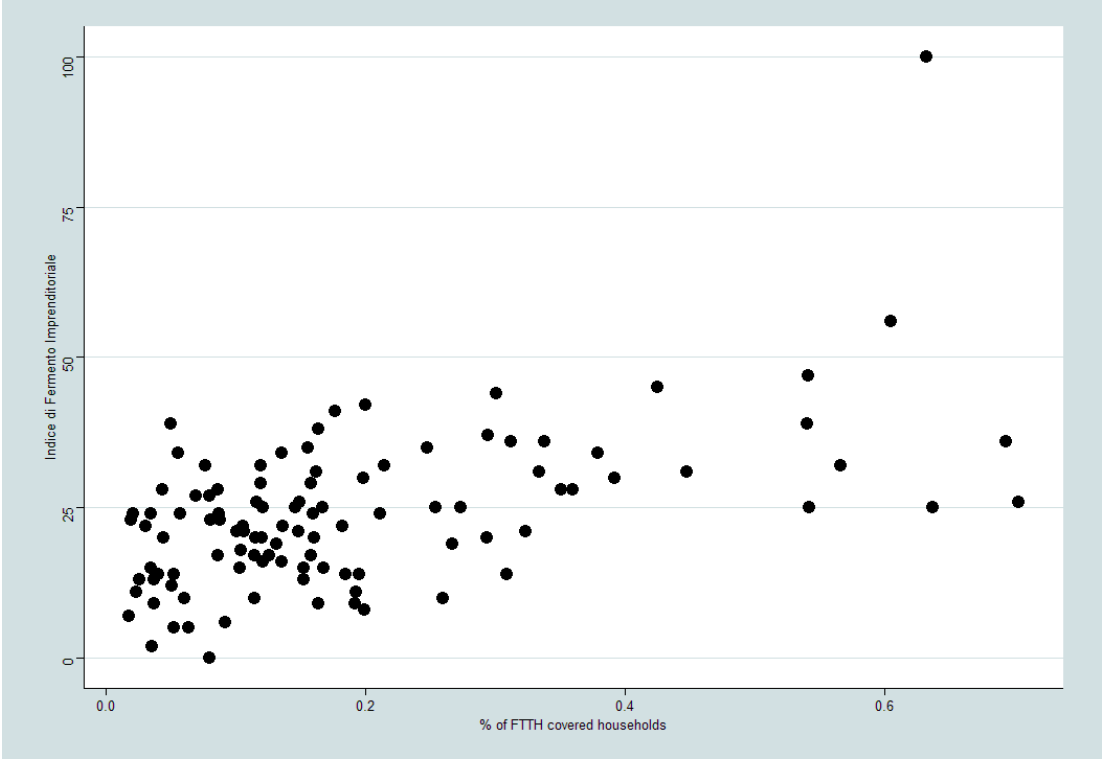


Figure 29 – *Institutional infrastructure vs Entrepreneurial Ferment*

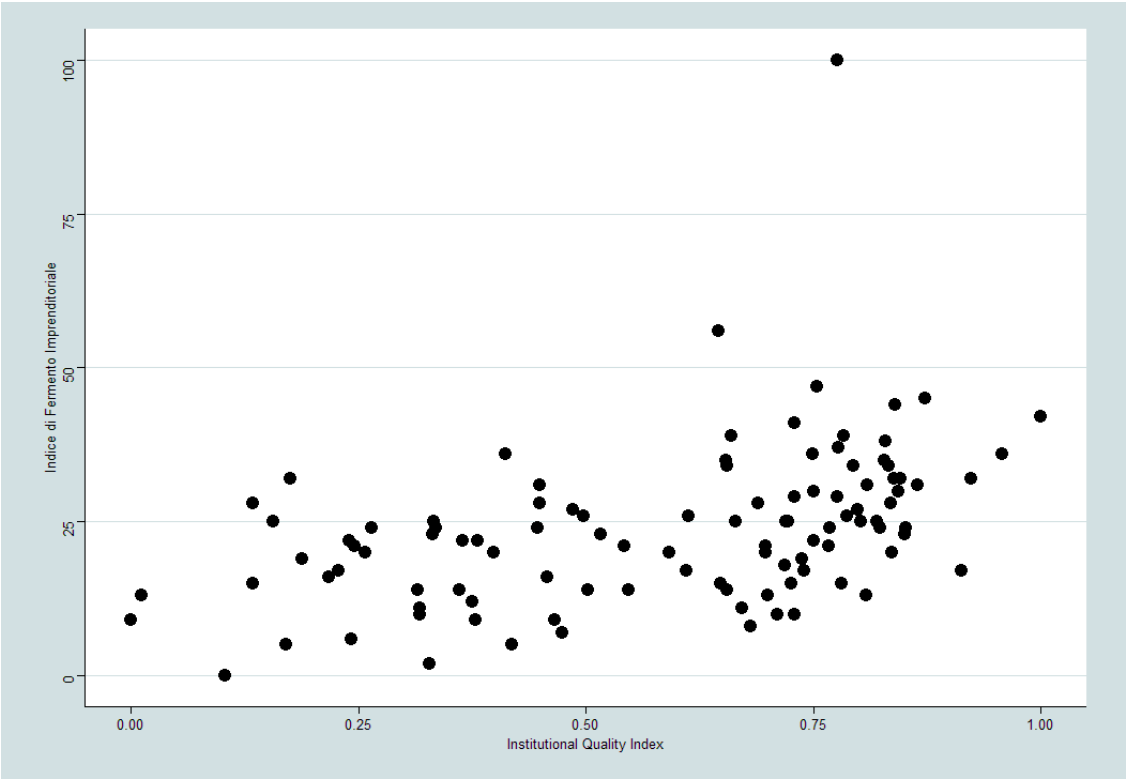


Figure 30 – *Educational infrastructure vs Entrepreneurial Ferment*

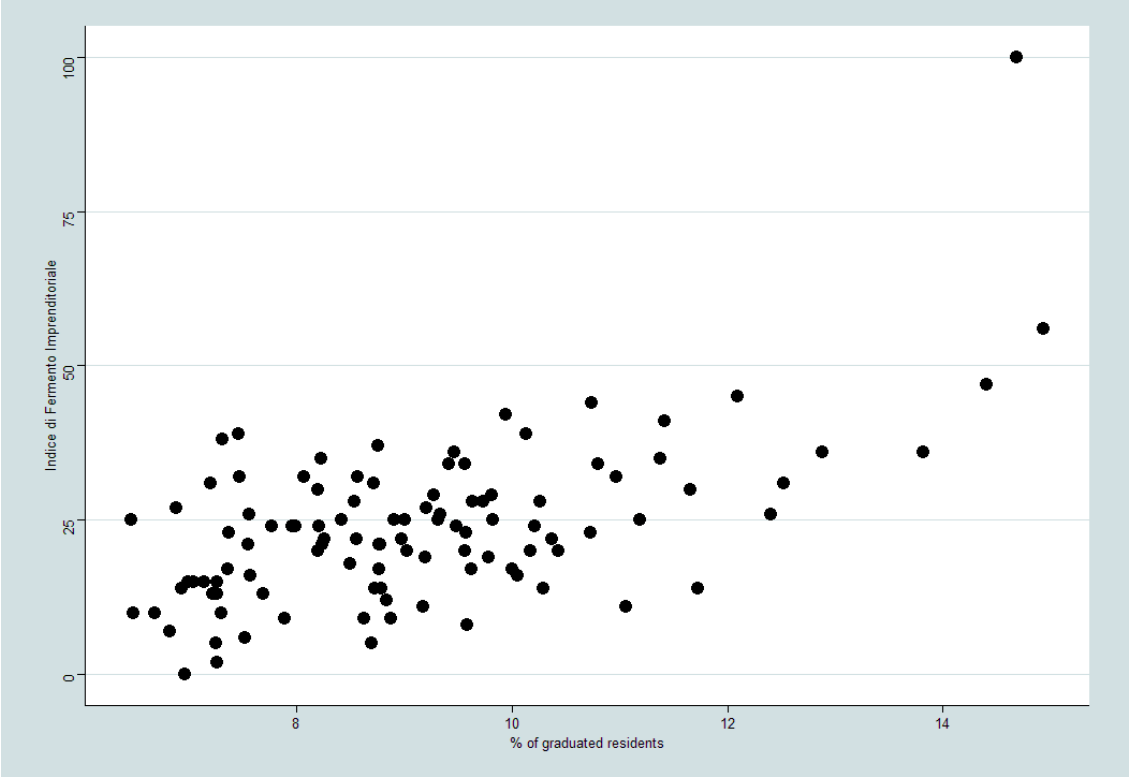


Figure 31 – *Residuals vs fitted plot*

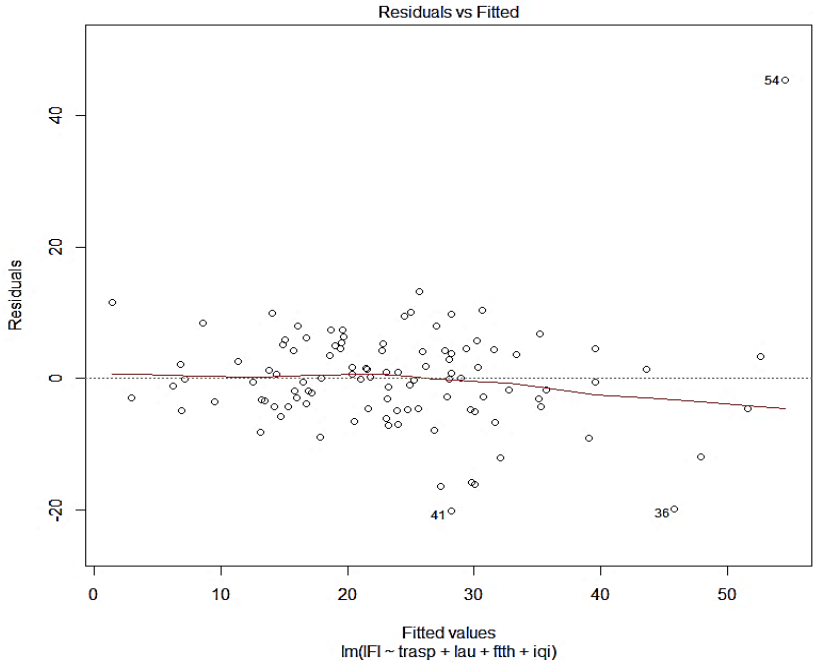


Figure 31 – *Normal QQ Plot*

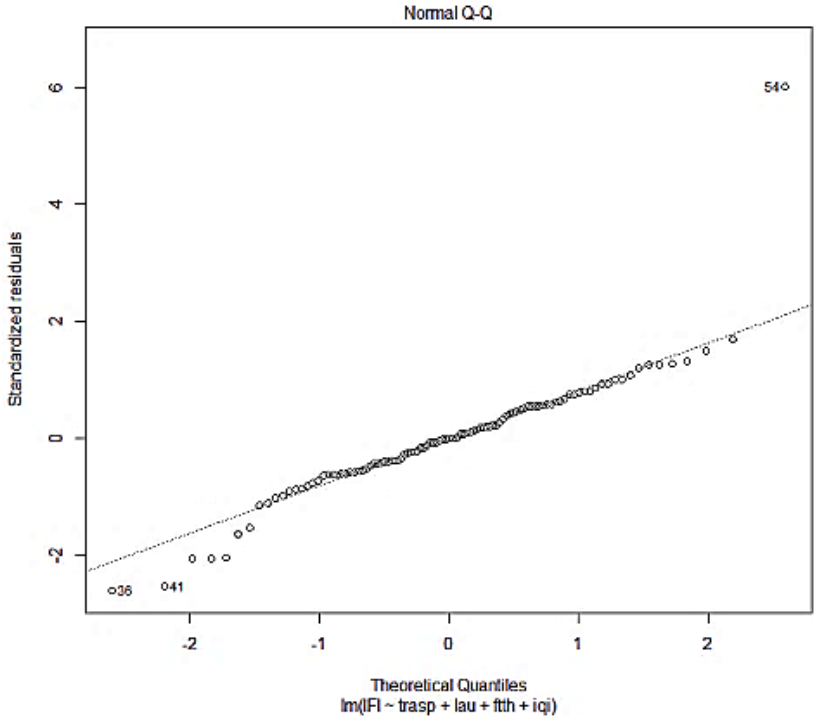


Figure 32 – *Homoscedasticity*

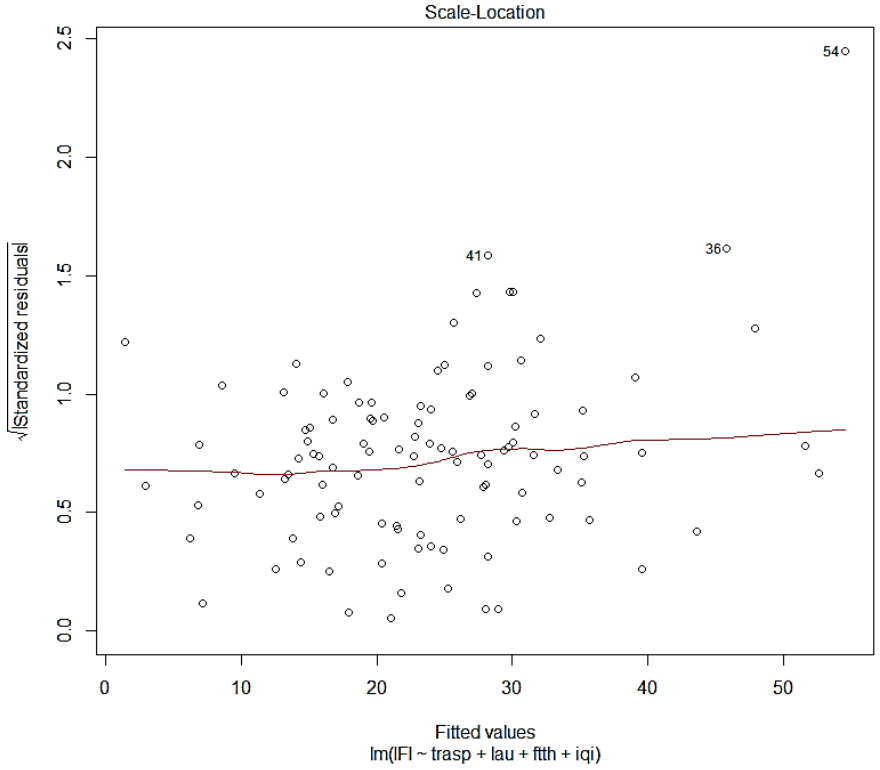
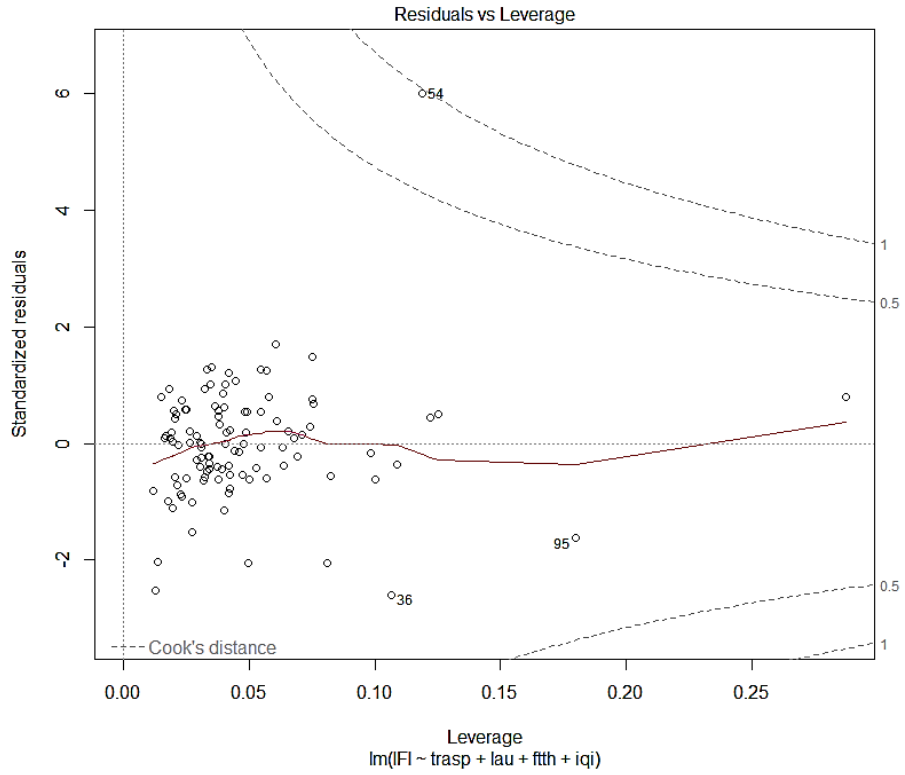


Figure 33 – *Influential observations*



Although some variables like #36 (Genova), #41 (La Spezia) and #95 (Trieste) distance themselves from the others, we would assume our model to respect the conditions of linearity, homoscedasticity and normal distribution of the residuals. However, there is an outlier that we cannot ignore: observation #54, which stands for the Province of Milan, is clearly an influential observation, which is well-spotted by the Cook distance test in the last plot (Figure 33).

Influential observations are defined as a variable that can dramatically change the coefficients of a model if removed from the dataset. If we removed it, we would find a regression line that fits the data more closely – so we try and do that.

Testing the same model – without Milan?

If we remove the Milan Province observations from the dataset, the results of the multiple linear regression model are the following:

- transportation infrastructure and entrepreneurial ferment are still positively linked, with an adjusted slope of 0.14841.
- the same goes for educational infrastructure, with an adjusted slope of 1.94.
- also institutional infrastructure presents a positive relationship with the output variable, with an adjusted slope of 15.55.
- we still reject the hypothesis of no relationship between FFTH coverage and entrepreneurial ferment, because p-value = 0.111.

By repeating the plot diagnostics, this time we reach better results in all four tests (see Annex) and no other influential observations can be spotted; moreover, the R^2 is now slightly improved, rising to 0.62.

However, removing such a relevant observation would not make much sense in terms of the application of our model to the real world. Milan, together with its metropolitan area, produces 10% of Italy's whole yearly GDP. With lower unemployment levels and higher per-capita GDP than the national average, it is, without doubt, the financial, business and marketing capital of our country. The historical roots of its success lie in the distant past, but we can possibly identify the economic boom of the 1960s, which found in Milan and Lombardy its birth, and the following rapid industrialization and population growth (fueled by immigration from all Italian regions) as one of the milestones that contributed to make it the economic engine that it is today. The networking effect that Milan has been able to put into work gradually transformed it into a magnet for financial institutions and a hub for entrepreneurial activities, both traditional and innovative. By fueling a self-reinforcing mechanism of attraction, retainment and cultivation of talent and opportunities, it is no surprise that its numbers exceed every other Italian urban area, making it one of the few entrepreneurial ecosystems that can compete successfully in today's global

economic framework. Therefore, it would have been very much unrealistic for our model to not include its observations – it is an outlier that cannot be ignored. For the representation of the visual fitting of the model and since it is such a relevant Province for the sake of our analysis' realness and context, we consequently take into consideration the Milan variable.

Our findings suggest that among all types of infrastructure for entrepreneurship considered, the one showing the most impact on entrepreneurial ferment is institutional infrastructure as depicted by the Institutional Quality Index. Educational and transportation infrastructure also play a role, although much more contained. Our measurement for digital infrastructure, on the other hand, does not seem to have a significant positive relationship with entrepreneurial ferment.

Table 4 – *Model results*

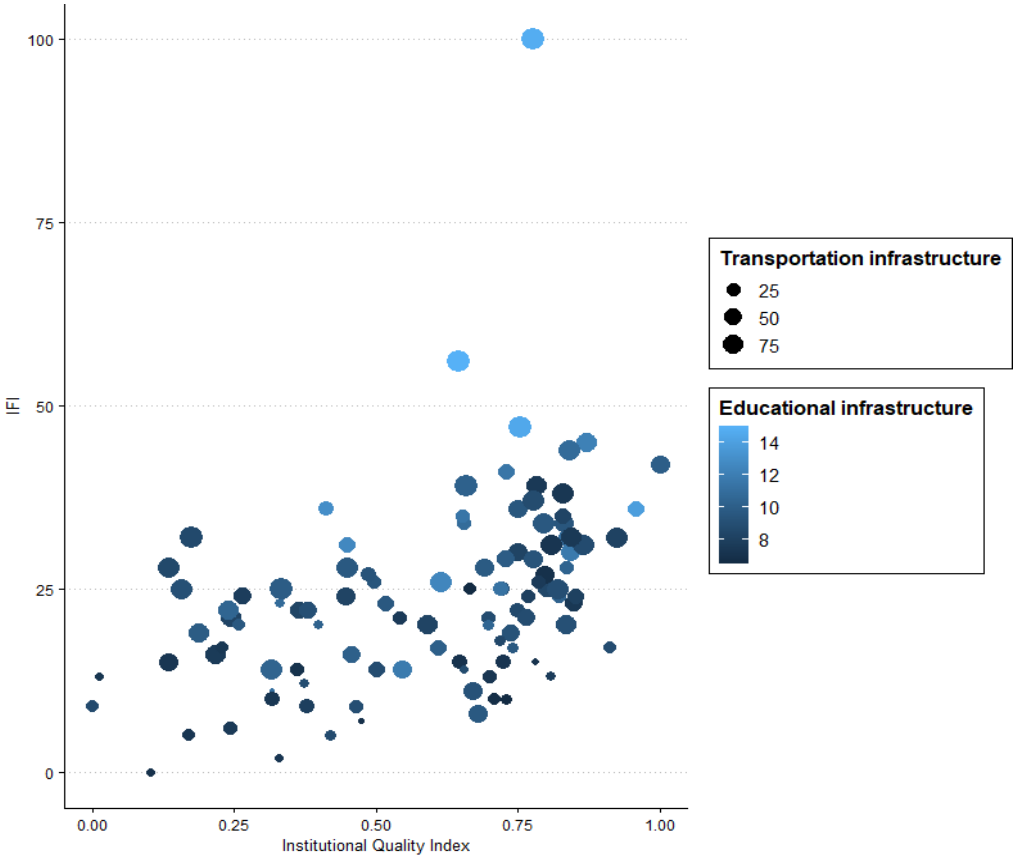
Model Summary					
Parameter	Coefficient	SE	95% CI	t(100)	p
(Intercept)	-18.66	4.53	(-27.65, -9.68)	-4.12	< .001
tr	0.16	0.03	(0.09, 0.22)	4.49	< .001
edu	2.56	0.52	(1.53, 3.59)	4.92	< .001
ftth	12.59	6.53	(-0.37, 25.55)	1.93	0.057
iqi	16.06	3.32	(9.47, 22.65)	4.83	< .001
Model: IFI ~ tr + edu + ftth + iqi (105 Observations)					

The non-significance of digital infrastructure measurement may be due to the fact that FTTH coverage is actually located on the high end of available Internet connections, being the most efficient and fast kind: many entrepreneurial ventures may not actually need such a high-quality type of connection, relying on less powerful (and less costly) alternatives such as FTTC (Fiber-to-the-cabinet) or even mobile connections. This could also suggest that the intense infrastructure investments operated in the past few years to expand the broadband coverage all across Italian regions and Provinces has smoothed out the impact of particularly faster connections across locations.

The positive yet low impact of transportation and educational infrastructure could be explained by pointing out one of this model's limits: that is, we are considering entrepreneurial ferment as a comprehensive and general output, not differentiating between different sectors of businesses – both for the lack of available data, and for

the scope of this paper. However, it would indeed be extremely interesting to zoom in on the different business sector making up for the Entrepreneurial Ferment Index: we could probably hypothesize that transportation infrastructure will affect in a more relevant way retail and commerce-related enterprises, whereas it would be less impactful on the activity of services-related firms. On the other hand, we could predict that the educational variable would be more impactful for those firms operating in sectors where higher levels of technical skills and competence are required, like software or finance just to cite two.

Figure 34 – *Model visualization*



The meaningful impact of institutional infrastructure stresses out once more, as we previously considered in Chapters 1 and 2, the relevance of governance and how an efficient and clear institutional structure can help leading to thriving entrepreneurial ecosystems and successful business activity.

In order to have a further insight on the distribution of entrepreneurial activity levels and infrastructure endowment, we provide four last scatterplots which show the same data provided in Figures 27 to 30 but with details concerning geographical location (Northern, Central or Southern Italy) and the number of residents.

Green dots refer to Northern Provinces; pink dots to Central Provinces; and blue dots to Southern Provinces. The size of the dots reflects the number of inhabitants as of 2019.

Figure 35 – *Transportation infrastructure vs entrepreneurial ferment – detail:*

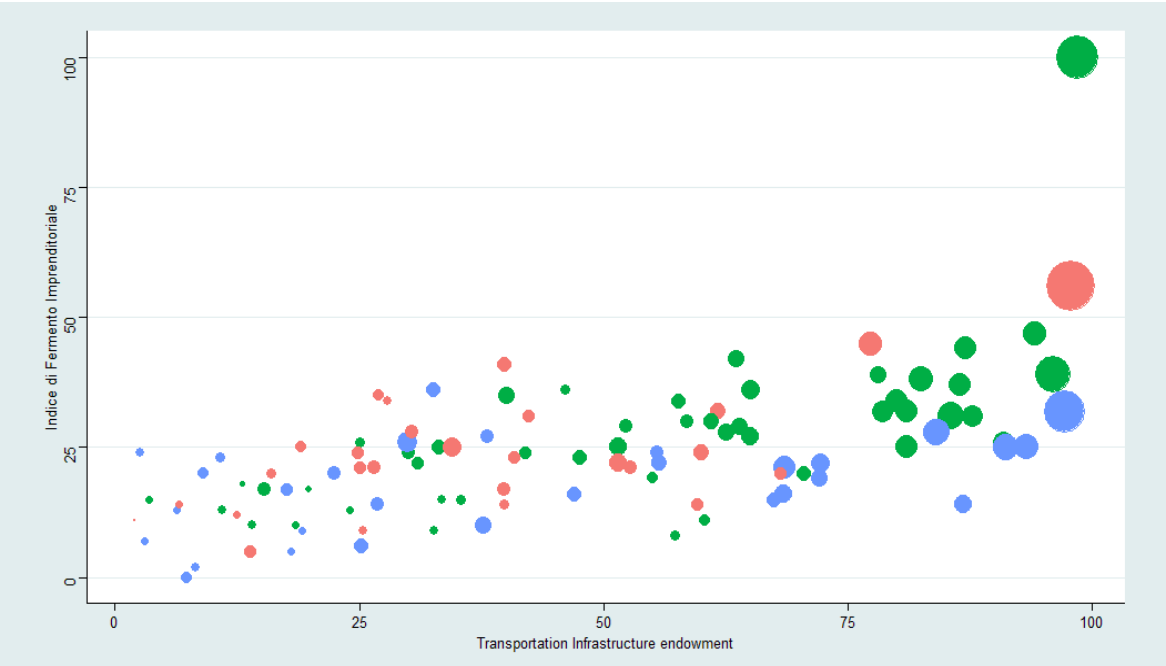


Figure 36 – *Digital infrastructure vs entrepreneurial ferment – detail:*

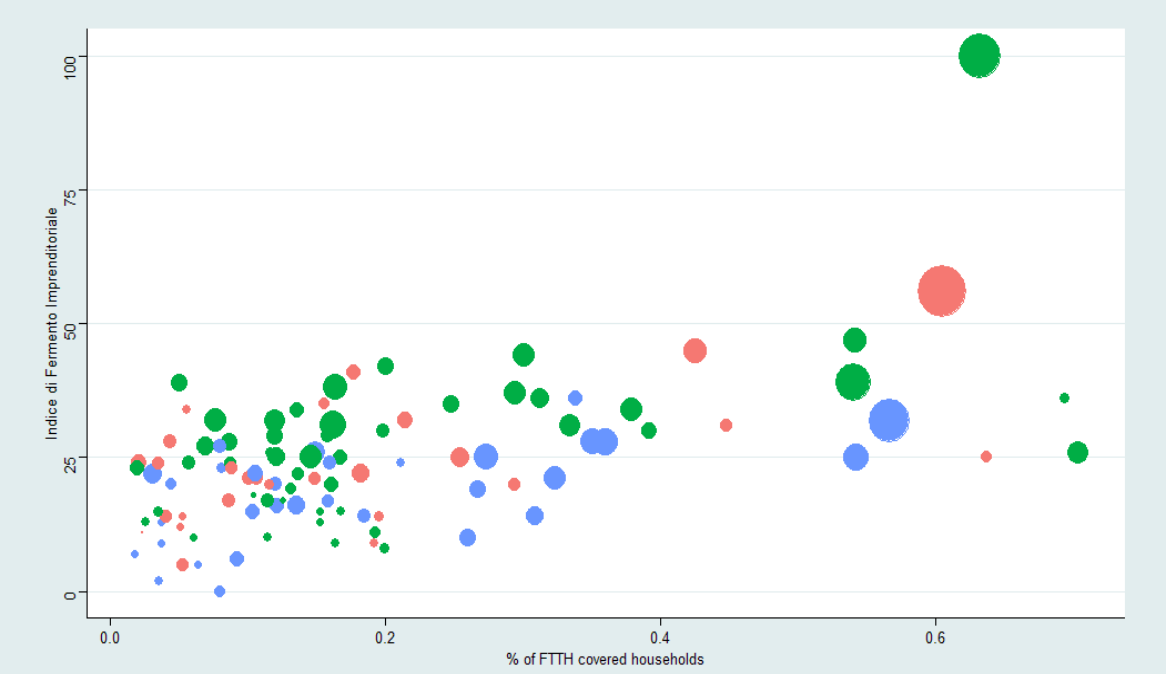


Figure 37 – *Institutional infrastructure vs entrepreneurial ferment – detail:*

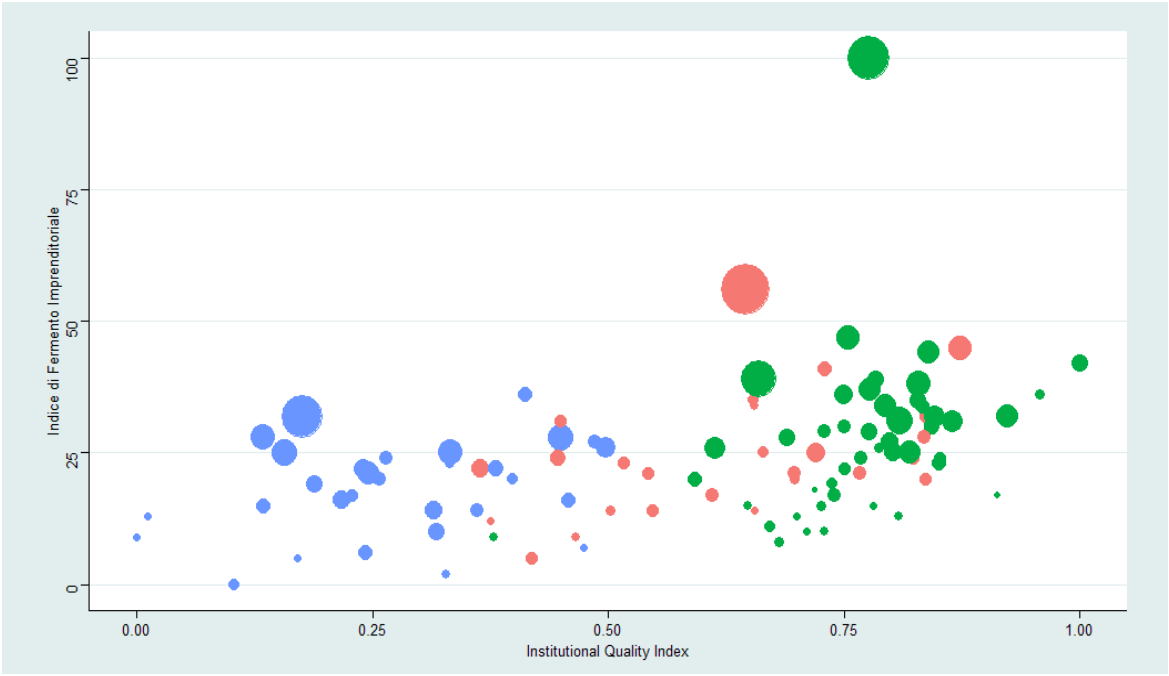
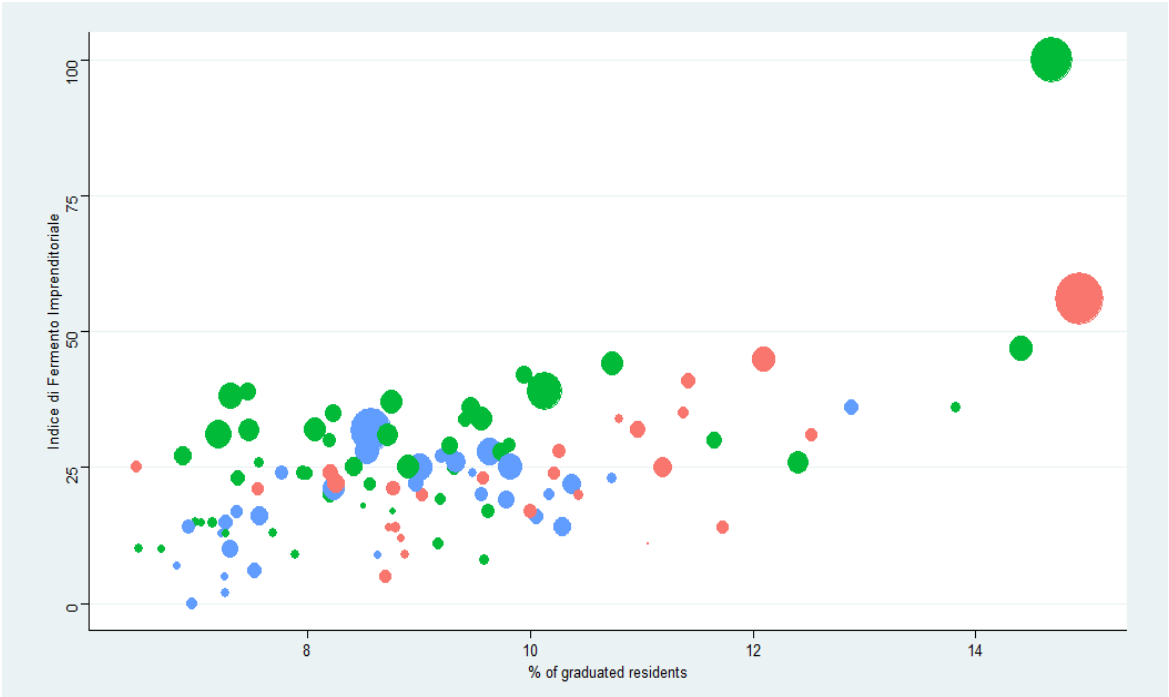


Figure 38 – *Educational infrastructure vs entrepreneurial ferment – detail:*



We notice that in terms of entrepreneurial ferment, Provinces exhibiting higher levels of entrepreneurial activity seem to belong to Northern and Central Italian Regions (Milan evidently distances itself from the following Provinces, scoring a perfect 100-points IFI and followed by 56-points Rome, 47-points Bologna, 45-points Firenze and 44-points Padova). In the top-20 Provinces exhibiting the higher IFI scores, there is only one Southern representative (Cagliari at 36 points). Six of these count less than 500.000 residents.

The transportation infrastructure scatterplot quite evidently shows how more populated Provinces benefit from higher endowments of transportation infrastructure, while Provinces with fewer inhabitants tend to lie in the lower-left side of the plot. Most of the central Provinces lie in the left side of the plot, while most of the densely-populated Northern Provinces all gather in the right-side.

As far as the % of FTTH-covered households is concerned, the difference between Northern, Central and Southern Provinces is way more smoothed, while a gap between more and less populated areas is observably present.

By looking at the IQI visualization plot, we can see that there is a decisive difference between Southern, Central and Northern Provinces: the Southern ones seem to group in the low-left section of the scatterplot, Central Provinces gather around the central area with outliers in the higher and in the lower part, and Northern Provinces in the high-right section of the plot, with the exception of Imperia. The top-20 Provinces exhibiting the higher IQIs account for 15 Northern Provinces and 5 Central Provinces – here, population does not seem to a be a relevant aspect. In fact, the first five Provinces all count less than 1 million inhabitants and the first one, Trento – which scores a perfect 1 – counts only 540.000.

Finally, with respect to the educational variable, it seems that the Northern-Southern gap also plays a role, with many Central and Northern Provinces – even smaller ones – surpassing Southern ones in terms of percentage of graduated residents.

Although it would be indeed very complex to account for all the differences and particular aspects that characterize our country's Provinces, we can note that the infrastructural gap between Northern and Southern regions of Italy is still present – in particular with respect to institutional infrastructure a.k.a. governance and regulatory aspects and to levels of education. Transportation and digital infrastructure seem to present less differences across North and South, but more with respect to densely populated vs non-densily populated Provinces.

It is important to clarify, however, that this model is not (and does not aim at) capturing the whole phenomenon of entrepreneurial ferment: other influences and variables definitely take part into influencing local entrepreneurial activity. As we previously stated, there is a relevant flow of academic literature suggesting that

personal features like self-confidence and risk-taking propensity play a crucial role in influencing entrepreneurship. The role of unemployment levels would also be an interesting aspect to consider, since some studies do suggest that areas showing higher degrees of unemployment are more eager to show higher levels of entrepreneurial activity: the high rate of unemployment and unfavorable job prospects could force individuals to attempt to engage in self-employment. As a consequence, the high rate of unemployment encourages more people to become entrepreneurs (see Evans and Leighton, 1990; Hamilton, 1989; Reynolds, Miller & Maki, 1995).

While the factors explaining and influencing entrepreneurship probably come from both individual characteristics and context dynamics, we cannot ignore the fact that those Provinces being rated with higher institutional quality do perform better in terms of entrepreneurial vivacity and growth, therefore functioning as innovation engines for their local economy. Aspects such as citizens' participation in public life, cultural liveliness, administrative capability at provincial and regional level, environment, waste management and health policies, safety from crimes against persons and property, efficient legal justice, low tax evasion levels and corruption levels are relevant in determining where to locate a new venture and conduct a business, and may be even more important in its growth and success, by supporting both entrepreneurs and their stakeholders.

IV. Infrastructure resilience for global development

« In the midst of chaos, there is also opportunity ».

Sun Tzu, *The Art of War*

4.1 The current global challenges for infrastructure investment

4.1.1. Covid-19 pandemic: impact and countries' recovery measures

A discussion on the role of infrastructure investment in economic growth and entrepreneurial activity could not overlook the profound impact that the pandemic had on global economy.

Many years from now we will probably remember 2020 as the year the world faced COVID-19 – a health crisis that, by type and magnitude, had not been experienced for decades. The impact on human health has been devastating, presenting immediate challenges to countries' healthcare systems and calling for rapid response to contain the spread of the virus while searching for a vaccine and treatment. It is painful to reflect on the millions of lives lost, the suffering and grief, and the myriad disruptions to lives and livelihoods. Now, in what we all hope to be the ultimate recovery from such a difficult time, the challenges the world is facing are many and call for important resolutions.

Covid-19 has so far highlighted the weaknesses of our health systems and societies more generally: it has been a reminder of our fragility and of how some risks are difficult to prevent or control. It has shown once again the profound differences and gaps existing not only from country to country, but also within countries from regions to region. It has brought focus on social or "soft" infrastructure, which is sometimes overshadowed by hard infrastructure like energy and transportation: these infrastructures that sustain the economic, health, education, cultural and social standards of a population and that are vital elements of modern societies.

With respect to past crises, the COVID-19 pandemic presented unique aspects. In order to contain the contagion and protect populations, in the first half of 2020 most countries around the world imposed stringent national measures, closing schools and business activities and sometimes preventing people from leaving their homes, except for essential reasons: as a consequence, economic activity contracted dramatically. No country was spared, with GDP declining sharply in advanced, emerging, and

developing economies. In previous declines, service-oriented businesses have tended to suffer smaller growth declines than manufacturing: in the COVID-19 case, service sectors reliant on social interaction and mobility (e.g. travel, hospitality, entertainment, and tourism) have seen much larger contractions than manufacturing.

According to the International Monetary Fund, lockdowns and social distancing measures were an important factor in causing the recession; however, they were also crucial in substantially reducing infections.

Figure 39 – *An empty San Marco Square in Venice during the first lockdown in April 2020*

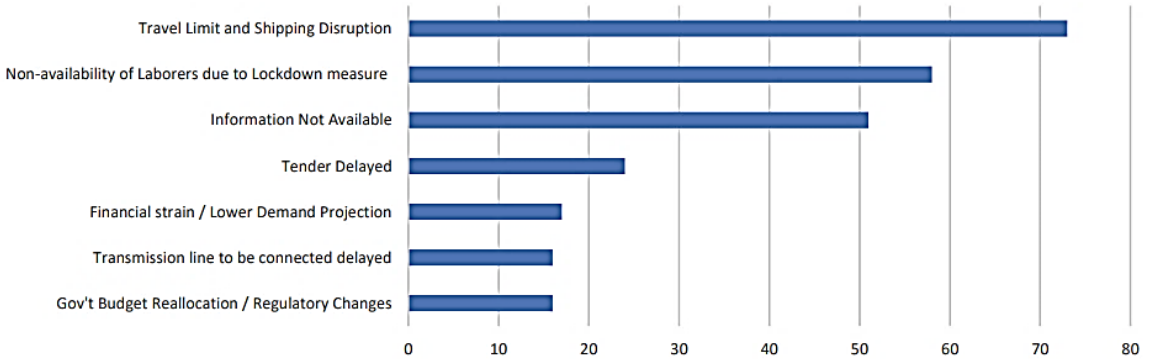
Source: Getty Images, 2020

From the very beginning of the virus spread, severe disruptions occurred in almost all infrastructure sectors, affecting different levels of supply chains, the availability of workers, causing demand and investment shocks, delays and cancellations. Even after the restrictions on movement across countries and regions have gradually been lifted, the uncertainty linked to new possible disruptions in the event of changes to policies for containment and travel has had a tremendous impact on infrastructure investment.

Workplace closures disrupted supply chains and lowered productivity. Layoffs, income declines, fear of contagion, and increased uncertainty caused consumption to

shrink, triggering further business closures and job losses. Domestic disruptions quickly spilled over to trading partners through trade and global value chains, adding to the overall macroeconomic effects.

Figure 40 – *Reasons reported for delays and cancellations of infrastructure projects (year 2020)*



Source: World Bank, Operational disruptions due to Covid-19

As is happens during severe crises, the initial shocks amplified through several channels: as a consequence of uncertainty, financial markets sharply repriced. Rushes to liquidity and to safe assets increased borrowing costs, while credit became more scarce worldwide, aggravating financial constraints. The rising unemployment increased the risk of widespread defaults. Meanwhile, commodity prices fell sharply first in China, then worldwide as a consequence of reduced travel and undermined global industrial activity. The price impact has varied significantly across commodities: flight to safety, for instance, supported gold prices. The outbreak reduced demand for some agricultural raw materials and animal feed; price support was, however, provided by cereals (such as wheat) following consumer stockpiling in areas affected by travel restrictions. A sharp reduction in road traffic led to an unprecedented decline in oil demand: oil prices collapsed in March 2020 as the OPEC+ coalition broke down, unable to reach agreement on how to react to the weak oil demand outlook - between January and March 2020, crude oil prices dropped by about 65% and natural gas prices by 38% (IMF World Economic Outlook, October 2020).

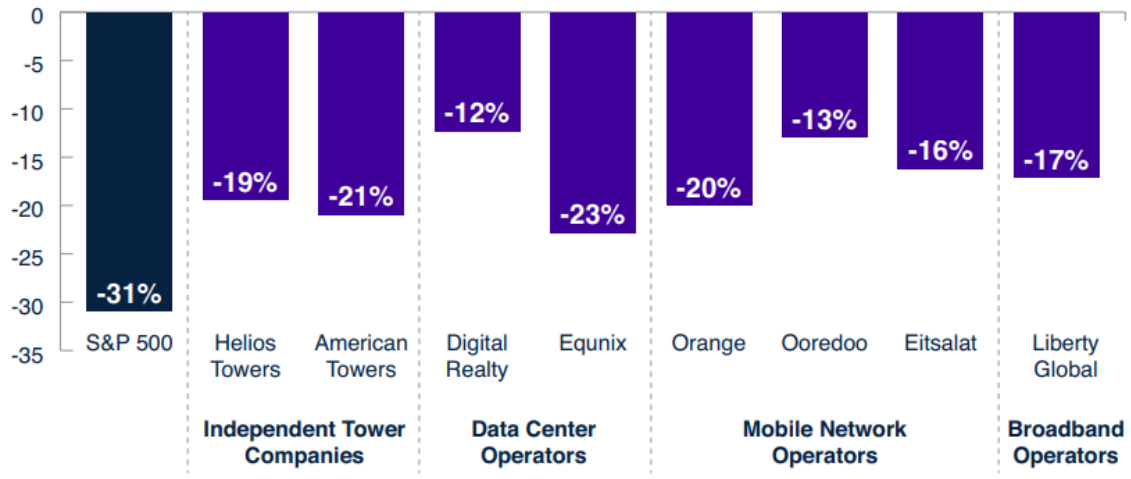
Meanwhile, a first, rapid reaction to the crisis was exhibited in a number of countries, including setting up temporary hospitals to handle the inflow of patients, prioritizing healthcare, or even solutions where care and information were administered remotely. Education services demonstrated remarkable flexibility, having rapidly instituted strategies for education continuity in extremely challenging conditions: many creative solutions have been implemented, particularly in the use of technologies for distance learning. Public administration also had to rapidly ensure the

availability of essential services to citizens, therefore expanding the disposal of digital content or transforming previous offline content into digital format. In the private sector, some internet service providers allowed bonus broadband data allowances for customers.

As for the infrastructure outlook, sectors were affected in different measures.

For some, the overall result was not negative. The pandemic has, for instance, demonstrated the critical importance that telecommunications infrastructure plays in keeping businesses, governments, and societies connected and operating. Because of the economic and social disruption, people across the globe relied – and they still do – on technology for information, for social distancing, and working from home. Over the course of the pandemic, reliance on telecommunication infrastructure has increased substantially, with operators experiencing about 60% increase in Internet traffic compared to before the crisis (OECD, 2020).

Figure 41 – *Performance of key global telecom players versus the S&P 500 during the Covid-19 pandemic*



Source: S&P Capital IQ

Many telecom players, from broadband to mobile to data center operator, have therefore benefitted from a surge in the traffic of data and voice. In sharp contrast with the other infrastructure sectors, telecommunication has been generally exempted from major COVID-19-related restrictions. Some telecom companies have been strengthened also after the release of containment measures by the increased use of broadband services, as even after the end of the immediate emergency, smart working and online learning became part of the standard way of living for many people across the globe. Traffic growth has demonstrated increased reliance on connectivity and

digital services. As a result, the telecom sector has remained acyclical relative to the Standard&Poor's 500 throughout the crisis, as shown in Figure 41.

Logistics firms, which are involved in the movement, storage, and flow of goods, have been directly affected by the pandemic. As an essential part of value chains, both within and across international borders, logistics companies enable trade and commerce and assist businesses in getting their products to customers. Supply chain disruptions to the sector directly affected revenues, availability of workforce and investment in the sector. The impact was first felt in China, due to the role it plays in global manufacturing and also being a major consumer of global commodities and agricultural products. Disruptions to manufacturing in China then flowed through global supply chains. Cargo was stockpiled at China's major ports, travel restrictions led to a shortage of truck drivers, and ocean carriers canceled sailings. The resulting shortage of components from China then impacted manufacturing operations overseas. Major industries around the world, including automotive, electronics, pharmaceuticals, medical equipment and supplies, as well as consumer goods, were affected.

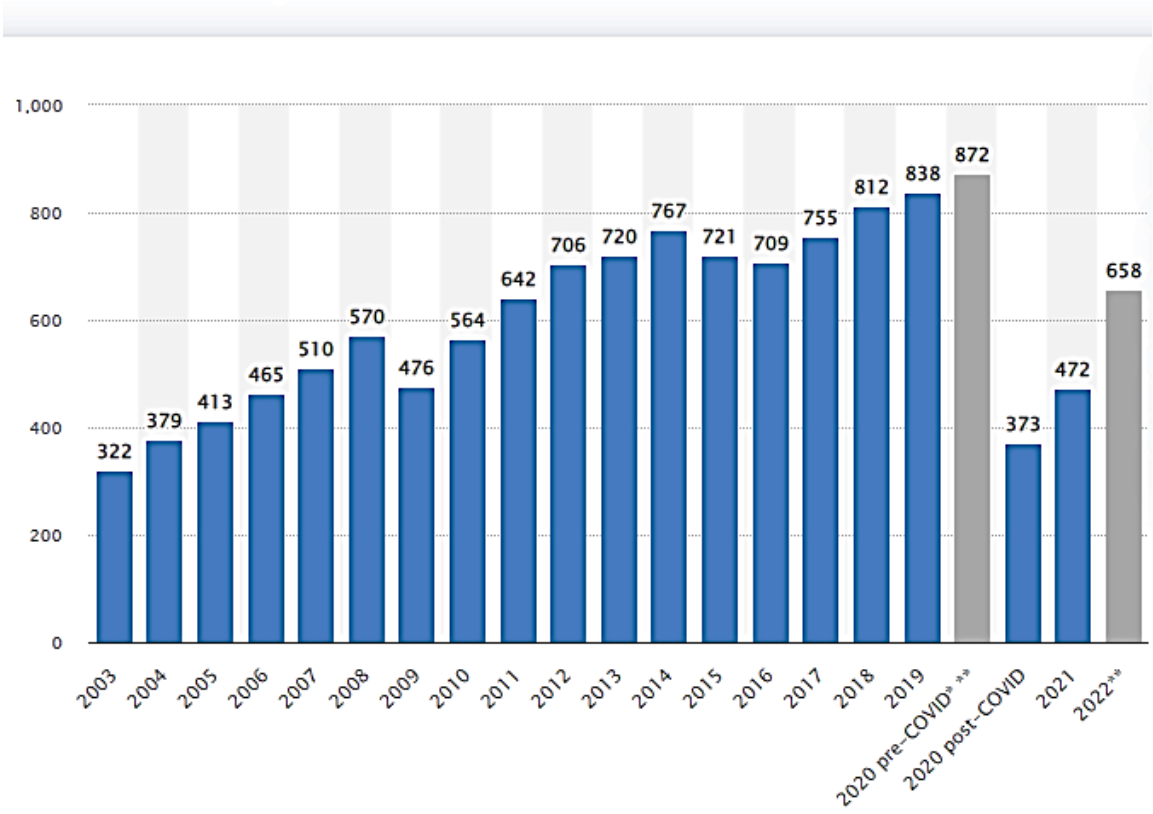
With the pandemic spreading to the rest of the world, more lockdowns and border closures further restricted movements of good and contributed to bottlenecks for freight. For instance, in the European Union, trucks formed 37-mile-long lines on the A4 highway after Poland closed its border with Germany in mid-March 2020. In India, the lockdown created a shortage of drivers, which resulted in over 50,000 containers piling up in major Indian ports.

The energy and power sector is the engine of the global economy, with goods and services fully depending on it. During the emergency, reliable electricity supply was critical for continuous medical services and working remotely, among other aspects of our new, daily lives. Commercial and industrial sectors however reduced their electricity demand, especially during lockdown measures. The International Energy Agency (IEA) estimated that global electricity demand decreased by 2.5% in the first quarter of 2020. At the same time, the Standard & Poor's Global reports show that the slowdown in demand caused an improvement of global air quality, with carbon emissions dropping by 17% in April 2020 compared to a year earlier. Falling industrial production, fewer cars on the road, and less power generation contributed to this. In addition, global power generation from renewables increased by 3% in the first months of 2020.

The aircraft and airline industry was one of the most affected sectors. Air travel and tourism, directly and indirectly, contribute about 10% of global GDP and support 330 million jobs worldwide. COVID-19 has had an immediate, dramatic impact on airport traffic and revenue which still lasts today. The disruption began in Asia-Pacific, but the rapid spread of the virus and the containment measures implemented led to a

22.9% drop in global air traffic in February; 53.1% in March; and 90% in April. The sudden drop in air traffic led to almost complete paralysis of both aeronautical and non-aeronautical revenues. As airlines cut capacity, the revenues airports receive from airlines, such as landing charges security charges, dropped. As people stopped flying, non-aeronautical revenue coming from airports' parking facilities, restaurants, or duty-free, also fell dramatically. According to Airport Councils International, total airport revenues fell by 35% worldwide in the first quarter of 2020 (equivalent to a $14 billion loss) and by 90% in the second quarter (equivalent to a $39 billion loss).

Figure 42 – *Revenues of commercial airlines worldwide, 2003-2022 (in billion US$)*



Source: Statista, 2022

Over the course of 2020, economies slowly began to reopen, although many firms remained cautious in responding to this revival, with industrial production in many countries still well below the pre-Covid levels. Global trade began recovering, with China being an important contributor: its exports quickly recovered from deep declines, supported by an earlier restart of activity and a strong pickup in external demand for medical equipment. In August 2020, the city of Wuhan, from where the COVID-19 Virus originally spread around the world, seemed to be officially out of the tunnel, with every type of social restriction levied – suggesting a possible end of the pandemic emergency.

However, as we know, the end of the crisis was far from over. The fall and winter of 2020 saw another tremendous wave of infections all over the world, with many countries re-enacting the same measures first introduced over the spring – lockdowns, online learning, smart working, restrictive measures for entertainment, tourism and hospitality businesses – again causing negative impacts on the possibilities of recovery.

Starting from December 2020, the first vaccines began to be administered, with a global vaccination campaign that saw a titanic effort put in place by countries at an unprecedented pace to ensure the vaccination of the most vulnerable people first, followed by the rest of the population. In September 2021, the European Union became global leader as for number of vaccinated citizens, reaching 70% of adult population.

As of June 2022, 66.3% of the world population has received at least one dose of a COVID-19 vaccine: 11.93 billion doses have been administered globally and 5.24 million are administered on average every day. However, only 17.8% of people in low-income countries have received at least one dose.

The pandemic and its consequences have triggered what can be defined as the deepest economic recession in nearly a century: though not concluded, it has so far produced many painful consequences, such as more than 6 million dead and 500 million infected people. From 2019 to 2020, due to the direct effects of the pandemic and subsequent confinement measures, the drop in real global median GDP was equal to 3.9% - the worst economic downturn since the Great Depression. The impact on employment has been ten times greater than during the global financial crisis of 2008-2009 (OECD, 2020). Public debt-to-GDP ratios rose by 20% points in 2020 compared with 2019 on average in the G20 advanced economies, reaching about 130 per cent, the highest level since World War Two (IMF, 2020a).

Massive policy support has, however, prevented worse outcomes. Discretionary revenue and spending measures announced in advanced economies amount to more than 9% of GDP, with another 11% in various forms of liquidity support, including equity injections, asset purchases, loans, and credit guarantees. In emerging and developing economies the response was smaller but still significant: about 3.5% of GDP in discretionary budget measures and more than 2% in liquidity support (IMF, 2021).

Already soon after the outbreak of the pandemic, governments in advanced economies implemented a massive fiscal response, with the goal of supporting the health sector while ensuring viability for households and enterprises. China and Italy were among the first nations to temporarily waive tax, social security, mortgage and rental payments for the most-affected areas and sectors. Japan announced cash handouts to affected households and firms, and delay of payment of tax and social security premiums. Canada implemented cash transfers and wage subsidies, while deferring federal tax and student loan payments. Germany and Spain introduced temporary interest-free tax suspensions, postponed enforcement of some debt

contracts, and implemented targeted cash transfers for the self-employed and SMEs. India announced new in-kind and cash transfers to poor households; Botswana and South Africa implemented tax relief measures and announced targeted support to households through cash transfers or wage subsidies; and many more.

In order to assist small and medium-sized enterprises, which were deeply affected by production shutdowns, Italy extended tax deadlines; Indonesia provided tax cuts to the tourism sector; Russia introduced tax deferrals (excluding value-added taxes) for companies negatively affected by COVID-19; Spain expanded eligibility for unemployment benefits and exempted firms that maintain employment from social contributions – the same was done by Japan and Korea.

Also central banks in advanced and emerging market economies have responded aggressively to the sudden stop in real activity and the rapidly tightening financial conditions. Beyond conventional interest rate cuts, several have significantly expanded asset purchase programs: for instance, the European Central Bank's €750 billion Pandemic Emergency Purchase Program to buy private and public securities.

Beyond their objective and immediate impact, these policy actions had the crucial effect of supporting sentiment: two later-on prominent examples are the €2 trillion European Union pandemic recovery package–fund – which we will discuss further section 4.2 – and the $1 trillion economic stimulus package signed by then US President Trump in March 2020. In 2021, President Joe Biden's administration has advocated a large investment plan worth about $2 trillion, with the aim of building modern infrastructure. A substantial share of the NextGenerationEU program, which we will discuss in the next section, will be targeted to resilient infrastructure investment. Such aggressive policy countermeasures are fundamental not only to provide immediate help and relief to the economy, but also to inject trust and optimism across the population, stimulate demand and investments, and prevent further amplifications of the shocks through the financial systems.

As of January 2022, most of the international institutions' predictions were projecting the global recovery to strengthen from the second quarter of 2022, after a short-lived impact caused by the spread of the Omicron variant. However, a new crisis erupted abruptly in February, causing global economic prospect to worsen significantly.

4.1.2. The Russian-Ukraine war and its projected consequences

In February 2022, Russia launched a full-scale military invasion into Ukraine, starting what soon became clear to be a planned operation of armed assault. Since then, according to the UN Rights Office, more than 4.000 people have lost their lives, and more than six million people have been internally displaced, whereas five million Ukrainians fled to neighboring countries. Since the beginning of the invasion, half of Ukrainians have lost their jobs and only 2% were able to find temporary earnings (World Economic Forum, 2022).

This tragic humanitarian crisis occurred at a time where the global economy was still recovering from the pandemic. And besides the immediate civil emergency, the war is projected to severely set back the global recovery, slow down growth, and increase inflation: with respect to the 5.7% growth that occurred in 2021, estimates of the World Bank and the International Monetary Fund project a rise of less than 3% for 2022.

In the aftermath of the invasion, the international community as a whole has strongly condemned Russian actions. As the conflict unfolded, many governments and international organizations, primarily led by the US and the EU example, imposed strong and wide-ranging sanctions on Russian banks, businesses, bank transfers, exports and imports, and private citizens.

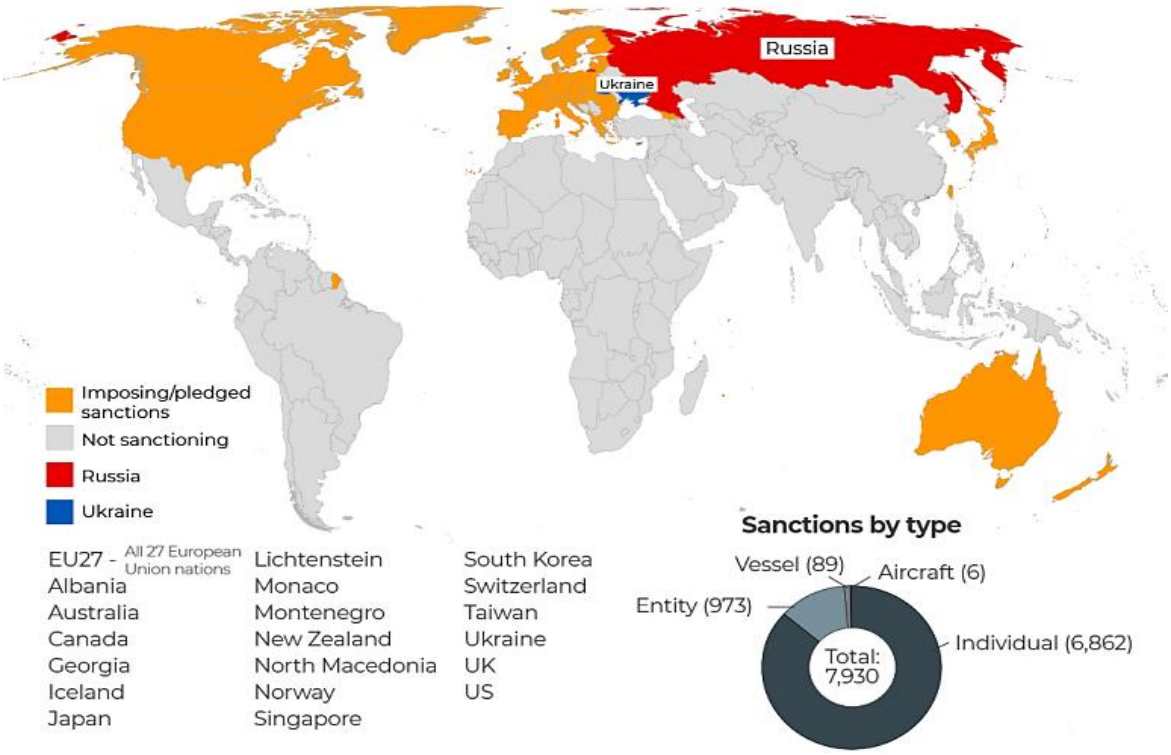
While Western countries had already imposed limited sanctions on Russia following the Russian invasion of Crimea in 2014, the amount and scope of the sanctions imposed on Russia after February 2022 is extraordinary both in terms of international scope and of economic damage intended: as of June 2022, Russia is the world's most sanctioned country, being subjected to more than 7.000 different targeted sanctions (more than Iran, Venezuela, Myanmar and Cuba combined). In a statement for BBC News, economic editors Faisal Islam stated that such measures have been far from normal sanctions and were "better seen as a form of economic war" (BBC News, 2022): the intent is allegedly to push Russia into a deep recession, with the likelihood of bank runs and hyperinflation.

Russia's central bank assets have been frozen to stop it using its $ 630 billion of foreign currency reserves: as a consequence, the value of the Rouble fell 22% in value, pushing up the price of imported goods and leading Russia's inflation rate to rise to 14%. The Rouble has since then recovered, mainly due to measures put in place by the Russian government to prop it up, but inflation has risen above 17%.

The United States has banned Russia from making debt payments using the $600m it holds in US banks, making it harder for Russia to pay off its international loans. Major Russian banks have also been removed from the international financial messaging system SWIFT, a measure which delays payments to Russia for energy exports. The US, the EU and many other countries have also been sanctioning private Russian individuals, mainly wealthy business leaders or oligarchs and government officials, by freezing foreign bank accounts and confiscating private properties abroad. All Russian airlines and Russian-registered private jets have been banned from a total of 52 countries around the world. A ban on the export of dual-use goods - items with both a civilian and military purpose, such as vehicle parts – has been imposed by several nations.

Furthermore, more than 1.000 private companies around the world have either suspended trading in Russia or withdrawn, including Coca-Cola, Starbucks, Marks & Spencer, McDonalds, General Motors, Nokia, Apple, BMW, Harley-Davidson, Jaguar Land Rover, Spotify, American Express, Volkswagen, Nike, Ikea, Microsoft, Netflix, Ferrari, Nestlè, Novartis, Johnson&Johnson, Autogrill, Marriot… and the list goes on.

Figure 43 – *46 countries around the world have imposed sanctions on Russia or pledged to adopt a combination of US and EU sanctions*



Source: Al Jazeera, 2022

The EU was at the frontline of the sanction-imposing operations, progressively enacting more and more restrictive measures against Russia from the start of the invasion. Restrictions on economic cooperation (no new lending by the European Investment Bank and the European Bank for Reconstruction and Development), diplomatic measures (suspended summits, no invitation to G8 meetings, no VISA for Russian diplomats and business people), media (suspension of broadcasting activities of Russian state-owned outlets), business (import and export bans, tourism ban), individual measures (ban from travelling to the EU, frozen assets).

As a response, Russia has banned exports of more than 200 products until the end of 2022, including telecoms, medical, vehicle, agricultural, electrical equipment and timber. In addition, it is blocking interest payments to foreign investors who hold government bonds, and banning Russian enterprises from paying foreign shareholders. It also stopped foreign investors who hold billions of dollars worth of Russian stocks and bonds from selling them.

This war presents some new aspects which must be taken into consideration in the global security and economic architecture: a grave humanitarian crisis with millions of refugees; economic hardships; risks of disinformation and propaganda campaigns; geopolitical tensions about energy supply; threats of nuclear attacks; a parallel war which is being fought through cyber attacks.

As the hostilities do not seem to be ending soon, the economic effects of the war have been spreading far and wide, like seismic waves emanating from the epicenter of an earthquake. Because Russia is a major supplier of oil, gas and metals – and together with Ukraine, of corn and wheat, the decline in the supply of such crucial commodities has driven their prices up sharply, with Europe, Central Asia, Middle East and North Africa being most affected. War-related supply shortages have already caused strong increases in the price of energy, metals and food.

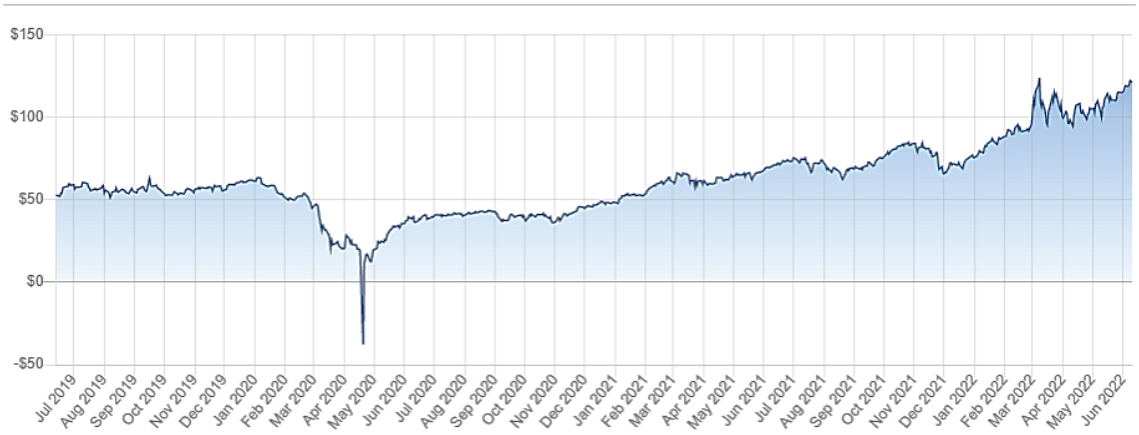
For Ukraine, the war is having a devastating economic impact. The Kyiv School of Economics claimed that the total amount of direct infrastructure damage inflicted to the country has reached $ 92 billion since Russian President Vladimir Putin ordered the invasion – costs related to bomb damage on buildings, roads, factories and businesses. According to the same estimates, the overall economic cost of the war for Ukraine could rise to $ 600 billion – almost four times the value of the country's GDP.

For the rest of the world, the consequences of the conflict are already tangible and could have far reaching effects. Due to the globalized network that features the global economy, the challenges this conflict poses affect each country directly. Ukraine grows enough food to feed 400 million people worldwide every year, providing to 50% of the world's sunflower oil supply, 10% of the total grain supply and 13% of the global corn supply. With up to 30% of crop areas in the country that will not be planted or harvested in 2022, and the disruption of supply chains as a consequence of the closure

of the Black Sea ports and limited capacity of transportation through the Western border, the risk of a global food crisis is tangible (World Economic Forum, 2022).

Consequences on energy prices are also well visible: to contrast the shortage of oil and gas and the resulting sharp increase in prices which is damaging both consumers and businesses, countries are working on contingency plans and in some cases accelerating the shift to green energy – a challenge that, however, will take time to be implemented.

Figure 44 – *Crude oil price per barrel in $US dollars, July 2019-June 2022*



Source: Nasdaq

In the EU case, Russia supplies about 40% of total natural gas, and 27% of imported oil: in return, the EU sends roughly about € 400 billion every year. In March 2022, the REPower EU strategy was first announced, with the stated goal of reducing Russian gas imports by two thirds over the course of the year: the plan is estimated to cost € 210 billion over the next five years. The plan also includes strategies to speed up the transition from fossil fuel burning boilers to electric heat pumps, therefore shifting towards a greener infrastructure for energy. Because new wind and solar plants will still take time, the EU short-term diversification energy plan includes investments up to € 12 billion in pipelines and Liquified Natural Gas terminals to improve access to gas and oil from other countries including Egypt, Israel and Nigeria. At the same time, the European Union has highlighted how energy savings will be cheapest and safest way to reduce dependence on Russian oil. It is plausible that the conflict could accelerate the shift of many countries towards renewables, which will be considered a component of energy security as well as of political stability. It is also likely that a rapid development of technology for green transition will accelerate the process.

4.2 Policies of infrastructure resilience for development

4.2.1. The NextGenerationEU program

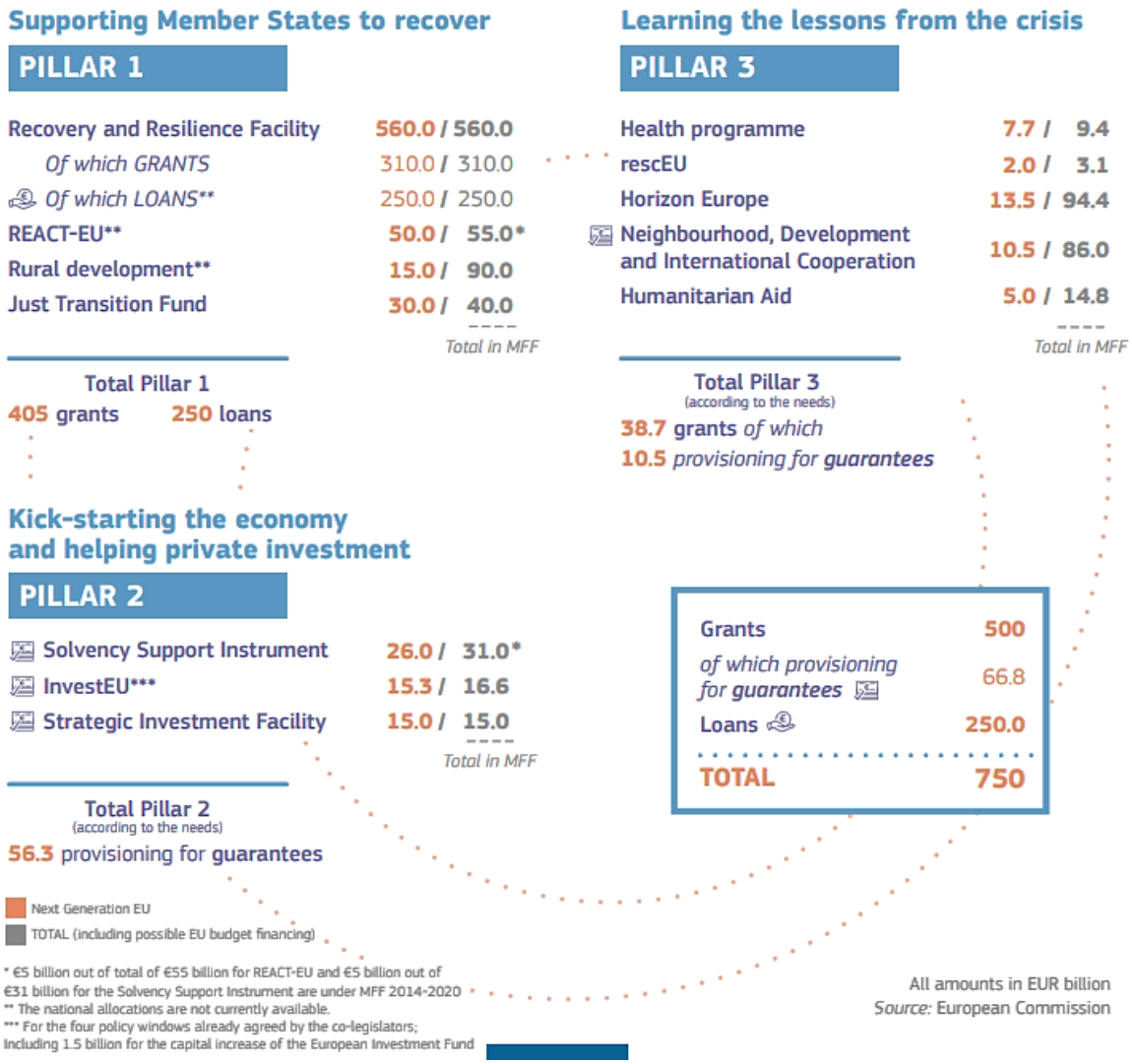
In 2020, the European Union provided an unprecedented response to the health crisis that hit the world. At its heart was a stimulus package worth € 2.018 trillion, consisting of the EU's long-term budget for 2021 to 2027 of €1.211 topped up by €806.9 billion through NextGenerationEU, a temporary instrument to power the recovery. Taken together, the funds aimed at repairing the economic and social damage caused by the pandemic and drive the transition towards a modern, sustainable, and resilient Europe. The program was founded by borrowing on the capital markets, with the European Commission applying a diversified funding strategy which combined the use of different funding instruments and funding techniques, including medium and long-term bonds and a combination of auctions and syndications.

In order to access the Recovery and Resiliency Facility funds, EU countries had to submit their own Recovery and Resilience Plan to the European Commission, which then checked the alignment with EU priorities and the country's specific recommendations. As a general rule, each country had to allocate a minimum of 37% to climate investments and reforms, and a minimum of 20% to digital transition.

The NextGenerationEU program is divided into three main pillars (Figure 48).

The first pillar, called *Supporting Member States*, represents the most substantial part of the initiative as it provides for the distribution of €655 billion to EU member states (about 87% of the total) by the end of 2024. Part of this amount is to be allocated in the form of transfers not to be repaid, which will be added to the transfer items traditionally included in the EU long-term budget; the remaining part will take the form of long-term loans at very low interest rates because as they will be guaranteed by the long-term budget itself.

Figure 45 – *The pillars of NextGenerationEU*



Source: European Commission

The most significant section of the first pillar is represented by the *Recovery and Resilience Facility* (RRF), which is awarded with resources of € 672.5 billion, corresponding to about 75% of the entire NG-EU initiative. The destination of these funds, which will take the form of both transfers (about 56%) and loans (for the remaining 44%), will be broad-based. The RRF's goal is in fact to protect employment, to improve education and the training of workers, to support research and innovation, to reinforce the healthcare system, to increase the efficiency of public administration and the social and economic environment. However, it is mainly meant to accompany the recovery phase of the Member States by supporting those investments and reforms at the basis of the national Recovery and Resilience Plans (NRRPs).

In its proposal, the European Commission emphasized that this investment support aims to build a solid connection between the economic recovery of the EU

states and the purposes of innovation in the digital field and of implementation of the Green Deal, with the progressive reduction of emissions. The RRF is therefore strictly connected to the original goals set out before the pandemic. In this sense, it is a fundamental instrument for the implementation of sustainable and long-term EU development.

The second section of *Supporting Member States*, the *React-EU* (REU), also seeks to support green investments and digital innovations with funding accounting for about €50 billion. This instrument is primarily intended for the states and sectors most affected by the pandemic: it therefore assigns a large part of the resources available to small and medium-sized companies and their employees, as well as to activities relating to tourism and culture. Finally, the first pillar of NextGenerationEU is completed by additional funds (worth approximately €45 billion) for the reforms needed to transition from the recovery phase.

The second pillar, called *Kick-starting the economy and helping private investment* has an allocation of just about €56 billion and is devoted to the reinforcement of that Invest-EU program which should ensure the maintenance of the Juncker Plan, and to a new tool of recapitalization of businesses located in the states most affected by the pandemic (the *Solvency Support Instrument*). The limited financial commitment of the second pillar should be able to activate, directly or indirectly, much greater financing and guarantees in favor of European firms.

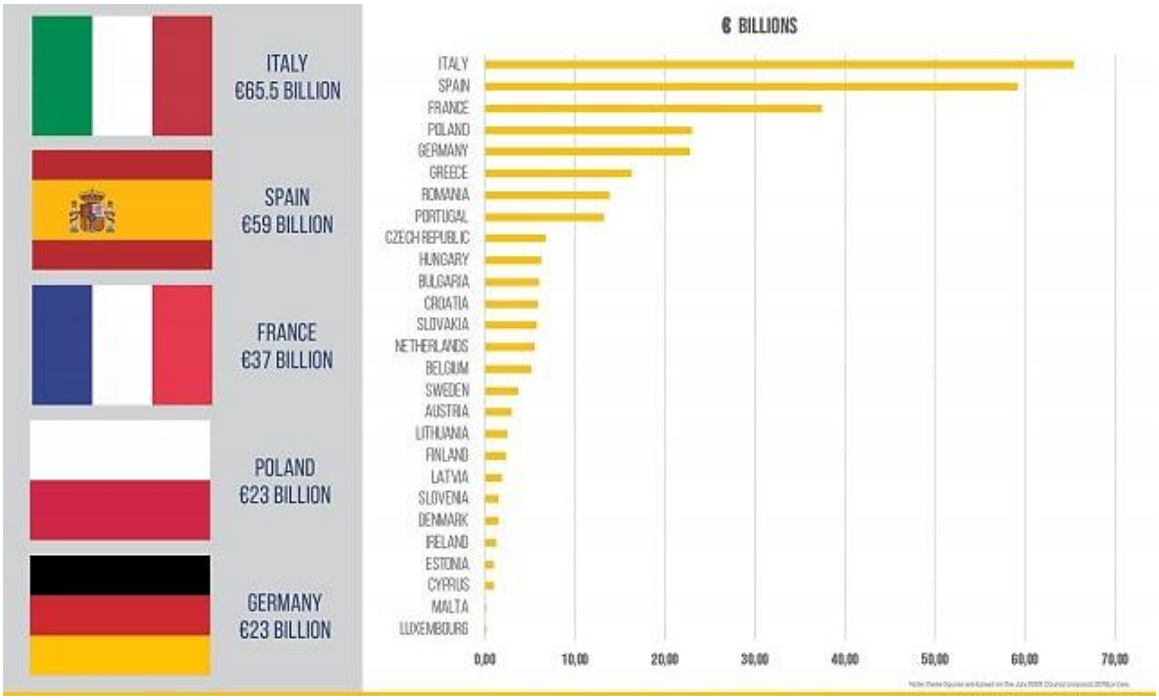
The third pillar *Learning the lessons from the crisis*, which has an allocation of just under €39 billion, aims at financing European "public goods" that arose as a priority during the crisis; in particular, it would have to launch a new health program at the European level. Moreover, this pillar defenses relations between the EU and Europe's economic partners in the new international scenery. Finally, this same pillar will have to support and strengthen funding for research projects (*'Horizon'*).

As it is now widely recognized, the pandemic was a typical symmetric exogenous shock that generated asymmetrical outcomes on EU states due to their various industrial structures being founded on sectors differently exposed, as well as due to their previous structural imbalances. Without ad hoc corrections, the post-pandemic phase would therefore be characterized by the strengthening of the divergences between EU countries: without a substantial intervention aimed at supporting the countries most affected, the risk would be to move from the Great Recession to a Great Fragmentation. Being allocated in proportion to the fragilities of the individual member states and to the impact of the pandemic, NG-EU resources are a potential tool for correcting the divergencies.

The redistributive effect is especially significant in the case of Italy. At the end of 2019, Italy's GDP was about 11.3% of EU GDP; and, in the 2014-2020 period, Italian contributions to the EU budget amounted to approximately 13.7% of the total of

national contributions. Conversely, Italy obtained from the NextGenerationEU €191.5 billion – an unprecedented level of investment. As it is clearly visible from Figure 46, our country is the one that could potentially benefit the most from the European program.

Figure 46 – *EU Recovery and Resilience Facility: maximum grant envelopes*



Source: Schuman Associates, 2021

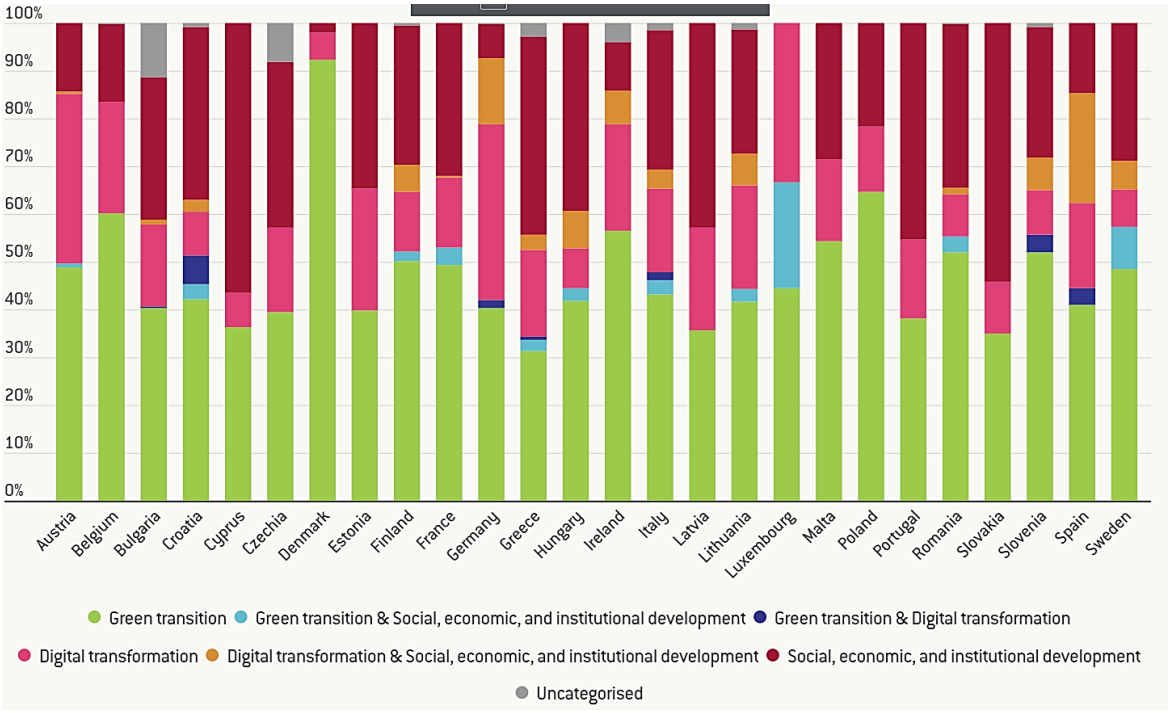
The RRF entered into force on February 19th 2021. Among the first countries to submit their national recovery and resilience plans were Portugal, Greece, Germany, Slovakia, France and Luxembourg. Italy submitted its plan on May 1st 2021. After the first disbursement of €24.9 billion in pre-financing, on April 13th 2022 Italy received other €21 billion as first payment.

As of June 2022, the number of submitted national plans stands at 22. To compare them is a challenging task, since they present data in very different structures. A first glance at the overall resource allocation shows that countries which received relatively smaller amounts from the RRF as a share of their GDP presented plans that concentrated more on green and digital spending (e.g. Germany, Luxembourg and Denmark), while countries that received larger amounts presented more diverse plans with higher 'other' (non-green and non-digital) shares of spending.

On March 1st, 2022, the European Commission has adopted its first annual report on the implementation of the Recovery and Resilience Facility. One year on from its introduction, the report takes stock of the progress made in the implementation of the

Facility, from the adoption of the RRF Regulation in February 2021 to the disbursement of the first regular payment in December 2021. The report shows that major headway has been made and confirms that the implementation of the RRF has well started and is in progress.

Figure 47 – *Composition of national recovery plans per sector*



Source: Bruegel, 2021

So far, the amount allocated in national plans totals €445 billion (€291 billion in grants and €154 billion in loans). Following the endorsement of 22 plans by the Council, the Commission swiftly disbursed €56.6 billion in pre-financing payments to the Member States which had requested it. So far, five Member States have submitted their first regular payment requests to the Commission, and more than 30 more requests are expected over the course of 2022 - the first payment request resulted in the disbursement of €10 billion to Spain in December 2021.

In the following section, which concludes this Chapter aimed at placing our considerations on the role of infrastructure in the current global and European conjuncture, we will observe how infrastructure is embodied in the Italian NRRP, both in terms of goals and actual implementation.

4.2.2. The role of infrastructure in the Italian National Recovery and Resilience Plan

Before the pandemic, our country presented quite unsatisfactory levels of economic growth mainly resulting from structural-related causes. The extremely high level of public debt over GDP (134.6% in 2019, 155.6% in 2020) paired with an above-the-average unemployment level (10% in 2019, 9.3% in 2020). Young people's unemployment rate also was well above the EU standard, setting at 29.5% in 2020.

The NRRP does represent an extraordinary instrument to adequately response to our country's long eradicated issues: the amount of liquid resources related to the NextGenerationEU program account for about 4.5% of Italian GDP, distributed across five years. The possibility of boosting public (and private) capital accumulation, foster innovation and strongly stimulate long-term growth. From a preliminary evaluation of the plan impact, the Italian Ministry of Economics and Finance or MEF has estimated that a 0.5% increase in growth rate could result from the improved expense, and 0.3% increase from the implementation of the projected reforms. The same estimations also projected a decrease in the unemployment rate, which is expected to reach 7.5% by 2026: the plan is overall expected to contribute to the creation of 240.000 new jobs.

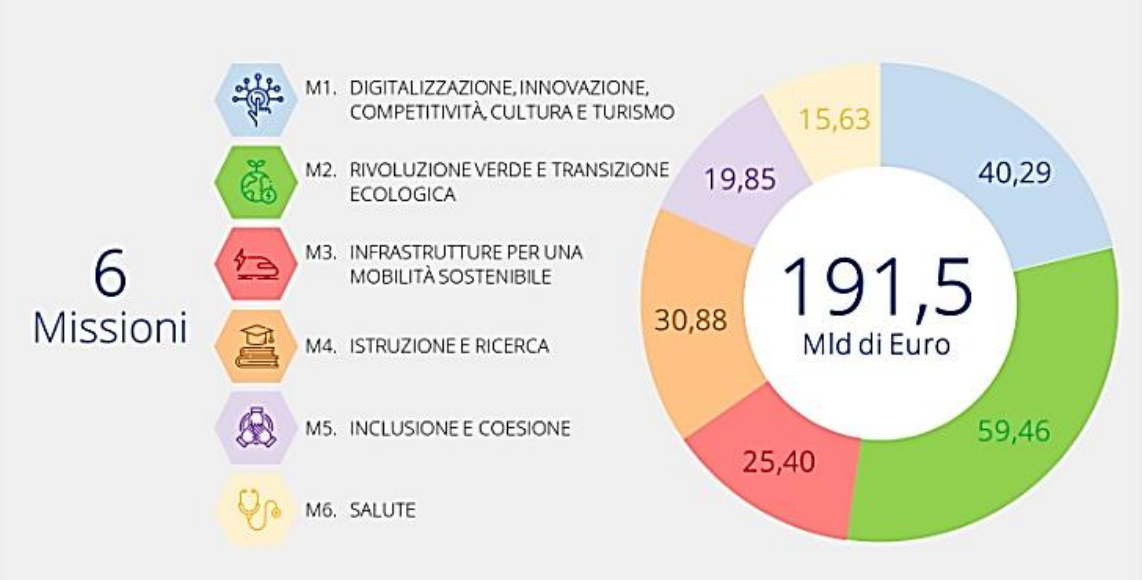
The Italian NRRP or *Piano Nazionale di Ripresa e Resilienza* submitted on April 30th, 2021 consists of 132 different investments and 58 political reforms. Amounting to a total of € 191.5 billion (of which € 68.9 billion in grants and €122.6 billion in loans), the plan is, in absolute terms, the largest one among EU countries: the goal is fostering a strong recovery while preparing the country for the challenges awaiting in the close future - as the Regulation on the Recovery and Resilience Facility foresees, reforms and investments have to be completed by August 2026. In order to respect the regulations imposed by the EU, 37.5% of the plan resources will support climate objectives and 25.1% the digital transition.

On June 22nd 2021, the Commission gave its green light to the plan: on this occasion, EU Commission President von der Leyen symbolically transmitted the Commission's assessment to Italian Prime Minister Draghi in Rome. The plan was in turn adopted by the Council on July 13th 2021, opening the door to its implementation and financing.

The plan was consolidated after months of discussions between the political parties, local administrations, and stakeholders representing the interests of different economic and social sectors. The final configuration of the program is built around

three priorities which are transversal among all forms of interventions: digitalization and innovation, green transition, and social inclusion.

Figure 48 – *Allocation of NRRP resources to the six Missions*



Source: Piano Nazionale di Ripresa e Resilienza, 2021

The NRRP is then structurally divided into sixteen "Components", clustered into six "Missions". Because of the complexity of the whole plan and for the sake of this paper, we will limit ourselves to understand which role is infrastructure investment playing in the implementation of the Italian NRRP – and at what stage the reforms and investments are as of June 2022.

Investments related to infrastructures are mainly present in Mission 3 and 2 of the NRRP: Mission 3 "*Infrastructure for Sustainable Mobility*" (allocated amount: € 25.40 billion) aims at building a modern, digital, sustainable infrastructural network by 2026 and is built around four great goals, common to all type of investments:

- Decarbonization and reduction of dioxide emissions by encouraging the shift of mobility of both passengers and goods from road transportation to railway transportation;
- Increased territorial connectivity and cohesion by reduced transportation times;
- Transportation network digitalization and improvement of bridges, highways and galleries safety;
- Increased competition of the Southern regions by improved railway linkages.

Mission 2 "*Green revolution and ecological transition*" has dedicated the 2nd component mainly to mobility-related factors, called "*Energetic transition and sustainable mobility*" (allocated amount: €23.78 billion).

The amount of resources that the NRRP allocates to pure public economic infrastructure investment corresponds to € 61.3 billion: that is the planned funding assigned to the administration of the Ministry for Infrastructure and Sustainable Mobility or MIMS. € 41 billion of such amount come from the NextGenerationEU program; € 313 million come from the ReactEU program; and € 21 billion come from national budget funding.

As depicted in Figure 49, 75.7% of the total resources at the MIMS disposal are allocated for investments and programs related to contrast of climate change risk. 56% of resources, accounting for € 34.7 billion, is directed towards the development of the Southern regions.

Figure 49 – *Visual representation of resources allocated to public infrastructure investment by the NRRP*

Source: MIMS

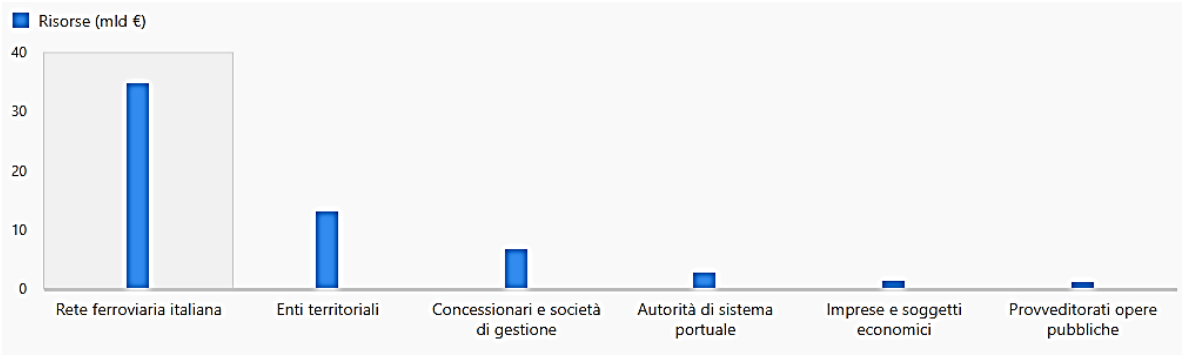
On December 21st, 2021, the MIMS has announced that 42% of the resources it had been awarded by the NRRP have been so far assigned to the recipients. The allocation of the resources to the recipients is depicted in Figure 53 below.

The cruciality of infrastructure and mobility investments seems to be quite clear if we consider the fact that MIMS is the Ministry which received the most consistent amount of resources from the NRRP.

However, the central public administration is managing only a portion of the total investments: a fundamental role is going to be performed by local institutions and players. The most prominent involvement is the one of the national railway network, which will receive about € 35 billion or 57%. Local administrations entities such as regions, metropolitan cities and municipalities will receive a total of € 13.4 billion or about 22 %. Dealers and contractors will receive about € 7 billion or 11.4% and

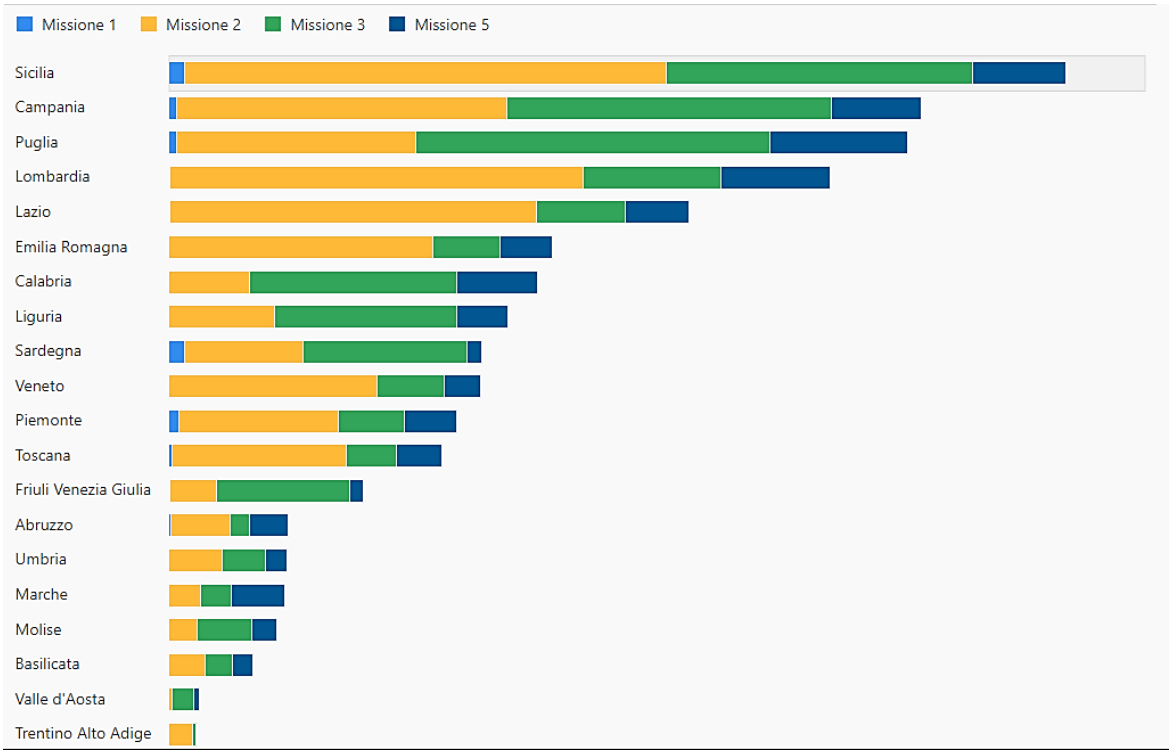
port/harbour system authorities about € 3 billion. Finally, private enterprises will receive € 1.6 billion and Public administration procurement € 1.4 billion.

Figure 50 – *Visual representations of the NRRP-MIMS resources recipients (players)*



Source: MIMS (Openpolis elaboration)

Figure 51 – *Visual representation of the NPPR-MIMS resources recipients (Regions)*



Source: MIMS (Openpolis elaboration)

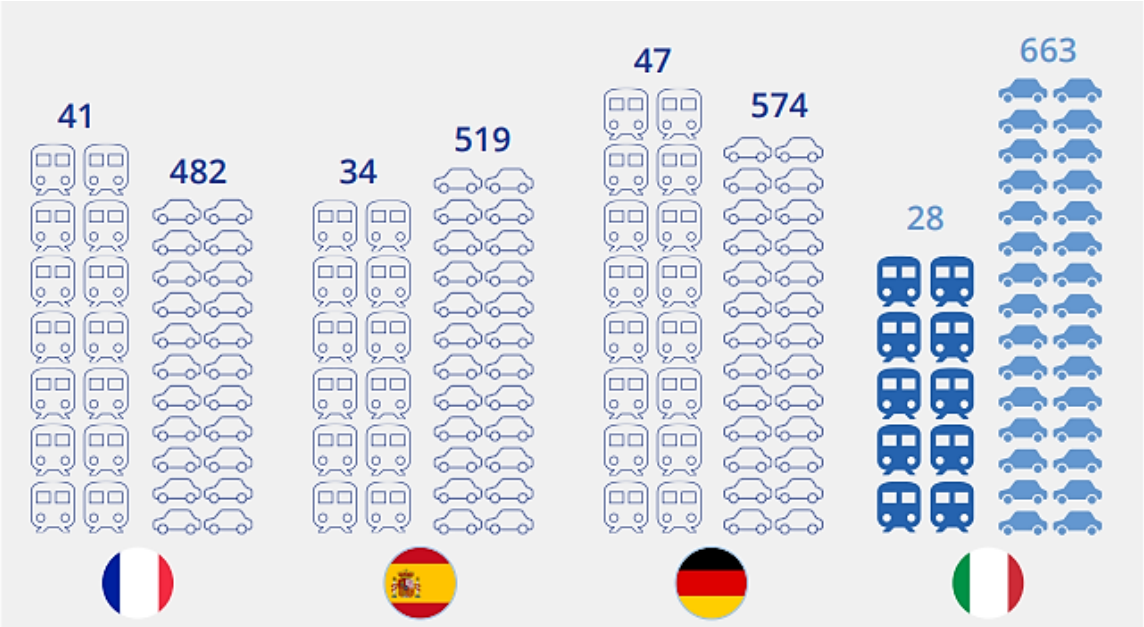
While the MIMS actions and programs are mainly related to Mission 3 of the NRRP (Infrastructure for Sustainable Mobility), they are also strictly correlated to Missions 1, 2, and 5 (Digitalization; Green transition; Inclusion and Cohesion), since

infrastructure investment is actually of a very transversal nature to several sectors of the NRRP.

The region that is altogether going to receive the most from the aforementioned resources is Sicily (about €3.5 billion), followed by Campania (€2.9 billion) and Puglia (€2.8 billion); at fourth place is Lombardy, which is going to receive about €2.5 billion in terms of economic infrastructure investment. This is not surprising, since the EU has specifically recommended the provision of specific measures to ensure the filling of infrastructural gaps across Southern and Northern regions.

As far as the different sectors of interventions, investments on the empowerment and enhancement of the railway network have a prominent role, with about € 10.5 billion already allocated to the sector. Moreover, €14.79 million and €9.4 million are dedicated to high-velocity railway networks only, respectively referring to short-run investments and long-run investments (2026 and 2030).

Figure 52 – *Italy's number of vehicles per 1,000 inhabitants (2019) and railway extension per 1,000 inhabitants (2019) compared with France, Spain and Germany*



Source: Eurostat, cited by Piano Nazionale di Ripresa e Resilienza

Investments related to green transition are another crucial transversal element. As Italy is particularly exposed to climate change risks and hazards, the goal is to accelerate the transition towards environmental sustainability and reach climate neutrality by 2050. Some progress had already been made between 2005 and 2019, when carbon-dioxide emissions decreased by 19%. As of today, Italy's emissions are below the EU average: however, our country still presents vulnerabilities and delays

with respect to road transportation vehicles (Italy's number of car vehicles per 1.000 inhabitants is the highest among major EU countries), also considering the strong presence of old and therefore extremely polluting automobiles. Sustainable mobility and public local transport measures include expenses to ensure a more environmentally-friendly local transport, hydrogen usage for road transportation and investments on the acquisition of electrical public buses.

Intermodality and integrated logistics measures involve interventions in support of the renewal and digitalization of the country's logistic network: in particular, some €270 million in loans will be dedicated to the development of the harbour and ports system.

As far as digital infrastructure is concerned, despite the progress made in recent years, Italy is still lagging behind the rest of the European Union with respect to digital infrastructure endowment and digital culture. The last DESI report highlights how our country is at the 24th place out of the 27 member States – therefore, the priority of the plan is to encompass the digital theme across all reforms and investments included in the NRRP. Specific goals related to such area include:

- Providing a homogeneous, high-speed connectivity infrastructure across all country's regions ensuring 1 Gbps connections across the whole country by 2026.
- Investing in the Public Administration digital transformation process and in e-government solutions for citizens as well as in cybersecurity improvement.
- Improving digital provisions of the healthcare system.

Such actions are thought to be deeply integrated with the broader National Strategy for Digital Competences, which aims at enhancing digital skills of the population, both at work level and in terms of professional educations (ITS and STEM education programs). In this context, the plan highlights how digital transformation will be highly integrated as a process with the infrastructure sector (transportation, energy and power, etc.) as digital technology will contribute to improve quality and efficiency of assets and processes.

Overall, economic infrastructure probably constitutes one of the main concerns of the investments planned by the NRRP, although scaled differently across lines of interventions, regions, and territories. The relevance of infrastructure investment not only for recovery but also for long-term growth and development is well reflected in the allocation projected.

As far as economic infrastructure-related goals are concerned, all the goals projected to be met by the end 2021 were reached on time. These included:

- The acceleration of the bureaucratic procedure for the signings of contracts between the Italian railway network and the Ministry of Infrastructure and Sustainable Mobility concerning railway investments;
- The acceleration of the bureaucratic procedure for the final approval of railway investment projects;
- The transfer of titularity of bridges and viaducts from second-level roads to first-level roads;
- Investments in the acquisition of electrical buses by the Public Administration;
- Infrastructural investments for Special Economic Zones or ZES – Southern regions.

As for the economic infrastructure-related goals that must be met by June 2022, both missions have already been completed:

- Simplification of governance procedure for water supply infrastructure investment;
- Innovative program on quality and sustainable homeliving.

In the aftermath of the Russian-Ukraine conflict outbreak, the current Italian Government has presented the new Documento di Economia e Finanza (DEF), making some relevant considerations – which we will use as conclusion for this Chapter – as to how the National Plan of Recovery and Resilience is going to be affected by the new tragic global situation.

While still recovering from one of the most difficult times of our history, and while still fighting internal, structural flaws and obstacles, our country is once again challenged to produce rapid and efficient responses to a new global crisis.

Cushioning the impact of the Ukrainian crisis is now a key necessity: the raise in prices that is hitting hardly both businesses and consumers can have dreadful consequences on economic growth, purchasing power and salaries through inflation influence, therefore deepening the already present inequalities within the country and possibly offsetting the investments that the EU funds are granting. Therefore, it is crucial to ensuring compatibility between the new priorities (avoiding energetic dependance from Russia and reinforcing national defense) and the 'old' ones, by reconverting the energetic base in a sustainable way.

Finally and maybe most importantly, we must not lose sight of the broader, long-term perspective: especially during difficult times of economic contraction, perspective investments enactment can act both as short-term fuel for optimism and sentiment and as long-term driver of economic development.

4.2.3. Resilient infrastructure investment for economic growth and development

We know that some of the features of infrastructure investment would suggest a shrinking of multipliers in the short-run: the long gestation periods, the frequency of implementation delays, the chance of interfering or causing disruptions with the functioning of already existing infrastructure, the possible distortions on local employment and demand are all aspects that may prevent short-term positive effects of infrastructure investment. Furthermore, infrastructures are typically debt-financed, which can put pressure on the interest rates, sovereign risk premiums and thereby discourage private investment. Governments may even end up increasing distortionary taxes in order to finance the service of newly issued debt: and it is well known how these last two features could undermine multiplier effects.

Should these considerations prevent countries from investing in infrastructure during periods of economic downturn or after sudden and unexpected shocks, like wars or fast-rising inflation?

The answer is negative. Several authors support the view that conditions of economic downturns, monetary constraints and uncertainty – which are exactly the what the global economy is experiencing at the moment – actually contribute to generate larger multipliers from infrastructure investment, well above unity, even over short horizons of 1 to 3 years. The potentially high returns on infrastructure investment can strengthen fiscal sustainability, which is a crucial factor in times of skyrocketing public debts. Infrastructure investment could also counteract stagnation and improve individuals' welfare (Christiano et al., 2011; Bohem, 2020; Coenen et al, 2012; Ercolani, 2021).

Covid-19 has generated the worst contraction since World War Two, during a time when many central banks were already constrained by the Zero Lower Bound - or hit the limit shortly afterwards. After the outbreak of the war and the global supply chains disruptions, uncertainty has risen to extremely high levels and is likely to be a factor for still quite some time. These so-called scarring effects may actually amplify the effectiveness of infrastructure stimulus, especially in the short run. When the economy is at the Zero Lower Bound, government consumption stimulus can be particularly powerful since higher inflation expectations lower the ex ante real interest rate: this boosts private consumption, spurring the economy and generating higher multiplier effects.

Furthermore, a well designed infrastructure stimulus plan has determinant positive effects on confidence, by signaling a government's commitment to reviving growth, which can also support long-term long-run stability. As an empirical validation, for a panel of 72 advanced and emerging economies, IMF (2020b) shows that a government investment stimulus is more effective during periods of high uncertainty. These considerations reflect the decisions of many advanced economies to continue directing a considerable part of their resources to infrastructure projects as part of their recovery economic plans even after the outbreak of the Russian-Ukraine war.

In the COVID-19 crisis containment, the extent and quality of infrastructure related to health such as hospitals, water, and sanitation have proven to be important for the effectiveness of responses. The cruciality of efficient telecommunication infrastructure was also pointed out. There may be scope to consider where infrastructure can play a role more generally in support of supply chains, for example through more efficient trade and transportation infrastructure to support delivery of essential goods – some of the bottlenecks occurring since the start of the war in Ukraine could also have been avoided, if the transportation infrastructure available for energy and raw materials were improved. The importance of preparedness and resilience in public and private investment is more evident than ever: as for infrastructure investment, social architectures that are built in such a way to respond to global crises and shocks can save people and resources.

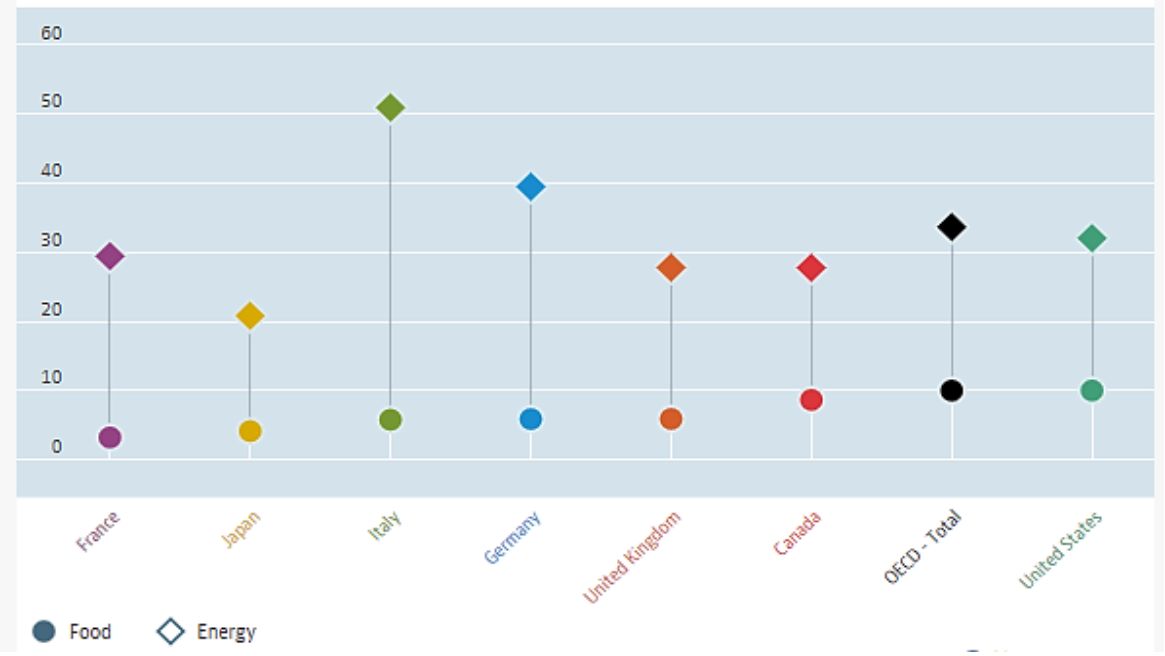
As for COVID-19 factor, while the peak of the Omicron wave is passing and global weekly deaths are declining, worker shortages and mobility restrictions together with supply disruptions and bottlenecks are still constraining global economic activity and adding to inflation. Given the issue of vaccination shortfalls in emerging and developing countries, the possibility of new outbreaks cannot unfortunately be excluded. Yet, the possible impact on activity is assumed to be lower than in earlier waves, thanks to improved adaptation, effective therapeutics, and immunity due to previous infections (IMF, 2022).

However, according to the World Bank's latest Global Economic Prospects report, the combined effect of the pandemic and the Russia-Ukraine conflict is raising the risk of stagflation, that is, a condition of high inflation and slow growth occurring at the same time. The consequences could persist for several years, unless major supply increases are set in motion. With the supply of natural gas constrained, announcements of major production increases worldwide will be essential for restoring noninflationary growth.

Consumer prices in the OECD area rose by 8.8% year-on-year in March 2022, compared with 7.8% in February 2022, and just 2.4% in March 2021; it was their sharpest increase since October 1988. One out of five OECD countries recorded double-digit inflation, with the highest rate in Turkey at 61.1%. Energy price inflation

in the OECD soared to 33.7% year-on-year in March, up from 26.6% in February, its highest rate since May 1980. Excluding food and energy, year-on-year inflation increased to 5.9% in March, after 5.6% in February 2022.

Figure 53 – *Consumer Price Index: prices of food and energy, annual growth rate % in May 2022 across selected countries*



Source: OECD, 2022

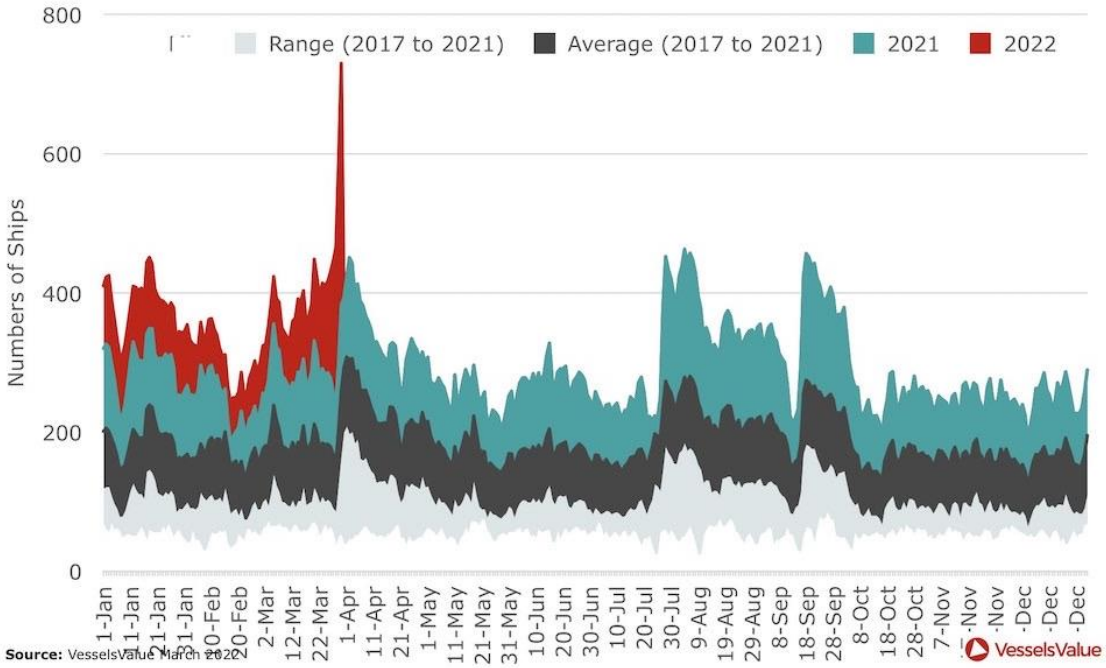
The slowdown of China's economy is another worrying aspect of the current conjuncture: the combination of more transmissible COVID variants and the country's zero-COVID strategy entail the prospect of frequent lockdowns, which directly affect private consumption. During the spring of this year, the number of container ships waiting outside the port of Shanghai, which is the largest commercial port in the world, reached an all-time high as a consequence of the lockdown imposed by Chinese authorities over new spotted COVID-19 cases. The risk of further bottlenecks in global supply chains is relevant.

In many countries, space for fiscal policy has been eroded by the necessary COVID-related spending and lower tax revenues in 2020 and 2021. Faced with rising borrowing costs, governments are already challenged and fiscal support is likely to reduce in 2022 and 2023, particularly in advanced economies. Expectations of tighter policies and worries about the war have contributed to financial market volatility and risk repricing (Global Financial Stability Report, 2022). War-related sanctions have tightened global financial conditions and lowered propensity to risk.

Overall, the combined effects of the pandemic, increased inflation, the war in Ukraine and the intensified geopolitical tensions, together with country-specific factors, call for extremely careful and farsighted policies.

The concept of resilience seems to be shared among all international economic plans for recovery: but what exactly is resilience, and how is it reached as far as infrastructure investment is concerned?

Figure 54 – *Ships waiting to load or discharge outside Shanghai harbour*



Source: Vessels Value, 2022

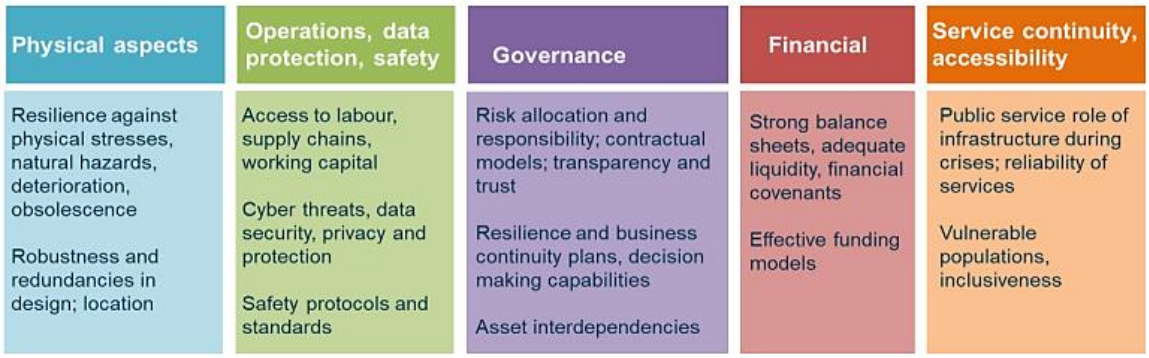
The idea of resilience is strongly linked to risk management frameworks: something that is not resilient is thought of being somehow exposed to disruption, failure or inadequacy. Resilience refers in fact to the capacity of systems to absorb a disturbance, recover from disruptions and adapt to changing conditions while retaining essentially the same function as prior to the disruptive shock at an acceptable service level (OECD, 2020). The system-wide impacts that global threats can produce and the key role played by infrastructure in sustaining both economic and social activity have heightened the need to consider infrastructure resilience as a priority.

According to the OECD, infrastructure resilience in the aftermath of COVID-19 presents five crucial elements to be considered.

Physical assets are probably the first aspect that comes to mind: infrastructure is naturally exposed to hazards such as extreme weather events, earthquakes, tsunami,

fire, and slow onset events (e.g. rising sea levels) as well as deterioration and obsolescence. Therefore, well-located and robust infrastructure able to withstand fluctuations in demand or physical stresses corresponds to the definition of resilience. Moreover, it should not operate beyond capacity, but rather in redundancy (e.g. having spare capacity in telecommunications networks, back-up systems). Redundancy can in fact ensure that the failure of one node of the network does critically injure the whole system.

Figure 55 – *The five elements of infrastructure resilience according to the OECD*



Source: OECD, 2020

Operations, data protection and safety are another essential feature of resilience. Considerable data are produced through infrastructure operations and provision, some of which may be sensitive. As infrastructure becomes more connected and complex, and as a result more exposed to digital threats, including cyber-attacks, improved procedures are needed to alleviate such risks, particularly with respect to data security, privacy, and integrity of communications networks. There is evidence that the COVID-19 crisis has increased chances for cyber-criminals to exploit weaknesses and fears, as more people shift to online activities (OECD, 2020). Vigilance against cyber-attacks requires constant monitoring and safe data storage, as technologies and tools change and threats become more and more sophisticated. Protocols and standards for safety ensure the protection of users of infrastructure as well as workers.

As we have previously seen, strong governance frameworks are at the heart of infrastructure investment models and are needed build social acceptance, transparency and trust (OECD, 2019). Strong resilience at the national and subnational government levels can reduce the risks and impact of disruption, also with respect to emergency management. Since infrastructure projects often occurs over long lifespans, frameworks that integrate the full investment cycle and can adapt to changing circumstances in a just and transparent can address unexpected shocks while also supporting investment.

Financial aspects also reflect the need for resilience. The way that infrastructure is funded plays a crucial role. Besides the observed drop in revenues generated by users of infrastructure during the pandemic, tax revenues may also have declined significantly, augmenting financial distress. Without sufficient compensation, many governments could be forced to cut operational and capital spending (OECD, 2020).

Continuity of service and accessibility is significant particularly for those infrastructure services – e.g. healthcare, transportation, water, electricity, communications – that are essential in nature for the functioning of the society, especially in times of stress when they may be relied on even more heavily. Indeed, public expectations may be high as to the "public service" role of infrastructure in times of crisis. This may require a coordinated approach between industry and governments.

Finally, time horizon matters for infrastructure resilience, as the probability of a hazard occurring increases with the length of time considered. A key consideration is that resilience planning and risk management is a process throughout the lifecycle of infrastructure investment.

Investment in infrastructure resilience can avoid economic losses, the need for expensive repairs, as well as preserve lives and protect the environment. Effective planning for resilience could also expose ways of spending better, not necessarily spending more.

Final considerations and conclusions

We are at a point in recovering from the pandemic crisis to reassess infrastructure role in the economy and to also consider the possibilities of how infrastructure investment and maintenance can contribute more generally to wellbeing, development and preparedness for possible future crises. There is a real opportunity for infrastructure systems to emerge from this challenge stronger, with a focus on improvement through regenerative responses. It is evident that costs of crises can be much higher than the incremental cost implied in resilience investments.

In the matter of a few weeks, the world has yet again experienced a major shock. Geopolitical division worsens trade-offs by increasing tensions and economic volatility while decreasing overall efficiency. Just as a lasting recovery from the epidemic-induced global collapse appeared in sight, the war has created the real possibility that a large part of the recent improvements will be erased. The long list of challenges calls for proportionate policy actions to prevent worse outcomes and improve economic prospects for all.

Even as policymakers focus on mitigating the impact of the war and the pandemic, attention will need to be maintained on longer-term goals. This involves reskilling workers for the ongoing digital transition while enabling the labor market transformation towards sustainability. Another long-term goal will be to improve the resilience of global supply chains. Just as important is the need to ensure fair worldwide access to the full set of COVID-19 tools - tests, therapies, and vaccines - to contain the infection, and to address other health priorities. Policymakers should also make certain that the global financial safety net operates successfully to help exposed economies adjust as interest rates rise in the fight against inflation.

Importantly, these risks and policies interact in complex ways, at short, medium, and longer horizons. The erosion of fiscal space makes it harder to invest in the climate transition, while delays in dealing with the climate crisis make economies more vulnerable to commodity price shocks, which feeds into inflation and economic instability.

Resilience will be the keyword for to be considered at multiple levels of all investments to be made. COVID-19 has highlighted vulnerabilities in infrastructure, particularly as healthcare infrastructure, such as hospitals, has tended to be overlooked

as part of critical infrastructure systems. The pandemic has also speeded up trends that were already underway, especially related to demand for communications infrastructure, digital services, and sustainable mobility solutions: the business models of millions of enterprises across the globe had to quickly adapt to the new circumstances, shifting from offline to online when possible, from in-person experiences to remote, enabling changes that many would have never thought of enacting, and certainly not in such short ranges of time.

Sustainable and quality infrastructure is now the infrastructure of the future. Concern for the environment and the impact of climate change has entered the mainstream. Based on a worldwide multi-stakeholder study, the World Economic Forum's latest Global Risk Report, for the first time lists exclusively environmental risks as its top five global risks in terms of probability, including extreme weather, natural disasters, biodiversity loss and human-caused environmental disasters. The pressure to do more for the environment may be one of the most important drivers for more sustainable infrastructure. What is more, accelerating investment in sustainable infrastructure also brings enormous opportunities for a new growth path.

In this context, it is crucial that the framework conditions are in place to ensure that infrastructure solutions can be intended, planned and implemented in a sustainable way. This requires strengthening governance capacities, including at the individual level (leadership and technical capabilities), institutional (ministries, sub-national level, monitoring and implementation) and system level (long-term vision policies, overall coordination).

As we have seen, infrastructure systems are complex and interlinked – even seemingly small events can have cascading effects due to interdependencies. That is why cooperation among countries remains key: synchronized infrastructure spending among various countries could boost global GDP thanks to the positive spillovers arising from interconnectedness. A coordinated infrastructure stimulus could generate a considerable boost for economic activity thanks to trade linkages and global value chains: an immediate priority is to find a peaceful resolution to the war.

Innovative and proactive responses to resilience challenges are needed, in order to overcome the current crisis, and to prepare for future ones, drawing together the elements of resilience for what could become a new infrastructure landscape. In this way, infrastructure may emerge as improved by the shock and better able to withstand future challenges.

References

Abiad, Abdul, Furceri, Davide and Topalova, Petia. *The macroeconomic effects of public investment: Evidence from advanced economies*. Journal of Macroeconomics, 50, issue C, p. 224-240, 2016.

Acemoglu, Daron, Johnson Simon, and Robinson James A., *An African Success Story: Botswana*, available at SSRN: https://ssrn.com/abstract=304100, 2002.

Acemoglu, Daron, Johnson Simon, and Robinson James A.. *Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution*. Quarterly Journal of Economics, 117, pp. 1231-1294, 2002.

Acemoglu, Daron, Johnson Simon, and Robinson James A.. *The Colonial Origins of Comparative Development: An Empirical Investigation: Reply*. The American Economic Review 102, no. 6, pp. 3077–3110, 2012.

Acs, Zoltan & Armington, Catherine. *Employment Growth and Entrepreneurial Activity in Cities*. Regional Studies, 2004.

Acs, Zoltan & Braunerhjelm, Pontus & Audretsch, David & Carlsson, Bo. *The Knowledge Spillover Theory of Entrepreneurship*. Small Business Economics. 32. 15-30., 2008.

AGCOM, Mappatura delle reti di accesso ad Internet, AGCOM Broadband Map, available at: https://www.agcom.it/mappatura-delle-reti-di-accesso-ad-internet

Agénor PR. *Public Capital, Growth and Welfare: Analytical Foundations for Public Policy*. Princeton University Press, 2013.

Al Jazeera, *Latest News on the Russia-Ukraine War*, available at: *https://www.aljazeera.com/tag/ukraine-russia-crisis/*

Alby, Philippe, Dethier, Jean-Jacques & Straub, Stephane. *Let there be Light! Firms Operating under Electricity Constraints in Developing Countries*. The World Bank Economic Review. 27, 2010.

Aldrich, H. *Using an Ecological Perspective to Study Organizational Founding Rates*. Entrepreneurship Theory and Practice 14(3):7-24., 1990.

Aliu Momoh, Mohammed. *Infrastructure Classification Revisited*. Journal of Social Science Research, Volume 12, Issue 1. University of Lagos, Akoka. Lagos, 2018.

Ansar, Atif, Flyvbjerg, Bent, Budzier, Alexander and Lunn, Daniel. *Does Infrastructure Investment Lead to Economic Growth or Economic Fragility? Evidence from China,* Oxford Review of Economic Policy, vol. 32, no. 3, autumn, pp. 360–390, 2016.

Aschauer, Daniel. A. *Is Public Expenditure Productive?* In: Journal of Monetary Economics, 1989.

Asiedu, E.. *On the Determinants of Foreign Direct Investment Developing Counties: Is Africa Different?*, World Development, Vol. 30 (1), pp. 107-119, 2002.

Audretsch, D. B., & Keilbach, M. The theory of knowledge spillover entrepreneurship. Journal of Management Studies, 44(7), 1242–1254, 2007.

Audretsch, D. B., Heger, D., & Veith, T. *Infrastructure and entrepreneurship*. Small Business Economics, 44, 219–230, 2015.

Audretsch, David & Thurik, Roy. *A model of the entrepreneurial economy*. International Journal of Entrepreneurship Education, 2004.

Audretsch, David B. and Thurik, Roy and Thurik, Roy, *What's New About the New Economy? Sources of Growth in the Managed and Entrepreneurial Economies*. ERIM Report Series, 2000.

Auerbach, Alan J. and Gorodnichenko, Yuriy. *Output spillovers from fiscal policy*. American Economic Review: Papers and Proceedings, 103(3): 141-146, 2013.

Banca d'Italia, *Le infrastrutture in Italia: dotazione, programmazione, realizzazione. Seminari e convegni*. Banca d'Italia, Aprile 2011.

Bank of Italy, *Annual Report for 2014*, Available at: https://www.bancaditalia.it/pubblicazioni/relazioneannuale/2014/index.html?com.dotmarketing.htmlpage.language=1&dotcache=refresh

Barro, Robert. *Economic growth in a cross section of countries*. The Quarterly Journal of Economics, Vol. 106, No. 2. Pp. 407-443, 1991.

Baughn, C.C., Neupert, K.E. *Culture and National Conditions Facilitating Entrepreneurial Start-ups*. Journal of International Entrepreneurship 1, 313–330, 2003.

BBC News, *Why the world is waging economic war on Russia,* edited by Faisal Islam, BCC news, February 28th 2022, available at: https://www.bbc.com/news/business-60550610

Becker, Gary S.. *Human Capital: a theoretical and empirical analysis with special reference to education*. New York: National Bureau of Economic Research, 1964.

Boehm, Christoph E. *Government consumption and investment: Does the composition of purchases affect the multiplier?,* Journal of Monetary Economics, 2020.

Brookings Institutions, 2019 Annual Report, Brookings. Available at https://www.brookings.edu/wp-content/uploads/2019/11/2019-annual-report.pdf

Brooks Douglas. Asia's infrastructure and trade. Conference on the Economics of Infrastructure in a Globalised World: Issues, Lessons and Future Challenges, Sydney, Australia. 2010.

Bruegel, *European Union countries' recovery and resilience plans,* edited by Zsolt Darvas et al., (last update: June 9th 2022) available at: https://www.bruegel.org/publications/datasets/european-union-countries-recovery-and-resilience-plans/

Buhr, Walter. *What is Infrastructure?* In: Siegen Discussion Paper No. 107- 03. Department of Economics, School of Economic Disciplines, University of Siegen, 2003.

Bullini Orlandi, Ludovico, Zardini Alessandro e Rossignoli Cecilia. *Highway to hell: Cultural propensity and digital infrastructure gap as recipe to entrepreneurial death*. Journal of Business Research 123, pp. 188, 2021.

Calderon, Cesar, Moral-Benito, Enrique and Servén, Luis, *Is infrastructure capital productive? A dynamic heterogeneous approach*, Journal of Applied Econometrics, 30, issue 2, p. 177-198, 2015.

Canning, D. and P. Pedroni. *Infrastructure and Long Run Economic Growth*. Mimeo, 1999.

Chakraborty, Shankha & Dabla-Norris, Era. The Quality of Public Investment. International Monetary Fund, IMF Working Papers, 2009.

Chambers, Judy. *Infrastructure research report*, Pension Consulting Alliance, 2007.

Christiano, Lawrence, Eichenbaum Martin and Rebelo Sergio. *When Is the Government Spending Multiplier Large?* Journal of Political Economy, Vol. 119, No. 1. pp. 78-121. The University of Chicago Press, 2011.

Coenen, Günter, et al. *Effects of Fiscal Stimulus in Structural Models*. American Economic Journal: Macroeconomics, 4 (1): 22-68., 2012.

Collier P and O'Connell SA. *Opportunities and choices*. In: Ndulu BJ, O'Connell SA, Azam JP, et al. (eds.) *The Political Economy of Economic Growth in Africa 1960–2000*. Cambridge, UK: Cambridge University Press, 2007.

Council of Europe Development Bank, *Investing in Public Infrastructure in Europe: a local economy perspective,* CEB, 2017. Available at: https://coebank.org/media/documents

Crafts, Nicholas. *Transport infrastructure investment: implications for growth and procurement.* In: Oxford Review of Economic Policy, Vol. 25, No. 3, Infrastructure, Utilities, And Regulations, pp. 327-343, Oxford University Press, 2009.

Daido, Kohei & Tabata, Ken, *Public infrastructure, production organization, and economic development*, Journal of Macroeconomics, Elsevier, vol. 38, pp 330-346, 2013.

David, Paul A.. *Knowledge, capabilities and human capital formation in economic growth*. New Zealand Treasury, Working Paper 01/13, 2001.

Decuir - Viruez, Maria Luisa M*easuring the Institutional Factors in the Economic Growth of the Mexican Regions 1970 - 2000*. ERSA conference papers, European Regional Science Association, 2004.

Djankov, Simeon et al. *The Regulation of Entry*. The Quarterly Journal of Economics, 2001.

Duckworth, Angela & Seligman, Martin E.P. *Self-Discipline Outdoes IQ in Predicting Academic Performance of Adolescents*, Sage, 2005.

Easterly W and Levine R. *Troubles with the neighbours: Africa's problem, Africa's opportunity*. Journal of African Economies, 7(1): 120–142, 1998.

Elhance, Arun P. and Lakshmanan, T. R., *Infrastructure-production system dynamics in national and regional systems: An econometric study of the Indian economy*, Regional Science and Urban Economics, 18, issue 4, p. 511-531, 1988.

Elhance, Arun P. and Lakshmanan, T. R., *Infrastructure-production system dynamics in national and regional systems: An econometric study of the Indian economy,* Regional Science and Urban Economics, 18:4, p. 511-531, 1988.

Ercolani, Valerio. *The macroeconomic impact of infrastructure investment: a review of channels.* In: Questioni di Economia e Finanza, Occasional Papers, Banca d'Italia, 2021.

Esfahani, Hadi Salehi and Ramirez, Maria Teresa. *Institutions, infrastructure and economic growth*. Journal of Development Economics 70, pp. 443 – 477, 2003.

European Commission, *The NextGenerationEU,* available at: https://europa.eu/next-generation-eu/index_it

EUROSTAT *Gross Fixed Capital Formation data*, updated 2021, available at: https://ec.europa.eu/eurostat/en/web/products-datasets//TIPSNA20#:~:text=Dataset%20Details&text=Gross%20fixed%20capital%20formation%20(GFCF,of%20producer%20or%20institutional%20units.

Evans, D.S., Leighton, L.S. *Some Empirical Aspects of Entrepreneurship*. In: The Economics of Small Firms. Studies in Industrial Organization, vol 11. Springer, Dordrecht, 1990.

Fay, Marianne and Morrison, Mary. *Infrastructure in Latin America and the Caribbean : Recent Developments and Key Challenges*. In: Directions in Development, Infrastructure. Washington, DC: World Bank, 2007.

Fulmer, Jeffrey E.. *What in the world is infrastructure?* In: Infrastructure Investor, 2009.

Getty Images Archive Photos, *Italia collection*, Getty Images, available at: https:// www.getty images.it /collections/archive-photos

Globerman, Steven & Shapiro, Daniel. *Global Foreign Direct Investment Flows: The Role of Governance Infrastructure*, World Development, 30:11, p. 1899-1919, 2002.

Governo Italiano - Presidenza del Consiglio dei Ministri, *Il Piano Nazionale di Ripresa e Resilienza*, 2021. Available at: https://italiadomani.gov.it/it/home.html

Gramlich, E. M.. *Infrastructure Investment: A Review Essay*. In: Journal of Economic Literature, 1994.

Grilo, I. & Thurik, Roy. *Determinants Of Entrepreneurship In Europe*. ERIM Report Series Reference No. ERS-2004-106-ORG, 2005.

Hadi Salehi Esfahani, María Teresa Ramírez. Institutions, infrastructure, and economic growth. Journal of Development Economics, Volume 70, Issue 2, 2003.

Hamilton, James D. *A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle*. Econometrica 57, no. 2, 1989.

Heckman, James J. & Kautz, Tim. *Hard evidence on soft skills*, Labour Economics, Elsevier, vol. 19(4), 2012.

Heckman, James J.. *The Economics of inequality: the value of early childhood education*. American Educator, Spring 2011.

Henisz, Witold. *The institutional environment for infrastructure investment, Industrial and Corporate Change*, 11, issue 2, p. 355-389, 2002.

Hirschman, Albert O.. *The Strategy of Economic Development*. In: Yale Studies in Economics: 10. New Haven: Yale University Press, 1958.

Hulten, Charles. *Infrastructure capital and economic growth: how well you use it may be more important than how much you have*. NBER Working Paper 5847, National Bureau of Economic Research, Cambridge, 1996.

Infrastructure Transparency Initiative, Construction sector data, 2012, available at https://infrastructuretransparency.org/

Institute for Entrepreneurship and Competitiveness, Indice del ferment imprenditoriale 2021, LIUC Università Cattaneo, 2021. Available at: https://italiacompete.it/wp-content/uploads/2021/04/Indice-Report-2021.pdf

International Energy Agency, World Energy Outlook 2020, IEA, 2020, available at: https://www.iea.org/reports/world-energy-outlook-2020

International Monetary Fund dataset, available at: https://www.imf.org/en/Data

International Monetary Fund, *Global Financial Stability Report April 2022: Schokwaves from the war in Ukraine test the financial system's resilience*. IMF, 2022. Available at: https://www.imf.org/en/Publications/GFSR/Issues/2022/04/19/global-financial-stability-report-april-2022

International Monetary Fund, *Public Investment Management Assessment (PIMA): Strengthening Infrastructure Governance*, IMF, 2019.

International Monetary Fund, *World Economic Outlooks 2019-2020-2021-2022*, International Monetary Fund, available at: https://www.imf.org/en/Publications/WEO

ISTAT dataset, *Indicatori territoriali di dotazione infrastrutturale*, available at: https://www.istat.it/it/archivio/234672

Jensen, Robert. *The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector*. The Quarterly Journal of Economics 122, no. 3, 2007.

Jochimsen, Reimut. *Theorie der Infrastruktur: Grundlagen der marktwirtschaftlichen Entwicklung*. Tübingen, J.C.B. Mohr, 1966.

Kasper, Eva. *A definition for Infrastructure: characteristics and their impact on firms active in infrastructure*. Technische Universität München, 2015.

Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, *The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010*). World Bank Policy Research Working Paper No. 5430, 2010.

Kumar, N.. *Multinational Enterprises and Industrial Organization*, Sage Publications, New Delhi, 1994.

Kuncel, Nathan & Hexzlett, Sarah A. *Fact and fiction in cognitive ability testing for admissions and hiring decisions*. In: Current Directions in Psychological Science 19(6):339-345, Sage, 2010.

Kyiv School of Economics, *Direct damages caused to Ukraine's infrastructure during the war has already reached almost $63 billion*. 2022. Available at: https://kse.ua/about-the-school/news/zbitki-naneseni-infrastrukturi-ukrayini-v-hodi-viyni-skladayut-mayzhe-63-mlrd/

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer. *The Economic Consequences of Legal Origins*. Journal of Economic Literature, 46 (2): 285-332, 2008.

Leduc, Sylvain and Wilson, Daniel. *Roads to prosperity or bridges to nowhere? Theory and evidence on the impact of public infrastructure investment*. NBER Working Paper 18042, National Bureau of Economic Research, Cambridge, 2012.

Lerner, Josh, *The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program*, The Journal of Business, 72, issue 3, p. 285-318, 1999.

Li Z, *Some evidence on the performance of transport infrastructure investment in China*. Conference on the Economics of Infrastructure in a Globalised World: Issues, Lessons and Future Challenges, 2010.

Limão N and Venables AJ. *Infrastructure, geographical disadvantage, transport costs, and trade*. The World Bank Economic Review, 15(3): 451–79, 2001.

Lindquist, Kristen & MacCormack, Jennifer & Shablack, Holly. *The role of language in emotion: Predictions from psychological constructionism*. Frontiers in Psychology. 2015.

Loree, D.W. and Guisinger, S.E.. *Policy and Non Policy Determinants of U.S. Equity Foreign Direct Investment*, Journal of International Business, 1995.

Maiorano, F. & Stern, J.. *Institutions and investment in low and middle-income countries: the case of mobile communications*, Working Papers 07/06, Department of Economics, City University London, 2007.

McKibbin, Warwick & Henckel, Timo. *The Economics of Infrastructure in a Globalized World: Issues, Lessons and Future Challenges*. In: Journal of Infrastructure, Policy and Development, 2010.

McKinsey & Company, *Infrastructure in a changing world: trends and challenges*, edited by Carlo Secchi and Alberto Belladonna, ISPI, Milan, 2020.

Ministero delle Infrastrutture e delle Mobilità Sostenibili, *Il MIMS e il PNRR*, available at: https://www.mit.gov.it/comunicazione/news/il-mims-e-il-pnrr

Miyamoto, Hiroaki et al., *Growth Impact of Public Investment and the Role of Infrastructure Governance*. In: Well spent: how strong infrastructure governance can end waste in public investment, Ch. 2. pp 15-29. International Monetary Fund, 2020.

Mowery, David C. and Ziedonis, Arvids A., *Numbers, Quality, and Entry: How Has the Bayh-Dole Act Affected US University Patenting and Licensing?* In: Innovation Policy and the Economy, Volume 1, National Bureau of Economic Research, Inc., 2001.

Nasdaq, *Crude Oil Price per barrel*, available at https://www.nasdaq.com/it/market-activity/commodities/cl:nmx

Ng, Thomas. W. H., Eby, Lillian. T., Sorensen, Kelly. L., & Feldman, Daniel. C.. *Predictors of objective and subjective career success. A meta-analysis*. In: Personnel Psychology, 58(2), 367–408. American Psychological Association, 2005.

Nifo A. and Vecchione G., *Do Institutions Play a Role in Skilled Migration? The Case of Italy*, Regional Studies. 48. Pp. 1628-1649. 2014.

North, Douglas. C. *Institutions, institutional change and economic performance*. Cambridge, U.K.: Cambridge University Press, 1990.

North, Douglass. *Institutions* In: The Journal of Economic Perspectives, Vol. 5, No. 1., pp. 97-112, 2001.

North, Douglass. *Institutions, institutional change and economic performance*. Cambridge University Press, 1990.

OECD Data, *Investment (GFCF),* available at: https://data.oecd.org/gdp/investment-gfcf.htm

OECD, *COVID-19 and a new resilient infrastructure landscape,* OECD Policy Responses to Coronavirus, OECD, available at: https://www.oecd.org/coronavirus/policy-responses/covid-19-and-a-new-resilient-infrastructure-landscape-d40a19e3/, 2021

OECD, OECD Employment Outlook 1998, available at https://www.oecd-ilibrary.org/employment/oecd-employment-outlook-1998_empl_outlook-1998-en

OECD, *OECD Foreign Bribery Report: an analysis of the crime of bribery and foreign public officials*, 2014. Available at: https://www.oecd.org/corruption/oecd-foreign-bribery-report-9789264226616-en.htm

OECD, *The Well-being of Nations: The role of human and social capital,* 2001.

OECD, *Glossary of Statistical Terms*, < https://stats.oecd.org/glossary/>.

OECD. *Employment outlook: June 2000*. Paris: OECD, 2000.

Ojomo, Efosa. *Building infrastructure that lasts*. Christensen Institute, 2018. Available at: https://www.christenseninstitute.org/blog/building-infrastructure-that-lasts/

Oxford Economics, *Data on infrastructure spending*, available at: https://www.oxfordeconomics.com/service-category/macro/

Prud'homme, Remy. *Infrastructure and development*. Paper Prepared for ABCDE (Annual Bank Conference on Development Economics): Washington DC, 2004.

Qian, Haifeng, Acs, Zoltan and Stough, Roger R., *Regional systems of entrepreneurship: the nexus of human capital, knowledge and new firm formation*, Journal of Economic Geography, 13, issue 4, p. 559-587, 2013.

Ramey, Valerie. *The Macroeconomic consequences of infrastructure investment.* NBER Working paper 27625, National Bureau of Economic Research, Cambridge, 2020.

Reynolds, Paul D, Miller, Brenda and Maki, Wilbur R, *Explaining Regional Variation in Business Births and Deaths: U.S. 1976-88*, Small Business Economics, 7, issue 5, p. 389-407, 1995.

Robbins, Steven. B., et al. *Do psychosocial and study skill factors predict college outcomes? a meta-analysis*. In: Psychol. Bull. 130, 261–288, 2004.

Roberts M and Deichmann U. *International growth spillovers, geography and infrastructure*. The World Economy, 34(9): 1507–1533, 2011.

Sahoo, Parvakar and Dash, Ranjan Kumar. *Economic growth in South Asia: the role of infrastructure*. Working paper series, Institute of Economic Growth, University of Delhi Enclave - Vol. 288, 2008.

Sahoo, Pravakar. *Foreign Direct Investment in South Asia: policy, trends, impact and determinants*. ADB Institute Discussion Paper No. 56, 2006.

Sanchez-robles, Blanca, *Infrastructure Investment And Growth: Some Empirical Evidence*, Contemporary Economic Policy, 16, issue 1, p. 98-108, 1998.

Saxenian, Annalee. *Inside-Out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128*. Cityscape. 2., 1996.

Schuman Associates, Recovery and Resilience Facility: budget, States and sectors, 2020, available at: https://www.schumanassociates.com/newsroom/recovery-and-resilience-facility-main-numbers-and-country-splits-1

Schumpeter, J. A. *Capitalism, socialism, and democracy*. London: Unwin University Books, 1942.

Schumpeter, J.A.. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*, New Brunswick (U.S.A) and London (U.K.): Transaction Publishers, 1934 (2008).

Shane, S. A., & Venkataraman, S. *The Promise of Entrepreneurship as a Field of Research*. The Academy of Management Review, 25(1), 217–226, 2000.

Shapero, A. & Sokol, L. *The social dimensions of entrepreneurship. In The Encyclopedia of entrepreneurship* (pp. 72-90). Englewood Cliffs, NJ: Prentice Hall, 1982.

Simanjuntak, M. et al. *The Entrepreneurial Potential among Undergraduate Students*. Jurnal Bisnis & Manajemen. Vol. XVII, No. 2, 75-84, 2016.

Smarzynska, Beata K. and Wei, Shang-Jin. *Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth?*, No 8465, NBER Working Papers, National Bureau of Economic Research, Inc., 2001.

Smith, Adam. *The Wealth of Nations*. Oxford, England: Bibliomania.com Ltd, 2002.

Sohl, J. *The angel investor market in 2012: A moderating recovery continues*. Center for Venture Research, University of New Hampshire, 2013.

Standard & Poor's Capital IQ, *Performance of key global telecom players versus the S&P 500 during the Covid-19 pandemic,* 2020, Available at: https://www.spglobal.com/marketintelligence/en/solutions/sp-capital-iq-pro

Standard & Poor's, 2020 Annual Report, available at: https://www.spglobal.com/en/annual-reports/2020/

Statista, *National debt in relation to gross domestic product (GDP) in China from 2010 to 2020 with forecasts until 2027*, Statista, 2022, available at: https://www.statista.com/statistics/270329/national-debt-of-china-in-relation-to-gross-domestic-product-gdp/

Sternberg, Rolf. *Regional Dimensions of Entrepreneurship*, Foundations and Trends in Entrepreneurship: Vol. 5: No. 4, pp 211-340, 2009.

Straub S. *Infrastructure and development: A critical appraisal of the macro-level literature*. The Journal of Development Studies, 47(5): 683–708, 2011.

Tatom, John. I*s an infrastructure crisis lowering the nation's productivity?*, Review, issue Nov, p. 3-21, 1993.

Thatcher, Margaret. *Speech to Conservative Women's Conference*. London, The Barbican, 1985.

Thurik, Roy & Wennekers, Sander. *Linking Entrepreneurship and Economic Growth. Small Business Economics*. 13. 27-55, 1999.

Tompkins, Emma. L. and Adger, Neil. *Does adaptive management of natural resources enhance resilience to climate change?* Ecology and Society 9:10. 2004 Available at http://www.ecologyandsociety.org/vol9/iss2/art10/

Torrisi, Gianpiero. *Public infrastructure: definition, classification and measurement issues*. University Library of Munich, Germany, MPRA Paper., 2009.

Tyszka, T. et al. *Motivation, self-efficacy, and risk attitudes among entrepreneurs during transition to a market economy*. The Journal of Socio-Economics. 40. 124-131., 2011.

Tzu, S., *The art of war* Capstone Publishing. 2010 edition.

University of Gothenburg, *European Quality of Government Index*, available at: https://www.gu.se/en/quality-government/qog-data/data-downloads/european-quality-of-government-index

US Congressional Budget Office dataset, CBO, 2017, available at: https://www.cbo.gov/data/budget-economic-data

Van de Ven, A. H. *The development of an infrastructure for entrepreneurship*. Journal of Business Venturing, 8(3), 211–230, 1993.

Van de Ven, A. H., & Garud, R. *A framework for understanding the emergence of new industries*. In R. S. Rosenbloom & R. A. Burgelman (Eds.), Research on technology innovation, management, and policy (Vol. 4, pp. 195–225). New York: Elsevier, 1989.

Van Stel, A., Storey, D.J. & Thurik, A.R. *The Effect of Business Regulations on Nascent and Young Business Entrepreneurship*. Small Bus Econ 28, 171–186, 2007.

Venkataraman, S. *Regional transformation through technological entrepreneurship*. Journal of Business Venturing, 19(1), 153–167, 2004.

Vessels Value, Disruptions at Shanghai Harbour, 2022, available at: https://www.vesselsvalue.com/

Vodafone. *Africa: The impact of Mobile Phones. Moving the debate forward*. The Vodafone Policy Paper Series, Number 2, 2005. Available at https://sarpn.org/documents/d0001181/P1309-Vodafone_March2005.pdf

Weisdorf, Mark A.. *Infrastructure: A Growing, Real Return Asset Class*. CFA Institute, 2007.

Woolley, Jennifer. L. *The creation and configuration of infrastructure for entrepreneurship in emerging domains of activity*. Entrepreneurship Theory and Practice, 38(4), 721–747, 2014.

World Bank Dataset, *Gross Fixed Capital Formation (% of GDP),* available at: https://data.worldbank.org/indicator/NE.GDI.FTOT.ZS

World Bank Enterprise Surveys, World Bank, available at https://www.enterprisesurveys.org/en/enterprisesurveys

World Bank, COVID-19 *Operational disruptions in infrastructure, February-September 2020*, World Bank, 2020, available at: https://ppi.worldbank.org/content/dam/PPI/documents/Operational-disruptions-due-to-COVID--September--.pdf

World Bank, *The impact of COVID-19 on Logistics*, International Finance Corporations, World Bank,. Available at: https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/infrastructure/resources/covid+infra+publications, 2020.

World Bank, *The impact of COVID-19 on the Airports*, International Finance Corporations, World Bank. Available at: https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/infrastructure/resources/covid+infra+publications, 2020.

World Bank, *The impact of COVID-19 on the Global Telecommunications Industry*, International Finance Corporations, World Bank. Available at: https://ppp.worldbank.org/public-private-partnership/library/covid-19-s-impact-global-telecommunications-industry, 2020.

World Bank, *The impact of COVID-19 on the Power Sector*, International Finance Corporations, World Bank. Available at: https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/infrastructure/resources/covid+infra+publications, 2020.

World Bank, *World Development Indicators 2017*, World Bank, 2017, available at: https://openknowledge.worldbank.org/handle/10986/26447

World Bank, *World Development Report 1994: Infrastructure for development*, World Bank, 1994.

World Bank, *World Development Report 2004*. Available at https://elibrary.worldbank.org/doi/abs/10.1596/0-8213-5468-X

World Economic Forum, *The Global Competitiveness Report 2017-2018*, Insight Report, edited by Professor Klaus Schwab (World Economic Forum) and Professor Xavier Sala-i-Martìn (Columbia University), World Economic Forum, Geneva, 2017, available at: www.weforum.org/gcr.

Annex

Annex Table #1: *Numerical data of impact analysis*

N°	Province	Total residents (ISTAT, 2019)	IFI (Institute for Entrepreneurship and Competitiveness, 2019)	% FTTH covered households (AGCOM, 2019)	IQI (Nifo & Vecchione, 2019)	Transportation Infrastructure Endowment (ISTAT, 2019)	% of bachelor-graduated residents (ISTAT, 2019)
1	Agrigento	412427	6	9,19%	24,23%	25,17	7,51
2	Alessandria	407049	20	16,08%	59,16%	70,50	8,20
3	Ancona	461745	32	21,49%	83,87%	61,73	10,97
4	Arezzo	334634	21	10,11%	69,71%	26,50	8,77
5	Ascoli Piceno	202317	34	5,59%	65,49%	27,84	10,79
6	Asti	207939	15	16,82%	64,79%	33,50	6,99
7	Avellino	399623	16	12,14%	45,77%	47,00	10,05
8	Bari	1224756	28	35,98%	44,97%	83,91	9,63
9	Belluno	198518	13	2,58%	80,76%	11,00	7,69
10	Benevento	263460	20	4,43%	39,89%	9,00	10,17
11	Bergamo	1102670	38	16,39%	82,93%	82,50	7,31
12	Biella	169560	15	15,28%	78,08%	3,50	7,04
13	Bologna	1015701	47	54,14%	75,42%	94,00	14,40
14	Bolzano	535774	39	4,98%	78,30%	78,00	7,46
15	Brescia	1254322	31	16,22%	80,88%	85,50	7,20
16	Brindisi	379851	14	18,46%	36,13%	26,89	6,93
17	Cagliari	419770	36	33,84%	41,17%	32,57	12,88
18	Caltanissetta	250550	0	7,97%	10,32%	7,33	6,96
19	Campobasso	210599	23	8,05%	33,21%	10,78	10,72
20	Caserta	900293	21	32,35%	24,55%	68,47	8,23
21	Catania	1068835	28	35,11%	13,39%	84,20	8,53
22	Catanzaro	341991	20	11,99%	25,80%	22,49	9,56

23	Chieti	372473	17	8,62%	61,01%	39,82	9,99
24	Como	594657	25	12,14%	80,21%	51,50	8,42
25	Cosenza	671171	22	3,07%	24,01%	72,16	10,36
26	Cremona	351287	24	5,74%	76,83%	30,00	7,96
27	Crotone	161744	13	3,75%	1,19%	6,35	7,22
28	Cuneo	580789	27	6,96%	79,82%	65,00	6,88
29	Enna	155982	5	6,35%	17,10%	18,00	7,25
30	Fermo	168485	14	5,26%	65,54%	6,49	8,73
31	Ferrara	340755	17	11,49%	74,02%	15,31	9,62
32	Firenze	994717	45	42,56%	87,24%	77,28	12,09
33	Foggia	597902	16	13,56%	21,77%	68,42	7,56
34	Forlì-Cesena	391524	25	16,72%	72,24%	33,06	9,31
35	Frosinone	468438	24	2,12%	44,65%	60,00	8,20
36	Genova	816250	26	70,38%	61,33%	90,88	12,40
37	Gorizia	138666	17	12,56%	91,26%	19,86	8,76
38	Grosseto	216989	14	19,52%	50,18%	39,85	8,787
39	Imperia	208561	9	16,38%	37,88%	32,69	7,89
40	Isernia	80170	11	2,32%	31,74%	2,00	11,05
41	La Spezia	214879	8	19,96%	68,06%	57,27	9,58
42	L'Aquila	288439	14	4,07%	54,64%	59,50	11,72
43	Latina	565840	22	18,22%	36,43%	51,46	8,25
44	Lecce	772276	26	14,94%	49,70%	29,89	9,33
45	Lecco	332435	22	13,62%	75,03%	31,00	8,56
46	Livorno	326716	20	29,40%	83,63%	68,03	9,02
47	Lodi	227064	26	11,66%	78,69%	25,00	7,56
48	Lucca	381890	21	10,66%	76,64%	52,72	8,76
49	Macerata	305249	24	3,45%	82,30%	24,87	10,20
50	Mantova	404440	23	1,97%	85,00%	47,50	7,37
51	Massa-Carrara	188395	9	19,17%	46,52%	25,37	8,88
52	Matera	191663	24	21,19%	33,50%	2,59	9,48
53	Messina	599990	14	30,93%	31,58%	86,84	10,29
54	Milano	3237101	100	63,24%	77,62%	98,50	14,67
55	Modena	702787	36	31,23%	74,89%	65,00	9,46
56	Monza e Brianza	870112	34	37,96%	79,42%	80,00	9,56
57	Napoli	2967117	32	56,63%	17,58%	97,07	8,56
58	Novara	361845	30	19,89%	75,03%	58,50	8,20

59	Nuoro	199349	2	3,60%	32,77%	8,25	7,25
60	Oristano	150812	7	1,78%	47,41%	3,04	6,83
61	Padova	930898	44	30,06%	83,93%	87,00	10,73
62	Palermo	1199626	25	54,23%	15,67%	91,10	9,00
63	Parma	450044	30	39,24%	84,35%	61,00	11,65
64	Pavia	534691	28	8,65%	68,98%	62,50	9,73
65	Perugia	641318	25	25,43%	71,97%	34,50	11,18
66	Pesaro e Urbino	351993	28	4,38%	83,49%	30,34	10,25
67	Pescara	313346	31	44,82%	44,90%	42,32	12,52
68	Piacenza	283889	19	13,17%	73,79%	55,00	9,19
69	Pisa	417245	41	17,65%	72,98%	39,77	11,41
70	Pistoia	289256	21	14,85%	54,21%	25,00	7,55
71	Pordenone	310158	24	8,70%	85,15%	42,00	7,99
72	Potenza	348336	27	8,02%	48,63%	38,09	9,20
73	Prato	264397	25	63,75%	66,50%	19,00	6,46
74	Ragusa	315082	17	15,83%	22,87%	17,61	7,36
75	Ravenna	386007	34	13,52%	83,22%	57,63	9,40
76	Reggio di Calabria	518978	19	26,75%	18,87%	72,04	9,77
77	Reggio nell'Emilia	524193	35	24,78%	82,80%	40,00	8,22
78	Rieti	150689	12	5,10%	37,52%	12,50	8,83
79	Rimini	336916	29	15,82%	72,91%	52,26	9,80
80	Roma	4222631	56	60,49%	64,55%	97,81	14,93
81	Rovigo	229097	15	3,51%	72,55%	35,41	7,14
82	Salerno	1060188	25	27,38%	33,24%	93,29	9,82
83	Sassari	474142	22	10,58%	38,07%	55,65	8,98
84	Savona	267748	11	19,28%	67,11%	60,30	9,17
85	Siena	262046	35	15,61%	65,34%	27,00	11,37
86	Siracusa	383743	24	15,99%	26,52%	55,44	7,76
87	Sondrio	178208	10	11,50%	72,93%	14,00	6,48
88	Taranto	558130	10	25,95%	31,80%	37,64	7,30
89	Teramo	299402	23	8,84%	51,61%	40,79	9,57
90	Terni	218254	20	11,51%	69,78%	16,00	10,43
91	Torino	2205104	39	54,07%	66,03%	96,00	10,13
92	Trapani	415233	15	10,35%	13,38%	67,34	7,26
93	Trento	542158	42	19,98%	100,00%	63,50	9,94
94	Treviso	876755	32	7,68%	92,38%	81,00	8,06

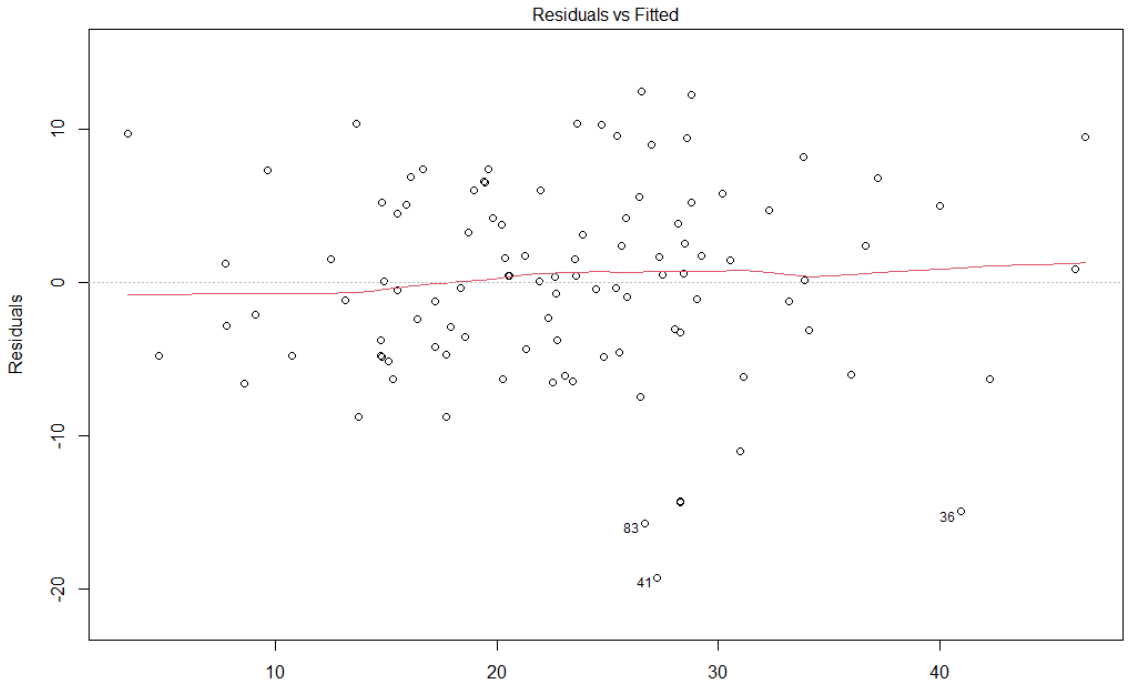
95	Trieste	230623	36	69,36%	95,69%	45,99	13,81
96	Udine	517848	29	11,95%	77,66%	63,88	9,27
97	Valle d'Aosta	123337	18	10,45%	71,92%	13,00	8,50
98	Varese	878059	25	14,61%	81,93%	81,00	8,90
99	Venezia	839396	31	33,41%	86,49%	87,72	8,71
100	Verbano	154233	10	6,07%	70,99%	18,50	6,68
101	Vercelli	165760	13	15,22%	69,93%	24,00	7,26
102	Verona	927108	37	29,50%	77,76%	86,50	8,755
103	Vibo Valentia	150702	9	3,72%	0,00%	19,13	8,62
104	Vicenza	852861	32	11,91%	84,59%	78,50	7,47
105	Viterbo	307592	5	5,27%	41,87%	13,86	8,69

Annex Table #2: *Model results without Milan Province observations*

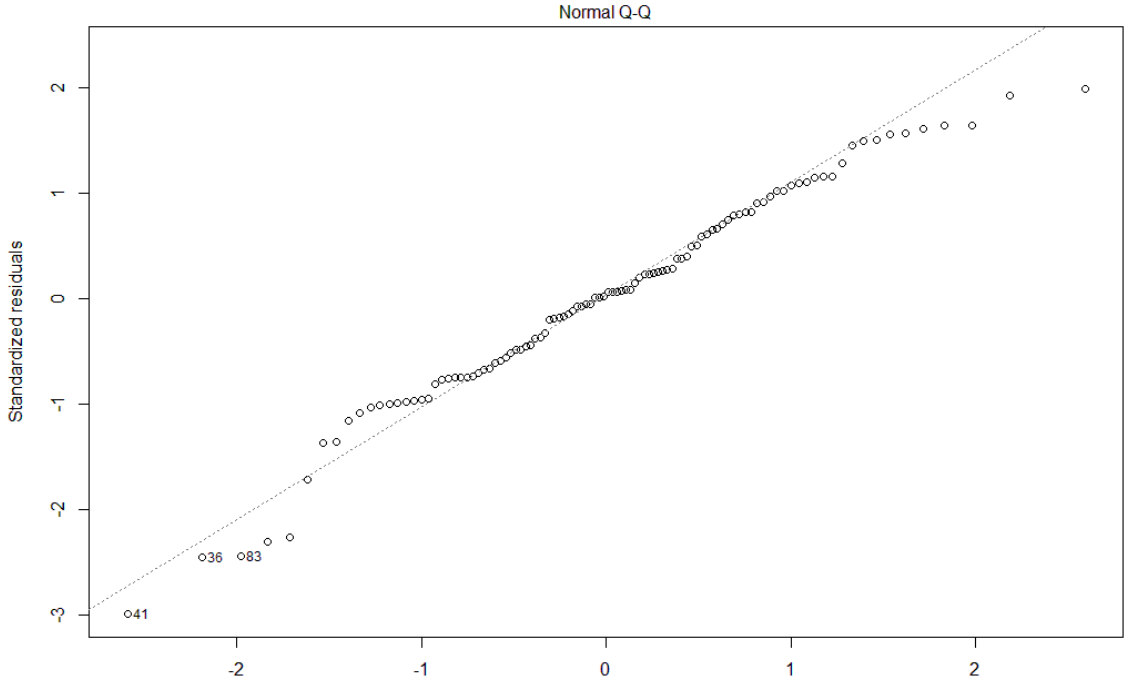
Model Summary					
Parameter	Coefficient	SE	95% CI	t(99)	p
(Intercept)	-12.15	3.74	(-19.58, -4.73)	-3.25	0.002
trasp	0.15	0.03	(0.09, 0.20)	5.35	< .001
lau	1.94	0.43	(1.10, 2.79)	4.57	< .001
ftth	8.48	5.28	(-1.99, 18.95)	1.61	0.111
iqi	15.55	2.67	(10.25, 20.85)	5.82	< .001
Model: IFI ~ trasp + lau + ftth + iqi (104 Observations)					

Table #2: *Plot diagnostics of impact analysis model without Milan Province observations*

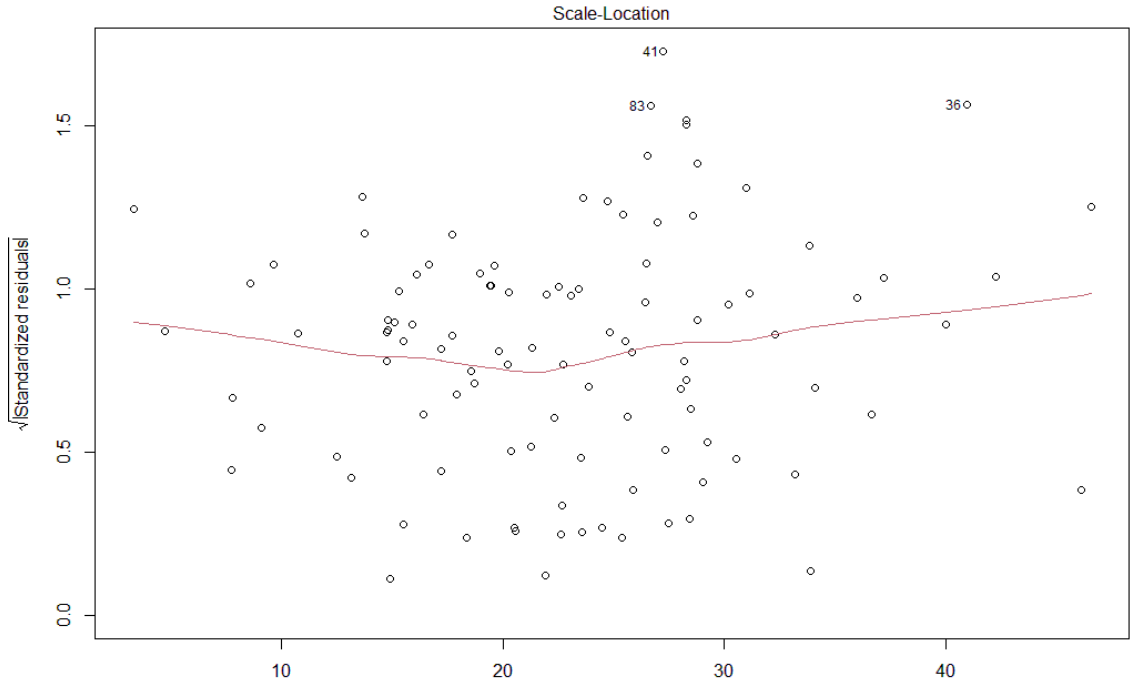
2A – Residuals vs fitted plot



2B – *Normal QQ Plot*



2C – *Homoscedasticity*



2D – *Influential observations*